AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

The Role of Transit in Support of High Growth Business Clusters in the U.S.


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Acknowledgement

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Executive Summary

The Role of Transit in Support of High Growth Business Clusters in the U.S.

A white paper prepared by Economic Development Research Group, Inc. for the American Public Transportation Association, December 2013.

This study addresses issues of business productivity, market access and transit service for high growth business clusters in the United States.

The study draws on eight high-growth knowledge-oriented business clusters and their transportation conditions in six US cities to provide an estimate of the total national income and employment consequences of road accessibility challenges—challenges that could be addressed through investment in public transportation.

A cross-section of clusters was selected to represent a diversity of key characteristics:

Case Study Area	Cluster Industry				Market Type		Metropolitan Setting		Anchors		Development Type		Existing Transit Service				Transit Improvement	
	Life Sciences/Biotech	Software/Computer	Social Media/ Internet/Gaming	Telecom	Mature	Emerging	Urban Core	Suburban	Research University	Other Research Institutions	Suburban Office Park	Build Reuse/Infill/ Densification	Bus	LRT/Streetcar	Heavy Rail/ Commuter Rail	Private Shuttles	Bus	Fixed Guideway (all Types)
Kendall Square	■		■			■	■		■	■		■	■		■	■	■	■
Route 128		■			■			■		■	■		■			■		
Atlanta Medline	■					■		■	■	■		■	■			■		■
Deerfield IL	■					■		■			■		■			■	■	
Denver Tech Center		■		■		■		■			■		■	■		■		■
Silicon Valley		■	■		■			■	■	■	■		■		■	■		■
SoMo/ MidMarket SF	■		■			■	■					■	■	■	■	■		■
South Lake Union	■		■			■	■		■	■		■	■	■		■		■

Key findings from these cases and the accompanying national-level analysis are:

- All of the examined clusters are rich with examples of firms choosing locations in proximity to other firms and actively seeking ways to get people to these places.
- There are very real transportation access constraints looming that will affect the growth of high tech business clusters and the competitiveness of US firms. Those constraints apply (to some extent) across all such business clusters.
- Efforts are currently being spearheaded by the private sector to develop transit to sustain the cluster location and ensure workforce accessibility.
- Between 379,000 and 480,000 jobs could potentially affected by the year 2040, depending on steps taken to address the transportation capacity constraint.
- Transit access to clusters could support approximately 104,000 of these jobs, along with their associated $13.6 Billion in annual business output, $5.7 Billion in wage income and nearly $8.6 Billion in GDP.
- Given constraints on continued roadway system expansion (detailed in the case studies), there is a solid case for expanding the future role of public transportation to support growth of high tech business clusters.

1 Introduction

1.1 Objective

There has been significant attention in the transportation research field regarding the extent to which transit investment supports "agglomerations economies" – the ability of business firms to realize productivity gains because of greater labor market access. This research study addresses this same general issue of business productivity, market access and transit service, but from a different perspective.

This study examines the extent to which America's economic growth is now occurring in technology-oriented business sectors that rely on the clustering (agglomeration) in specific urban locations – where they can best access R&D centers, information sharing and a large, skilled workforce. And it examines an emerging problem that each of these high growth, technology-oriented clusters is facing – the limitation of a road system that cannot continue to expand capacity forever.

To address this issue, the study also examines the extent to which these types of employment cluster already have, or are starting to, turn to bus and rail investment as a necessary step to allow continued economic health and continued employment growth. It uses both national data on technology industries, along with analysis of eight technology industry clusters, to draw national findings on the potential economic stakes and emerging need for public transportation investment.

1.2 Approach

The analysis relating public transportation and technology cluster growth involves a logical sequence of five research steps, which together build a case regarding the extent to which public transportation must play a role in enabling America's technology clusters to thrive economically and grow in terms of employment and income generation. The five analysis steps, and associated hypotheses that were tested, are described below. Supporting evidence for each step is presented in subsequent sections of this report.

(1) The American economy is changing. The high growth industries that represent America's future are disproportionately "knowledge-based, technology-oriented" industries. This occurs because America's relative advantage is in R&D, technology application and innovation.

(2) High growth industries have specific location requirements and clustering patterns. The "knowledge-based, technology-oriented" businesses tend to (a) locate in large metro areas, and (b) cluster within specific parts of those metro areas. This occurs because: (a) knowledge-based industries need large metro areas to maximize access to skilled workers and R&D, and (b) clustering maximizes the ability for workers to interact, share ideas and innovate.

(3) High growth clusters concentrate travel demand and increasingly strain resources. These high growth industry clusters concentrate commuting both spatially and temporally, because of their (a) scale of employment and (b) single-shift operation (as compare, for example, to manufacturing). This occurs because innovation requires workplace collaboration and social interaction.

(4) To sustain growth industries, needs for supporting infrastructure must be addressed. The viability of high growth industry clusters cannot be sustained unless there is supporting infrastructure capacity to meet their future needs. There are limitations to expanding road lanes, related to physical space limitations, practical road system engineering limitations and local impact considerations. Many or most of the technology clusters are (or will be) facing a future in which those limitations could present a very real problem. Thus, broader, multi-modal solutions involving public transportation become inevitable.

(5) Failure to provide sufficient capacity for high growth industry clusters has a cost. A failure to provide sufficient capacity for future employment in high growth industry clusters will have consequences in terms of lost productivity or foregone employment growth. However, public transportation investment can potentially enable high growth industry clusters to continue growing, and thus avoid the undesirable consequences of constrained growth. In that context, public transportation can enable economic growth that otherwise would not occur.

To assess the economic stakes, it can be useful to consider the economic consequences of future scenarios in which road system capacity limitations at growing employment clusters will lead to substantial costs in terms of either: (a) loss of business productivity due to increasing work-related delay, schedule time unreliability and loss of effective labor market size, or (b) loss of business productivity from imposition of local growth limitations, as firms move away to accept second-best locations elsewhere in the local area, US or abroad.

1.3 Report Organization

Chapter 2 of this report provides a discussion and analysis of the five elements of inquiry laid out in the Section 1.2. It also provides an estimate of the total national income and employment consequences. To accomplish this, it draws upon eight high growth employment clusters in six US cities. These illustrations demonstrate not only the importance of clusters to the US Economy, but also the limitations of highway capacity for serving the concentrated employment associated with clusters in the long term.

Chapters 3 – 10 then present summaries of current and forecast economic and traffic conditions for each of the eight employment clusters. They are:

- "Medline" Cluster, Atlanta, GA
- Kendall Square in Boston, MA
- 128 Corridor in Burlington (Near Boston, MA)
- Downtown, San Francisco, CA
- Silicon Valley, San Francisco, CA
- Deerfield Illinois (Near Chicago, IL)
- Denver Technology Center, Denver, CO
- Union South of Lake Cluster in Seattle, WA

The clusters are selected to represent they dynamics of clustering in the high-growth, knowledge based industries. Further effort was taken to ensure that clusters would be representative of all geographical regions of the US and metropolitan areas of varying size. Some clusters are already served by transit, whereas others are not, and yet others have new transit services planned.

The assessment of each cluster highlights (1) the importance of the cluster to US and regional economic competitiveness, (2) the ways in which commuting accessibility is increasingly challenged by highway capacity limitations and (3) the potential for transit to support the ongoing contribution and growth of the cluster. In some cases two clusters from within the same metropolitan area were selected to illustrate the comparative role of transit between urban and suburban clusters in the same region.

Each cluster is analyzed using an “all sources” approach, including information from interviews with business and economic leaders, numbers and assessments derived from local travel models and data, open source media reporting and past studies and plans from the areas. For this reason, it is important to note that findings regarding numbers of trips, lanes that may be needed to accommodate traffic growth, and accessibility-sheds for individual clusters do not reflect actual local plans or direct results of MPO models, but rather reflect inferences drawn based on overall growth rates, numbers of lanes, general capacities and other operating characteristics. Furthermore, when roadway facilities are described as being “at or exceeding capacities” the capacities are understood to reflect thresholds at which traffic might reasonably divert to alternative routes or modes to avoid congestion and not an “absolute capacity” of how many cars can physically fit into the right of way.

2 Job Access for High Growth Industries

This chapter draws from case studies of eight high growth employment clusters in six US cities to provide an estimate of the total national income and employment consequences of transit for high growth employment clusters. Chapters 3 – 10 then presents more complete details of current and forecast economic and traffic conditions for each of the eight employment clusters.

This chapter also makes reference to sections of a separate report titled *Economic Impact of Public Transportation Investment: 2013 Update* (APTA, 2013)—to be referred to as Report 1.

Chapter 4 (Section 4.6) of Report 1 examined the productivity benefits of reducing traffic congestion and enabling "agglomeration benefits" at a national level. This report provides a more in-depth look at the ways that these benefits can occur. It focuses on high-tech, high-growth industries that locate in business clusters, as this is the portion of the economy that is most likely to actually gain from market access and agglomeration benefits. Thus, this report may be viewed as: (a) a real world illustration of the more general findings of Report 1 - Section 4.4.6 and (b) a more specific demonstration of the critical importance of public transportation and worker access for industries that represent a critical driver of U.S. economic growth.

2.1 Concept of Agglomeration Economics

There has been significant attention in the transportation research field regarding the extent to which public transportation investment supports "agglomerations economies" -- the ability of business firms to realize productivity gains because of greater market access. One particular way to get at this same issue is to consider the emerging role of public transportation in enabling the growth of technology-oriented business sectors that are fast growing drivers of America's economy. To a significant degree, businesses in this sector of the economy tend to cluster (agglomerate) in specific urban locations – where they can best access research centers, information sharing and a large, skilled workforce.

To examine the issue, we conducted this study to examine the extent to which these types of employment cluster already have, or are starting to, turn to bus and rail investment as a necessary step to allow continued economic health and continued employment growth. It uses both national data on technology industries and analysis of eight technology industry clusters to derive national findings on the potential economic stakes of- and emerging need for public transportation investment. This chapter presents a summary of national impacts. Each section of the chapter details one of the five analysis steps introduced in Section 1.2 and provides supporting evidence for each step. Together, the sequence of five research steps builds a case regarding the extent to which public transportation must play a role in enabling America's technology clusters to thrive economically and grow in terms of employment and income generation.

2.2 The Changing Economy

The high growth industries that represents America's future are disproportionately "knowledge-based, technology-oriented" industries.

Identifying High Growth Industries. The U.S. Bureau of Labor Statistics publishes national employment trends as well as forecasts to 2020. Exhibit 2-1 shows the major industries (those with over 200,000 jobs across America) that are forecast to have the fastest rate of business output and employment growth over the 2010 -2020 period.

Exhibit 2-1: BLS Projections of Fastest Growing Industries, 2010 – 2020

Sector	$ Output Growth (Top Six)	Employment Growth (Top Six)
Professional, technical & business services	X	X
Financial Services	X	X
Software – Information Service	X	X
Construction	X	X
Retail	X	
Wholesale & warehousing	X	
Health care services		X
Education		X

Source: Industry Employment and Output Projections to 2020, Monthly Labor Review, U.S. Bureau of Labor Statistics , 2012. www.bls.gov/opub/mlr/2012/01/art4full.pdf

Exhibit 2-2: Job Growth in U.S. Growth Sectors

Industry Sectors Associated with Clusters	Compound Annual Employment Growth		Share of U.S. Economy (Employment)	
	Past: 1990 to 2010	Forecast: 1990 - 2040	As of 2010	Forecast for 2040
Professional & Scientific Services	4.01%	0.41%	5.5%	6.0%
Financial Services	0.96% *	0.82%	4.3%	5.2%
Information Services: film/video, data, internet	0.78%	0.24%	2.0%	1.8%
Administrative & Support	5.13%	2.03%	5.5%	9.2%
TOTAL U.S. EMPLOYMENT	**0.59%**	**0.15%**	**100.0%**	**100.0%**

*** reflects a drop due to financial crisis of 2007-2008, but its annual growth rate before and after that period has been higher than the national average*

Source: analysis based on data from Moody's Analytics.

Among these industry sectors, the first three often serve national and global clientele. The others are known as "population serving industries" because they grow wherever there are increases in local population. A longer range forecast to 2040 is available from Moody's Analytics, and it shows largely the same industries continuing to grow in the long term. Exhibit 2-2 shows four sectors of the economy that are either growing at rates exceeding the national average, and forecast to growth at significantly faster rates in the future:

- Professional & scientific services (includes computer, biotech, and environmental R&D)
- Financial services (includes credit, finance and securities)
- Information services (includes video, data, internet, software; excludes print media)
- Business services: outsourced administrative and support services.

Together, these four industry categories account for 17.3% of the U.S. economy (in terms of GDP), and that is forecast to grow to 22.2% in the future.

These industry sectors have several common features. They are all services of a form that often rely on cutting edge technologies and highly educated workers to serve broad national and international clients. In addition, they all tend to involve people collaborating together to innovate and develop products or solve problems, as well as implement and deliver products and solutions to customers. The one exception is administrative services, which actually is a "follower" industry – while this industry does not rely directly on innovation and collaboration, it appears wherever fast growing firms are present and is an indicator that other service sectors are likely to be expanding.

Cities with a nexus of scientific and financial activities are playing an increasingly important role in national and global economies. Such cities have been defined as "Global Cities".[1] This indicates that the role of U.S. financial and scientific leadership in the global economy will depend in part on our success sustaining the growth of financial and scientific sectors in U.S. cities, and the viability of clusters in which these firms are most productive.

Related Industries. Knowledge-based service industries are not only high-growth sectors in the U.S. economy, but also play a critical role in enabling other industries to grow. For example, while many types of manufacturing are not high growth sectors, manufacturing businesses often benefit from the knowledge and innovation of a nearby cluster of research & development, financial or other services. An industry classification analysis model shows how a concentration of specific knowledge-driven industries within a local economy usually indicates higher employment levels in some other supported industries.[2]

For example, areas with high concentrations of financial service jobs are also likely to have high concentrations of professional and scientific jobs as well as information services, management, and administrative support jobs. Over time, the high-growth industries supporting growth in America's economy have been observed to "cluster" not only in specific urban economies, but at certain locations within metropolitan areas.

Economic Performance and Concentrated Economic Activity. Firms that benefit from co-location with other firms are expected to demonstrate either (1) a faster rate of growth in areas where a high concentration of such firms exist, (2) a higher level of output per worker when located in such an area, or both. Exhibit 2-3 provides national statistics on employment growth and output per worker for specific industry groups associated with clusters. This includes the four high growth industry

Exhibit 2-3: Performance of High-Growth U.S. Industries by Concentration of Workers

Industry	Employment Growth (1990-2010)		Average Output per Worker in 2010 ($)	
	25% Most Concentrated Areas	Rest of U.S.	25% Most Concentrated Areas	Rest of U.S.
Financial Services	1.41% *	0.81%	342,630	308,461
Information Tech Services	0.84%	0.76%	205,922	182,958
Professional / Scientific	4.00%	4.01%	118,150	109,403
Admin Support	5.04%	5.16%	51,207	53,701
Management	4.46%	-2.01%	103,994	95,468
Real Estate	1.94%	1.03%	840,722	733,957
Other Services	2.40%	1.69%	51,560	61,039

*** reflects a drop due to financial crisis of 2007-2008, but its annual growth rate before and after that period has been higher than the national average*

Source: data from Moody's Analytics, joined with LEHD (Longitudinal Employer-Household Dynamics) data

1 *A.T. Kearney, 2012 Global Cities Index. www.atkearney.com/documents/10192/dfedfc4c-8a62-4162-90e5-2a3f14f0da3a*

2 *Appendix 2, "Statistical Analysis of Economic Performance and Industry Clusters."*

groups that were previously identified (and shown in Exhibit 2-1), plus two other industry categories that also tend to cluster. It shows that among businesses in those specified industries, those located in counties with high concentrations of their industry employment grew 84% faster and produced significantly more output per worker as counterparts (workers in those same industries) located elsewhere.

The employment growth and output differentials (between concentrated industry locations and others) are most pronounced for the management, financial services and real estate sectors, all of which are knowledge-based industries. (Real estate is largely associated with financial services and follows a similar pattern) While employment growth differentials have been more modest (or not observed) in Information technology and professional/scientific services, both of these sectors have significant differences in productivity when located in areas with high concentrations of firms in the same industry.

Based on economic forecasts, it is estimated that by 2040, 38% of America's job growth and 50% of America's GDP growth will in the six broad industry groups often associated with clusters – and of that growth, 81% will be in the 25% of counties with the highest concentrations of employment in these industries.
While these statistics do confirm that there is a clustering effect for high growth industries across the nation, the county-level concentration is merely a rough indicator of this phenomenon. To better understand the localized urban clustering requirements of key growth industries, we profile key cluster industries in the next section.

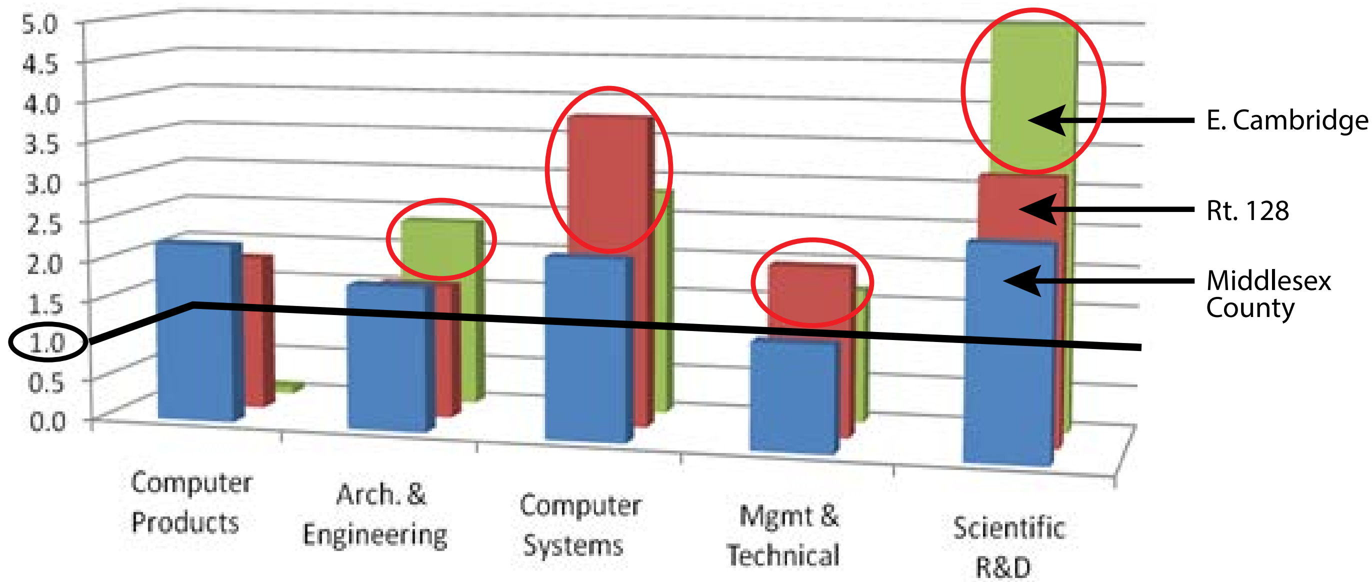
2.3 Industry Clustering Patterns

"Knowledge-based, technology-oriented" businesses tend to (1) locate in large metro areas and (2) cluster within specific parts of those metro areas.

The phenomenon that technology industries tend to cluster in specific areas within large metro regions is illustrated in Exhibit 2-4, which examines the relative concentration of selected technology industry sectors in parts of Massachusetts. It shows that four technology industries have a substantially higher-than-average concentration in Middlesex County, though the concentration is even higher within parts of that county – engineering and scientific research are most concentrated in the East Cambridge (Kendall Square) district, while computer and technical services are most concentrated within the Route 128 technology corridor. (These two business cluster locations are known to also have a concentration of pharmaceutical and related biotech product manufacturers, though that finding cannot be shown because available employment data for small areas does not separate these specialized industries from the larger category of non-durable products manufacturing.)

Exhibit 2-4. Relative Concentration of Technology Industry Sectors in Massachusetts

(Values represent Location Quotients; a value of 1.0 means that the study area has the statewide average concentration of the given industry, 2.0 means the area has double the state average concentration and 0.5 means it has half of the state average concentration of the given industry.)



Source: Massachusetts Office of Labor and Workforce Development, 2011 data

Why growth industries are clustering. Business clusters exist primarily because some places offer a superior business environment compared to others. In the 20th century manufacturing economy, industry clusters emerged around proximity to the means of production, and points of access to freight transportation. For example, steel and metal manufacturing tended to cluster near mines and railroads, lumber and wood products tended to cluster around near forests and waterways. As more firms located in concentrated places, the workforce, infrastructure and local policies came to support regional economies that were highly specialized both domestically and globally in various manufacturing sectors.

Today we have production clusters that have formed to take advantage of shared access to natural resources and know-how (e.g., California's Napa and Sonoma Valley wine clusters), and others that have formed to enable supply chains and logistics efficiencies enabled by locating along specific highway corridors (e.g., the southern" "Auto Alley").

Yet if we examine where the greatest growth is occurring in America's economy, we find that the high-growth industries are primarily service-oriented, knowledge-driven industries. Firms in these industries do not depend on proximity to natural resources and freight facilities, but rather, depend on proximity to other knowledge intensive firms and access to a concentration of knowledge workers and supporting research institutions.

America's economic landscape is increasingly characterized by concentrations of high-value knowledge-based employment. Industries such as financial services, biotechnology and computer/IT research and development are known to co-locate in places where highly skilled workers have access to firms in allied professions and to opportunities for collaboration and knowledge sharing.

Places where high concentrations of firms in these industries exist are referred to as technology-oriented "business clusters." Case studies developed for this research study are profiled in a separate, accompanying

Defining Business Clusters

Clusters are geographic concentrations of interconnected companies, specialized suppliers, service providers, and associated institutions in a particular field that are present in a nation or region. Clusters arise because they increase the productivity with which companies can compete.

Harvard Business School, Institute for Strategy and Competitiveness

http://www.isc.hbs.edu/econ-clusters.htm

volume. They are: Silicon Valley, Midtown/ SOMA in San Francisco, Atlanta's "Medline" Corridor (serving Emory University and the Centers for Disease Control), Kendall Square and the Rt. 128 Corridor in the Boston area, the Deerfield business cluster in the Chicago area, the Denver Technology Center and Seattle's South Lake Union cluster.

Broader examples of technology and information-reliant business clusters are shown in Exhibit 2-5. All of these clusters represent medium and large size labor markets that have particularly high concentrations of technology-oriented worker skills for R&D or financial activities. In most cases, the business activity is concentrated in a specific location within the labor market. (There are also broader regional business clusters but they are more typically related to manufacturing rather than R&D.)

The importance of clusters to U.S. businesses in general was confirmed in a 2010 corporate survey conducted by Area Development magazine. Sixty percent of respondents in a national site selection survey reported that the presence of activities similar to theirs was a consideration when selecting a business location and 50% said it was important. [3] A recent national survey of office space absorption by Jones Lang Lasalle found that the growth rate of high tech services clusters was 2.5 times higher than the overall average for all other office markets. [4]

Why clusters are becoming increasingly important. It is clear that firms in some industries do systematically choose to co-locate in concentrated business clusters where there is competition for scarce land. This indicates that there must be some advantage of doing so, over locating in less expensive, lower density places. The advantage that occurs when businesses become more productive by clustering, is known as *"agglomeration economies."* The concept dates back to Alfred Marshall's work in 1890, which explained the economic advantage of businesses clustering within cities in terms of gaining access to larger size markets for labor, products and services (which lead to what economists call "increasing returns to scale"). He further explained the sources of agglomeration economies as: knowledge spillover (interaction between firms that brings technology knowledge transfer), access to labor markets (availability of a large pool of workers to maximize matching of worker skills to business needs) and access to supplier markets (availability of materials and services that maximizes matching to business needs). Duranton and Puga (2004) later re-characterized these mechanisms as: (1) sharing, (2) matching and (3) learning. [8]

Not all industries gain productivity benefits from clustering. Technology product/service development and global financial activities tend to closely cluster, presumably because they are knowledge-based activities, operating in markets where there is rapid change, imperfect information and knowledge to be gained by worker interaction.

A recent Brookings-Rockefeller study further emphasized the importance of clusters because of their role enabling firms to unleash synergies and efficiencies among member firms in ways that can enhance the overall performance of economies where they are located. The study demonstrates how clusters build on existing assets to promote growth by enhancing interactions, enabling the exchange of ideas and opportunities to start new enterprises. The study points out that across the U.S, around 2 percent or less of job growth is from attraction of new business, whereas

Exhibit 2-5 Major Technology R&D Clusters in Urban Districts

Biotech Office Clusters [5]	**Computer/Tech Clusters** [6]	**Financial Services Clusters** [7] (downtown business districts)
Atlanta Area (emerging market)	**Austin, TX**	**Global Financial Centers**
Mid-town	**Boston Area**	Boston (A, B, C, D)
Northlake	East Cambridge (Kendall Square)	Chicago (A, B, C, D)
Boston Area	Seaport District	New York City (A, B, C, D)
East Cambridge (Kendall Square)	Route 128/Route 3 Corridor	San Francisco (A, B, C, D)
Longwood Medical Area	(Bedford, Burlington, Waltham, Lexington)	
Seaport District	**Denver Area**	**Specialized Int. Trade Finance**
Route 128/Route 3 Corridor	Tech Center/US-87 Corridor	Washington, DC (A, B, D)
(Bedford, Burlington, Waltham, Lexington)	Northwest - Boulder	Miami (B, D)
Chicago Area (emerging market)	**New York City**	
North/Northwest (Deerfield)	Midtown South	**National Banking Centers**
Denver Area (emerging market)	Downtown	Charlotte (C)
Northwest - Boulder	Penn Station/Garment District	Los Angeles (B, D)
Philadelphia Area	**Portland, OR**	
University City	Sunset Corridor	**Regional Banking/Finance Ctrs**
Route 202 Corridor	**San Diego Area**	Atlanta (B, D)
Raleigh Durham Area	Sorrento Mesa	Minneapolis (B)
Research Triangle	UC / Eastgate	Philadelphia (B)
San Diego Area	**San Francisco Bay Area**	
Torrey Pines	South of Market / Mission Bay	
UC/Eastgate	Mid Market	
Sorrento Mesa, Sorrento Valley	Redwood City	(A) = Global Financial Cities Top 100 in World
San Francisco Bay Area	San Mateo	
Mid-Peninsula – South SF	Silicon Valley (Cupertino-(Sunnyvale-Santa Clara-North San Jose-Palo Alto)	(B) = City Data Forum, Top 10 Financial Centers in the U.S.
Mission Bay		
Oakland- East Bay	**Seattle Area**	(C) = Mass Insight, Leading U.S. Financial Centers, Top 5
Seattle Area	South Lake Union	
South Lake Union	Bellevue CBD	(D) = Global Cities Index, Top 50 in World
Bothell		
Washington, DC / Maryland		
I-270 Corridor / Frederick		

3 *25th Annual Corporate Survey, Area Development, Winter, 2011. www.areadevelopment.com/AnnualReports/jan2011/25th-annual-corporate-executive-survey48843.shtml?Page=5*

4 *Jones Lang Lasalle, High-technology Office Outlook, United States, 2012. www.us.am.joneslanglasalle.com/ResearchLevel1/US%20High-Technology%20Outlook_2012.pdf*

5 *Based on: Jones Lang Lasalle, Life Sciences Cluster Report Global, 2012. www.us.am.joneslanglasalle.com/ResearchLevel1/Life%20Sciences%20Cluster%20Report_Global_2012.pdf .*
(Table shows "established" biotech clusters excluding three that are regionally diffused rather than urban district concentrations: New York City/New Jersey, Los Angeles/Orange County, and Minneapolis-St. Paul. Eleven 'emerging" clusters are also identified in the report; three featured in case studies are shown here.)

6 *Based on: Jones Lang Lasalle, High-technology Office Outlook, United States, 2012.*
www.us.am.joneslanglasalle.com/ResearchLevel1/US%20High-Technology%20Outlook_2012.pdf
(Table shows "established" technology clusters. Ten other "emerging" clusters are identified in the report.)

7 *Based on four sources: Global Financial Cities Index, www.longfinance.net/Publications/GFCI%2012.5.pdf ,*
Top 10 US Financial Centers www.city-data.com/forum/city-vs-city/1490663-top-10-us-financial-centers.html , Global Cities Index www.atkearney.com/documents/10192/dfedfc4c-8a62-4162-90e5-2a3f14f0da3a and , Leading US Financial Centers www.massinsight.com/cms_page_media/5/Bill%20Guenther%20Slides%20final.pdf

8 *Duranton, G. and D. Puga, "Micro-foundations of urban agglomeration economies," in Handbook of Regional and Urban Economics, Henderson and Thisse, eds., Elsevier, v.4, n. 4, 2004.*

nearly 42 percent is from the expansion of existing businesses and 56 percent is from the creation of new businesses. The study further highlights the role of business clusters in industry expansion and new business formation. [9]

These same points are supported by academic research on the role of employment clustering and productivity for various industries.

- At the metropolitan level, Meijers and Burger (2009)[10] reviewed evidence regarding the benefits that accrue from the large scale operation of cities. They noted that the benefits include access to a large and diverse labor pool, extensive infrastructure and public facilities, access to universities, and access to a large market that reduces travel costs and increases stability.

- Looking within a metropolitan area, there is further evidence of these relationships. Rosenthal and Strange (2005) studied agglomeration benefits within the New York metropolitan area. They looked at 1 to 5 mile areas surrounding locations of entrepreneurial activity, and found that the concentration of employment within a one mile radius was a significantly more important predictor of entrepreneurial activity than even the concentration in the larger five-mile radius. Their finding was that having a concentration of employment within a fairly small (one mile or less) area, and having a location near other firms in the same industry, were key factors contributing to how much entrepreneurial activity is likely to occur in a place. [11]

- Clustering occurs despite the concentration of traffic that it can create. A study by Ciccone and Anthony (1996) found that agglomeration more than offsets congestion effects in dense urban areas. The research specifically looked at the effect on increasing returns caused by the intensity of labor and capital relative to physical space." They found that the concentration of economic activity can account for as much as 50% of the variation in business productivity. They concluded that the ability to sustain increasing concentrations of economic activity is an important factor in growth for the economies of U.S. cities. [12]

Of course, there are absolute or practical limits to the expansion of road systems that serve growing employment clusters, so eventually congestion delays or outright traffic volume limitations can become severe enough to limit the growth of those clusters.

9 Muro, Mark and Kenan Fikri, "Job Creation on a Budget: How Regional Industry Clusters Can Add Jobs, Bolster Entrepreneurship and Spark Innovation", Brookings-Rockefeller Project on State and Metropolitan Innovations, 2011. www.brookings.edu/~/media/research/files/papers/2011/1/19%20clusters%2 muro/0119_clusters_muro.pdf

10 Meijers, Evert and Martijn Burger, Spatial Structure and Productivity in US Metropolitan Areas, Erasmus Institute of Research and Planning, Rotterdam, NL, 2009, p. 7. http://repub.eur.nl/res/pub/17431/ERS-2009-057-ORG.pdf

11 Rosenthal, Stuart S. and William C. Strange, "The Geography of Entrepreneurship in the New York Metropolitan Area", April 7, 2005.

12 Ciccone, Anthony and Robert E. Hall, Productivity and the Density of Economic activity, Working Paper No. 4313, National Bureau of Economic Research, May 1996. http://www.nber.org/papers/w4313, Business activities that depend on clusters. While Exhibits 2-1, 2-2 and 2-3 show that geographic clustering concentration correlates with growth and productivity for a range of industry groups, some of America's fastest growing industries have been particularly dependent on location within highly concentrated business clusters. These include: (1) Life-Sciences & Bio-Technology firms, (2) Software and Information Technology firms, and (3) Financial Services firms. A profile of each one and its location requirements follows.

- ***Life-Science & Biotechnology Clusters.*** The global pharmaceuticals, biotechnology, and life sciences industries are a critical driver of U.S. economic growth. It has been noted that these sectors of the economy "generated in excess of $1.1 trillion in 2011, representing a compounded annual growth rate of 6.7% between 2007 and 2011. The Economics Intelligence Unit (EIU) projects the U.S. pharmaceutical market, the world's largest at $396 billion, will grow 6.4 percent annually through 2011-2016. … Analysts forecast that U.S. biotech sales will grow by 8.7% annually through 2012-2017." [13]

  Life-Science and biotechnology firms tend to cluster near research institutions and industry leaders that can provide cutting edge research support and ideas to spawn entrepreneurial ventures. Biotech is part of the larger professional scientific industry group described in prior tables and includes a range of disciplines, such as new drug development, production of environmentally friendly products, energy, food production and forensic science.

  Examples of biotech office clusters are shown in column #1 of Exhibit 2-5, which was presented earlier. The clustering effect of biotechnology is further compounded by the propensity of bio-tech to also locate near research hospitals and highly specialized health care facilities. Kendall Square (Cambridge) in the Boston area, the CDC-Emory corridor in Atlanta and the South of Lake Union area in Seattle are some examples of nationally significant clusters where biotechnology plays a central role. (Each is further described in the separate case study volume). A 2008 article in FTSE Global Markets discussed the substantial advantages that the State of California has had in attracting biotech firms. Climate, access to capital and access to research were all noted, but the article also stated that highway congestion is likely to negatively affect the industry because in California, a drive of 25 miles "can take an hour or more during peak traffic." [14]

13 *Carlyle and Conlan, Life Science Trends Report 2013. www.labautopedia.org/mw/images/LifeScienceTrends2013.pdf*

14 *"Big Pharma Muscles in on the California Biotech Dream," FTSE Global Markets, Issue 29, October 2008. www.ftseglobalmarkets.com/issues/issue-29-october-2008/big-pharma-muscles-in-on-the-california-biotech-dream.html*

- ***Software & Information Technology Clusters.*** The software and information technology (IT) services industry is another critical growth industry for the U.S. Some of the information services associated with internet portals and social media are included in the broad "information industry" group shown in preceding Exhibits 2-1 through 2-3. Research and development services supporting the information industry are also counted as scientific and professional employment in those tables.

  According to the U.S. Department of Commerce, between 2010 and 2011, the information technology industry increased revenue by 6%, reaching $606 billion dollars. Research and Development (R&D) spending increased by 6% in that year to $126.3 billion. The United States is responsible for more than 55% of world-wide IT research and development spending. Some of the high growth and rapidly evolving subsectors in this industry include cloud computing, media/ entertainment software, and electronic commerce.[15]

  This sector of the economy generated some of the earliest highway oriented business clusters, including Silicon Valley in California (along US-101) and the Route 128 technology corridor in Massachusetts. These and other clusters are profiled in subsequent sections of this report. Additional examples of software and computer/ technology office clusters can be seen in column #2 of Exhibit 2-5 (presented earlier).

- ***Financial Services Clusters.*** The financial services industry is another knowledge-based industry that demonstrates strong growth and productivity advantages by locating in concentrated clusters (as was shown earlier in Exhibits 2-2 and 2-3). Although the financial crisis in 2008 caused a decline in this sector's jobs through 2010, its employment is now increasing again, and reached 7.95 million in 2012. This industry is integrally tied to the overall health of the U.S. economy, and will continue to recover as the economy grows.

  Examples of global and national financial clusters are shown in column #3 of Exhibit 2-5, which was presented earlier. Major clusters of this industry include the downtown financial districts of New York City, Chicago, Boston, San Francisco, Los Angeles, Miami and Washington, DC. Statistics on their financial services employment shows the extent of industry concentration.[16] For example, in downtown Boston, 25% of the top tier office space leased is occupied by financial services firms. In Chicago, 17% of top tier office space is leased by financial services firms. In New York, the figure is 41% in Downtown and 25% in Midtown. Commercial real estate sources report that the financial services industry is also starting to expand to technology clusters. This includes the Denver Technology cluster. In addition, some Los Angeles area venture capital and private equity firms are also starting to move to Santa Monica, where many of the high tech firms (their clients) are located.

15 *"The Software and Information Technology Services Industry in the United States," Select USA. http://selectusa.commerce.gov/industry-snapshots/software-and-information-technology-services-industry-united-states*

16 *www.joneslanglasalle.com/ResearchLevel1/Banking%20and%20Finance%20Outlook_2013.pdf*

2.4 Transportation Needs of Business Clusters

The presence of high growth industry clusters means that there will be a concentration of commuting volumes both spatially and temporally, because of (a) the large scale of employment in those clusters and (b) the single-shift operation of knowledge-based industries, which is desirable to facilitate collaboration and professional interaction.

The Transportation Challenge. Technology-oriented business clusters, by their very existence, draw commuters from a wide labor market area and bring them into an area that has a concentration of business activity. And if a cluster is to maintain relevance as a business location, then it must maintain a productivity advantage that makes it attractive.

Of course, the growing concentrations of workers in such clusters also introduce a formidable and growing challenge to transportation agencies seeking to provide adequate capacity to serve these critically important places. It is understood that different types of clusters have different transportation needs (which may involve passenger or freight, depending on the industries involved). The scope of the current study concentrates on business clusters involving high-growth, knowledge intensive industries where passenger commuting is the primary transportation need. This is not to suggest that other types of clusters do not exist, representing other types of transportation needs, but rather to explore the specific transportation needs of a type of cluster that is especially important to America's long-term economic growth.

Since technology-oriented businesses typically require specialized worker skills and draw from a large labor market of skilled workers, they have traditionally located along major highways and locations where highways intersect. (Silicon Valley and Rt. 128 are classic examples of such clusters.) That has served them well, though every highway has a capacity limitation, and road widening to add lanes cannot be continued forever. Inevitably road congestion will become a limiting factor if those clusters continue to increase employment. That can present a problem, for firms reliant on highly concentrated business clusters cannot simply move to less crowded or congested locations without losing many of the productivity and competitiveness advantages of the cluster business environment.

A 2012 study by Melo and Graham used employment densities and wages to measure the relationship between productivity and urban agglomeration. They found that "doubling the number of jobs accessible within 20 minutes of driving time leads to an increase in real average wages of 6.5%, while the impact for a similar increase within 20 to 30 minutes is as small as 0.5%."[17] This type of finding is also supported by other researchers. This and other studies support a finding that highway congestion can negatively affect the growth and productivity of densely developed areas by increasing travel

17 *Melo, Patricia and Daniel Graham. "Agglomeration, Accessibility, and Productivity: Evidence for Urbanized Areas," Transportation Research Board, Annual Meeting, 2013.*

times, and potentially erase the agglomeration benefits that would otherwise be available from concentrated employment centers.

Case Study Data. To better understand the severity of transportation needs for these clusters, we examine a cross-section of eight high-growth, knowledge-oriented business clusters across the United States and their transportation conditions. These clusters are listed in Exhibit 2-6. Detailed profiles of these case studies are provided in Chapters 3 through 10.

All of the selected clusters are centers of research innovation and product development for biotechnology, computer, internet or related products and services. They have disproportionately high levels of jobs in information technology, professional and scientific services, as well as some manufacturers of related computer and health care products. While financial services businesses are also technology-dependent and tend to cluster, they are generally concentrated in downtown areas that are already well-served by public transportation.[18] As a consequence there is less interest in how they address highway limitations. Thus, no financial services business clusters were selected for this study. (However, downtown locations can be affected by transit congestion, which also has transit investment implications.)

Exhibit 2-6. Overview of the Eight Clusters Studied

Cluster	Key Industries	Region	Setting
Boston area: Kendall Square	biotech; IT; internet; social media	Eastern	Urban
Boston area: 128 Corridor	software; hardware, pharmaceuticals	Eastern	Suburban
San Francisco area: Silicon Valley	software; internet; IT, social media	Pacific	Suburban
San Francisco: Midtown/SOM	social media/gaming; internet; biotech	Pacific	Urban
Atlanta area: Medline	health; biotech	Southern	Suburban
Chicago area: Deerfield	pharmaceuticals; headquarters	Central	Suburban
Denver Technology Center	IT; telecom.; software	Mountain	Suburban
Seattle area: South Lake Union	health; biotech; internet	Pacific NW	Urban

18 *It is notable that the cities named as global financial centers in Exhibit 2-6 all have high reliance on public transportation and nearly all of the other cities named as major financial centers also have public transportation shares well above the national average.*

The technology-based clusters that were selected represent a range of regions across all four time zones of the US. And they represent a range of locations within metropolitan areas – from urban districts to suburban office parks. They also represent variation in cluster evolution, ranging from newly emerging clusters (started under ten years ago) to more mature clusters (started over 25 years ago).

The clusters also represent specific industry groups – including life sciences, software/computer technology, social media and telecommunications. Some are mature, representing well developed labor, real estate and service markets and some represent still-emerging areas. Clusters were selected to represent both urban and sub-urban areas, with anchors that may be research universities or other research institutions. The clusters represent both sub-urban as well as urban areas and are served by most types of transit. The clusters also represent areas where different types of transit improvements are envisioned. Exhibit 2-7 below shows the diversity of the selected clusters with respect to these key characteristics.

In the case of the San Francisco and Boston areas, two clusters were intentionally selected for comparison: (1) an older, auto-oriented technology corridor that has transformed from computer hardware to newer software technologies (Silicon Valley and Rt. 128), and (2) a newer, urban cluster with strong public transportation service that is more focused on attracting the millennial generation (Midtown/South of Market in San Francisco and Kendall Square in Cambridge, MA).

Exhibit 2-7: Key Characteristics of Selected Clusters

Case Study Area	Cluster Industry				Market Type		Metropolitan Setting		Anchors		Development Type		Existing Transit Service				Transit Improvement	
	Life Sciences/Biotech	Software/Computer	Social Media/ Internet/Gaming	Telecom	Mature	Emerging	Urban Core	Suburban	Research University	Other Research Institutions	Suburban Office Park	Build Reuse/Infill/ Densification	Bus	LRT/Streetcar	Heavy Rail/ Commuter Rail	Private Shuttles	Bus	Fixed Guideway (all Types)
Kendall Square	■		■			■	■		■	■		■	■		■	■	■	■
Route 128		■			■			■		■	■		■			■		
Atlanta Medline	■					■		■	■	■		■	■			■		■
Deerfield IL	■					■		■			■		■			■	■	
Denver Tech Center		■		■		■		■			■		■	■		■		■
Silicon Valley		■	■		■			■	■	■	■		■		■	■		■
SoMo/ MidMarket SF	■		■			■	■					■	■	■	■	■		■
South Lake Union	■		■			■	■		■	■		■	■	■		■		■

Exhibit 2-8: Roadway Accessibility Challenges for Major U.S. Clusters [19]

Industry Cluster	Number of Commuting Trips Occuring at Peak		Peak V/C* Ratio on Routes Accessing Cluster		% Increase in Auto Commuting Delay Expected 2010-2040
	2010	2040	2010	2040	
Boston area: Kendall Square	50,000	69,000	At capacity	1.4	27%
Boston area: 128 Corridor	24,000	26,000	At capacity	1.3	39%
San Francisco area: Silicon Valley	39,000	56,000	At capacity	1.4	45%
San Francisco area: Midtown/SOM	102,000	116,000	At capacity	1.5	20%
Atlanta area: Medline	64,000	97,000	At capacity	1.2	22%
Chicago area: Deerfield	27,000	41,000	At capacity	1.5	39%
Denver Technology Center	9,000	10,000	At capacity	1.5	**
Seattle area: South Lake Union	14,000	18,000	At capacity	1.5	53%

Source: Derived from Travel Models from Metropolitan Planning Organizations

**V/C ratio is the volume/capacity ratio at peak period, based on the highest congestion level on a major route accessing the cluster.*

*** no congestion delay in 2010, so the percent increase in delay cannot be calculated.*

Exhibit 2-8 shows the current and forecast future volume of commuting trips to each cluster, and how that will affect peak volume/capacity and delay on existing access routes. In total, another 104,000 jobs are expected to be generated at these industry clusters.

In all of the clusters, auto commuting delay is expected to increase significantly by 2040 and travel demand models forecast that total automobile volumes projected for commuters would “exceed the capacity” of primary access routes if changes are not made. Of course, in the real world, traffic volumes cannot keep increasing beyond the design capacity of roads without total gridlock, so what actually happens (and what would ultimately be forecast with the travel demand models) would be a full saturation of existing roadways, leading to traffic diversion and backs up onto other facilities in the region, thus causing more congestion elsewhere. If the eight clusters observed were to attempt to “build their way out” of highway congestion, significant

19 *It is notable that the cities named as global financial centers in Exhibit 2-5 all have high reliance on public transportation and nearly all of the other cities named as major financial centers also have public transportation shares well above the national average.*

expansion in the number of lanes on roads throughout the clusters would have to be considerable. Exhibit 2-9 shows the number of lanes that would be needed simply to accommodate the 104,000 added commuting trips expected to occur in the eight clusters by the year 2040. The numbers shown in Exhibit 2-9 do not include the additional lanes that might also be needed on routes throughout the region to ensure an entire uncongested trip, but rather only the lanes needed to prevent traffic from backing up on the roads that actually touch the cluster area. ("Lanes Needed" are defined as lanes that would be required to achieve a capacity such that traffic would not be expected to divert to alternative routes. It does not indicate lanes needed simply to 'fit' the number of vehicles demanding access to the facility).

For example, to achieve uncongested conditions on the 2 major routes serving Kendall Square, each of the routes would have to add 4 additional lanes (2 in each direction), requiring 8 additional lanes to be constructed today. By 2040 yet another lane would need to be added in each direction, for a total of 10 new lanes to be added on roads into Kendall Square by 2040. While uncongested commuting conditions are not a realistic goal, Exhibit 2-9 is still useful as a way of showing the vast gulf between projected future demand and current road system capacity. It is also clear that existing level of build-out (and high demand for land) in the cluster renders widening infeasible without taking valuable properties and potentially crowding out the very high-value economic activity that makes the cluster such a valuable business location. However, there are other options for serving these added trips, most prominently public transportation.

Exhibit 2-9: Roadway Capacity on Primary Access Routes to Selected Clusters [20]

Cluster	Access Routes		Lanes Needed for Free Flow (both ways)		
	Major Highways at Site	Lanes Available today	Additional Lanes Needed today	Total Lanes Needed by 2040	Widening Feasible?
Boston area: Kendall Square	2	8	+8	+10	No
Boston area: 128 Corridor	2	12	+4	+6	Partially
San Francisco area: Silicon Valley	2	14	+2	+4	Partially
Atlanta area: Medline	2	18	+6	+10	No
Chicago area: Deerfield	2	12	+2	+6	Partially
San Francisco area: Midtown/SOM	1	10	+4	+6	No
Denver Technology Center	2	16	0	+8	No
Seattle area: South Lake Union	2	16	+4	+10	No

Source: Derived from Travel Models from Metropolitan Planning Organizations

** conditions as of "today" were derived from models developed between 2010 and 2012*

20 *The number of lanes needed is estimated based on projected traffic growth in comparison to the current volumes, number of lanes, functional classification and operating characteristics of facilities accessing clusters and not based on any specific plans or studies done by MPO's regarding expansion needs.*

2.5 Public Transportation Support for Business Clusters

The viability of high growth industry clusters cannot be sustained unless there is supporting infrastructure capacity to meet their future needs. There are limitations to expanding road lanes, so broader multi- modal solutions become inevitable.

To accommodate added employment growth, plans have been adopted for major improvement in public transportation service for seven of the eight clusters. This includes clusters that already have some bus and rail service but have plans for further enhancement to it, and others that have no little or no public transportation but have plans to introduce new light rail or BRT service in the future.

These clusters represent a wide range of different settings, with major differences in current availability of public transportation, as explained in the later case studies (Chapters 3 – 10). Two of the clusters (Kendall Square in the Boston area and Midtown/SoMo in San Francisco) are relatively new and are located in urban districts with high rates of reliance on pre-existing rail transit. The other six are located along highways at the city fringe or in a nearby suburb. Of those six, two now have light rail or streetcar service. (Denver Technology Center and Seattle's South Lake Union). In addition, there are plans for enhanced high capacity transit (rail or LRT) service to be added in the future to the Atlanta Medline and Silicon Valley clusters. Upgraded bus service is also proposed for the Deerfield cluster. Only one cluster (128 Technology Corridor) has not yet developed a formal plan for significantly upgraded transit service.

Notably in all eight of the clusters, private firms have already invested funds to operate shuttle services, as a way to help attract workers and sustain their workforce accessibility despite a congested business cluster environment. In fact, the shuttle service provided by Google to connect the Mid-Town/ SoMo and Silicon Valley clusters is actually larger than some public transit fleets. Firms in all eight of the clusters also indicated in interviews that they see a need for increased public transportation, and all but one (the Denver cluster) have housing planned near the cluster. Exhibit 2-10 summarizes characteristics of the eight clusters studied.

Exhibit 2-10. Transit and Residential Investments in the Cluster Areas Studied

Cluster	Transit Expansion Planned		Private Shuttles in Existence	Housing for Millennials Planned
	Bus Service	Fixed Guideway		
Boston area: Kendall Square	Yes	Yes	Yes	Yes
Boston area: 128 Corridor			Yes	Yes
Atlanta area: Medline		Yes	Yes	Yes
Chicago area: Deerfield	Yes		Yes	Yes
Denver Technology Center		Yes	Yes	
Seattle area: South Lake Union		Yes	Yes	Yes
San Francisco area: Silicon Valley		Yes	Yes	Yes
San Francisco area: Midtown/SoMo		Yes	Yes	Yes

Taken together, these eight case studies illustrate a very wide range of situations related to public transportation planning and investment. On the one hand, they can be classified in terms of their *highway limitations*. This includes:

(1) Clusters where highways are limited because of build-out, space and density (no more room for highways);

(2) Clusters where highway widening opportunities are effectively limited because of some combination of neighborhood impact concerns, environmental concerns or workforce preferences (workers don't want to commute long distances); and

(3) Clusters where both 1 and 2 apply

It is also possible to classify the clusters in terms *of transit availability.* This includes:

(1) Clusters that were started and have grown based on transit access (e.g., Kendall Square and Midtown San Francisco);

(2) Clusters that initially grew without transit, but cannot be sustained in the future that way (e.g., 128 Tech Corridor, Silicon Valley, Deerfield, Atlanta Medline); and

(3) Clusters that have invested in transit and are poised to grow (e.g., Denver Tech Center, Seattle South Lake Union).

2.6 National Implications

2.6.1 *Drawing Conclusions from the Cluster Research Study*

There are two ways to draw national findings from the cluster research study. The *"bottom up"* approach calculates total impacts for the eight case studies and then expands those findings to the full set of technology-based, urban office clusters in the U.S. The *"top down"* approach utilizes coefficients from national statistical studies to estimate the productivity loss associated with limited density for future growth of technology-based office clusters. While both approaches have limitations, the two together enable the greatest possible insight into the ways that technology clusters, and indeed our nation's future economic growth, can depend on future public transportation investment.

APPROACH 1: BOTTOM UP ESTIMATION

Extrapolating from Travel Characteristics of Case Study Locations

To draw conclusions from the case studies, it is first useful to note that high growth, technology-oriented clusters are -- by definition -- areas of high employment growth. As a result, their employment growth will inevitably bump against the limitations of road capacity on access routes. Not surprisingly, that is exactly what has occurred in all eight of the case studies. Because they represent knowledge-based industries that depend on interaction and collaboration, the options of moving to multi-shift operations, satellite locations or telecommuting are seen as undesirable paths to substantial productivity losses. (The recent case of Yahoo's new CEO limiting telecommuting reflects this reality.) As a consequence, efforts are now underway to enhance public transportation service to most of the clusters studied.

In these situations, the value of adding public transportation service may be measured in terms of the added employment growth that they enable. In the eight case study zones, it has been calculated that forecast growth of 104,000 new jobs (a 32% increase in employment for the study area zones) by the year 2040 would be jeopardized by lack of road capacity, and unlikely to occur without introduction of public transportation or some other steps to enable greater commuting volumes.

Expanding to Include Broader Influence Areas of Clusters

Further adjustment must be made to these numbers, for as noted in the case study details, the employment zones selected for analysis were actually a subset of the full cluster areas. In each case, the broader cluster area is between 1.3 and 3.6 times larger (in total employment) than the traffic zones studied. This provides a basis to extrapolate the regional access capacity constraint to the full cluster areas of influence (which is reasonable because the same access routes are involved). Altogether, the employment growth that is at risk because of roadway limitations (and potentially enabled if there is sufficient public transportation service) is on the order of 2.3 times larger. That raises the at-risk employment growth to be in the range of roughly 239,000 jobs. To a limited extent, other actions such as better traffic management and doubling the rate of carpooling could also help – reducing the unmet capacity need by 15-20% (down to 191,000).

Extrapolating to Other Clusters and Communities Nationally

The eight case study clusters are not the only technology clusters in America that are facing increasingly congested roads. In fact, the list of clusters shown earlier in Exhibit 2-5 lists other technology business clusters in four of the regions that were studied (Denver/Boulder, Boston, Seattle and San Francisco Bay/Mid-Peninsula), plus established biotech or computer technology office clusters in seven other metropolitan areas that were not studied (Austin, New York City, Portland, Philadelphia, Raleigh Durham/ Research Triangle, San Diego and Washington, DC region). In addition, the two Jones Lang Lasalle (JLL) cluster reports that were cited in that table's footnote provide information on emerging urban office clusters for technology industries in five more cities (Baltimore, Las Vegas, Los Angeles, Minneapolis and Phoenix). This is not counting any of the regionally dispersed manufacturer clusters that are also identified in those reports.

While the other technology office clusters have not been extensively studied, it appears that most of them have also been facing increasing traffic congestion. This includes the Research Triangle Park area in NC, Bellevue area outside of Seattle, suburban Washington DC region (I-270 Corridor in Maryland and Dulles Corridor in Virginia), Rt. 202 Corridor in the Philadelphia area, and Sunset Hwy in the Portland, OR area, and many others.

Together, the cluster areas covered by our case studies account for approximately 39% of national employment in the set of technology office clusters covered by JLL reports. In other words, employment in the full set of recognized technology-oriented urban office clusters is 2.5 times that of our case study sites. And so, cluster employment growth threatened by road capacity limitations could be as high as 480,000, representing around $32 billion/year of income (expressed in terms of today's pay rates) by the year 2040.

This threatened capacity shortfall could be entirely eliminated if another 25% of the employment base of these clusters were to switch to using public transportation. While that goal may not be realistic, a lesser increase in public transportation expansion would lead to proportionally smaller (but still very significant) job growth impacts.

APPROACH 2: TOP DOWN

Foregone National Productivity and Business Expansion

An alternative way to draw national conclusions from this study is to assess the national loss of productivity that would likely occur if public transportation is not implemented in the high-growth, technology-oriented industries which are attracted to these business clusters. To estimate this effect, a sequence of five steps was applied.

(1) The first step was to assemble a national database that combined data from Texas Transportation Institute (TTI) on congestion delay with data on employment and economic growth by industry, for every county in the U.S. over the period of 2000 - 2010. Statistical (regression) analysis was applied to relate observed differences in employment growth (for each of the four economic sectors shown earlier in Exhibit 2-2) to levels of congestion present at the time. To ensure accuracy of the relationships, a series of step-wise regressions were run that also controlled for other explanatory variables including population, population density, presence and size of a major university, presence of a major airport, and public transportation mode share. The congestion effect was represented in terms of both the TTI congestion index and a measure of total delay.

(2) The outcome of this step was a predictive formula that reflected a statistically significant negative relationship between traffic congestion and economic growth in the targeted industries. Details of those results are shown in Appendix 2, "Statistical Analysis of Economic Performance and Industry Clusters." The second step applied the regression formulas to estimate how predicted worsening of traffic congestion would lead to an annual slowing of growth for those four sectors. The result was an estimate of the effect of congestion delays on employment growth in the four industry sectors. The result was an estimated reduction in the annual employment growth rate, leading approximately 70,000 fewer jobs generated each year in those industries. This would occur year after year from 2013 to 2040, if congestion trends were to continue without additional action.

(3) The third step was to factor down the step 2 result to apply just to those counties that have a high concentration (cluster) of workers in the four industry sectors. A national analysis for all counties in the U.S. indicated that 81% of all employment growth in the four industries would occur in counties with a high concentration of employment in those industry clusters. If we focus just on technology business clusters, then the percentage drops to 64%, yielding an impact of roughly more 45,000 jobs potentially foregone each year.

(4) The fourth step was to factor up the impact, to account for manufacturers of pharmaceutical, aerospace or electronic technology products that depend directly on scientific and technical research services. (Those sectors were not covered in prior steps because available small area employment data could not isolate those specialized sectors for all of the individual clusters.) Supplemental analysis indicates that the manufacturing industries add an average of 17% to employment totals for the studied clusters. That brings the potential impact on future employment growth to a level of 52,000 per year.

(5) The fifth step was to adjust for modal diversion. Although the "at risk" employment growth represented 25% of all forecast employment in the clusters, it was assumed here that only 15% of workers would divert to public transportation if it were made available. (This value was based on the change in public transportation share modeled for the Clifton Corridor in the Atlanta Medline Case). This allowed an assumption that total public transportation shares could increase by up to 27% in each cluster. Applying that share to the 52,000 jobs at risk yields an estimate of 14,000 jobs foregone each year that might be secured by public transportation, with a cumulative effect that 379,000 jobs could be lost by the year 2040 if there is no further investment in public transportation to provide needed access capacity for congested technology clusters. That represents roughly $21 billion of income potentially lost. Or alternatively, the number can be viewed as the amount potentially gained if public transportation is implemented to relieve expected traffic congestion at the clusters.

2.6.2 Unifying Observations From Cases

Businesses Often Take Initiative

The case studies in the following chapters consistently give examples of how private businesses often take the initiative and expense to provide private transit – hence demonstrating the importance of transit to businesses utilizing cluster locations. As described in the Silicon Valley and San Francisco Mid-Town/South of Market (SOM) cases -- Google provides neighborhood shuttle services throughout San Francisco to both its SOM and Silicon Valley locations. Another example is given from the Deerfield cluster outside of Chicago in which a group of businesses collaborate to provide aprivate bus service. While private initiative in offering transit to US business clusters reveals the value of transit to American firms – it can be problematic that US firms are paying out of their bottom line to provide a level of access that their competitors abroad can obtain publicly. In the long-term as US clusters grow, the costs of privately subsidized transit (lacking a public alternative) for US firms could potentially become a competitive disadvantage in America's critical high-growth industries.

Productive Use of Travel Time

One of the reasons why private firm invest in transit to clusters is because of the productive time that knowledge workers can spend during the transit ride itself (either working or collaborating with colleagues). For example, Google's buses are equipped with wi-fi and dim lighting that makes it easier to read computer screens. Employees use time on the shuttle to sort through emails so they arrive at work ready to tackle the day's activities. They also use time to interact with colleagues, sharing ideas that may lead to innovation at work. Many of the firms that provide shuttle services spend millions of dollars a year providing these services so that employees do not have to deal with traffic congestion directly. This finding points to the importance of not only the availability, but also the quality of transit services to business clusters.

Wider Implications for Land Use and Urban Development in US Cities

The cases in the subsequent chapters illustrate how the emergence of strong knowledge-based clusters in dense urban areas already supported by transit is leading to adaptive reuse of many long-vacant or underutilized facilities. The clusters include places where many formerly vacant buildings are now being used for lab and office space in high-value industries. A good case in point is the reuse of the building in the Mid-Market area of San Francisco. The building had been vacant for more than 50 years. In addition to Twitter, the renovated building has attracted Zendesk, Zoosk and One King's Lane as well as Twitter. A similar trend is happening in the SOM area of San Francisco. In both districts, infill is also taking place, with new offices and residential development occurring in once-neglected neighborhoods. In Kendall Square in Cambridge and South Lake Union in Seattle, the same phenomenon is occurring, with tech and life science firms taking up space in old buildings, or building new space on vacant or underutilized parcels. These businesses are being followed by new entertainment and eating establishments, retail and high rise housing, creating redevelopment activity that was once only a dream of city planners. This finding points to the importance of sustaining clusters, not only because of the global role of industries they house, but because of the local role they play in creating jobs, supporting quality of life and efficiently using land and other resources.

Generational, Cultural and Historical Context

The millennial generation has come into the workforce at a time when gas prices are climbing, global warming is front and center, and health and fitness issues also dominate the news. In the discussion of clusters in the following chapters – there is a consistent thread of businesses increasingly selecting locations which appeal to knowledge workers of this generation. Many of these workers are making choices based on environmental and health concerns, choosing alternatives to single occupancy vehicle use, and looking for living options that require less space and provide access to services, entertainment and shopping within walking distance of their homes. These factors have led many millennials to choose housing in well-established urban areas in contrast with past generations who often selected more sub-urban locations. The case studies also suggest new trend in business location decisions. Rather than choosing a location and expecting employees to find a way to get to the office, many of the firms observed in the subsequent chapters are choosing locations based on where their employees are choosing to live.

This aspect of business location speaks in part to the competitive climate for attracting young, knowledge workers to a company. Because the high-growth industries are more service and knowledge oriented (in contrast to manufacturing firms which are very commodity oriented and must locate near the physical inputs of production), service firms in high-growth can be more flexible about where to locate. The research from the eight clusters considered in this report finds many examples of firms that have seen an advantage in locating near the employment base where commutes are shortest, and modal alternatives most abundant. Google is a case in point. A spokesperson for Google noted that the firm opened a satellite office in San Francisco's South of Market cluster because so many of its employees live in San Francisco. Over 90 percent of the employees at the San Francisco office live in the city. As the millennial generation goes through the life cycle (establishing families, putting children in school and facing related choices), preferred work and residential locations will continue have evolving effects on the size, shape and viability of US business clusters.

Tip of the Iceberg

The current study only begins to shed light on how transit is helping and can continue to help fast growing, knowledge-based industries attract workers and sustain and increase productivity levels. More research is needed to assess under what circumstances, by what policies and at what cost specific transit solutions can be most effectively delivered to US business clusters. The research offered in this report is intended to demonstrate the need and importance of multi-modal passenger access to clusters, and as a starting point for developing a more refined approach to understanding when, where, how and at what cost appropriate transit solutions can be deployed to help sustain these places.

Order of Magnitude for Expected National Impact

The calculations involved in estimating cluster employment growth and transportation constraints include many assumptions, and that is true for both the top down and bottom up methods. In reality, there are many factors that could make actual impacts larger or smaller than the levels calculated here. Despite uncertainties about calculations, the case studies themselves (detailed in Chapter 3-10) make it quite clear that there are very real transportation access constraints looming that will affect the growth of high tech business clusters, and those constraints appear to apply (to some extent) across all such business clusters.

The computational exercises shown here indicate – at the very least – that the stakes are not trivial. Findingsy suggest that between 379,000 and 480,000 jobs could potentially be lost or gained by the year 2040, depending on steps taken to address the transportation capacity constraint. As described in section 2.6.1 above, it is likely that only a fraction of these are likely to be sensitive to transit investment per-se, however even a fraction could influence as many as 104,000 jobs in the US economy by 2040. Exhibit 2-11 shows the expected range in the magnitude of US jobs, income, output and GDP by 2040 are likely to be affected by the accessibility challenges of business clusters, as well as the potential degree to which transit access to clusters may support better economic performance.

Given constraints on continued roadway system expansion (detailed in the case studies), there appears to be a solid case for expanding the future role of public transportation to support growth of high tech business clusters. The value of potential income at stake emerging from the detailed analysis of technology business clusters in this chapter are larger (more than double) the simpler ("elasticity"-based) calculation of national market access and business productivity effects calculated in Chapter 4 (Exhibit 4-11) of Report 1.

Exhibit 2-11: Potential Magnitude of Economic Effects of Limited Mobility to Clusters, and Potential Impact of Improved Transit Access

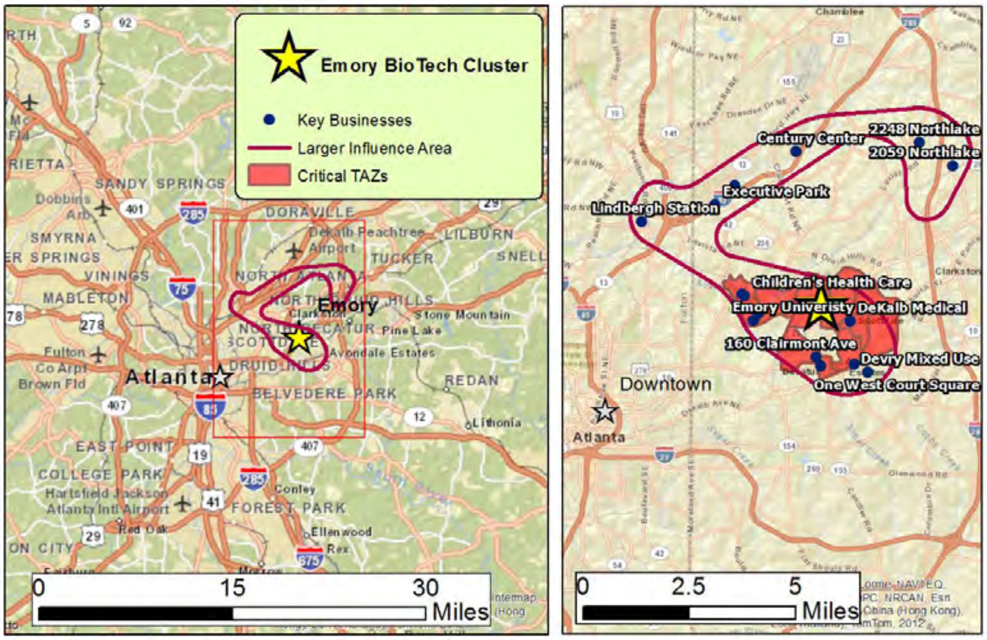
	Jobs in 2040	Wage Income/ Year in 2040 (In $Millions/Year)	Business Output in 2040 (In $Millions/ Year)	GDP in 2040 (In $Millions/Year)
Range of Likely Effects of Highway CapacityLimitations to Cluster Access	379,000-480,000	$8,112-$10,274	$19,516-$24,717	$12,306-$15,586
Potential Impact of Transit Access to Clusters	104,000	$2,226	$5,355	$3,376

3 Atlanta: “Medline” Cluster

3.1 Overview of the Cluster

Jones Lang LaSalle identified Atlanta as one of ten regions with an emerging life science cluster, in part because of its strong research institutions and hospitals. The Atlanta “Medline” cluster is located in DeKalb County, approximately 5 miles northeast of downtown Atlanta. It encompasses a corridor of approximately 7 miles from the US Center for Disease Control (CDC) headquarters and Emory University in the west, to the Avondale Metropolitan Atlanta Rapid Transit Authority (MARTA) station in Decatur to the east. The study area is served primarily by secondary and local roads. MARTA’s heavy rail blue line runs along the eastern edge of the study area, with one stop at Avondale. Several MARTA bus routes serve the area, and Emory University runs the Cliff Shuttle, providing a circulation system on campus, and a commuter service that stops at several apartment building complexes, some malls, and the Avondale station. Exhibit 3-1 shows the area of the “Medline” cluster with the highest existing concentration of commuting trips (shaded in red and further described in the analysis of the cluster’s transportation characteristics), and also shows the larger area of influence, which includes those parts of the Atlanta region where there is a growing demand for concentrated land, access and activity related to the cluster. In the case of Atlanta, it is important to also note that this cluster draws firms to the entire Atlanta region (well beyond even the wider area of influence shown on the map) – making access to this cluster important not only for commuting and regular daily trips – but also for a sphere of business activities throughout the region.

Exhibit 3-1: Location of the "Medline" Cluster



The cluster is dominated by a concentration of health care, education and research establishments co-locating for proximity to the research and academic resources of the CDC and Emory University. Some of the major establishments in this cluster include Emory University, Emory University Hospital, Children's Healthcare of Atlanta Hospital, the federal Centers for Disease Control and Prevention, the Veterans' Administration Medical Center and Regional Offices, and the DeKalb Medical Center.[22] In 2013, Emory University (including the hospital) employed 21,797 people, while the CDC had 6,500 employees and Children's' Healthcare employed 4,668 people. All three are among Atlanta's 32 largest employers.[23]

DeKalb County recently completed an economic development study for the corridor from Emory to Decatur, naming the area the "Medline" because of the connections to the Emory-CDC cluster and DeKalb Hospital. The Medline district is shown in Exhibit 3-1, which also shows the cluster's current roadway access and major establishments.

22 *MARTA web site http://itsmarta.com/Clifton-Corr.aspx*

23 *http://www.mba-today.com/business/georgia-mba-employers.html#atlanta*

The cluster's economic development strategy entails attracting new biotech and health care industries to the area, and in so doing, attract millennial generation knowledge workers to the county. The plans for redevelopment call for "green" buildings and transportation options. The Clifton Corridor light rail project (discussed in Section 3.3) is key to the success of these plans. A spokesman for the DeKalb County Commissioners Office noted that there are many start-up companies that develop from the research that goes on at the Emory node, but there is little space around the campus to house start-ups. Many leave Atlanta in part because of congestion levels.

The University, Emory Hospital and Children's Healthcare have continued to grow and expand throughout Atlanta, concentrating in the cluster, and spurring growth throughout the region. Because the CDC is a federal agency, it is not subject to local land use controls, and has continued to build on its current site more densely. The University has grown into a world-renowned educational facility, attracting students from around the world. In 2012, fall enrollment included 7,656 undergraduates and 6,580 graduate students.[24] The Emory University Hospital began construction of an 8-story tower on campus in 2011 to accommodate 200 hospital beds. The proximity of the hospital, the University and the CDC headquarters to each other, and the collaborative environment this proximity nurtures, have been instrumental in the cluster's growth.

The influence of the Medline cluster reaches throughout the Atlanta region and beyond biotechnology. An example is the growing interface between bio-technology, health care and information technology in the emerging Health Information Technology, or "Health-IT" sector. Health IT is an umbrella term for a variety of information technology solutions for managing medical records, interfacing with insurance, and collecting medical bill payments. Georgia ranks No. 1 in the U.S. in health-care IT industry revenue. Health-care IT companies in the state generated $4 billion in revenues last year, according to Healthcare Informatics magazine.[25] The state is home to over 130 health IT firms, with many located in Atlanta.

3.2 Transportation Challenges & Outlook

While the Avondale MARTA station is located in the southeastern periphery of this cluster, it is not within walking distance of most of the employment in the area; hence the CDC/Emory Corridor has been described as the largest activity center in the metro Atlanta region with no direct access to a MARTA station or the interstate system. The same two and four lane arterial roads that have served these facilities through decades of tremendous expansion are at congestion capacity. In addition to the thousands of employees, patients, visitors and students who strive to get to and from the Corridor each

24 *http://www.emory.edu/home/about/factsfigures/index.html*

25 *http://www.bizjournals.com/atlanta/print-edition/2010/11/19/high-tech-health.html*

day, close to 50,000 additional cars pass through this area going to other destinations. As businesses have built-out around this infrastructure, there is not available right-of-way to expand or retrofit the roadway system without significantly upsetting the critical mix of businesses collaborating in this cluster.

Exhibit 3-2 summarizes transportation characteristics of the Medline cluster in Atlanta today, and the anticipated conditions in 2040 under the Atlanta Regional Commission's current long-range plan.

Exhibit 3-2: Transportation Characteristics of Atlanta's Medline Cluster

Factor	2010	2040
Total Peak 3-hr of Trips	64,000	97,000
Auto Trips	59,000	76,000
Transit Trips	5,000	21,000
Transit Share	8%	22%
Increased Trip Time Due to Congestion	105%	127%
Population in 30 Minute (Free Flow)	693,000	739,000
Population in 30 Minute (Congested)	220,000	98,000
Population in 45 Minute Transit	27,000	57,000
Employment in 30 Minute (Free Flow)	438,000	519,000
Employment in 30 Minute (Congested)	137,000	98,000
Employment in 45 Minute Transit	49,000	85,000
Lost Population/Employment Access (Free Flow vs. Peak – Highway)	-68%	-84%

Source: Atlanta Regional Council, Travel Demand Model

With 64,000 peak period trips accessing this cluster in 2010, all routes serving the cluster exceed their current capacity, causing peak period travel times to take more than twice as long as they would in uncongested conditions. By 2040, peak period demand for trips to the cluster is expected to increase by over 50%, driving congested commute times to well more than twice (127%) what they would be in uncongested conditions. Exhibit 3-3 shows that if the area is fully built out by 2040, roadway demand on routes to the cluster will exceed capacity by between 10% and 120%. This will require 2 additional lanes through many of the major facilities within the cluster, potentially infringing on land currently used by businesses in the cluster.

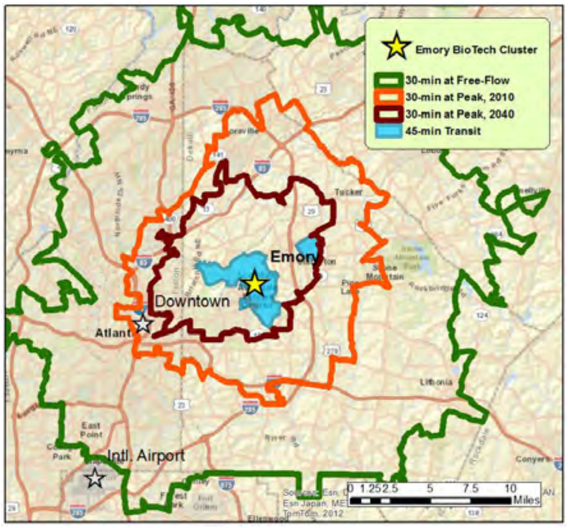
Exhibit 3-3: Lanes needed for 2040 Demand to Atlanta's "Medline" Cluster (Assuming Full Build-out)

To accommodate this growth in an area where there is little room to expand highway capacity, a 15% increase in transit share is projected, with Atlanta seeking to fund expanded light rail service (the Clifton Corridor, described in the following section). It is difficult to envision realizing the projected growth in this cluster if the transit share does not increase by at least this much. The current and growing problem of congestion at this cluster threatens to undermine the very access to labor for collaborating firms, which makes the cluster attractive. Congestion reduces the number of people and jobs accessible to this cluster by 68% in 2010.

Of the 693,000 people who reside within a 30-minute drive to the Medline cluster in 2010, only just over 220,000 (approximately 40%) can access the cluster within 30 minutes during peak period congestion. By 2040, the percentage of the population accessible to this cluster by car in the peak period is expected to further decline to 13% of the population that could access the site in uncongested conditions, with the actual number if people within a 30-minute peak period commute of the site declining by 60% from approximately 220,000 in 2010 approximately 98,000 in 2040. The cluster faces a similar challenge with its access to Atlanta's businesses, for which the number of jobs accessible within a 30-minute peak drive to the site in 2010 accounting for only 18% of those that would be able to reach the site in uncongested conditions.

Exhibit 3-4 shows the diminishing highway accessibility of Atlanta's Medline cluster. The green shape represents the area that is within 30 minutes of the cluster in uncongested conditions, the orange shape shows the smaller area accessible in 2010 congested conditions and the crimson area shows the area that will be accessible in 2040's congested conditions. The blue polygon shows areas that will be transit accessible by 2040 (in 45 minutes, to allowing for 30-minute in-vehicle time plus an assumed 15 minute allowance for terminal and walk to transit times) under current planning.

Exhibit 3-4: Diminishing Highway Accessibility of Atlanta's Medline Cluster



These results, derived from the Atlanta Regional Council's travel demand model, demonstrate the natural limitations of highway capacity alone for supporting a highly concentrated and productive industry cluster environment in a major US City. The results show the diminishing capability of Atlanta's robust highway network to serve the growing intensity of activity in this critical cluster. The results also show that while transit accessibility to the cluster doesn't diminish over time as traffic increases – the area served by transit even under current planning is not large enough to sustain today's commuting accessibility market for this cluster. If greater investment in transit could further expand the blue area Exhibit 3-4, transit has the potential to play a significantly greater role in sustaining this cluster.

Of the potential new commuting trips attracted to this cluster by 2040 (as shown in Exhibit 3-2), at least 7,150 are expected to be jobs that could be directly enabled by transit capacity (based on existing and projected modal shares in clusters nationally). By 2040, these jobs would be expected to create over $277 Million of wage income, $1.7 Billion in business output and over $500 Million annually in Atlanta's regional economy. Exhibit 3-5 summarizes the direct effects of jobs in this cluster that may be directly enabled by transit by 2040.

Exhibit 3-5: Potential Direct Economic Effects of "Medline" Cluster Growth Enabled by Transit Access

Potential New Jobs Enabled by Transit 2040	Income ($Million/Year)	Business Output ($Million/Year)	GDP ($Million/Year)
7,150	$277.8	$1,761.5	$501.7

With even more expansion planned in the future for Emory and the CDC, including a new hospital, new research facilities and a large mixed use residential project across the street from the CDC, a more comprehensive high capacity transit alternative to the automobile is critical to the future of this thriving employment and activity center. A spokesperson for the Atlanta Chamber of Commerce noted in an interview with EDR Group that congestion throughout the metro area has been a factor in some firms' decisions to relocate from or not locate in Atlanta. It was further stated that the long-term growth of Emory University will be limited without fixed guide way transit, and there is "no question that [the Emory-CDC area] could reach greater potential with the realization of light rail." [26]

3.3 Role of Transit in Sustaining the Cluster

The blue shaded area in the Exhibit 3-4 already assumes a significant improvement in transit access over today's conditions. Pursuant to a strong interest from the business community, plans are currently under consideration to make a much larger share of the Atlanta region accessible to the Medline by 2040. In 2009, MARTA and the Clifton Corridor Transportation Demand Management Association began work on the Clifton Corridor Transit Initiative Alternatives Analysis. The project explored ways to improve transit along a corridor running from the Lindbergh MARTA station, to the CDC, Emory University, DeKalb Medical Center and the Avondale MARTA station.

The analysis explored bus rapid transit, light rail, and heavy rail options, with the locally preferred alternative emerging as light rail. It estimates that this transit line will serve 39,100 jobs by 2030, and will achieve 5,450 daily boardings in that year. The first phase of the project calls for ten stops from Lindbergh station to DeKalb Medical Center, including one at the CDC and two additional stations at Emory. Riders traveling between Emory and the airport will save an average of 38 minutes per trip compared to using an auto for the same trip.

Funding for the Clifton Corridor was part of a transportation initiative that went to voters in July 2012, and was rejected. Despite not having funding for the project, MARTA has embarked on an environmental impact analysis to move the project forward in the planning process so that it is ready to proceed when a new funding source is found. If this corridor is not funded, the diminishing accessibility of the Medline could be greatly exacerbated beyond the findings given above (which assume the corridor will be in place). This is one example of an area where a lack of funding for a transit alternative may contribute to a mounting accessibility challenge in one of America's strategically critical high-value industry clusters.

26 *Telephone conversation with Dave Willliams, V.P. of Transportation, Atlanta Regional Chamber, May 29, 2013*

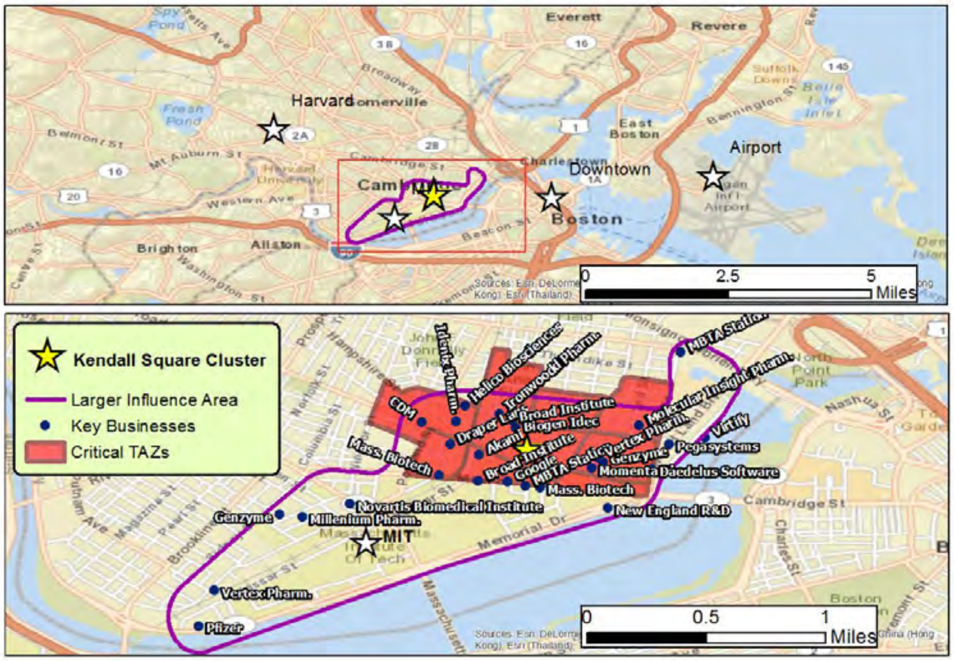

SOUTHWAY

4 Boston: Kendall Square Cluster

4.1 Overview of the Cluster

The Kendall Square cluster in Cambridge, Massachusetts abuts the Massachusetts Institute of Technology (MIT) to the west and includes a cluster of globally significant business and technology establishments along the Charles River. Since it began to re-develop in the 1980's Kendall Square has increasingly been a nursery for business start-ups led by MIT researchers, professors and students. Exhibit 4-1 shows the geography of the Kendall Square cluster. Today, Kendall Square is bustling with activity seven days a week, night and day. The area is home to 62 Biotech/ Life Sciences firms, 32 consultancies, 33 Financial Services firms, 61 IT/ High Technology service firms, 34 Marketing and Communications firms, 5 colleges and universities (including MIT), 13 venture capital firms and 22 corporate headquarters. Exhibit 4-1 shows the location of the Kendall Square cluster within the larger Boston-Cambridge region. The area shaded in red is the area that currently has the most concentrated trip-making (and reflected in the transportation characteristics below), whereas the area within the purple line shows the larger area of influence where jobs, economic activities and the demand for trips is highly dependent on the vitality of the cluster. It should also be noted that some other areas of the Boston region (such as the Longwood Medical area and Seaport District) depend on access to the Kendall Square cluster.

Exhibit 4-1: Location of the Kendall Square Cluster



Kendall Square attracts knowledge-based companies for a number of reasons, not least of which is its proximity to MIT. As a world-renowned research university, MIT attracts the most intellectually gifted students, researchers and professors from around the world. The MIT population provides the ideas, talent, and energy sought by knowledge-based industries. Cambridge and Boston also have concentrations of venture capital firms looking to invest in the next great idea. Thirteen venture capital firms are located in Kendall Square itself. The area also is home to the Massachusetts Biotechnology Council, the Cambridge Innovation Center (a high-tech incubator facility), Draper Laboratory, the Volpe Transportation Center, the Whitehead Institute for Biomedical Research, and the Broad Institute, all of which add to the intellectual capacity of the area.

Kendall Square is located on the Massachusetts Bay Transportation Authority's (MBTA) Red Line heavy rail system. Trains run every 4.5 minutes in the peak period and every 6.5 minutes mid-day. Four MBTA bus routes serve the Kendall Square area, as well as three shuttle services. The EZ Ride shuttle runs between the MBTA Green Line Lechmere Station and MIT. In addition, MIT runs its own shuttles to and from the Square, as does the Galleria shopping center. Shuttle ridership has been increasing by 4% annually.

4.2 Transportation Challenges & Outlook

Those driving to Kendall Square can use one of several main routes to get to the area, including McGrath Highway (SR28) and Memorial Drive (parkway), and both I-93 and I-90 have exits within two miles of the area. However, road congestion is currently a significant problem in Kendall Square.

As a highly concentrated center of knowledge-based businesses, tens of thousands of commuters stream into Kendall Square every day. Thousands of additional people come to the area for conferences, classes, and business meetings. Exhibit 4-2 summarizes the transportation characteristics of the MIT/Kendall Square cluster.

Exhibit 4-2: Transportation Characteristics of Boston/Cambridge's MIT/Kendall Square Cluster

Factor	2010	2040
Total Peak 3-hr of Trips	50,000	69,000
Auto Trips	25,000	39,000
Transit Trips	25,000	30,000
Transit Share	50%	44%
Increased Trip Time Due to Congestion	26%	34%
Population in 30 Minute (Free Flow)	1,436,000	1,570,000
Population in 30 Minute (Congested)	1,122,000	1,189,000
Population in 45 Minute Transit	361,000	417,000
Employment in 30 Minute (Free Flow)	938,000	1,040,000
Employment in 30 Minute (Congested)	799,000	872,000
Employment in 45 Minute Transit	455,000	514,000
Lost Population/Employment Access (Free Flow vs. Peak – Highway)	-19%	-21%

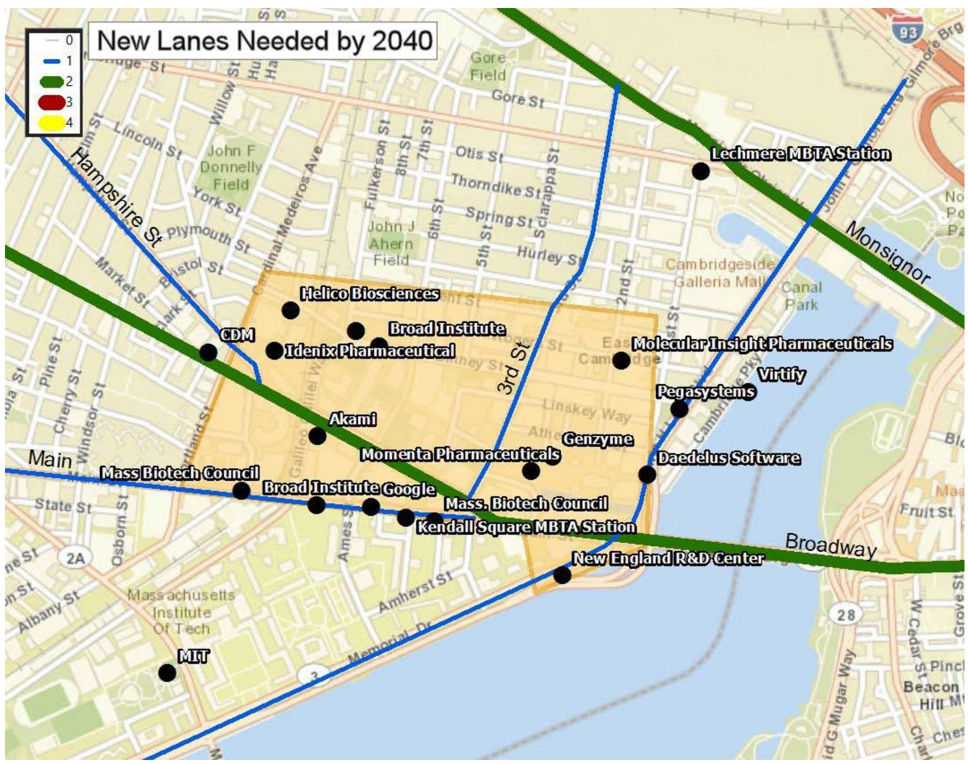
Source: CTPS Travel Demand Model, 2013

With over 50,000 peak period trips accessing this cluster in 2010, all routes serving the cluster exceed their current capacity, causing peak period auto commutes to take 26% longer than they would in uncongested conditions. By 2040, peak period demand for trips to the cluster is expected to increase by 38% with volumes exceeding capacities on all major routes accessing the cluster. As the Boston metropolitan workforce and business markets continue to grow, Kendall Square is expected to draw workers from more areas of the metropolitan area, reducing the transit share by approximately 8% (to 44% of total commuting). This change is expected to correlate with congestion lengthening the average commuting time into the cluster by approximately 8% (with congested trips in 2010 taking 26% longer than uncongested in 2010, and 34% longer in 2040).

Overall, approximately 19% of the people and jobs in a 30 minute drive of Kendall Square of Market/Mission cluster can no longer make the 30 minute commute due to congestion, with this share increasing to 21% in 2040. When compared to the loss of accessibility clusters with significantly lower transit shares (like the Atlanta Medline or the 128 Technology Corridors in Massachusetts), it is clear that transit's role in sharing the capacity burden contributes significantly to Kendall Square's ongoing accessibility.

Exhibit 4-3, based on data from the Central Transportation Planning Staff (CTPS) of the Boston MPO, shows that two additional lanes would be needed on major routes accessing Kendall Square by 2040 to achieve a capacity less than or equal to projected volumes. This level of widening is not likely to be feasible given the concentration of high-value locations in the cluster as well as the ongoing demand for additional space. Enhancing roadway capacity to this cluster is also unlikely, given the level of build-out, the proximity to the Charles River, and the need to accommodate pedestrians and other modes. In fact, planned improvements to the Longfellow Bridge (the main route between Kendall Square and Boston) will require the removal of one lane of traffic to be replaced by a bicycle lane and sidewalks.

Exhibit 4-3: Lanes Needed for 2040 Demand to Kendall Square Cluster



Of the potential new commuting trips attracted to this cluster by 2040 (as shown in Exhibit 4-2), at least 4,117 are expected to be jobs directly enabled by transit capacity (based on existing and projected modal shares in clusters nationally). By 2040, these jobs would be expected to create over $403 Million of wage income, $1.8 Billion in business output and over $659 Million annually in greater Boston's regional economy. Exhibit 4-4 summarizes the direct effects of jobs in this cluster that may be directly enabled by transit by 2040.

Exhibit 4-4: Potential Direct Economic Effects of Kendall Square Cluster Growth Enabled by Transit Access

Potential New Jobs Enabled by Transit 2040	Income ($Million/Year)	Business Output ($Million/Year)	GDP ($Million/Year)
4,117	$403.9	$1,862.4	$659.5

4.3 Role of Transit in Sustaining the Cluster

As the concentration of activity in Kendall Square has increased, there is evidence that transit has played a key role enabling the cluster to maintain its accessibility. Between 2000 and 2010, almost 4 million square feet of commercial space were developed in Kendall Square (+37.8%). Over that time, however, traffic volumes stayed steady or fell. The City of Cambridge expects the Kendall Square area to continue to grow through 2030 and beyond. The new Kendall Square Plan has identified opportunities for allowing densification, infill and redevelopment to accommodate growth. Access to transit is a key concern to the knowledge based industries located in Kendall Square. The Cambridge Technology Center is currently looking for a second site, preferably near the Kendall Square MBTA Red Line Station. If no site can be found in the Kendall Square area, they will seek a site near another Red Line Station [27] to retain good transit access to the cluster.

The recently completed Urban Design/Planning Study for the Central and Kendall Square Area is clear that transit improvements will be vital for maintaining the vibrancy of Kendall Square and supporting expected growth. The plan identifies several transit investments that can address transportation issues that the Kendall Square Cluster will face.

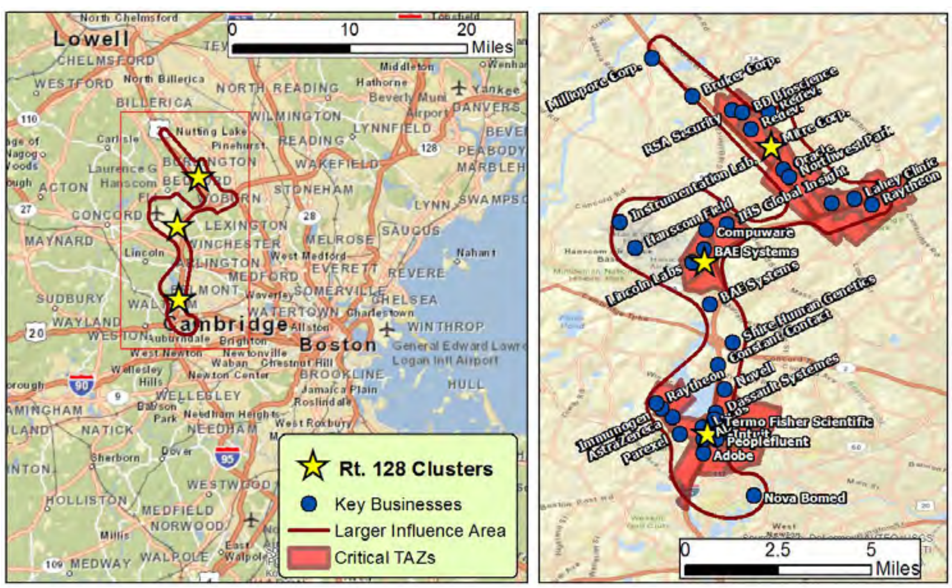
27 *Alspach, Kyle, Cambridge Innovation Center plans to expand with 2nd location, Boston Business Journal, June 21, 2012 http://www.bizjournals.com/boston/blog/startups/2012/06/cambridge-innovation-center-expand.html*

5 Route 128 Technology Cluster

5.1 Overview of the Cluster

While the above assessment of Kendall Square points to the role of transit in sustaining a vital industry cluster's access to workforce and supporting businesses, the Burlington, MA Route 128 Technology Corridor provides a contrasting example from the same regional economy of the challenges that clusters experience when transit access is limited. Exhibit 5-1 shows the 128 Technology Cluster, with its most concentrated core shaded in red (as further described in the cluster's transportation characteristics), and its wider area of influence (including areas where the cluster is expanding, as well as areas with significant cluster-dependent business activity) shown within the crimson shape.

Exhibit 5-1: Location of the Route 128 Technology Cluster



The Route 128 Technology Corridor is recognized as one of the first high technology corridors developed in the United States. The corridor is home to a mix of information technology, software, medical technology and financial services firms, including office functions, research and development, and light manufacturing. Some of the major private sector employers include Mitre Corporation (over 1,000 employees), Ratheon (3,500 employees), Oracle (which merged with Sun Microsystems, a major employer in the area, in 2010), TD Bank, the Lahey Clinic (over 4,000 daytime employees plus consultants), RSA Security (500-1000 employees), BD Bioscience, Instrumentation Lab (500-1000 employees),and Milipore Corporation. Other major job generators in the area are the Burlington Mall (a super-regional shopping center), Lincoln Labs (a research facility associated with MIT), and Hanscom Field, which accommodates corporate jets.

In the 1980s, the area emerged as one of the premier tech corridors in the country. Land was inexpensive and plentiful, and companies could locate at the area's preferred campus-like, auto-oriented sites. The location of Lincoln Labs in Bedford has helped attract firms to the area, as has the ability of the region to attract federal research and development funds. The corridor has also attracted companies involved in medical information technology, medical device research, and medical device manufacturing. The presence of the Lahey Clinic in the heart of the study area, as well as Boston's cluster of major health care institutions, has helped attract such firms. The corridor continues to attract firms drawn because of the prestige of being located near Route 128. The area also continues to attract support services such as banking and shops and restaurants that attract both the large workforce in the area and residents of the nearby communities

5.2 Transportation Challenges & Outlook

Growth in this cluster poses increasing transportation challenges, both due to the intensity of activity and the limitation of modal options. Exhibit 5-2 summarizes transportation characteristics of the Route 128 Technology Corridor today, and the anticipated conditions in 2040 according to the CPTS's travel demand model.

Exhibit 5-2: Transportation Characteristics of the Route 128 Technology Corridor

Factor	2010	2035
Total Peak 3-hr of Trips	24,000	26,000
Auto Trips	22,000	24,000
Transit Trips	2,000	2,000
Transit Share	7%	6%
Increased Trip Time Due to Congestion	40%	56%
Population in 30 Minute (Free Flow)	843,000	896,000
Population in 30 Minute (Congested)	480,000	453,000
Population in 45 Minute Transit	15,000	15,000
Employment in 30 Minute (Free Flow)	469,000	501,000
Employment in 30 Minute (Congested)	288,000	283,000
Employment in 45 Minute Transit	20,000	20,000
Lost Population/Employment Access (Free Flow vs. Peak – Highway)	-41%	-47%

Source: CTPS Travel Demand Model (2013)

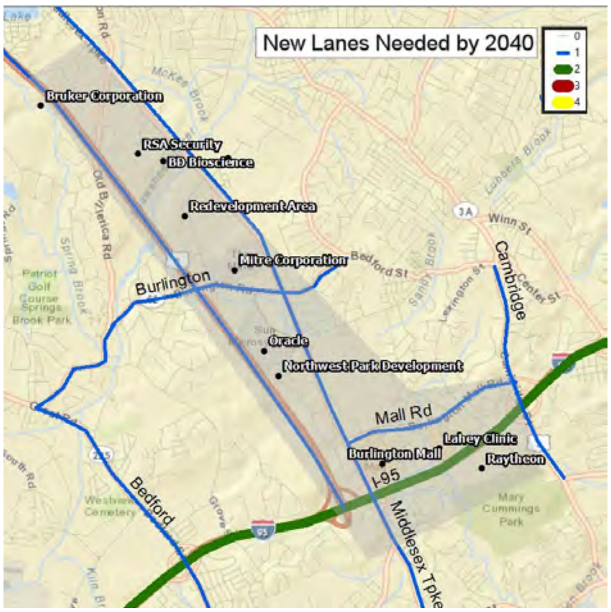
When the area first developed, Route 128 and Route 3 provided good highway access to the area. However, the growing concentration of activity in the cluster has outpaced this capacity such that by 2007, Route 3 was approaching 99% of capacity, and Route 128/I-95 between Route 3 and Winn Street in Burlington had a volume to capacity ratio of 122%.[28] While the 128 Technology Corridor was already exceeding capacity in 2007, demand for trips to the area are expected to continue to further increase, from 24,000 to 26,000 by 2035. New development and re-development projects continue to be proposed along the corridor, with shortages of parking, land and highway capacity making these developments increasingly difficult to accommodate. The area has limited transit service. The MBTA runs 3 routes that serve the area, and local service is provided by the Burlington Bee, Express (a Lexington local service) and an express route from Lowell provided by Lowell RTA.

28 *MAPC, Route 128 Corridor Plan, 2011, p. 5. Retrieved from the World Wide Web on May 30, 2013 at http://www.mapc.org/sites/default/files/images/smartgrowth/transportation/Route%20128%20Plan_Final_6.11.pdf*

There is no commuter rail or heavy rail service in the study area. There are, however, shuttle services run by Lincoln Labs, the Lahey Clinic, the Route 128 Business Council and local hotels.

Exhibit 5-3 shows the lanes that would need to be added on the major routes serving the area to achieve the capacity needed for 2040 projected traffic levels.

Exhibit 5-3: Lanes Needed for 2040 Demand to 128 Technology Corridor

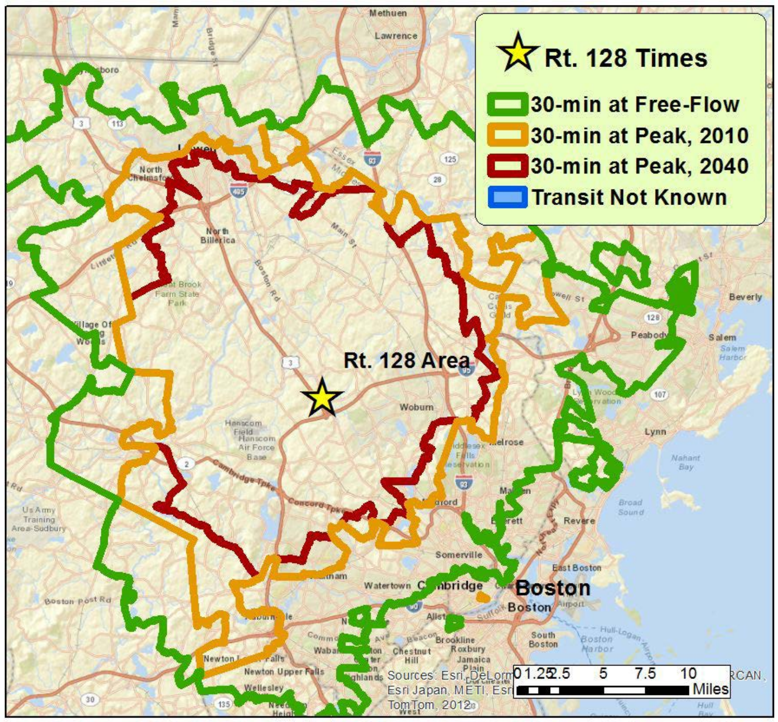


While significant highway capacity could support the local accessibility of this cluster, the business demand for land competes with the right-of-way that would be required to achieve this level of build out. The limitations of highway capacity for serving the intensity of activity that has developed in the 128 corridor are highlighted by the findings in Exhibit 5-2 regarding access to Boston's regional economy. Today, congestion reduces the number of people and jobs within a 30 minute peak trip to this cluster by 41%, and will reduce this accessibility by 48% by 2040.

As of 2010, approximately 843,000 households in the Boston area could access the cluster within a 30 minute commuting time from their homes in uncongested conditions. However, at peak periods, severe congestion makes 43% of them (roughly 363,000) no longer accessible to the area within that same 30-minute commuting time threshold. By 2040, forecasts indicate fully half of households that would otherwise be within a 30 minute highway commute of the corridor will lose this level of accessibility to the cluster due to congestion. Currently, the transit share of trips to this cluster is projected to remain about the same, largely because as the cluster was developing, high-capacity transit options (and associated land use measures) have made it less conducive to route productivity than other clusters in metro-Boston.

Exhibit 5-4 shows how growing demand and limited capacity are combining to diminish the accessibility of this important cluster. Furthermore, Exhibit 5-4 shows that, as in the Atlanta case, simply resolving congestion at the cluster itself may not provide access to the larger regional labor and business markets that currently supports this cluster. In an interview with EDR Group in May of 2013, the Town Planner for Burlington noted that the lack of transit options to the area is hampering the ability of firms to attract younger workers who do not want to own a car and prefer to live in Boston or the inner suburbs of Somerville, Cambridge, Arlington and others. [29]

Exhibit 5-4: Diminishing Highway Accessibility of Burlington's 128 Technology Corridor



Of the potential new commuting trips attracted to this cluster by 2040 (as shown in Exhibit 5-2), at least 433 are expected to be jobs directly enabled by transit capacity (based on existing and projected modal shares in clusters nationally). By 2040, these jobs would be expected to create over $34 Million of wage income, $146 Million in business output and over $62 Million annually in greater Boston's regional economy. Exhibit 5-5 summarizes the direct effects of jobs in this cluster that may be directly enabled by transit by 2040.

Exhibit 5-5: Potential Direct Economic Effects of Route 128 Technology Corridor Growth Enabled by Transit Access

Potential New Jobs Enabled by Transit 2040	Income ($Million/Year)	Business Output ($Million/Year)	GDP ($Million/Year)
433	$34.9	$146.3	$62.5

29 *Telephone discussion with Kristen Kassner, Burlington Town Planner, May 30, 2013.*

5.3 Role of Transit in Sustaining the Cluster

For this reason, despite the surge in development and anticipated future growth, communities in the corridor are very concerned that the existing transportation system will not be able to accommodate the expected employment and residential growth. Burlington tried to put a maximum on parking for new office space in an effort to discourage the use of single occupancy vehicles, but developer pushback has made these efforts unsuccessful. Town Managers of both Bedford and Burlington have approached Massachusetts Area Planning Commision (MAPC) to say that they will not be able to handle future growth without more transit options. Municipal and regional planners who have looked at transit in the study area have indicated they would support additional transit service to reduce dependence on the automobile. However, historic development patterns have resulted in development that is sprawled and not easily served by transit. They note that area businesses may already be having difficulty attracting young people who do not want to own cars to their suburban employment sites. The concern that Town officials and planners have regarding the highway capacity of this study area to handle additional development given the current transportation system is highlighted by a number of recent plans and activities in the study area.

Most notably, in 2011, Burlington was one of five towns to participate with MAPC in the development of the Route 128 Central Corridor Plan. [30] The plan finds that while market conditions would create demand for over 8,000 additional jobs along the corridor from 2010 to 2030, the highway capacity simply cannot be expanded to accommodate the trips associated with these jobs. In a survey done as part of the plan, 21% of respondents listed travel time to work, and 21% listed roadway congestions as the primary concerns of employees who drive to work. [31] The plan recommends multi-modal solutions including creating a new Multi Modal Transit Center and new express bus service. The towns of Bedford and Burlington are now working with MAPC on a “bottleneck” study to identify how transit service can be enhanced to better serve the area.

The 128 Corridor provides an example of issues that emerge when a highly effective industry cluster emerges with a spatial and infrastructure pattern that is overly auto-dependent. Clearly the 128 Technology Corridor is a center of critical activity for the US economy in major growth sectors. However, unlike Kendall Square, only a few miles away, its ability to sustain the type and level of activity in demand is jeopardized by the natural limitations of highway capacity combined with a need to ‘catch up’ in transit orientation.

30 *http://www.mapc.org/sites/default/files/images/smartgrowth/transportation/Route%20128%20Plan_Final_6.11.pdf*

31 *Ibid, p. 24.*

6 San Francisco: Mid-Town & South of Market Cluster

6.1 Overview of the Cluster

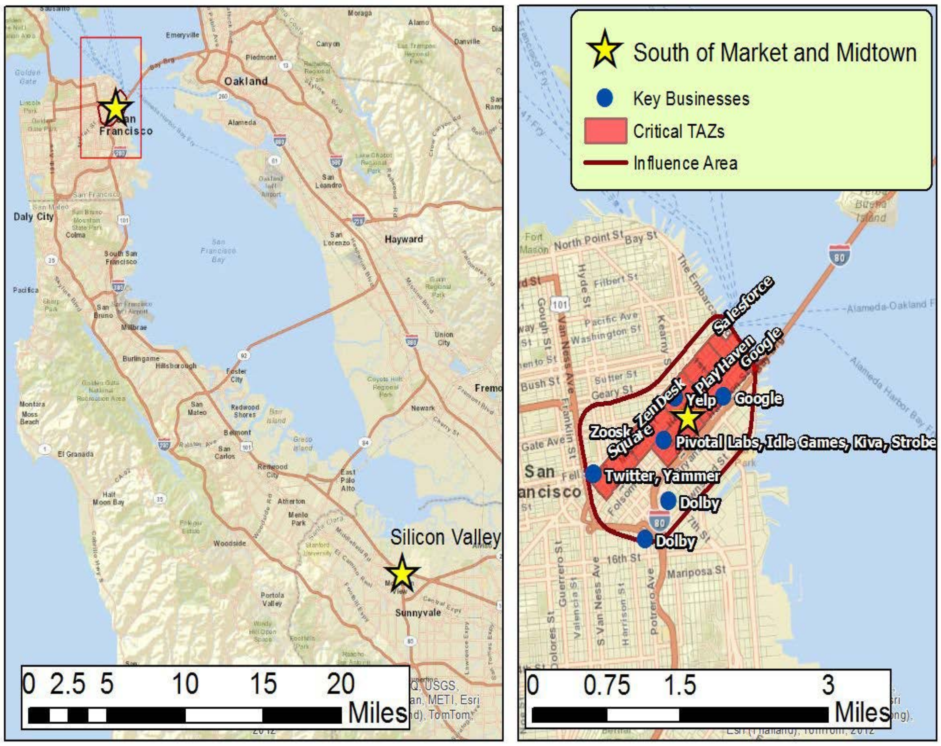
The Mid-Town and South of Market/Mission area of San Francisco comprises one of America's most vibrant business clusters in biotechnology, digital media and social media firms. Significant tech employers located South of Market include Google's new satellite office, Yelp, MetaCafe, PlayHaven, Idle Games, Pivotal Labs, Strobe, Salesforce, and Kiva. The Mid-Market area is dominated by Twitter's headquarters, with employment projected to reach 3,000 by July of 2013.[32] Other tech firms that have flocked to the area include Dolby, Square, Yammer, One King's Lane, ZenDesk, and Zoosk. The firms have been attracted to these sites both because the City adopted an aggressive policy of tax incentives to lure tech firms, and the City has also attracted legions of young, well-educated techies who want to live in San Francisco, enjoy its culture and amenities, and do so without owning a car. This cluster illustrates how location dynamics are shifting in the current generation—with firms coming to the labor force instead of labor moving to where the firms are located.[33]

Exhibit 6-1 show the location of the Mid-Town & South of Market Cluster within the larger Bay Area. The shaded red area shows the concentrated core of the cluster (as described in the transportation characteristics analysis below), with the dark red shape showing a wider influence area within which business and economic activities are (or are predicted to be) highly dependent on the cluster in the future.

32 *Sabatini, Joshua, "Tax break incentive to keep Twitter up for key vote", San Francisco Examiner, March 14, 2011. www.sfexaminer.com/local/2011/03/twitter-tax-break-takes-stage*

33 *Temple, James, "Tech firms making S.F. new home", SFGate, June 21,, 2010. www.sfgate.com/realestate/article/Tech-firms-making-S-F-new-home-3184428.php*

Exhibit 6-1: Location of the Mid-Town & South of Market Cluster



Most successful entrepreneurs have one foot in Silicon Valley, where most of the venture capital firms remain, and another in the city. Google has a huge office in San Francisco and a headquarters in Mountain View. Google, as well as Facebook, LinkedIn and others, operate free shuttle buses so their younger employees can enjoy a vibrant social life in the city. The top incubators and accelerator programs like Y Combinator still operate in Silicon Valley, but many of the young graduates flock to San Francisco[34] .

Mid-Town and South of Market/Mission District are well-positioned to continue to attract social media, digital media and biotech firms. The limit to growth will be available space as both areas begin to see shortages of space. However, major new developments are planned and redevelopment opportunities exist. One key development is planned next to the new

"For younger startups, locating in San Francisco is] a hiring tactic...young and talented developers and designers expect you to be in San Francisco,"

Cullen Wilson, chief executive of Sponsorfied, a startup which recently re-located from Mountain View.

http://venturebeat.com/2012/09/03/expanded-silicon-valley/

34 *http://venturebeat.com/2012/09/03/expanded-silicon-valley/*

"Transportation challenges are a real constraint on the ability of Silicon Valley firms to reach the labor market they want. San Francisco is where the talent wants to live and the technology cluster has reached the critical mass so that it is where people want to be. Firms locate near the employees and become embedded in the technology ecosystem. The robust transit options serving the City are critical for employees."

Michael Cunningham, Bay Area Council

Transbay Transit Center. Boston Properties and Hines has negotiated the purchase of a key parcel at 1st and Mission, where they have plans to build an office tower that will be the tallest skyscraper on the west coast. It will include 1.7 million square feet of space, including 1.37 million square feet of office space and 10,000 square feet of retail space.[35]

6.2 Transportation Challenges & Outlook

The San Francisco Midtown/South of Market Cluster is largely sustained by its well-developed transit system, including MUNI buses, trolleys and streetcars, regional bus transit services , and the Bay Area Rapid Transit (BART) heavy rail system. Regional buses provide connections from the East Bay, points north, and the Peninsula. BART provides service from the East Bay to downtown and south along the Peninsula to the San Francisco International Airport. There is also Caltrain commuter rail service from as far south as Gilroy up through the Silicon Valley to downtown. Private transportation options are available as well, including informal taxi services such as Lyft, and an extensive network of private shuttles run by companies located in the City.

Construction began on a new transit terminal, called the Transbay Transit Center, in 2010, which will replace the old San Francisco Transbay Terminal. The new transit center is located on Mission Street within a short walk of much of the new high tech development occurring South of Market. The new terminal will have bus service from MUNI, AC transit (from the East Bay), Golden Gate Transit (from Marin County), SamTrans (from San Mateo County), WestCat Linx (western Contra Costa County commuter service), and Greyhound. Amtrak will also have a berth at the center, and Caltrain will be extended from its current terminal at 4th Street to the Transit Center. Initial plans call for BART to be connected to the terminal by an underground tunnel under Beale Street to BART's Embarcadero stop. The Caltrain extension will also serve the High Speed Rail (HSR) line that is planned to run between Southern California and San Francisco.

Exhibit 6-2 summarizes transportation characteristics of the South of Market cluster today, and the anticipated conditions in 2040 under San Francisco Metropolitan Transportation Commission (MTC)'s 2013 long-range transportation plan.

35 *Billings, Mike, "Transbay Tower land sale expected to be completed soon", sfexaminer.com, March 20, 2013. www.sfexaminer.com/local/development/2013/03/transbay-transit-center-land-sale-expected-be-completed-soon*

Exhibit 6-2: Transportation Characteristics of San Francisco's Midtown/South of Market Cluster

Factor	2010	2040
Total Peak 3-hr of Trips	102,000	116,000
Auto Trips	64,000	65,000
Transit Trips	38,000	51,000
Transit Share	37%	44%
Increased Trip Time Due to Congestion	115%	137%
Population in 30 Minute (Free Flow)	1,740,000	2,321,000
Population in 30 Minute (Congested)	1,193,000	1,137,000
Population in 45 Minute Transit	1,192,000	1,678,000
Employment in 30 Minute (Free Flow)	985,000	1,362,000
Employment in 30 Minute (Congested)	707,000	779,000
Employment in 45 Minute Transit	774,000	1,127,000
Lost Population/Employment Access (Free Flow vs. Peak – Highway)	-30%	-48%

Source: derived from data provided by San Francisco Metropolitan Transportation Commission (MTC), 2013

With over 100,000 peaks period tips accessing this cluster in 2010, all routes serving the cluster exceed their current capacity, causing peak period travel times to take 37% longer than they would in uncongested conditions. By 2040, peak period demand for trips to the cluster is increase by 14% with the transit share of trips increasing by 7 percentage points (from 37% in 2010 to 44% in 2040).

In 2010, the effects of congestion more than doubled that peak commuting auto travel times making them 115% of what they would have been in uncongested conditions. Congestion related delay is expected to get worse by 2040, making peak commutes 137% longer than they would otherwise be.

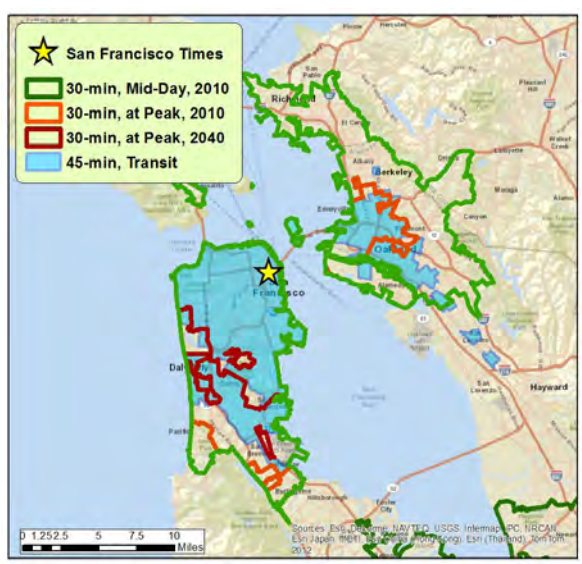
Exhibit 6-3 shows anticipated number of lanes that would be needed for roadways serving the major employers in the cluster to achieve an uncongested condition in 2040. Current build out in the area is unlikely to allow space for the 2-3 lanes of additional roadway that would need to be uncongested without demolishing a significant amount of the valuable property in which the cluster businesses reside.

Exhibit 6-3: Lanes Needed for 2040 Access to South of Market/Mission in San Francisco

However, of the 1.7 million workers who could access this cluster in uncongested conditions, 22% are unable to make the 30-minute commute due to peak congestion, with this percentage increasing to 52% by 2040. As shown in Exhibit 6-4, in 2010 there were already some areas of San Francisco that were within transit commuting times of the cluster, but not within congested auto-commuting times (as shown by blue shaded areas within the orange polygon), and still more such areas by 2040 (shown as blue shaded areas within the red polygon).

Today approximately 30% of the people and jobs in a 30-minute drive of the Midtown & South of Market/Mission cluster can no longer make the 30-minute commute due to congestion, with this share increasing to 48% in 2040. When compared to the loss of accessibility in places with significantly lower transit shares (like the Atlanta Medline or the Route 128 Technology Corridor in Massachusetts), it is clear that transit access contributes significantly to Midtown & South of Market/Mission's ongoing accessibility.

Exhibit 6-4: Diminishing Highway Accessibility to the Midtown & South of Market/ Mission Cluster



Of the potential new commuting trips attracted to this cluster by 2040 (as shown in Exhibit 6-2), at least 3,000 are expected to be jobs directly enabled by transit capacity (based on existing and projected modal shares in clusters nationally). By 2040, these jobs would be expected to create over $312 Million of wage income, $1.4 Billion in business output and over $509 Million annually in the bay area regional economy. Exhibit 6-5 summarizes the direct effects of jobs in this cluster that may be directly enabled by transit by 2040.

Exhibit 6-5: Potential Direct Economic Effects of Midtown South of Market/Mission Cluster Growth Enabled by Transit Access

Potential New Jobs Enabled by Transit 2040	Income ($Million/Year)	Business Output ($Million/Year)	GDP ($Million/Year)
3,033	$312.2	$1,439.5	$509.7

6.3 Role of Transit in Sustaining the Cluster

One of the keys to the projected continued success of this cluster is the robust transit options that serve the area. BART, Caltrain, Muni, AC Transit, SamTrans, Golden Gate Transit, car sharing programs, and private corporate shuttles all make the area highly accessible and allow young professionals to enjoy living in San Francisco without a car. The expansion of Caltrain to the Transbay Transit Center will further augment the transit network serving the area. Without the transit service, the area would not be able to operate effectively.

The Bay Area continues to expand transit options that serve the downtown, Mid-Market and South of Market/Mission areas. The new Transbay Transit Center will provide updated bus terminal facilities for several Bay Area carriers. By 2017, Caltrain service will be extended to this facility, and high speed rail will follow. The electrification of Caltrain, which is being done in preparation for the HSR service, will be completed by 2019 and will provide faster, more frequent service with shorter headways and more trains all along the Peninsula and into the City.[36] BART plans to initially connect to the Center via a tunnel under Beale Street that will connect to the Embarcadero station.[37] BART's longer term plans call for a second Transbay Tube that would connect Oakland and Alameda to the Transit Center, and perhaps extend as far as North Beach. The City's Transbay Transit Center area plan calls for wider sidewalks, street diets, transit lanes and boarding islands on the streets around the station. The City is revising its parking caps to reduce the allowable parking in the downtown to further encourage use of the Transit Center, and is proposing to reduce traffic lanes on streets adjacent to the center.

36 *http://sf.streetsblog.org/2012/06/01/transbay-transit-center-to-fill-downtown-with-people-not-cars/*

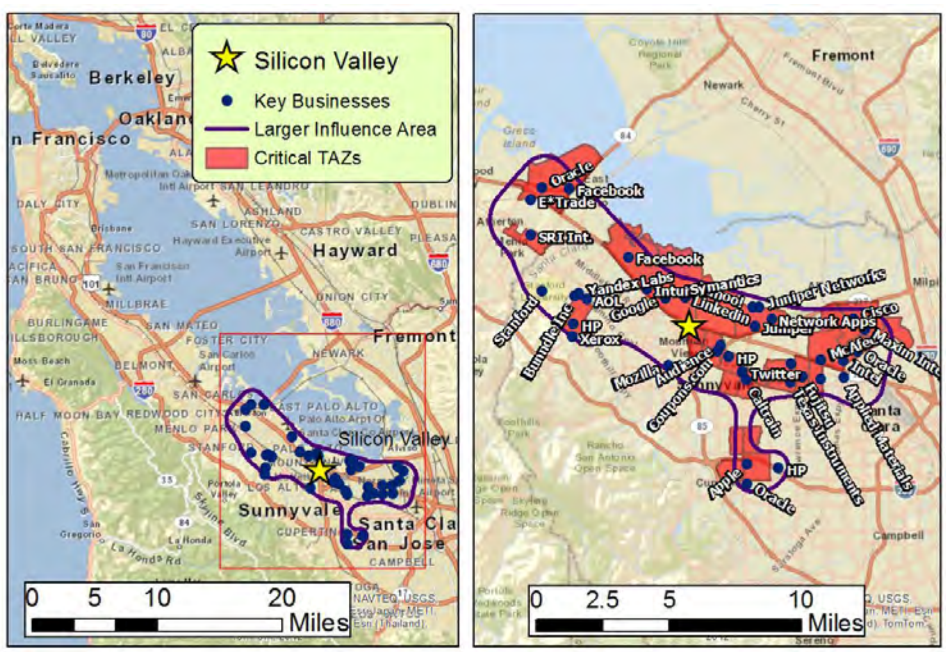
37 *Cabanatuan, Michael, "BART's New Vision: More, Bigger, Faster", SFGate, June 22, 2007. www.sfgate.com/bayarea/article/BART-S-NEW-VISION-MORE-BIGGER-FASTER-2584901.php*

7 California: Silicon Valley Cluster

7.1 Overview of the Cluster

While the above assessment of the Midtown/South of Market cluster points to the role of transit in sustaining a vital industry cluster's access to workforce and supporting businesses, the nearby Silicon Valley cluster provides a contrasting example from the same regional economy of the challenges that clusters experience when transit access is limited. Exhibit 7-1 shows the location of the Silicon Valley cluster within the larger Bay Area. The shaded red areas show the core of the cluster as shown in the travel characteristics analysis below, whereas the large purple shape shows the business core of the cluster as defined by business activity. Unlike some of the other clusters, the Silicon Valley cluster is so large that even the broad area shown within the purple line below can best be understood as the "nucleus" of the Silicon Valley "mega-cluster" which some would argue encompasses most of the economies of Sunnyvale, San Jose, Santa Clara and surrounding areas.

Exhibit 7-1: Location of the Silicon Valley Cluster



The Silicon Valley is located in Santa Clara County California on the San Francisco Peninsula, about 35 miles south of the City of San Francisco. For the purposes of this study, it includes parts of Menlo Park (which is in southern San Mateo County), Palo Alto, Mountain View, and Sunnyvale along the US 101 corridor. The Silicon Valley was one of the first places to be identified as an "economic cluster" in 1994, although the area had been recognized as the center of the high technology industry beginning in the 1960s. Major employers in the corridor include Google (14-15,000 employees plus contract workers in Mountain View)[38] , Yahoo! (Sunnyvale), Facebook (2,200 in Menlo Park), and SRI International (1,457 in Menlo Park).[39] The corridor is home to many established tech firms such as Hewlett Packard and Intel, as well as hundreds of start-ups.

The Silicon Valley has fostered the growth of the entire San Francisco Bay area as a high tech mecca. The draw of urban life has attracted many young high tech workers to live in San Francisco and commute to jobs in the Valley, and this migration has led to the recent location and relocation of several information technology and biotechnology start-ups and established firms into the City. (See the San Francisco South of Market/Mid-Market case study.) The Silicon Valley remains dominated by the tech industry. In 2010, only 7 of the top 75 companies in the Silicon Valley based on sales were not tech firms. All of the others on the list involved software development, hardware, internet technology, biotechnology, information technology, data storage, gaming, or other related topics.[40]

The Silicon Valley remains the epicenter of the high tech industry in the Bay Area, with other nodes, such as downtown San Francisco, Dublin-Pleasanton, and Fremont growing in capacity. The Valley still is home to the majority of venture capital firms that specialize in computer and internet technology, which attracts start-ups to the area. Access to the research being done at Stanford and some of the larger, established tech firms and to a well-trained labor market of new engineering grads and those who have trained at other Silicon Valley firms continues to be an asset of the area. Access to the social and professional network for both businesses and employees still is a big draw for businesses to locate in the Valley. However, ever increasing land costs and housing prices, and limited space for additional growth are starting to hinder the region's growth potential. In addition, the life style and accessibility of San Francisco is luring young tech workers to the City, and many businesses that start in the Valley are migrating north to San Francisco.

38 *Kevin Mathy, Google Transportation Manager*

39 *http://www.menlopark.org/departments/mgr/employers.pdf*

40 *http://www.docstoc.com/docs/document-preview.aspx?doc_id=76830259 Silicon Valley 150*

7.2 Transportation Challenges & Outlook

The Silicon Valley is served by two major north-south highways: Interstate 280 and Highway 101, although I-280 serves more as a route between destinations in San Francisco and San Jose, while US 101 passes through the heart of the technology industry cluster. Transit service is provided by Caltrain, the Bay Area's commuter rail system, and by local bus service provided by SamTrans (San Mateo County), and Santa Clara Valley Transportation Authority. The study area for this case study includes the 101 corridor from Menlo Park in the north to Sunnyvale in the south.

Transportation access is clearly a growing issue. The major highway route serving the Silicon Valley is the 101 corridor, which is heavily developed on both sides and has little opportunity for expanded capacity. (I-280 runs further west through the Peninsula, and transverses a lot of protected land. It provides a good alternative for traveling between San Francisco and San Jose, but not for workers trying to reach employment sites in the Valley.) Businesses in the Silicon Valley have already reached a point where it is difficult to attract employees because of the difficult commute along the Peninsula. In response, several large companies have developed their own fleet of luxury buses that make stops from Marin County north of San Francisco through city neighborhoods and down the Peninsula. Google now has the eighth largest fleet of buses in the nine county Bay area, including those of public transit agencies.

Despite access constraints, Google continues to expand near its headquarters in Mountain View, including the development of a vast new office complex at NASA Ames Research Center on the old Moffett Field Naval Air Station. This and other current development is likely to drive traffic levels even higher in the future.

Exhibit 7-2 summarizes transportation characteristics of Silicon Valley cluster today, and the anticipated conditions in 2040 under the MTC's current long-range plan.

A Business Perspective

Our commute must change. High Density means more cars, and cities and companies are mitigating the impact in different ways. Google is going to heroic lengths 0 running a massive transit fleet – augmented with thousands of bikes on campus to keep employees away from their cars. And Mountain View is implementing transportation agencies to extend the shuttle strategy to more companies. "We think all the time about, 'How do we get the density,' but also, 'How do we get the cars of the road?"

–Jay Bechtel, Google Project executive quoted in "Tech real estate; 6 crucial issues in Silicon Valley", Silicon Valley Business Journal, April 26, 2013.

Exhibit 7-2 Transportation Characteristics of the Silicon Valley Cluster

	2010	2040
Total Peak 3-hr of Trips	39,000	56,000
Auto Trips	38,000	54,000
Transit Trips	1,000	2,000
Transit Share	2%	4%
Increased Trip Time Due to Congestion	44%	64%
Population in 30 Minute (Free Flow)	1,124,000	1,574,000
Population in 30 Minute (Congested)	770,000	904,000
Population in 45 Minute Transit	N/A	N/A
Employment in 30 Minute (Free Flow)	723,000	1,050,000
Employment in 30 Minute (Congested)	535,000	673,000
Employment in 45 Minute Transit	N/A	N/A
Lost Population/Employment Access (Free Flow vs. Peak – Highway)	-29%	-40%

Source: derived from data provided by MTC, Travel Demand Model

With over 39,000 peak period tips accessing this cluster in 2010, all routes serving the cluster exceed their current capacity, causing peak period travel times to take 44% longer than they would in uncongested conditions. By 2040, peak period demand for trips to the cluster is expected to increase by 43% with congested commute trips taking 64% longer than they would under uncongested conditions. By 2040 roadway demand on routes to the cluster will exceed capacity by as much as 30%. If present trends continue, it is not expected that the public transit share will significantly reduce this congestion level. Exhibit 7-3 illustrates the number of additional lanes that would be needed in 2040 to accommodate projected travel demand accessing this cluster.

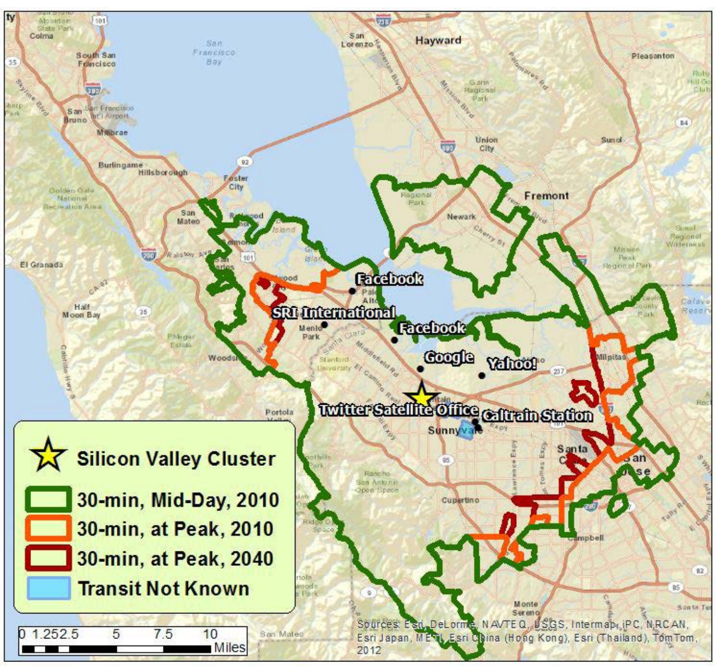
Exhibit 7-3: Lanes Needed for 2040 Demand to Silicon Valley

As with the other clusters, expanding the highways as envisioned in Exhibit 7-3 would require significant land acquisition in areas where space is at a premium, threatening to crowd out the very concentration of activity that makes the cluster attractive. There are limited options for addressing congestion in the Silicon Valley through highway improvements. According to Michael Cunningham of the Bay Area Council, the 101 is difficult to expand because it is built out on both the east and west sides of the roadway. There are currently gaps in the high occupancy vehicle (HOV) lanes along the road, and there is potential to fill in these gaps to provide continuous HOV lanes. There are also plans to toll the HOV lanes along the 101. The El Camino Real also runs north-south along the peninsula through the Silicon Valley; however, this road is commercially developed with curb cuts and traffic lights. There are long-range plans to develop higher capacity bus transit along the corridor, including signal pre-emption for buses. There is no time frame for these plans.

Furthermore, simply adding capacity within the cluster itself may only induce further demand from regional highway networks, failing to truly sustain or enhance the cluster's access to San Francisco's labor and business markets. Reliance on increasingly congested highway transportation threatens to undermine the very access to labor and collaborating firms that makes the cluster attractive. Overall in 2010 highway congestion reduced the number of San Francisco's people and jobs accessible within a peak 30-minute commute to Silicon Valley by 29%, with this number increasing to 40% by 2040. Of the 1.2 Million people housed within a 30-minute drive to Silicon Valley in 2010, only 770,000 (approximately 68%) can access the cluster within 30 minutes during peak period congestion. By 2040, the percentage of the people accessible to this cluster by highway in the peak period is expected to decrease to approximately 57% of what would be in uncongested conditions. The cluster faces a similar challenge with its access to San Francisco's businesses, for which the number of jobs accessible within a 30-minute peak drive to the site in 2010 accounting for 73% of those that would be able to reach the site in uncongested conditions in 2010 and 64% in 2040.

Exhibit 7-4 shows the diminishing highway accessibility of Silicon Valley in 2010 and 2040. The green shape represents the area that is within 30 minutes of the cluster in uncongested conditions, the orange shape shows the smaller area accessible in 2010 congested conditions and the crimson area shows the area that will be accessible in 2040's congested conditions. One reason why the accessible area does not decline significantly by 2040 is because even in 2010 most highway facilities accessing the facility had already exceed capacity as suggested by the findings in Exhibit 2-8. With highway capacity already exhausted in 2010 and declining further by 2040 to an area with limited space for expansion, the relatively small blue shape Exhibit 7-4 represents the area within accessible transit commuting time. In contrast to the South of Market/Mission cluster in San Francisco, it is easy to see why firms in this area are concerned about sustaining access to the regional labor and business market.

Exhibit 7-4: Diminishing Highway Accessibility of Silicon Valley Cluster



These results, taken from the MTC travel demand model, demonstrate the natural limitations of highway capacity alone for supporting a one of the most critical locations for the US Economy. The results show the limited capability of San Francisco's highway network to serve the intensity of activity in this critical cluster, even if traffic volumes decline as build out plateaus and some workers are able to live closer to work.

Of the potential new commuting trips attracted to this cluster by 2040 (as shown in Exhibit 7-2), at least 3,600 are expected to be jobs directly enabled by transit capacity (based on existing and projected modal shares in clusters nationally). By 2040, these jobs would be expected to create over $433 Million of wage income, $1.5 Billion in business output and over $690 Million annually in the bay area regional economy. Exhibit 7-5 summarizes the direct effects of jobs in this cluster that may be directly enabled by transit by 2040.

Exhibit 7-5: Potential Direct Economic Effects of the Silicon Valley Cluster Growth Enabled by Transit Access

Potential New Jobs Enabled by Transit 2040	Income ($Million/Year)	Business Output ($Million/Year)	GDP ($Million/Year)
3,683	$433.1	$1,560.6	$690.1

7.3 Role of Transit in Sustaining the Cluster

In 2012, the state legislature approved a funding package for High Speed Rail that would run from southern California, through San Jose up to San Francisco. The funding package included money for the electrification of Caltrain (commuter rail line from San Francisco south through the Peninsula and San Jose to Gilroy), which will increase capacity, reduce headways, increase frequency and improve station access. The Bay Area Rapid Transit (BART) system also is expanding service to the Peninsula from the East Bay. Construction on a 10-mile expansion from Freemont to San Jose began in 2012 and is expected to be completed by 2017. This initial phase will do little to help commuters trying to reach the Silicon Valley, but phase 2 will add an additional 5.1 miles of service culminating at the Santa Clara Caltrain station, providing good transfer options for travelers from the southern East Bay who work in the Valley.[41] Construction on this phase is dependent on securing funding. Finally, as described at the outset of this case study, Google is a leader in the Shuttle Phenomenon, described below, and relating the Silicon Valley Cluster to the previously described South of Market Cluster.

The Shuttle Phenomenon

Perhaps one of the clearest indications of the business need for transit at a concentrated industry cluster is the investment that private firms make in transit services to ensure the efficient movement of people to and from the cluster. Private knowledge-based companies are running shuttles from all over San Francisco to transport the young, educated workforce that wants to live in the city to jobs in both Silicon Valley and the Midtown & South of Market/Mission clusters. Google alone makes 150 shuttle runs per day within San Francisco,[42] and a total of 380 throughout the City and Peninsula.[43] Employers note several reasons for providing shuttle services, including:

- "To address rising commute, due to increased traffic congestion by promoting transit use as a more productive and "green" mode of transportation;
- To fill service gaps and other inadequacies in the local and regional transit systems;
- To recruit and retain a highly skilled workforce who may value living in an urban center and thus be attracted by an easy commute to a distant employment site away from the urban core;

41 *http://svlg.org/policy-areas/transportation/bart-to-silicon-valley*

42 *http://stamen.com/zero1/*

43 *Kevin Mathy, Google Transportation Manager*

- To discourage driving due to a shortage of on-site parking spaces; and
- In some cases as a response to mandatory planning stipulations and conditions of original site development." [44]

A study of the impacts of shuttles on transportation in the City identified a number of benefits including avoidance of 327,000 solo vehicle round trips per year, a reduction of 20 million vehicle miles of travel per year, a reduction in CO2 and other emissions, an increase in local spending at shops near shuttle stops, assistance in employer recruitment and retention, increased productivity, improved accessibility, a reduction in car ownership, and gains in leisure or personal time. Negative impacts include localized emissions from motor coaches, increased noise and vibration, conflicts with cars and cyclists, conflicts with Muni buses when loading or idling at bus stops, safety, weight restriction violations, and wear and tear on curb bulbs."[45]

Following is an example of one company's shuttle use and reasoning for having a shuttle:

The Genetech example illustrates how a firm in a high-growth industry values access to a business cluster location enough to stay and pay the price for a transit service as a more viable option than moving to a site away from the cluster but with improved highway capacity – even at a $10 Million expense to the firm.

The example also raises two critical issues:

- In key industries, American businesses and workers who already pay taxes to support the transportation system are also contributing additional funds to provide a level of mobility that only transit can provide, and
- This unmet need in the current transportation infrastructure imposes significant costs on firms in some of America's most high-value and high-growth industries.

In the future, as firms continue to develop in industry clusters, it is likely that many other firms will not be in a position to invest as Genetech has. Such firms may simply be unable to grow in business clusters if transit is not otherwise available, and consequently may be less productive or may even chose to locate in clusters in other countries. Furthermore, firms like Genetech who invest their private dollars in transit (when their tax dollars already go to support transportation) are then less able to invest in research and development, new technologies and strategies to help them better compete internationally.

44 *San Francisco County Transportation Authority, "Final SAR 08/09-2 Strategic Analysis Report the Role of Shuttle Services in San Francisco's Transportation System", June 28, 2011.*

45 *Ibid., pp. 7-8.*

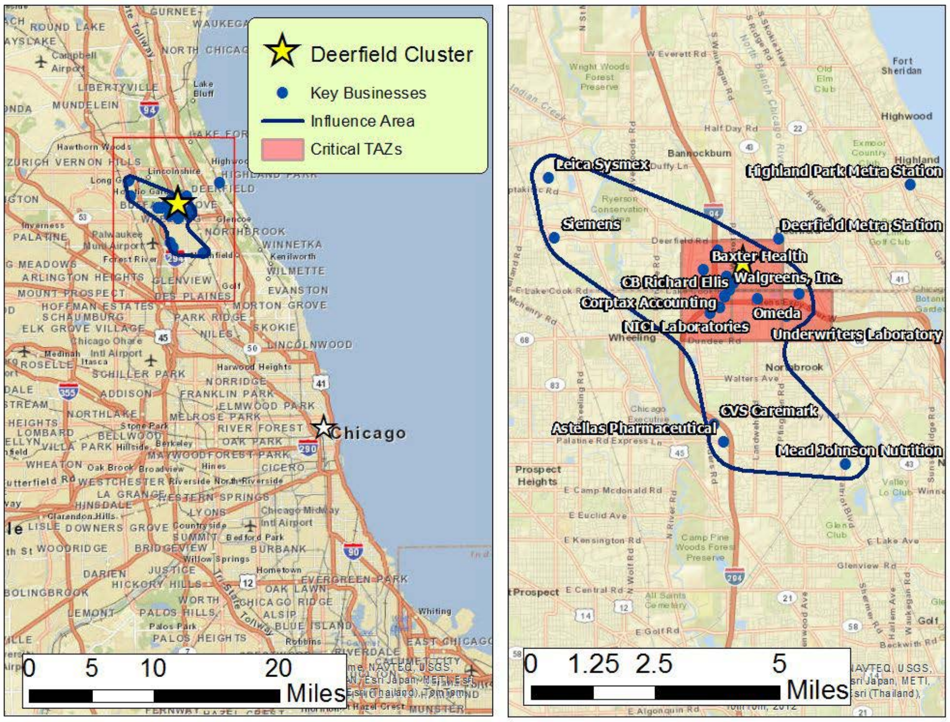
8 Deerfield, IL: Business Cluster

8.1 Overview of the Cluster

The Deerfield, IL cluster is located about 35 miles north of Chicago. The study area features the intersection of I-94 (The Tri-State Tollway), which runs from Milwaukee southeast to Chicago, and I-294, which runs south from this intersection to O'Hare International Airport. The businesses in the study area are clustered around this interchange and are accessed by state and county highways. Waukegan Road, located 1 mile east of Deerfield provides north-south arterial access. Lake Cook Road on the south and Deerfield Road on the north are major east-west arterials through the study area.

Exhibit 8-1 shows the location of the Deerfield cluster within the context of the larger Chicago region. As a suburban cluster, the Deerfield cluster is geographically well defined (not spilling over into larger urban economies as some of the other clusters). The shaded red area shows the core of the cluster as reflected in the travel characteristics analysis below, with the navy blue line showing the larger influence area that is both dependent on the cluster today, and into which the cluster may be expected to expand over time.

Exhibit 8-1: Location of the Deerfield Cluster



The cluster is home to US firms Walgreens, Baxter Healthcare, Business Technology Partners, APAC Customer Services, Fortune Brands Home and Security, Cosi, Big Apple Bagels, Consumers Digest, Beam, Mondelez International, and CF Industries. The village also houses the headquarters of three US subsidiaries of Takeda Pharmaceutical Company – Takeda Pharmaceuticals International, Takeda Pharmaceuticals North America, Inc., and Takeda Global Research and Development Center, Inc.[46]

The large headquarters and pharmaceutical companies historically located in Deerfield, are there, in part, because of its proximity to affluent villages making up Chicago's "North Shore". While these communities are highly attractive to executives and top managers, many younger and lower-wage employees working at Deerfield-based companies prefer to live within the City of Chicago and either drive or use public transit to reach their job.[47]

46 *http://en.wikipedia.org/wiki/Deerfield,_Illinois#cite_note-36*

47 *Kermit Weis, CMAP*

The Village of Deerfield is almost built-out and has limited capacity for more development. The goal of the Village is to ensure that its existing businesses have the ability to expand as needed, and to attract workers. The Village would like to continue to attract corporate offices for high tech, research and development and pharmaceuticals firms.[48]

8.2 Transportation Challenges & Outlook

Deerfield is an example of a cluster that is has gradually seen increasing congestion, but anticipates significantly greater challenges in the future if some action is not taken. As the cluster has developed since the 1980's, traffic and congestion have increased steadily. In recent years traffic has become an increasing constraint on development as workers located in Chicago commute into the cluster, contributing to increased congestion. The Lake-Cook and Deerfield Metra stations on the eastern periphery of the cluster are not within walking distance of most of the major employers and the business community has recognized an ongoing need to improve transit accessibility.

Recognizing the need for transit operations beyond what are publicly available, area businesses have formed the Transportation Management Association (TMA) of Lake-Cook , which has been operating in Lake and Cook Counties since 1989. Its services include Shuttle Bug, 12 shuttle bus routes that connect with Metra and PACE stations, and area businesses. Several routes serve the study area. Employees that use the shuttle ride free, with service costs shared by the employers and participating transit agencies.[49]

Developers have expressed a desire to attract the young professionals who now prefer to live in Chicago because they can walk, bike and use transit, thus lessening dependence on the automobile. The developers have expressed to the Village officials that they expect to attract young couples who can use transit to get to jobs in Chicago, or can walk to a job in Deerfield, thus letting a couple get by with one car. These developments are being built with pedestrian and bicycling facilities that will attract young professionals. The Village planners have requested that the developers work with PACE to ensure that Shuttle Bug and bus stops are added at these developments to ensure that those living in the developments have transit options.[50]

Private Firms See the Need for Transit Serving the Deerfield Cluster

During the past 25 years, the Lake-Cook Road corridor has seen a dramatic increase in the number and size of corporate campuses along its length. An estimated 95 percent increase in employment between 1979 and 1999 in the corridor has produced severe traffic congestion as employees pour into the area from suburban communities and Chicago. In 1988, in the face of increased congestion and air quality degradation, business leaders in the Lake-Cook corridor began to recognize the need for a more comprehensive approach and formed a transportation management association. Since then, the TMA of Lake-Cook has been instrumental in developing and implementing transit priorities, promoting rideshare, removing the delay-causing Deerfield toll plaza, developing shuttles to rail stations and advocating for intelligent transportation systems.

-Metropolitan Planning Council Website

https://www.metroplanning.org/multimedia/publication/226

48 *Laveque*

49 *http://www.tmalakecook.org/Annual%20Reports/Annual%20Report2011forWeb.pdf*

50 *Laveque*

Exhibit 8-2 summarizes transportation characteristics of Deerfield cluster today, and the anticipated conditions in 2040 under the CMAP's current long-range plan.

Exhibit 8-2: Transportation Characteristics of the Deerfield Cluster

Factor	2010	2040
Total Peak 3-hr of Trips	27,216	41,419
Auto Trips	27,074	41,159
Transit Trips	142	260
Transit Share	1%	1%
Increased Trip Time Due to Congestion	58%	81%
Population in 30 Minute (Free Flow)	6,908,000	5,025,000
Population in 30 Minute (Congested)	3,810,000	3,754,000
Population in 45 Minute Transit	N/A	N/A
Employment in 30 Minute (Free Flow)	354,000	262,000
Employment in 30 Minute (Congested)	177,000	172,000
Employment in 45 Minute Transit	N/A	N/A
Lost Population/Employment Access (Free Flow vs. Peak – Highway)	-45%	-26%

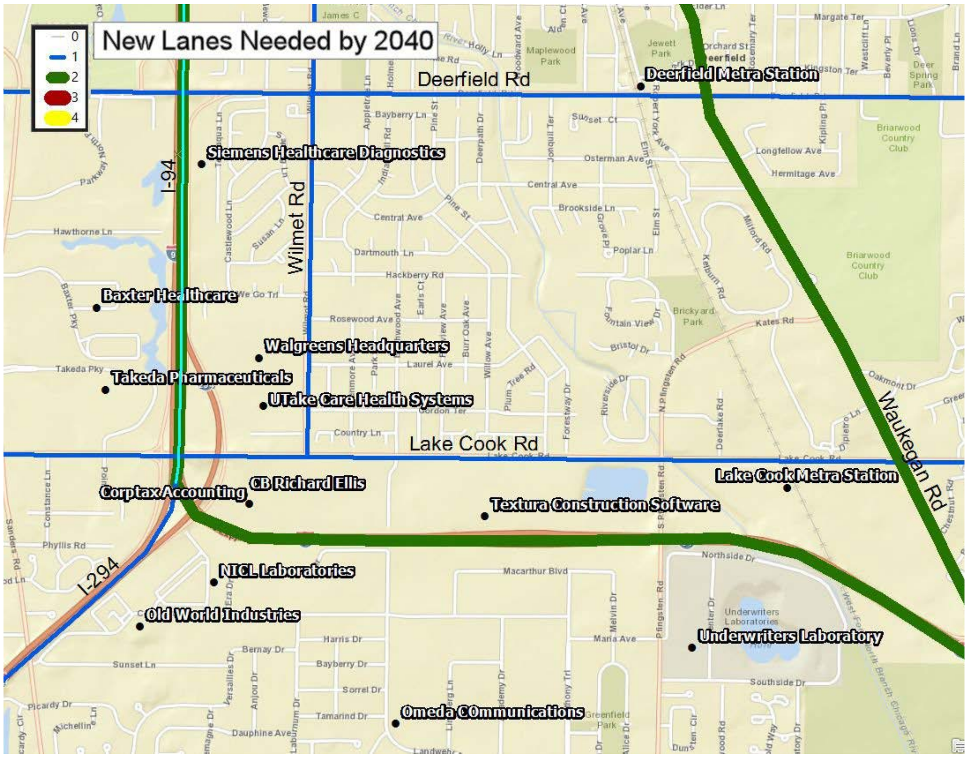
Source: CMAP, Travel Demand Model

With over 27,074 peak period tips accessing this cluster in 2010, most routes serving this cluster, while congested are likely to have adequate capacity in the near term, given current expansion efforts, with congested travel times only 3% longer than they would in uncongested conditions. A project to widen Lake Cook Road from I-294 to Waukegan Road, adding two lanes in each direction, is currently underway and expected to be completed in the fall of 2013. The project also includes improvements to the Waukegan-Lake Cook intersection. Within the next three years, two lanes in each direction will be added to Lake Cook Road west of I-94 in Buffalo Grove.[51]

51 *Bill Baltutis, Executive Director, TMA of Lake Cook. Telephone conversation June 11, 2013.*

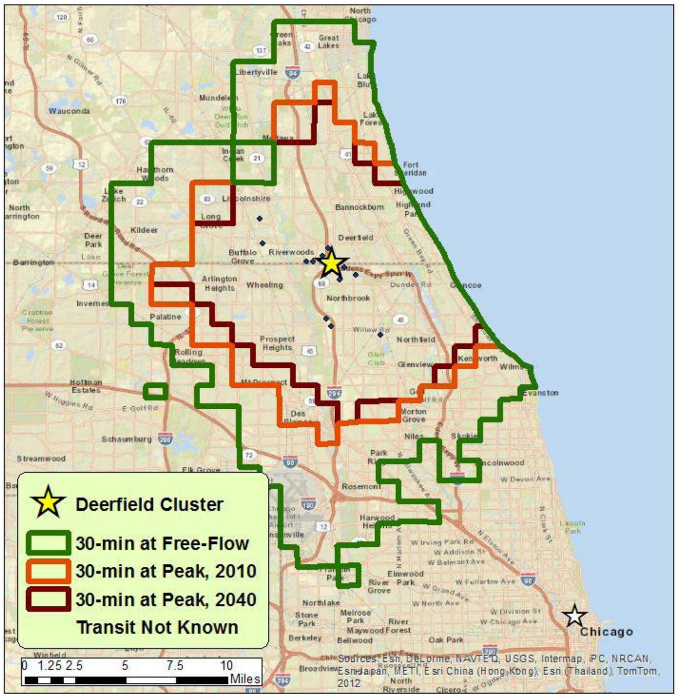
Despite these robust enhancements to highway capacity, by 2040, peak period demand for trips to the cluster is expected to increase by 52%, with congested commute times expected to take 81% longer than they would under uncongested 2040 conditions. By 2040 roadway demand on routes to the cluster will exceed capacity by as much as 50%. Exhibit 8-3 shows the number of additional lanes will be needed in 2040 (above and beyond those recently built or currently funded) to provide uncongested access to this cluster.

Exhibit 8-3: Lanes Needed for 2040 Demand to Deerfield, IL Cluster



While it is conceivable that I-294, I-94 and Waukegan Road could be expanded to resolve congestion facing this cluster, it is unlikely that this will resolve the larger issue of commuting times between Deerfield and areas of Chicago where Deerfield's target workforce increasingly seeks to locate. As shown in Exhibit 8-4, even under uncongested conditions, most of Chicago is beyond a 30-minute commuting window for Deerfield, with an even smaller share of Chicago accessible within commuting distance by highway under 2040 congested conditions.

Exhibit 8-4: Diminishing Highway Accessibility of the Deerfield Cluster



Because Deerfield is beyond a 30-minute commute from Chicago, even in uncongested conditions, it faces challenges of both congestion as well as simple distance in its access to Chicago's regional economy. CMAP's forecasts indicate that by 2040, as workers and jobs increasingly concentrate closer into Chicago (and away from the suburban communities surrounding Deerfield), the number of people housed within a 30-minute uncongested drive time of the cluster will decrease by 28% (from just 6.2 Million in 2010 to just over 5.0 Million in 2040). A similar effect is expected with employment, whereby the number of Chicago's jobs accessible from Deerfield will decline by 26% (from 354,000 in 2010 to 262,000 in 2040). Of the people and jobs that remain within this smaller commuting shed of Deerfield, congestion will further reduce accessibility by an additional 26%. Consequently, even though congestion itself will play less of a role in reducing Deerfield's access to Chicago's business and labor market than it does today, the increasing physical distance between the Deerfield cluster and the regions with other preferred housing and business locations will exacerbate the loss of access that does occur due to congestion.

These results, taken from the CMAP travel demand model, demonstrate both that a cluster can thrive in a relatively low-density environment outside of the urban core, but also that the combined effects of distance from the urban core and congested commuting routes pose a need for innovative and multi-modal transportation.

Of the potential new commuting trips attracted to this cluster by 2040 (as shown in Exhibit 8-2), at least 3,000 are expected to be jobs directly enabled by transit capacity (based on existing and projected modal shares in clusters nationally). By 2040, these jobs would be expected to create over $241 Million of wage income, $1.5 Billion in business output and over $435 Million annually in greater Chicago's regional economy. Exhibit 8-5 summarizes the direct effects of jobs in this cluster that may be directly enabled by transit by 2040.

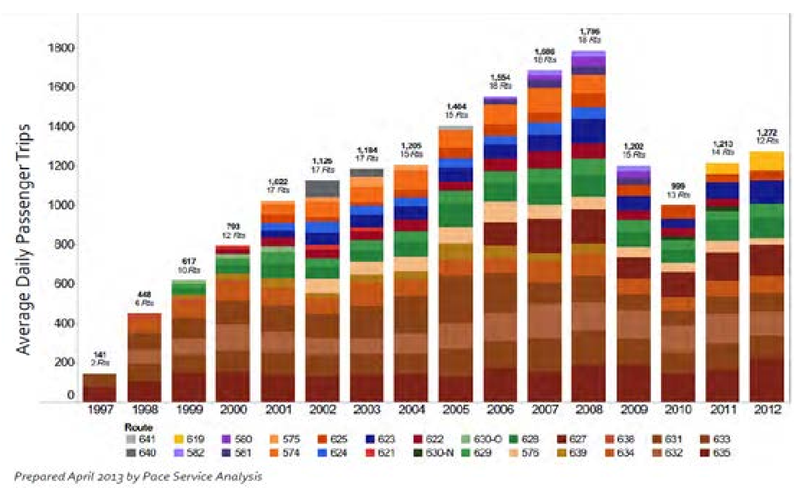
Exhibit 8-5: Potential Direct Economic Effects of Deerfield, IL: Business Center Cluster Growth Enabled by Transit Access

Potential New Jobs Enabled by Transit 2040	Income ($Million/Year)	Business Output ($Million/Year)	GDP ($Million/Year)
3,077	$ 241.1	$ 1,528.6	$ 435.4

8.3 Role of Transit in Sustaining the Cluster

Illinois DOT is in the first phase of study with PACE (the regional bus system) to evaluate the potential for bus-down-the-shoulder service on I-94 northbound from Chicago to the Deerfield cluster during peak periods.[52] Ridership on the TMA Shuttle Bug continues to increase with gas prices and underlying demand, experiencing 1.19% spike in ridership in the first quarter of 2012. Exhibit 8-6 shows increases in Shuttle Bug ridership since 1998, with drops in 2009 and 2010 correlating with regional economic downturns and declines in gas prices. Despite this instability, ridership began to rebound in 2011 and is expected to increase in the future.

Exhibit 8-6: Trend in "Shuttle Bug" Ridership 1997-2012



52 *Baltutis*

9 Denver Technology Center Cluster

9.1 Overview of the Cluster

The Denver Technological Center (DTC) is located in the southeast section of Denver, CO, with a portion of the Center within the city limits, and a portion within Greenwood Village. The DTC is recognized as one of Denver's major employment centers. Major employers at the DTC include United Cable Vision, AT&T Broadband, and United Artists Cable, all of which have been here since the 1970s when the center first opened. Additional firms that have located at the site include Sprint, Echo Star Communications, Nextel, Dow Jones and Company, Regis College, Nissan Motor Corporation, and DirecTV (more than 1,000 customer support employees.)[53] The area continues to attract national and international firms that want a western location.

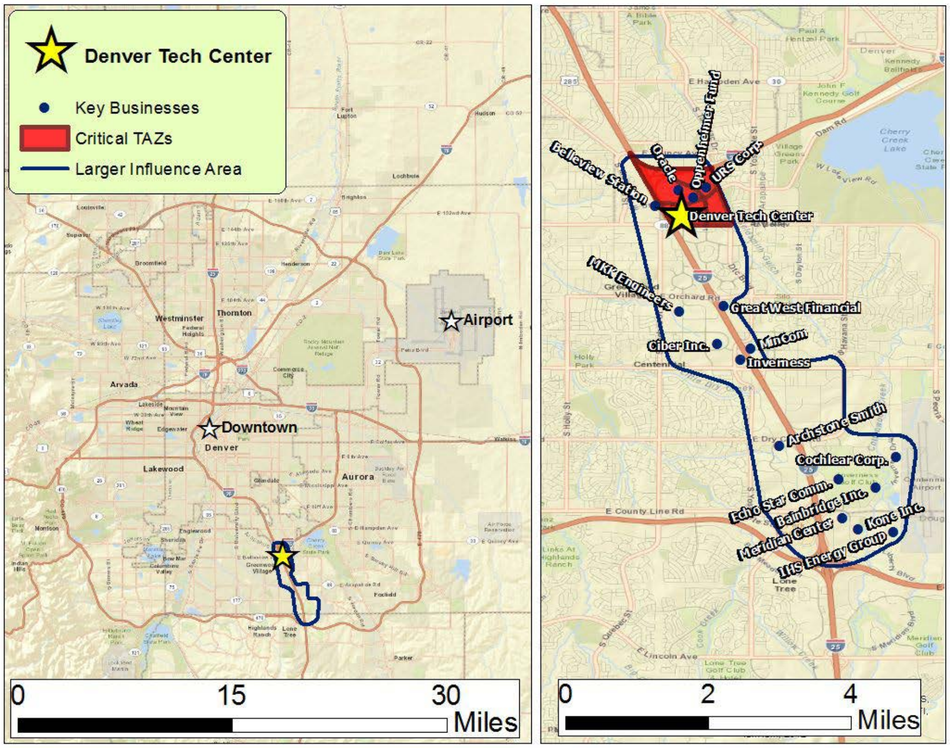
Exhibit 9-1 shows the location of the DTC cluster within the larger Denver region. The shaded red area shows the existing core of the cluster as reflected in the travel characteristics analysis. The navy blue shape shows the much larger area within which there are current businesses dependent on the cluster, and into which it is plausible to expect the cluster to expand by 2040.

"[The Denver Technology Center Corridor produces] nearly 30 percent of the earnings in the state. It is home to approximately 20,000 businesses and 300,000 employees. Seven of the nine Fortune 500 companies headquartered in Denver are located in this corridor. The corridor has 40 million square feet of leasable area."

Steven Klausing, Executive Vice President, Denver South Economic Development Corporation

53 *http://denvertechcenter.wordpress.com/category/dtc-area-company-news/*

Exhibit 9-1: Location of the DTC Cluster



9.2 Transportation Challenges & Outlook

The Denver Technology center provides an instructive case of where a comprehensive multi-modal solution involving both high-capacity transit and highway expansion has been undertaken. However, all of the recently completed new highway access is expected to be utilized by 2040, pinpointing the strategic significance of the light rail line in sustaining the cluster in the long-term.

The cluster is located at the intersection of Interstates 25 and 225, about 15 minutes from downtown and 30-40 minutes from the Denver International Airport (DIA).   Circumferential highways serving the corridor from the south include the C-470 (west from I-25 to the foothills) and the E-470 (private toll road that runs east from I-25, then north to Denver International Airport (DIA), then back west north of Denver.) The center is also served by Denver's Regional Transit District (RTD) light rail (E and F lines) with a stop at Belleview Station. The H line also serves Southmoor station, where passngers can transfer to buses serving the DTC. The LRT began service from downtown along I-25 in November 2006. The LRT connects to existing LRT that provides service to the Central Platte Valley, downtown, and Denver's southwest suburbs.[54]   The expansion of LRT to the area was part of what is known

54 *http://www.metrodenver.org/files/documents/transportation-infrastructure/highways/Trans_HWY_T-REXFactBook.pdf*

Elected Leadership Ties Transit Expansion to Workforce attraction at Denver Technology Center

"Keeping the capacity of our principal highways, C-470 and I-25 at Arapahoe Road, currently denotes a major challenge. Extending Light Rail to Ridge Gate (a major housing development catering to millennials), as well as completing FasTracks Denver's commuter rail expansion plan), is likewise a significant issue for the next generation of job creators and entrepreneurs."

Ron Rakowsky, Mayor of Greenwood Village, CO

http://denversouthedp.org/Postioning_South_Denver_for_Global_Competition.aspx as the T-REX (for Transportation Expansion) Project, which included the addition of two lanes in each direction along I-25 between downtown and Douglas County, the addition of two lanes in each direction on I-225 near the intersection with I-25, interchange improvements, and the construction of 19 miles of double tracked light rail along the I-25 corridor and I-255.[55]

Good transportation access has long been recognized by the businesses in the corridor as crucial to their success. The Denver South Economic Development Corporation was instrumental in pushing for the T-REX project, and continues to advocate for transportation improvements. The further southward extension of the LRT line serving the cluster will be an important key for getting employees to the corridor.

Economic development agencies view the LRT as an important amenity for attracting young, knowledge workers to live in Denver and work in the DTC Cluster. Employers in the cluster seeking to recruit young talent report that younger workers want to live in the foothills where they can live without a car, or where a couple can get by with only one car. Schwab chose its location in close proximity to the LRT precisely for this reason, and Merrick built their 210,000 square foot building near an LRT station for the same reason. The importance of continued, reliable transportation access is well-recognized by the Denver South Economic Development Corporations, area businesses, and municipal officials.

Exhibit 9-2 summarizes transportation characteristics of the Denver Technology Center cluster today, and the anticipated conditions in 2040 under the Denver Regional Council of Government (DRCOG)'s current long-range plan.

55 *http://denversouthedp.org/5th_Anniversary)of_T_REX.aspx*

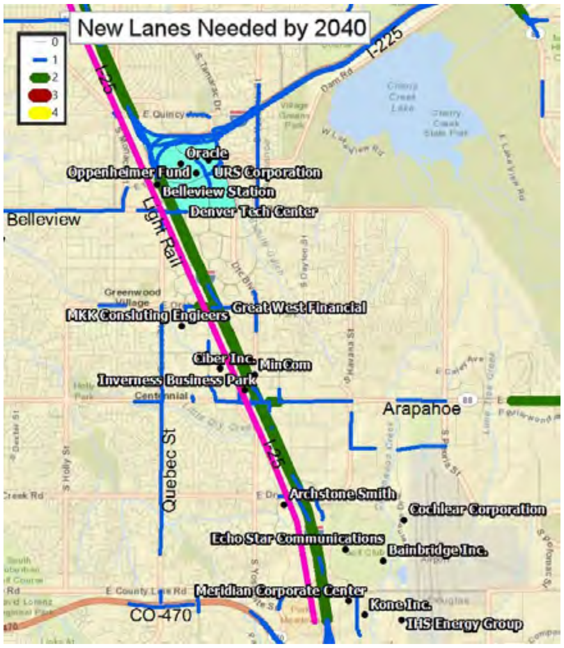
Exhibit 9-2: Transportation Characteristics Denver Technology Center Cluster

Factor	2010	2040
Total Peak 3-hr of Trips	9,096	10,412
Auto Trips	6,822	7,080
Transit Trips	2,274	3,332
Transit Share	25%	32%
Increased Trip Time Due to Congestion	35%	100%
Population in 30 Minute (Free Flow)	1,725,000	2,369,000
Population in 30 Minute (Congested)	675,000	388,000
Population in 45 Minute Transit	N/A	904,000
Employment in 30 Minute (Free Flow)	1,097,000	1,775,000
Employment in 30 Minute (Congested)	511,000	402,000
Employment in 45 Minute Transit	533,000	820,000
Lost Population/Employment Access (Free Flow vs. Peak – Highway)	-58%	-81%

Source: Denver Regional Council of Government Travel Demand Model

With nearly 10,000 peak period tips accessing this cluster in 2010, the expanded highway and transit capacity of T-REX have brought transportation capacity to a level allowing significantly less congested access than would otherwise be the case. However, by 2040, congestion both on regional routes to housing areas where DTC workers reside and even on the recently expanded highway facilities is expected to double travel times by 2040 in comparison to what they would be in uncongested conditions. Exhibit 9-3 shows that if the area is fully built out by 2040 roadway demand on routes to the cluster will exceed capacity by between 10% and 120%. Uncongested conditions would require 2 additional lanes through many of the major facilities within the cluster and potentially infringing on land currently used by businesses in the cluster. Exhibit 9-3 also shows that the highly concentrated area (shaded in blue) covered by the current traffic analysis represents only a part of the corridor where high-value firms are locating, and it is likely that the cluster will geographically expand along the corridor to the south, raising the possibility that job growth may well drive demand growth at a faster rate than shown in Exhibit 9-2.

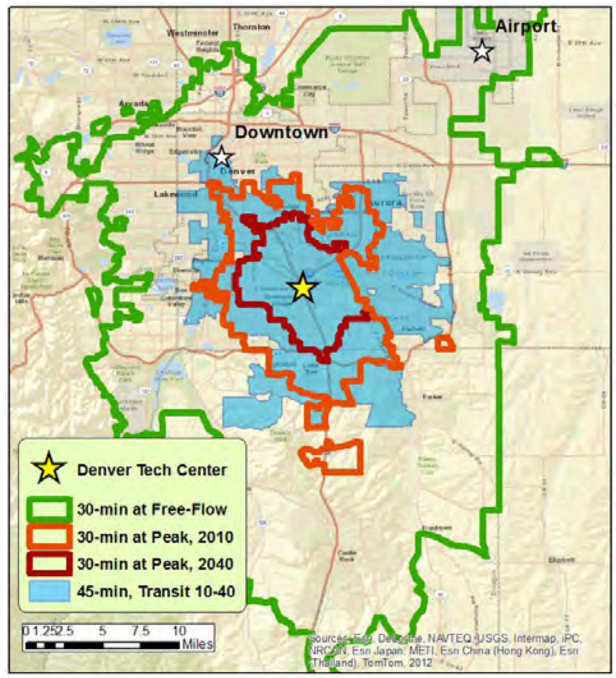
Exhibit 9-3: Lanes Needed for 2040 Demand to DTC Cluster



Highway congestion is likely to significantly curtail the cluster's access to Denver's larger regional economy. Overall, in 2010 the share of Denver's people and jobs within a 30-minute peak drive time to the cluster was reduced by 58% due to congestion, and is expected to be reduced by 81% in 2040. Of the 1.7 Million people who resided within a 30-minute drive to the DTC cluster in 2010, only just over 675,000 (approximately 39%) can access the cluster within 30 minutes during peak period congestion. By 2040, the percentage of the population accessible to this cluster in the peak period is expected to further decline to 16% of the population that could access the site in uncongested conditions, with the actual number if people within a 30-minute peak period commute of the site declining by 43% from approximately 675,000 in 2010 to approximately 388,000 in 2040. The cluster faces a similar challenge with its access to Denver's businesses, for which the number of jobs accessible within a 30-minute peak drive to the site in 2010 accounting for only 46% of those that would be able to reach the site in uncongested conditions, and this share declining to 22% by 2040.

Exhibit 9-4 shows the diminishing highway accessibility of Denver's DTC cluster. The green shape represents the area that is within 30 minutes of the cluster in uncongested conditions, the orange shape shows the smaller area accessible in 2010 congested conditions and the crimson area shows the area that will be accessible in 2040's congested conditions. The blue polygon shows areas that will be transit accessible by 2040 (in 45 minutes, to allowing for 30-minute in-vehicle time plus an assumed 15 minute allowance for terminal and walk to transit times) under current planning.

Exhibit 9-4: Diminishing Highway Accessibility of Denver Technology Center Cluster



These results, taken from Denver's regional travel demand model, demonstrate more clearly than most other cases that when investments are made in Transit, even in a city of average density – a concentrated business cluster can preserve workforce accessibility when transit is available. It is significant to note that while Denver has made recent significant expansions in highway capacity serving the technology center in recent years, by 2040 a larger share of the region's population will be within a 45 minute transit commute than a 30 minute auto commute of the cluster. Of the potential new commuting trips attracted to this cluster by 2040 (as shown in Exhibit 9-2), at least 285 are expected to be jobs directly enabled by transit capacity (based on existing and projected modal shares in clusters nationally). By 2040, these jobs would be expected to create over $24.6 Million of wage income, $131 Billion in business output and over $67 Million annually in greater Denver's regional economy. Exhibit 9-5 summarizes the direct effects of jobs in this cluster that may be directly enabled by transit by 2040.

Exhibit 9-5: Potential Direct Economic Effects of Denver Technology Center Cluster Growth Enabled by Transit Access

Potential New Jobs Enabled by Transit 2040	Income ($Million/Year)	Business Output ($Million/Year)	GDP ($Million/Year)
285	$24.6	$131.7	$67.3

9.3 Role of Transit in Sustaining the Cluster

The I-25 corridor is recognized as a future growth area from the DTC southward. As such, there are a number of both transit and highway improvement projects planned for the area. Some major initiatives underway that are expected to directly affect the accessibility of the DTC include:

- Three-mile extensions of the southeast LRT line (the line serving the DTC cluster) to a terminus at the Ridge Gate business park, adding three more stations. These stations will serve Schwab and the hospital.
- Continued construction of the FasTracks light rail initiative, which will add six more routes to the system, including the I-225 beltway line that began construction in Aurora in 2013. This will connect to the southeast line (serving the DTC) at the Belleview station. Other lines will go from downtown to Denver International Airport, providing a rail option to DIA from the DTC.
- Pursue options to address the "last ½ mile problem." This refers to the problem of getting workers from the transit stations to their ultimate destination. The business community is expected to be a partner in solving this problem. Public-private or private shuttle systems, enhanced carpooling incentives and other options are under consideration.

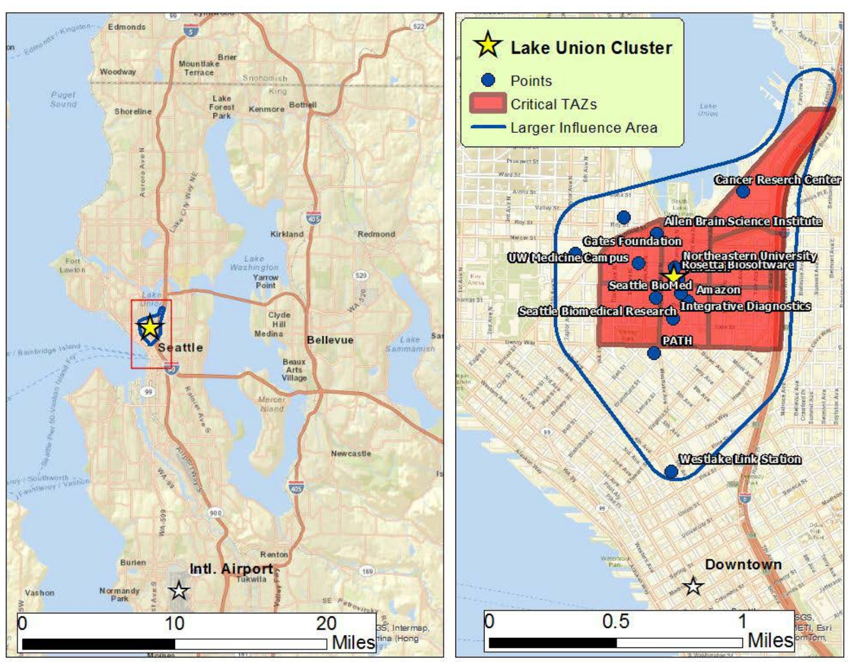
10 Seattle: South Lake Union Cluster

10.1 Overview of the Cluster

The South Lake Union area in Seattle is located at the south tip of Seattle's Lake Union. Due to recent development by Paul Allen's Vulcan Inc., as well as other prominent developers, South Lake Union is becoming a hub for life science organizations. Some in the area include: Fred Hutchinson Cancer Research Center, Zymogenetics, Battelle, Seattle Biomedical Research Institute, Seattle Children's Hospital, PATH, Rosetta (now part of Merck & Co.), Bio-Rad, and University of Washington Medicine[56] .

Exhibit 10-1 shows the location of the South Lake Union Cluster. The red shaded area shows the existing core of the cluster as reflected in the travel characteristics analysis, whereas the navy blue shape indicates the broader area of Seattle into which the cluster is expected to expand as office space in the cluster becomes increasingly scarce.

Exhibit 10-1: Location of the South Lake Union Cluster



56 *Wikipedia (http://en.wikipedia.org/wiki/South_Lake_Union,_Seattle), accessed on 13 June, 2013*

The South Lake Union Campus of the University of Washington School of Medicine now includes 1,250 people (researchers and staff) in four buildings. The oldest is the "Blue Flame" building (the former home of Washington Natural Gas) at 815 Mercer St, which houses 4 floors of biotechnology and medical research laboratories. Among the varied research areas are four Centers, focused on Allergy & Inflammation, Cardiovascular Biology & Regenerative Medicine, Lung Biology and Translational Medicine in Women's Health.

In October 2012, Amazon announced it would spend over $1 billion to purchase its South Lake Union corporate headquarters from Microsoft founder Paul Allen's investment firm. Based on the value of the deal, Amazon would pay the highest ever price for an office building over 100,000 square feet in Seattle at around $644 per square foot, more than double the then-current average rate of $308 per square foot for the city's office space, according to Real Capital Analytics.

The roots of biotechnology in the area extend back before the designation of South Lake Union as an urban center. In 1993, the Fred Hutchinson Cancer Research Center opened its headquarters in the district and began buying land for future expansion. ZymoGenetics moved to the district the following year. (It vacated its space in 2011 after being bought out by Bristol Meyers.) At that time, large parcels of inexpensive land were the big draws for these firms. In 2003, then mayor Greg Nickels announced plans to create a biotech hub in South Lake Union, with plans to create thousands of jobs. By 2008, 1.5 million square feet of biotech space had been built in the district. Housing and retail also took off during this period, but in 2008, there were still 7.5 jobs for every household in the district , making it a net employee importer.

Although the growth of the biotech sector in South Lake Union slowed during the recession, activity has picked up in recent years. PATH, the global health non-profit, relocated to the district from Ballard in 2010. In 2011, the Institute for Systems Biology (IBS) relocated from North Lake Union because they had outgrown their space, had located their administrative functions in another building, and wanted to bring all functions back together under one roof. They leased space in a building which had formerly housed Rosetta. One reason for the move to South Lake Union was to be within a 10-minute walk of top biologists and half a dozen research institutions. The original move brought 300 employees to the site, with plans to grow to 500 over ten years. The Gates Foundation, with its substantial global health initiatives, located in the district in 2011.

Public infrastructure and services are seen as a critical element of sustaining the South Lake Union cluster.

Public Infrastructure & Services Contribute to Cluster Success

"The success in South Lake Union with the life sciences and global health sector is an example of successful public-private partnership. We are committed to continued engagement with industry and community leaders on issues of job training, power reliability, zoning, transportation infrastructure and urban design to continue this momentum."

Seattle Mayor Mike McGinn (News Release, 2011)

10.2 Transportation Challenges & Outlook

The South Lake Union cluster is an area of highly concentrated development currently served by Seattle's streetcar system, but still largely highway dependent. Because of the concentration of development in the area, adding capacity by building new lanes of roadway is limited, hence the city is seeking to better manage available capacity by making Mercer Street two-ways and supporting some intersection improvements. In 2007, the South Lake Union Streetcar began operation, connecting Westlake Center to the south end of Lake Union at Yale Avenue N. and the area is currently served by three of Seattle's five streetcar lines. However, managing the current highway routes into the cluster has limited potential for supporting its long-term development unless the streetcar lines or other transit services can enable more of Seattle's workforce and businesses to access the cluster.

As the city realizes its plans to increase the density of the area, transportation access becomes more critical. The district is hemmed in by Lake Union to the north, I-5 to the east, SR 99 to the west, and established neighborhoods and downtown to the south. The Mercer Street corridor project will provide some improved vehicle access, but for the most part, any further roadway improvements will be limited in their ability to significantly improve vehicle access to the area. Seattle has been diligent and successful in its efforts to create dense, mixed use areas that encourage alternative modes to the automobile. People are attracted to living and working in this neighborhood because of its diversity of uses, housing options and employment options within a short distance of each other. Additional efforts to increase transit options, improve the pedestrian and bicycling environment and locate housing in close proximity to the jobs in the district will all be necessary to keep the area operating as a vibrant, technology and world health center and livable community.

Exhibit 10-2 summarizes transportation characteristics of Seattle's South Lake Union cluster today, and the anticipated conditions in 2040 under the Puget Sound Regional Council (PSRC)'s current long-range plan.

Exhibit 10-2: Transportation Characteristics South Lake Union Cluster

Factor	2010	2040
Total Peak 3-hr of Trips	14,351	18,000
Auto Trips	13,964	17,000
Transit Trips	387	1,000
Transit Share	3%	5%
Increased Trip Time Due to Congestion	73%	112%
Population in 30 Minute (Free Flow)	3,514,000	4,711,000
Population in 30 Minute (Congested)	2,408,000	2,319,000
Population in 45 Minute Transit	N/A	N/A
Employment in 30 Minute (Free Flow)	N/A	2,828,000
Employment in 30 Minute (Congested)	N/A	1,642,000
Employment in 45 Minute Transit	N/A	N/A
Lost Population/Employment Access (Free Flow vs. Peak – Highway)	-31%	-51%

Source: Puget Sound Regional Council, Travel Demand Model

The area was congested in 2010, with congestion increasing the peak period commute time by 73%, and is likely to become more congested by 2040, with congestion anticipated to make future travel times more than twice (112%) what they would otherwise be. Trips to the area are expected to increase by approximately 25% from just over 14,000 to 18,000, however transit trips are expected to more than double from 387 to 1,000. Most of the major roadway facilities accessing the cluster are expected to exceed capacity in 2040.

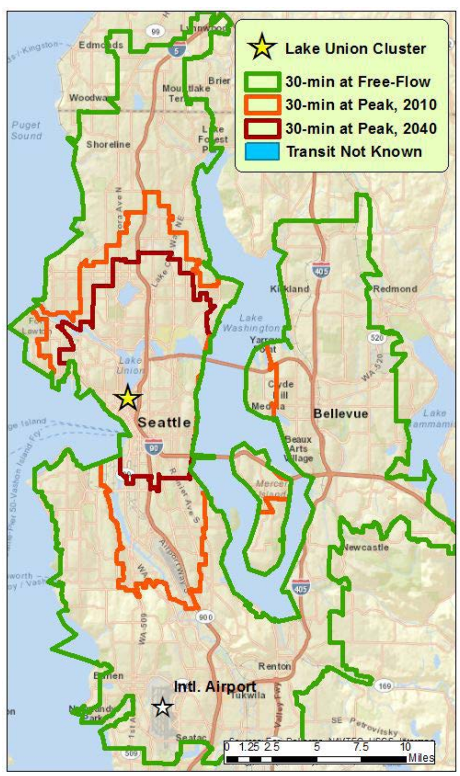
Exhibit 10-3 shows the number of lanes that would need to be constructed to accommodate anticipated highway demand without congestion.

Exhibit 10-3: Lanes Required by 2040 Traffic at South Lake Union Cluster in Seattle

As with other clusters, given the current level of build-out, constructing the additional 1-3 lanes of roadway that would be needed to accommodate future highway traffic is unlikely to be financially feasible and would threaten to crowd out much of the valuable land needed by this cluster.

Furthermore, congestion already significantly reduces access to this cluster, with 31% fewer people and jobs within a 30-minute peak auto commute window than would be able to reach the cluster in uncongested conditions. By 2040, the share of people and jobs within a 30 minute peak commute will go down to 51% less than would be the case in uncongested conditions. Exhibit 10-4 illustrates how the effects congestion will continue to diminish highway access to this cluster over time.

Exhibit 10-4: Diminishing Highway Access to Seattle's Union South of Lake Cluster



These results, taken from Seattle's regional travel demand model, demonstrate more clearly than most other cases that when investments are made in transit, even in a city of average density – a concentrated business cluster can preserve workforce accessibility when transit is available.

Of the potential new commuting trips attracted to this cluster by 2040 (as shown in Exhibit 10-2), nearly 800 are expected to be jobs directly enabled by transit capacity (based on existing and projected modal shares in clusters nationally). By 2040, these jobs would be expected to create over $65 Million of wage income, $301 Million in business output and over $106 Million annually in Seattle's regional economy. Exhibit 10-5 summarizes the direct effects of jobs in this cluster that may be directly enabled by transit by 2040.

Exhibit 10-5: Potential Direct Economic Effects of the Union South of Lake Cluster Growth Enabled by Transit Access

Potential New Jobs Enabled by Transit 2040	Income ($Million/Year)	Business Output ($Million/Year)	GDP ($Million/Year)
791	$65.3	$301.2	$106.6

10.3 Role of Transit in Sustaining the Cluster

The area is highly dependent on good transit access. The importance of the Streetcar service to area businesses is demonstrated by a current demonstration project to run the streetcar at 10-minute intervals from 3-6 pm. This demonstration project is being funded by Amazon.com, the Fred Hutchinson Cancer Research Center, the Group Health Cooperative, and UW Medicine.

The City is evaluating two options for creating a third streetcar line to be called the Center City Connector, which would connect the South Lake Union line to the First Hill Line. The First Hill line is currently under construction and will run from Capitol Hill to Pioneer Square through the International District. Other potential streetcar lines would link to the University and to Ballard.

In May 2011, the South Lake Union Community Council presented a Mobility Plan for the South Lake Union/Uptown Triangle neighborhoods. The purpose of the plan was to develop recommendations for addressing current and projected future transportation issues in the neighborhood resulting from the growth the area has seen and will continue to see. The plan calls for improved connections within the communities such as street calming, pedestrian and bike improvements including bike lanes and amenities, and some street improvements. Transit recommendations call for new bus routes, a new RapidRide transit center to facilitate transfers between local and regional buses, more reliable service, expanded service, improved amenities for pedestrians at transit stops, and more streetcar lines. The plan also calls for support of private shuttles run by area companies by creating designated drop-off areas and working to change legislation that makes it difficult for private companies to share shuttle services. Finally, it calls for two mobility hubs, one at the RapidRide transit center and one on Valley Street where it could interface with ferry service.

11 Conclusions

These detailed examples of high-value industry clusters in the US economy demonstrate different aspects of the accessibility challenges facing these places. All of the clusters are rich with examples of firms choosing locations in proximity to other firms and actively seeking ways to get people to these places. It is notable that the clusters in more mature urban areas, such as Boston's Kendall Square and San Francisco's Midtown & South of Market/Mission where the public transit share is the highest, the accessibility losses to highways are also the lowest. The examples also show that, in most of the clusters, the private sector is spearheading the initiative to develop transit to ensure the availability to sustain the cluster location and ensure workforce accessibility (either through private shuttles or through forming transportation management associations).

The examples suggest that America's firms in high-value, high growth industries are increasingly forced to choose between either (1) locating in clusters with a largely auto-dependent workforce, sustaining significant losses in workforce accessibility (ranging from 20% to 84%) due to congestion, (2) locating in clusters and pay the price of subsidizing transit for their workers to augment limited public transit services to these places or (3) foregoing the productivity and competitiveness advantages of locating in clusters altogether. When faced with these choices, these cases suggest that currently many of America's firms are choosing to pay the price of private transit as a way to avoid the accessibility losses of being fully auto-dependent. However the cases raise questions about how facing the above choices may affect the competitiveness of US firms in comparison to foreign competitors who often enjoy shorter commutes, better accessibility and more public transit, sparing foreign firms these difficult decisions.

The national implications of diminished access to high-value business clusters can be significant. The loss of travel time and reliability as well as workforce and business accessibility reaching these clusters directly undermines the competitiveness, profitability and efficiency of some of the most important activities in the US Economy. However, it is important to note that when access to business clusters is compromised by highway-delay and the affected jobs, value-added, earnings and output are placed at risk, the result is not a 100% deadweight loss to the US Economy. Global and national economic models have shown that over time, workers and firms respond to limited accessibility in various ways. It is likely that as the accessibility of US Business clusters diminishes, firms will respond in one of three ways:

(1) Firms may relocate abroad to international cities offering both agglomeration and multi-modal access.

(2) Firms may simply stay small, continuing to operate as they do today, but curtailing any plans to expand their high-value agglomeration-dependent activities.

(3) Firms may relocate domestically to clusters in those increasingly limited US Cities that still have have both agglomeration and multi-modal access.

While there are significant costs associated with any of the above, options (1) and (2) are likely to be more costly than option (3) to firms in terms of foregone profits or increased operating costs. For this reason, while additional research may show more about actual firm responses, it is prudent to assumes that only 25 to 30 percent of 'at risk' jobs may actually be lost to the US through responses (1) and (2), with the other 'at-risk' jobs retained in the economy, but functioning less efficiently than they otherwise might. The national impact calculations described below derive the total number of all 'at-risk jobs' (not the actual job loss). It is notable that assuming between 25 and 30 percent of these jobs could be actually lost to the US economy yields a loss estimate comparable to the number of jobs shown in Chapter 4 of Report 1 as potentially gained through a doubling of transit investment.

Ultimately these eight cases complement the statistical modeling and economic data presented at the national level to further explain how and why improved transit to concentrated business clusters can be expected to offer at least some marginal agglomeration impact on national and regional earnings, output, employment and GDP.

Findings suggest that between 379,000 and 480,000 jobs could potentially be lost or gained by the year 2040, depending on steps taken to address the transportation capacity constraint. As described above it is likely that only a fraction of these are likely to be sensitive to transit investment per-se, however even a fraction could influence as many as 104,000 jobs in the US economy by 2040. Exhibit 10-1 shows the expected range in the magnitude of US jobs, income, output and GDP by 2040 are likely to be affected by the accessibility challenges of business clusters, as well as the potential degree to which transit access to clusters may support better economic performance.

Exhibit 10-1: Potential Magnitude of Economic Effects of Limited Mobility to Clusters, and Potential Impact of Improved Transit Access

	Jobs in 2040	Wage Income/ Year in 2040 (In $Millions/Year)	Business Output in 2040 (In $Millions/ Year)	GDP in 2040 (In $Millions/Year)
Range of Likely Effects of Highway Capacity Limitations to Cluster Access	379,000 - 480,000	$20,647 - $26,150	$49,674 - $62,911	$31,323 - $39,670
Potential Impact of Transit Access to Clusters	104,000	$5,666	$13,631	$8,595

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