

Appendix P

Economic Analysis

Appendix Contents

Introduction and Summary

The Regional Plan Benefit-Cost Analysis

The Regional Plan Economic Impact Analysis

Economic Competitiveness Analysis

Economic Analysis

Introduction and Summary

To measure the potential impacts of our Regional Plan on the local economy, SANDAG developed a detailed economic analysis. The analysis has three parts. The first uses transportation modeling to compare the benefits of the transportation investments with the costs of the projects (i.e., benefit-cost analysis or BCA). The second part explores how those benefits, such as reduced travel times and operating costs, translate into increased economic activity (more output, more jobs) for the San Diego region. The third part of the analysis takes a broader view of the regional economy. It looks at how transportation and planning efforts can reduce costs, boost growth and opportunity, and considers the views of business leaders to get real-world perspectives on the potential impacts of our Regional Plan on the overall business climate. In essence, the first two parts of the analysis provide important quantitative measures of the economic impacts of our Regional Plan, and the third part provides broader perspectives about the interrelationships of our economy and the Regional Plan.

The **benefit-cost analysis** uses the output of the SANDAG activity-based travel model to monetize and aggregate the benefits of the plan. This analysis tells us things such as how much time and money drivers and transit riders will save, and how much safer, healthier, and cleaner our system becomes as the Regional Plan is implemented. We can then compare those monetized benefits to the cost of the plan to get a “benefit-cost ratio.” The results indicate that the benefits of the proposed Regional Plan transportation plan *outweigh the costs by a factor of almost two-to-one (1.86)*, meaning that for every dollar invested in the Regional Plan, San Diegans receive almost two dollars of benefit. The primary driver of these benefits is the time savings, which represent 80 percent of the benefits, followed by reduced operating costs, and the rest of the benefits categories.

The costs of the plan are primarily capital (80%), with about 10 percent for both operations/maintenance, and financing costs. The net present value (benefits minus costs) is \$28.3 billion, and the internal rate of return of 4.9 percent. Detailed results and methodology are available in Section I of this report.

The **Economic Impact Analysis** uses economic modeling to measure economic effects of the Regional Plan in two ways: (1) the economic effects of the stimulus obtained from constructing and operation of the transportation system; and (2) the economic effects of a more efficient transportation system (compared with a “no-build” scenario). The combined impacts are listed in Table P.1 and show an average annual increase in the San Diego economy of roughly 52,500 jobs and \$13.4 billion in Gross Regional Product (GRP) from now until 2050, which is an increase of about 2.5 percent in employment, and 4 percent of GRP versus the “no-build” scenario. About 11,500 of those jobs, and \$1.2 billion of the GRP increase, result directly from transportation investment. The rest, over 40,000 jobs and over \$12 billion in GRP, result from private sector investment enabled by the improved efficiency in the transportation system. These benefits rise over time as projects in the build scenario are completed and as congestion in the no-build scenario gets worse as San Diego grows. By 2050, the impacts are roughly 95,000 jobs and \$34 billion in GRP, which is an increase of 4.3 percent in employment, and 8.9 percent in GRP. These transportation improvements will also lower prices in the San Diego region by roughly 1 percent on average, and about 2 percent in 2050. The impacts of both types of effects were estimated using Regional Economic Models, Inc. (REMI) TranSight model. These impacts, including the industry’s most heavily affected, are detailed in Section II of this report.

Table P.1
Economic Impact of the Regional Plan

	2020	2035	2050	Average	TOTAL
Impacts from Construction and Operation	Jobs: 8,258 GRP: \$0.7 billion	Jobs: 25,020 GRP: \$2.8 billion	Jobs: 3,633 ¹ GRP: \$0.3 billion ¹	Jobs: 11,427 GRP: \$1.2 billion	Jobs: 434,237 ² GRP: \$46.3 billion
Impacts from Increased System Efficiency	Jobs: 11,868 GRP: \$2.0 billion	Jobs: 48,033 GRP: \$13.1 billion	Jobs: 91,480 GRP: \$34.1 billion	Jobs: 41,097 GRP: \$12.2 billion	Jobs: 1,561,695 ² GRP: \$464.4 billion
TOTAL IMPACTS	Jobs: 20,126 GRP: \$2.7 billion	Jobs: 73,053 GRP: \$15.9 billion	Jobs: 95,113 GRP: \$34.4 billion	Jobs: 52,524 GRP: \$13.4 billion	Jobs: 1,995,932 ² GRP: \$510.7 billion

Figure P.1
Economic Impact of the Regional Plan

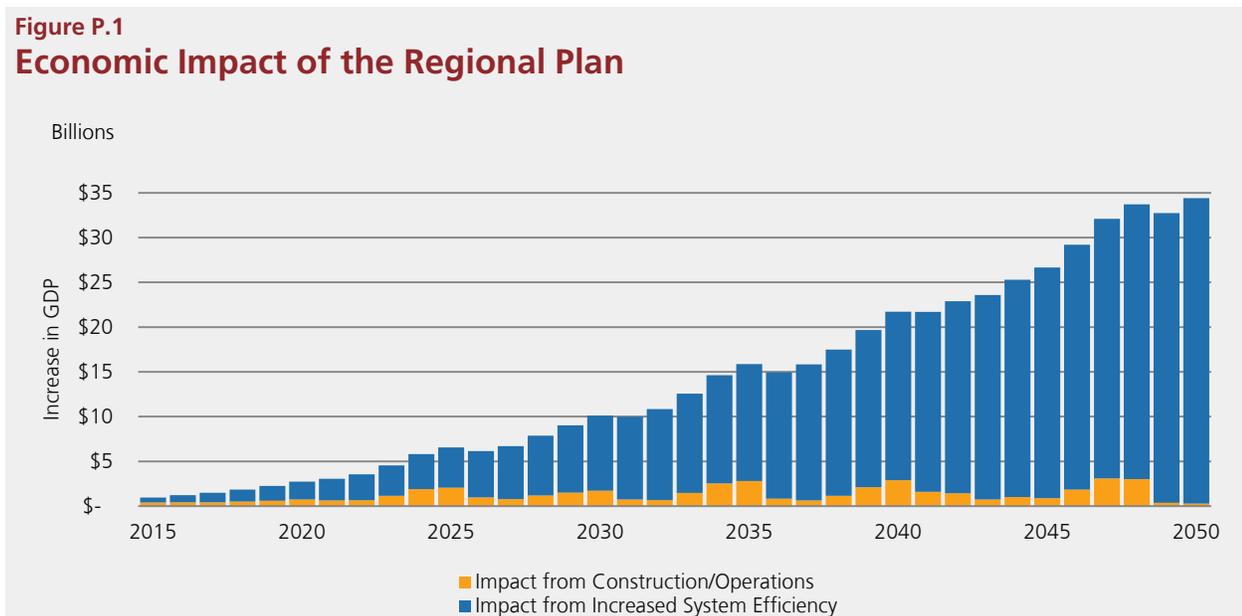
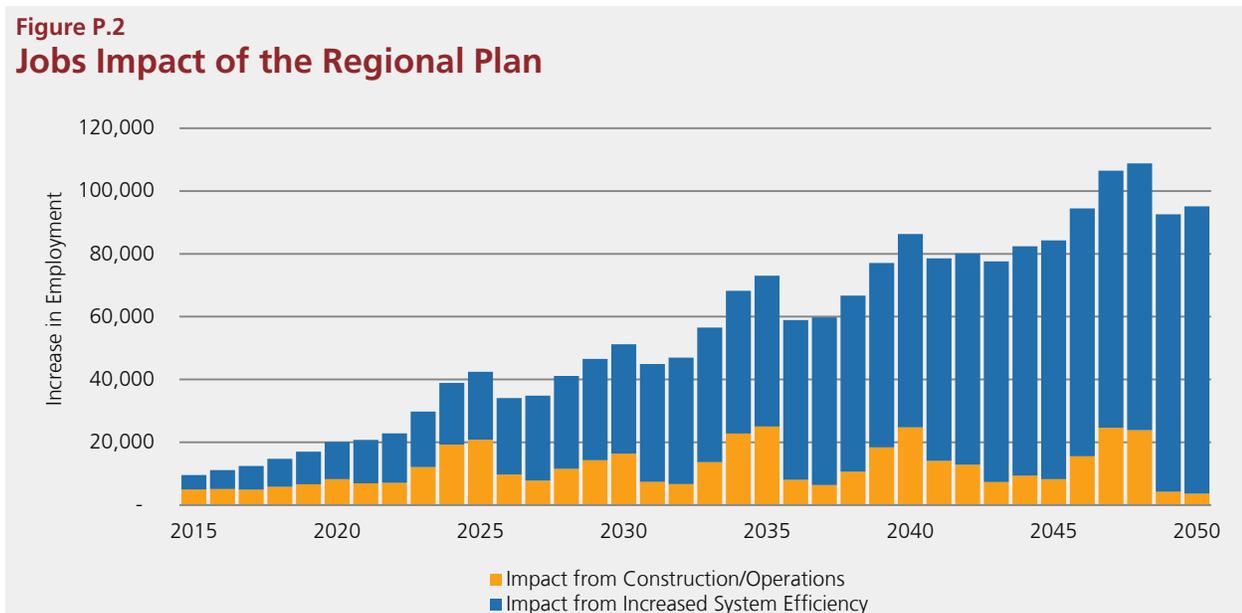


Figure P.2
Jobs Impact of the Regional Plan



The economic impacts of the construction and operations flow through the economy, and using an input-output model, SANDAG estimates that in the average year transportation investment will contribute roughly 11,400 jobs and \$1.2 billion in GRP to the San Diego regional economy. These jobs include direct impacts of spending in transportation construction and operations, indirect impacts in industries that support transportation construction and operations (e.g., equipment, concrete, surveying, engineering), and induced impacts across the economy (from increased expenditures by workers in the direct and indirect industries). The total impact over 35 years is almost 430,000 job-years³ and \$46.3 billion in GRP. See Section II for details.

In addition to the impacts of transportation spending, the economic impact analysis estimates the impact of the improved transportation system that the Regional Plan proposes. Compared to a “no-build” scenario in which few transportation investments are completed, the Regional Plan transportation network adds over 40,000 jobs and \$12.2 billion in GRP on average annually through increased system efficiency. These impacts result from private firms responding to the improved ability to access inputs, tap into a wider labor pool, and save on transportation-related production costs. Basically, it translates the monetary benefits calculated in the BCA into increased economic activity by the private sector. Section II of this report documents the methods and results of the Economic Impact Analysis in detail.

The **Economic Competitiveness Analysis** provides a more qualitative investigation into the economic effects of the Regional Plan. The competitiveness analysis does this in five ways. First, it provides a detailed background into the literature of economic effects of transportation and development policies. This review points out the benefits that effective transportation and development policies can have on regional economies, such as reducing costs for both users and municipalities, encouraging important industries (“clusters”), providing access to opportunity for economically-challenged populations, and improving the business climate for small businesses that rely on neighborhood development.

Second, the economic competitiveness analysis examines the impact of proposed transport investment on industry clusters by reducing travel times. These key industry clusters provide higher wage jobs in the region compared to non-cluster industries and are fundamental to region’s economic development. SANDAG compared travel times for automotive and transit travel between the no-build scenario and the proposed Regional Plan network. Under the Regional Plan scenario, travel times would decrease compared to the no-build scenario on all automotive corridors except one, and decrease across all transit corridors. While cluster employment is lower in transit corridors in comparison to automotive corridors, cluster industries near transit stations would benefit significantly from improved travel times. In summary, with decreased travel times for both automotive and transit corridors, industry clusters would have easier access to labor and capital in the region, with a corresponding increase in ease of access to jobs by residents living near transportation corridors. Since the transit corridors are projected to experience greater time savings (compared to automotive corridors), it is expected that transit will be a more attractive transportation option in the future. Transit stops can serve as focal points around which industry clusters can agglomerate for economic efficiencies. Thus, investment in transit would support growth in high-wage, job-generating industry clusters that would not otherwise be achievable by additional road capacity.

Third, the economic competitiveness analysis looks at San Diego region’s capacity to provide affordable housing in key transportation corridors that serve industry clusters to help assess whether spending on transportation can improve the standard of living of San Diego residents. In the analysis, home price supported by average cluster wage and average supportable rental payment are compared to San Diego region’s median home price (\$407,000) and median rental price (\$1,249), across automotive and transit corridors. Results are mixed; no automotive corridors have a housing price supported by average cluster wage, suggesting an average worker working in these corridors will have difficulty purchasing a house. But all automotive corridors support median monthly rental payment, indicating that a

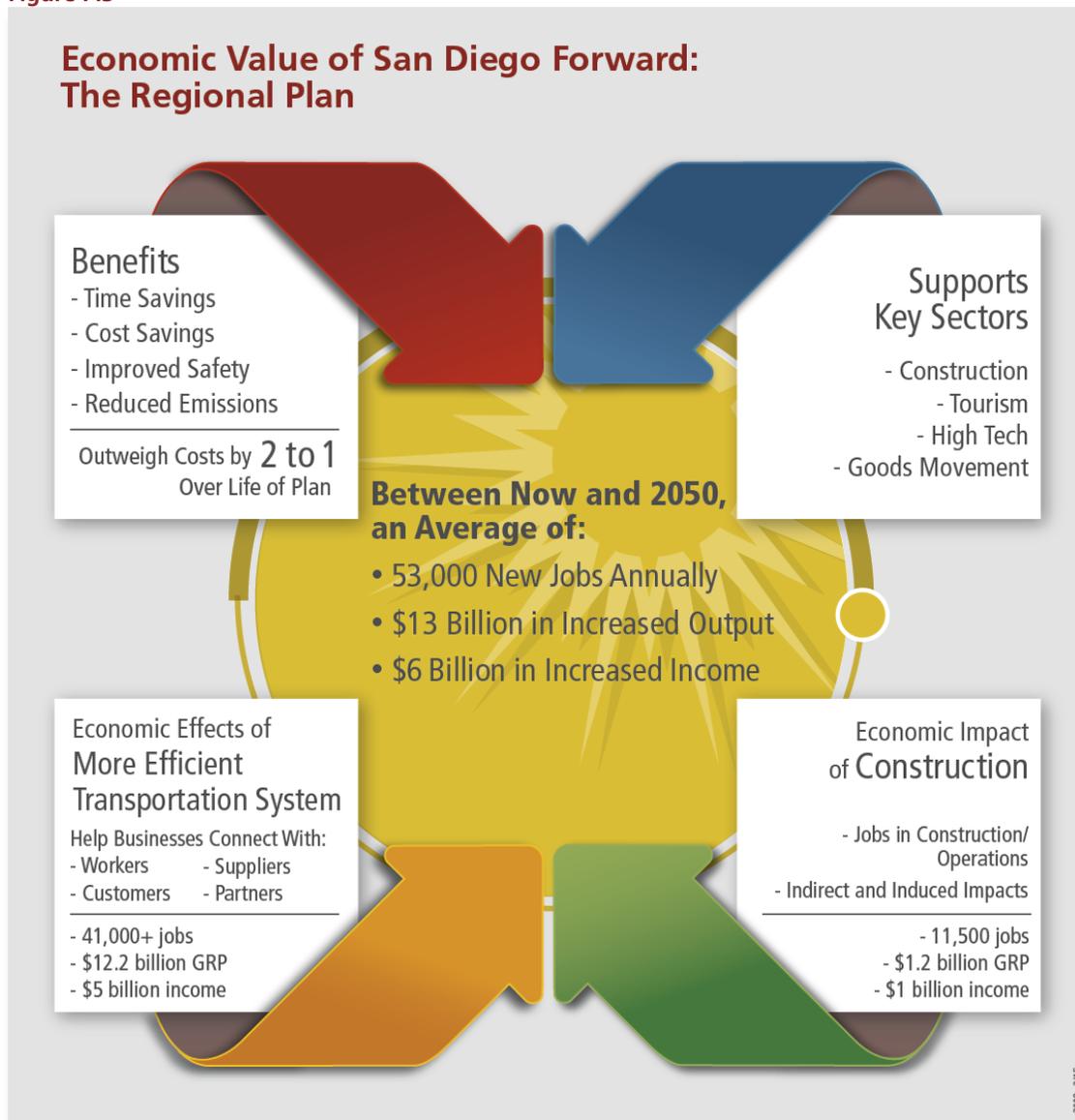
broad range of rental housing is within the reach of the average cluster worker in the automotive corridor. For transit corridors, only two corridors can afford to purchase a house given the average wage; however, residents of all transit corridors can afford rental units on average. While investments in transportation reduce costs of traveling and improve productivity, potentially leading to a rise in wages, this analysis suggests that it may still be difficult for San Diego residents to afford houses in the transportation corridors, and more high-wage jobs are needed.

Fourth, the economic competitive analysis synthesizes comments and observations received at a series of focus groups with industry in San Diego. The purpose of these focus groups was to provide a “reality check” or sounding board for the Regional Plan and its impact on the regional economy. SANDAG met with 15 groups, including groups like the San Diego Tourism Authority, SANDAG Military Working Group, BIOCUM, San Diego BID Council, NGOs, Higher Education organizations, the Hospital sector, and others. The groups were presented with the basics of the Regional Plan’s proposed transportation network. There was a high-level of support for the balanced approach that SANDAG is taking with the plan. There was also a general understanding of the economic benefits of denser development and transit, though many groups noted that the existing transit system does not meet their needs. Many of the groups also had specific concerns and recommendations, such as support for rail or border infrastructure.

Fifth, a few brief case studies from Denver; Portland, Oregon; and Eugene-Springfield, Oregon investigate how transit (light rail, bus rapid transit, and streetcar) infrastructure has spurred private investment and economic development, creating vibrant and economically successful areas.

With this multifaceted economic analysis, SANDAG has tried to capture the full range of economic effects that the San Diego region will realize from the proposed Regional Plan. The results are summarized in Figure P.3, which shows the interrelationships of the several analyses. The average of nearly 52,500 jobs and \$13.4 billion in GRP annually between now and 2050 indicates that the Regional Plan will be a boon to the regional economy in the long-term. But, in addition, there are also many unquantifiable economic benefits stemming from the Regional Plan that also will help make San Diego a more prosperous, sustainable, and equitable place going forward, for businesses and residents.

Figure P.3



I. The Regional Plan Benefit-Cost Analysis

I.1 Summary and Results

The Benefit-Cost Analysis (BCA) tool used to evaluate the transportation scenarios for the Regional Plan was created specifically to take advantage of the output from the SANDAG activity-based travel demand forecasting model (ABM). The BCA tool uses estimates of trips, travel times, travel costs, auto ownership and other indicators output by the ABM and assigns monetary values to these outputs to create a stream of benefits that result from the transportation investments in the scenario. This stream of benefits is compared with the stream of costs (including capital costs, operations and maintenance costs, and financing costs) that results from the projects included in the scenario to get a benefit-cost (B-C) ratio. A B-C ratio greater than 1 indicates that the benefits of the scenario are greater than the total costs, and thus provide a net benefit to society.

Because the Benefit-Cost Analysis relies on the outputs of the ABM, only transportation projects that can be modeled using ABM are included in the BCA. For that reason, projects such as the new mobility hubs, which may influence travel behavior but are not modeled in ABM, are not included in either the costs or benefits of the BCA.

Another factor of the BCA is the discount rate chosen. Future costs and benefits are “discounted” in recognition of the “time value of money,” the fact that a dollar next year is worth less than a dollar today.⁴ The higher the discount rate, less future benefits and costs affect the outcome of the analysis. The discount rate used in this BCA is 4 percent.

Benefits for the BCA were calculated for the following types of benefits:

1. Time Savings (residential and commercial)
 2. Operating Cost Savings
 3. Accident Cost Savings
 4. Emissions Savings
 5. Reliability Savings
 6. Physical Activity Benefits
 7. Vehicle Ownership Cost Savings
- Time savings compares the time of travel for all travelers for each scenario versus a no-build scenario. For example, by adding capacity to roads and transit, the time spent traveling is reduced. This time savings for personal travel has an economic value-to-people that is assumed to be roughly one-half of the average wage rate. The value of time for personal travel (calculated by ABM as an average of all trips) is \$11.39 per hour. Higher values are assigned for truck travel (\$30 per hour for light truck, \$43.20 per hour for heavy truck) as it is work-related and assumed to include a factor for the time value of the freight in the truck. Higher values are also assumed for “out-of-vehicle” time, such as time spent waiting for transit (approx. \$25 per hour), which is assumed to be roughly twice as burdensome as travel time.
 - Vehicle operating costs are simply the avoided costs from not operating a vehicle, which may be due to a mode switch (e.g., from auto to transit), or from changes in destinations or overall trip-making. The operating cost is calculated on a per-mile basis and is based on the assumed operating costs used in the ABM. In 2050, the assumed operating cost of personal vehicles is roughly \$0.26 per mile, and for trucks is roughly \$0.35.
 - Accident costs savings simply result from an estimated net reduction in the number of accidents for automobiles versus the no-build scenario. The number of accidents is based on the estimated difference in vehicle miles travelled (VMT) between the base and the build scenario. The BCA analysis and the ABM do not reflect the effect of potentially safer roadway types, or of the potential safety gains from autonomous cars. Accident values are based on the most recent federal guidelines and vary from roughly \$10,000 for a property-damage-only (non-injury) accident to over \$9 million for a fatality.
 - Emissions reductions results from fewer VMT, from reductions in congestion that improve vehicle efficiency, and from overall assumptions about future year fleet efficiency. Emissions are modeled using EMFAC, based on outputs from the ABM. Emissions values are based on the health effects of pollutants.
 - Reliability savings are time savings that result from having more consistent travel times over the same trip. For example, if variable congestion or poor transit performance require a traveler to add five extra minutes onto their travel time to ensure timely arrival, this is a cost. Reliability savings are largely a function of congestion and are valued as time savings.
 - Physical activity benefits result from the increase in active transportation in the plan scenarios over the no-build. Research suggests that physical activity benefits are non-linear and that persons going from below a threshold amount of activity to over it see the most benefits, so this is how the benefit is modeled: those whose increase in physical activity pushes them over the threshold of 150 minutes weekly (approximately 22 minutes per day) receive a physical activity benefit based on the latest value of health research of roughly \$180 annually.

- Vehicle ownership cost savings are the result of reductions in the number of vehicles that households in the county opt to own. Ownership costs for a private automobile are roughly \$6,000 annually.

The costs for this analysis were estimated by SANDAG project managers, engineers, and other experts.

The horizon year for the B-C analysis is 2070, which allows the projects completed in 2050 to accrue benefits over the typical 20-year lifespan.

The results of the BCA are summarized in Table P.2:

Table P.2
Benefit-Cost Analysis Results (2010\$ Billion)

Benefits by Category

Time Savings	\$52.18
Emissions Cost Savings	\$0.22
Safety Benefits	\$2.15
Reliability Benefits	\$0.20
Auto Operating Costs Savings	\$3.67
Auto Ownership Costs Savings	\$2.83
Physical Activity Benefits	\$0.01
<i>Total Benefits</i>	\$61.26

Costs by Category

Capital Costs	\$27.21
O&M Costs	\$2.89
Finance Costs	\$2.86
<i>Total Costs</i>	\$32.96
Net Present Value	\$28.30
Benefit/Cost Ratio	1.86
Internal Rate of Return	4.9%

In summary, these results indicate that the benefits of the proposed the Regional Plan transportation plan outweigh the costs by a factor of almost two-to-one (1.86), meaning that for every dollar invested in the Regional Plan, San Diegans receive almost two dollars of benefit. The primary driver of these benefits is the time savings, which represent 80 percent of the benefits, followed by reduced operating costs, and the rest of the benefits categories.

The costs of the plan are primarily capital (80%), with about 10 percent for both operations/maintenance, and financing costs. The net present value (benefits minus costs) is \$28.3 billion, and the internal rate of return of 4.9 percent.

I.2 Detailed BCA Methodology

I.2.1 Purpose

The SANDAG BCA tool was developed to measure the benefits and costs of the SANDAG investments in transportation infrastructure and operations as well as other policy objectives such as the Smart Growth Incentive Program. The tool was designed to consider a wide range of factors such as regional resident, commercial vehicle and truck mobility benefits, emissions savings, and safety savings, and to consider the effects of these and other factors over a multiyear time horizon. It provides users with the opportunity to specify multiyear start and end analysis years in order to account for transit and other late-stage benefits. A distinguishing feature of the BCA tool is that it uses the SANDAG disaggregate activity-based model outputs, which provides the opportunity to mitigate aggregation biases, and provides the opportunity to perform more detailed analyses of social equity concerns.

The first stage in the tool development was to inventory the existing data produced by the SANDAG activity-based model system and other analysis tools (such as EMFAC), and to identify the critical types of benefits measures that could be produced using the available data. Ultimately, a set of eight types of benefits were included in the tool design:

- Regional resident mobility
- Truck and commercial vehicle mobility
- Vehicle operating costs
- Auto ownership
- Vehicle operating costs
- Reliability
- Safety
- Emissions

A detailed design specification was then developed that outlined the functional logic for calculating the required benefit-cost metrics using the available data. In conjunction with the development of the design specification, it was also necessary to identify appropriate economic assumptions, such as values-of-time, operating costs, accident rates and costs, and capital, operating and financing costs. The tool was implemented in SQL Server in order to allow the tool to interact directly with the database in which SANDAG stores all activity-based model inputs and outputs for all scenarios.

I.2.2 Activity-based model

All of the benefit-cost analysis metrics are based on two primary data sources. Benefits (and disbenefits) are calculated using information extracted directly from the SANDAG activity-based model (ABM) system, or using information derived from ABM post processing tools, such as EMFAC. The benefits are derived primarily from estimates of travel demand and associated metrics. Travel demand includes both personal travel made by regional residents as well as travel demand associated with truck and commercial vehicles and external travel. The ABM includes a network supply model component that interacts with the demand components and which produces indicators for network performance, such as link volumes and speeds by time-of-day. The second primary type of data source, costs, were prepared by SANDAG regional planning staff to represent the capital, operating and maintenance, and financing associated with different alternatives.

ABM Sensitivities

CT-RAMP is the activity-based travel demand forecasting component of the SANDAG integrated model system. Activity-based models are used to predict the detailed travel patterns of regional residents as they travel within the region on a typical weekday. These estimates of travel demand are highly spatially and temporally detailed, and reflect the complex relationships amongst the trips that individuals make, as well as the inter-related travel of members of the same household. The activity-based model is complemented by a number of additional models that address other important travel demand market segments, including a truck and commercial vehicle model that estimates travel demand for these vehicle types.

There are three primary types of inputs to the activity-based model system, and a number of other inputs associated with specific auxiliary models. The first primary input is a geographic input file containing information on employment by sector, housing, households, persons, enrollment, urban form, parking, and open space. This file incorporates dynamic information derived from upstream integrated model system components and tools such as PECAS and UDM, as well as fixed information from exogenous sources. The second primary input is a synthetic population created by the upstream PopSyn component. The third primary input to the activity-based model are measures of network performance created by prior runs of the downstream network model. Outputs from the activity-based model system include detailed estimates of travel demand used by the downstream network model, as well as accessibility measures and travel time and cost “skims” used by the upstream model components.

ABM Database

The BCA tool operates directly on information included in the SANDAG ABM database. The ABM requires as input, and produces as output, significant amounts of data. In order to systematically analyze and archive these data, SANDAG established an ABM database which includes both ABM inputs and outputs. These inputs and outputs provide fundamental information required for the benefit-cost analysis.

Key ABM input data used by the BCA tool include:

- *Synthetic population*: A detailed representation of all regional households and persons, and includes critical demographic information such as age, income, and employment status.
- *Land use data*: Spatial data describing base year and future year employment by industrial sector, enrollment, and other variables is available at two primary geographic levels – MGRAs (which are comparable to Census block groups), and TAZs (which are larger aggregations of MGRAs).
- *Multimodal Network Information*: Data describing network attributes.

Key ABM output data used by the BCA tool include:

- *Trip demand lists*: Detailed lists of trips for all regional residents.
- *Tour lists*: Detailed lists of tours, or chains of linked trips that start and end at the home or workplace, for all regional residents.
- *Synthetic population*: The ABM updates synthetic information during the model run process. Some of this updated information, such as the number of vehicles each household chooses to own, is used by the BCA tool.
- *Multimodal Network Impedances*: Data representing travel times, costs and volumes by different modes (such as drive alone vehicles, local buses, etc.) and time-of-day (for five broad time periods which combined represent the 24 hours of the day).

Two additions to the ABM database were required to implement the BCA tool. First, it was necessary to add a table that contains the emissions information produced by EMFAC. Second, it was necessary to add some indices to the TAZSKIM table in order to support more rapid data access. Note that while the BCA tool operates directly on the data stored within the SANDAG ABM database, the BCA tool stores benefit-cost input assumptions and output results in a separate, parallel BCA database.

I.2.3 Benefit-Cost Analysis Tool

Capabilities

The Benefit-Cost Analysis (BCA) tool provides estimates for eight types of benefits. The following sections describe each of these benefit types, as well as the key data items in the ABM database used to calculate these benefits.

Residential Mobility Benefits

Residential mobility benefits are the travel time benefits that accrue to regional residents. These benefits are calculated for each individual trip by monetizing the differences between base and build travel time impedances. These impedances are either at the spatial detail level of either MGRAs or TAZs, depending on the travel mode. In order to monetize these travel time benefits, value-of-time assumptions were calculated and applied based on an analysis of trips by purpose, household income, and vehicle occupancy levels. Note that for some transit trips, it was necessary to impute a base impedance to compare to the build impedance because no transit service existed in the base networks. Telecommuting benefits are also included in this category of benefits (see details on telecommuting assumptions below).

Truck Mobility Benefits

Truck mobility benefits are the travel time benefits that accrue to truck trips and commercial vehicle trips. These benefits are calculated at an aggregate TAZ-level by monetizing the differences between base and build impedances. The monetization was based on ABM assumptions and varied by vehicle type, and the impedances were TAZ-level.

Emissions Benefits

Emissions benefits are due to changes in emissions by pollutant type. Estimates of emissions are derived from the California Air Resources Board's EMFAC model, California's emissions factors modeling software. EMFAC uses ABM network supply model outputs, calculated at an aggregate level. The monetization factors used to calculate the benefits are based on regional and Federal guidance.

Safety Benefits

Safety benefits are due to reductions in vehicle accidents by accident type. Accident types include fatal, injury, and property damage only. Accidents by type estimated using San Diego-specific information about accidents by type per VMT. These VMT estimates are produced by the ABM network supply model. Monetization factors used to calculate the benefits are based on Federal guidance regarding the value of a statistical life.

Reliability

Reliability benefits are due to reductions based on the concept of "total equivalent delay" resulting from unreliable travel times, which can be thought of as the amount of "schedule buffer time" (in minutes) that travelers require in order to ensure they arrive at their activities on time. Estimates of total equivalent delay pivot off of estimates of free-flow and congested travel times derived from the ABM network supply model. The "value-of-reliability" used to monetize this time is assumed to be equivalent to the value-of-time used to monetize travel time benefits.

Vehicle Operating Benefits

Vehicle operating benefits are due to reductions in vehicle operating costs. Vehicle operating costs are calculated separately for autos and trucks (by type), on a per mile basis. These costs are derived from the ABM's network supply model, and the monetization factors based on per mile operating costs used in ABM.

Auto Ownership Benefits

Auto ownership benefits are due to reductions in the number of vehicles that regional households choose to own, as forecast directly by the ABM. Ownership costs include costs such as insurance and financing, but exclude costs associated with vehicle usage such as fuel and maintenance costs. The factors used to monetize these changes are based on Federal and private industry research on annual per vehicle ownership.

Physical Activity Benefits

Physical activity benefits are due to increases in the amount of transportation-related physical activity that regional residents get. The monetization factors used to calculate these benefits are based on review and adjustment of numerous exogenous sources, as described in a subsequent section.

Multiyear Processing

The multiyear benefit-cost analysis metrics are calculated in two stages. In the first stage, a comparison of base and build alternative ABM model results, is performed for each alternative scenario year. This produces a set of single year estimates of benefits by type. In the second stage, a multiyear benefit stream is calculated by interpolating and extrapolating benefits and costs between start year, scenario years, and end year. The multiyear benefit stream calculation also incorporates inflation and discount rates, animalization factors, and produces summary benefit-cost metrics.

User Controls

This section will describe the list of controls or information that the user must provide, such as analysis years, VOT assumptions, animalization factors, and other key inputs.

The BCA tool is implemented in the BCA database. The BCA database includes stored procedures that implement the logic required to calculate each of the seven types of benefits and calculate the multiyear benefit-cost stream, as well as tables that contain the BCA input assumptions and the BCA output results. The stored procedures operate on information contained in the SANDAG 'abm_SD' database, which contains all the results of SANDAG model runs. In order to setup a new multiyear benefit-cost analysis, the user modifies two tables in the BCA database: (1) the Analysis Table (Table P.3); and (2) the Analysis Parameters Table (Table P.4).

The Analysis Table (Table P.3) contains one record for each multiyear scenario analysis. The contents of this table are show in Table P.3. Key user controls include the start year and end year of the analysis, the intermediate years for which ABM and other model outputs are available, and the inflation and discount rates. Note that it is not necessary to specify all five intermediate years if fewer scenario year results are available. Once added, an id field is populated. This id field is referenced in the Analysis Parameters Table.

Table P.3
Analysis Table

Column Name	Description
id	Analysis ID number
title	Name of benefit-cost analysis
description	Description of benefit-cost analysis
year_reference	Constant dollar reference year
year_start	Multiyear analysis start year
year_intermediate_1	Multiyear analysis scenario year 1
year_intermediate_2	Multiyear analysis scenario year 2
year_intermediate_3	Multiyear analysis scenario year 3
year_intermediate_4	Multiyear analysis scenario year 4
year_intermediate_5	Multiyear analysis scenario year 5
year_end	Multiyear analysis end year
rate_inflation	Inflation rate
rate_discount	Discount rate
annualization_factor	Animalization factor
last_update_date	

The Analysis Parameters Table (Table P.4) contains one record for each alternative scenario comparison year that the user wishes to include in a multiyear analysis. In addition to critical scenario and comparison year id's that are used when running the individual BCA tool components, this table also includes all of the assumptions describing how different benefit types are monetized. Within any given scenario comparison year, these assumptions generally remain consistent. For example, the assumed values-of-time are consistent across all alternative scenario comparison years. However, some assumptions may vary across alternative scenario years, such as the auto operating costs, and CO₂ costs, which are assumed to increase over time.

Table P.4
Analysis Parameters Table

Column Name	Description
id	Scenario comparison year analysis id
analysis_id	Multiyear analysis id
comparison_year	Scenario comparison year
vot_commute	Commute trip value-of-time (\$ / hour)
vot_noncommute	Non-commute trip value-of-time (\$ / hour)
vot_work	Work-related trip value-of-time (\$ / hour)
vot_truck_light	Light duty truck value-of-time (\$ / hour)
vot_truck_medium	Medium duty truck value-of-time (\$ / hour)
vot_truck_heavy	Heavy duty truck value-of-time (\$ / hour)
vor_auto	Auto trip value-of-reliability (\$ / hour)
vor_work	Work trip value-of-reliability (\$ / hour)

Table P.4 (continued)**Analysis Parameters Table**

Column Name	Description
vor_truck_light	Light duty truck value-of-reliability (\$ / hour)
vor_truck_medium	Medium duty truck value-of-reliability (\$ / hour)
vor_truck_heavy	Heavy duty truck value-of-reliability (\$ / hour)
vot_uniform	Uniform value-of-time (\$ / hour)
ovt_weight	Transit out-of-vehicle time generalized cost weight
ovt_time_multiplier	Transit out-of-vehicle time generalized cost multiplier
voc_auto	Auto operating cost (\$/mile)
voc_truck_light	Light duty truck operating cost (\$/mile)
voc_truck_medium	Medium duty operating cost (\$/mile)
voc_truck_heavy	Heavy duty operating cost (\$/mile)
aoc_auto	Auto ownership cost (\$/year)
phys_activity_threshold	Minutes of daily transportation related physical activity required for benefit
cost_phys_activ	Annual health care savings if threshold of physical activity is exceeded
crash_rate_fatal	Fatal crash rate (crashes / 1,000,000 VMT)
crash_rate_injury	Injury crash rate (crashes / 1,000,000 VMT)
crash_rate_pdo	Property damage only crash rate (crashes / 1,000,000 VMT)
crash_fatal_cost	Fatality crash cost (\$ / crash)
crash_injury_cost	Injury crash cost (\$ / crash)
crash_pdo_cost	Property damage only cost (\$ / crash)
co2_value	CO ₂ cost (\$ / metric ton)
pm2_5_value	PM 2.5 cost (\$ / ton)
pm10_value	PM 10 cost (\$ / ton)
nox_value	NO _x cost (\$ / ton)
rog_value	Reactive Organic Gas cost (\$ / ton)
so2_value	SO ₂ cost (\$ / ton)
co_value	CO cost (\$ / ton)
rate_inflation	Inflation rate
rate_discount	Discount rate
coc_age_thresh	Age threshold for community of concern identification
coc_race_thresh	Race identifier for community of concern identification
coc_hinc_thresh	HH income threshold for community of concern identification
coc_poverty_thresh	Poverty identifier for community of concern identification
coc_hisp_thresh	Ethnicity identifier for community of concern identification
rel_ratio	Value-of reliability / Value-of-time ratio

Implementation

The BCA tool is implemented in the SQL Server. The tool is comprised of a set of stored procedures, a set of input assumption tables, and a set of output results tables. There are three primary types of stored procedures. The first type of stored procedures calculates the benefits by benefit type. For each benefit type, there are two or three component stored procedures that are executed in sequence. The second type of stored procedure summarizes the demographics for each analysis year. The third type of stored procedure performs the multi-year analysis and produces estimates of benefits and costs for each year, as well as summary metrics for the overall benefit-cost analysis.

I.2.4 Tool Components

I.2.4.1 Mobility Benefits

Mobility benefits represent the monetized value of travel time savings that accrue to regional travelers' trips and to commercial and truck vehicle trips. The travel time savings are calculated by comparing the travel times that are experienced by travelers or trucks under a "build" scenario to the travel times that they would have experienced under a "no-build" or "base" scenario, for the same origin-destination pair, mode, and time-of-day. These savings are then monetized using market segment specific values-of-time. The following sections describe the calculation of these mobility benefits for resident travel, and for commercial and truck travel.

Travel Time Benefit Calculation

Resident Travel

Regional resident travel time savings are calculated at the individual trip level. The travel time savings are calculated by comparing the travel times that are experienced by travelers under a "build" scenario to the travel times that they would have experienced under a "no-build" or "base" scenario, for the same origin-destination pair, mode, and time-of-day. A set of table joins is performed to define existing, new, and dropped trips. All these different types of trips are included in the analysis. The travel time calculations include both in-vehicle and out-of-vehicle travel time components. In some cases where transit service did not exist in the base scenario, but did exist in the build scenario, it was necessary to impute a no-build transit travel time. This imputation was based on a statistical analysis of the relationship between auto distance and walk-to-transit generalized cost, and auto distance and drive-to-transit generalized cost.

$$\text{Time}_{\text{walk-to-transit}} = \text{Time}_{\text{drive alone auto}} * (19.700 * \text{Distance}_{\text{drive alone auto}}^{-0.362})$$

$$\text{Time}_{\text{drive-to-transit}} = \text{Time}_{\text{drive alone auto}} * (12.653 * \text{Distance}_{\text{drive alone auto}}^{-0.358})$$

Telecommuting Benefits

Calculating the benefits from transportation investments, as they relate to telecommuting patterns, is complex as many factors (some known and some yet to be determined) will influence and shape travel patterns over the next 35 years. While there is a degree of uncertainty in the estimate associated with telecommuting benefits, the resulting benefit-cost ratio, and net present value, presented in this plan are similar to earlier estimates where telecommuting assumptions are precluded.

In response to the SANDAG travel demand management programs, the Regional Plan "build" scenario assumes a significant increase in telecommuting over the baseline scenario. To make this adjustment, the travel model alters individuals' propensity to stay at home on a given day.

The telecommuting assumptions were implemented after the initial development of the benefit-cost tool, so that currently the travel model does not fully accommodate the positive effects of telecommuting; the telecommuting

assumptions used also resulted in a decrease in non-work trips (e.g., lunch time errands, stopping for coffee on the way to work) associated with going to or returning from a job site.

To correct these two issues, two steps were necessary. First, total resident (non-commercial travel) time benefits were re-estimated by calculating monetary value of the total difference in person hours of travel from the baseline scenario to the build scenario; however, the resulting estimate of resident benefits excludes increases in travel that would otherwise occur; in the real world, some of the time people save as a result of telecommuting is used to make new or alternative trips.

Second, to take this expected increase in travel activity into account, and to correct for the reduction in non-work tours that should not be affected by telecommuting, the revised estimate of total resident travel-time benefits was increased by a factor based on information derived from earlier travel model runs and benefit-cost analysis that excluded the telecommuting assumptions. This results in a more accurate estimation of resident time-travel benefits in the presence of increased telecommuting.

Trucks and Commercial Vehicles

Truck and commercial vehicle trip travel time savings are calculated at the zone pair level. The travel time savings are calculated by comparing the commercial vehicle and truck travel times experienced under a “build” scenario to the travel times they would have experienced under a “base” scenario. Travel time difference calculations were segmented by mode and payment status, with truck benefits using truck-specific travel impedance toll and no toll skims, and commercial vehicles using the drive alone auto toll and no toll skims.

Mobility Benefit Monetization

After calculating travel time differences, these benefits are monetized by using assumed values of time. These values-of-time vary by market segment, with different values for regional resident travel, commercial vehicle travel, and truck travel.

Value of Time: Resident Travel

For regional resident travel, in-vehicle travel time is monetized using the latest research regarding value-of-time (VOT) derived from the Strategic Highway Research Programs C04 project. This research was used because it allows for an average implied value of time to be estimated that reflects the different values of time associated with different household incomes, travel purposes, and occupancy. The implied value of time is the ratio between the time coefficient used in the model and the cost coefficient used in the model.

For the Regional Plan alternatives analysis, a single uniform value of time that incorporates all trip purpose was used. This value-of-time was calculated applying the latest SHRP2 VOT research to all the trips generated by the SANDAG activity-based model system. This overall uniform average value of time reflects the distribution of regional household income, trip purposes (work and non-work), and vehicle occupancy.

For trips on work purposes, the calculated cost coefficient and asserted time coefficient are shown as follows:

$$c(i) = (-0.15/\$ / [((income(i) / 30,000 ^{0.6}) * (occupancy(i) ^{0.8}))])$$

$$b(i) = -0.030/min$$

For trips on non-work purposes, the calculated cost coefficient and asserted time coefficient are shown as follows:

$$c(i) = -0.15/\$ / [((income(i) / 30,000 ^{0.5}) * (occupancy(i) ^{0.7}))])$$

$$b(i) = -0.015/min$$

Note that out-of-vehicle time is perceived by travelers to be more onerous than in-vehicle time. Out-of-vehicle time is considered only for transit trips and includes the amount of time spent walking to or from transit, waiting for transit, or transferring. Out-of-vehicle time is valued at 2.2 times in-vehicle time, based on guidance from the Federal Highway Administrations Surface Transportation Economic Analysis Model (STEAM).

Value of Time: Truck / Commercial Travel

Truck and commercial vehicle VOT assumptions are derived directly from the SANDAG activity-based model input assumptions, which use this information when calculating generalized cost paths in truck and commercial travel network assignment.

**Table P.5
Truck / Commercial Vehicle Values of Time**

Market Segment	Value-of-time (\$ / hour)
Heavy duty trucks	\$43.20
Medium duty trucks	\$30.00
Light duty trucks	\$30.00
Commercial vehicles	\$30.00

Other Out-of-Pocket Costs

Parking costs are incorporated into the overall monetized regional travel mobility benefits.

Treatment of Transfers

Tolls and fares are treated distinctly from other out-of-pocket costs such as parking, and vehicle operating expenses. This is because, although they are paid out-of-pocket by travelers, they accrue as income to regional transportation agencies and thus help offset monetary costs associated with building and maintaining the transportation system. Consequently, these values represent both costs and benefits and as a result are treated as internal “transfers.” These costs reduce the overall net benefit to travelers, but also reduce the overall net costs of developing and maintaining transportation infrastructure.

1.2.4.2 Vehicle Operating Cost Benefits

Vehicle operating costs represent the variable cost associated with operating a vehicle, such as fuel costs and maintenance. Vehicle operating costs do not include fixed costs associated with vehicle ownership, such as purchase, financing, and insurance costs.

Vehicle Operating Cost Calculation

Vehicle operating costs are calculated using activity-based model network link information on link distanced and volumes by vehicle type market segment. A potential future enhancement to the BCA tool would be to calculate this at the individual trip level for regional resident travel, in order to support the assessment of equity impacts of changes in these operating costs.

Vehicle Operating Cost Monetization

For regional residents, the valuation of auto operating costs is based on assumed distance-based auto operating costs used in the SANDAG activity-based model system. Note that this valuation is assumed to change over time, in order to

be consistent with the assumptions used in the activity based model. Table P.6 shows the cost per mile assumed in various alternative analysis scenario years.

Table P.6
Vehicle Operating Costs

YEAR	Auto Operating Cost (\$ / mile)
2020	\$0.240
2025	\$0.242
2035	\$0.267
2050	\$0.289

The current SANDAG model does not incorporate a truck-specific operating cost, so the valuation of truck operating costs is based on assumed distance-based auto operating costs used in MTC’s activity-based model system. For all analysis years, the truck operating cost is assumed to be \$0.346 / mile.

1.2.4.3 Vehicle Ownership Cost Benefits

The valuation of annual auto ownership costs is intended to capture all the aspects of auto ownership not captured by the operating cost valuation. These costs would include factors such as purchase and depreciation, financing and insurance. Reductions in vehicle ownership are considered to be a net benefit or savings.

Vehicle Ownership Cost Calculation

The SANDAG activity-based model system incorporates a sub-component that forecasts the number of vehicles that each regional household chooses to own. Changes in auto ownership, predicted by the model, can be monetized using this information. The SANDAG auto ownership model is sensitive to changes in accessibility. For example, if transit services improve, this may induce households to own fewer vehicles.

Vehicle Ownership Cost Monetization

The valuation of annual auto ownership costs is intended to capture all the aspects of auto ownership not captured by the operating cost valuation. These costs would include factors such as purchase and depreciation, financing and insurance. The assumption of costs of \$5,900 per vehicle is applied to the total number of vehicles maintained by regional households. This assumption is based on information from MTC and the California Automobile Club (AAA).

1.2.4.4 Emissions Benefits

The valuation of emissions is intended to capture the benefits and costs associated, respectively, with reductions or increases in emissions by pollutant type.

Emission Type Estimation

Emissions are not directly output or forecast by the SANDAG activity-based model. Rather, forecasts of regional network link volumes and speeds output by the activity-based model are used as input to the EMFAC, which is the California Air Resources Board’s tool for estimating emissions from on-road vehicles. EMFAC outputs forecasts of emissions by pollutant type.

Emission Type Monetization

Each pollutant type is associated with a unique monetization factor. In some cases, this monetization factor increases over time. Each pollutant type and associated unit cost is summarized below:

- *CO₂ PER METRIC TON*: The valuation per metric ton of CO₂ emissions is based on assumptions from the 2010 Bay Area Air Quality Management District (BAAQMD) Clean Air Plan 2010. This assumption was reviewed and approved by San Diego Air Pollution Control District staff. The assumption of costs rising from \$21.18 per metric ton in 2015 to \$51.81 per metric ton in 2050 is applied to estimates of tons of CO₂ emitted produced by EMFAC.
- *PM_{2.5} (FINE PARTICULATE MATTER) PER TON, BOTH DIRECT AND DIESEL*: The valuation per metric ton of fine particulate matter emissions is based on assumptions from the 2010 Bay Area Air Quality Management District (BAAQMD) Clean Air Plan 2010. This assumption was reviewed and approved by San Diego Air Pollution Control District staff. The assumption of \$459,000 per metric ton is applied to estimates of tons of fine particulate matter emitted produced by EMFAC.
- *PM₁₀*: The valuation per metric ton of PM 10 particulate matter is based on assumptions from Caltrans "Life--Cycle Benefit-Cost Analysis Economic Parameters 2012" site (dot.ca.gov/hq/tpp/offices/eab/benefit_cost/LCBCA-economic_parameters.html). This site cited a valuation of \$139,900 per ton for California urban areas.
- *NO_x PER TON*: The valuation per metric ton of NO_x emissions is based on assumptions from the 2010 Bay Area Air Quality Management District (BAAQMD) Clean Air Plan 2010. This assumption was reviewed and approved by San Diego Air Pollution Control District staff. The assumption of \$7,300 per metric ton is applied to estimates of tons of NO_x emitted produced by EMFAC.
- *ROG (REACTIVE ORGANIC GASES) PER TON, ALL TYPES*: The valuation per metric ton of NO_x emissions is based on an analysis of the assumptions from the 2010 Bay Area Air Quality Management District (BAAQMD) Clean Air Plan 2010, and the distribution of ROGs by type. The assumption of \$6,365 per metric ton is applied to estimates of tons of ROGs emitted produced by EMFAC.
- *SO₂ PER METRIC TON*: The valuation per metric ton of SO₂ emissions is based on assumptions from the 2010 Bay Area Air Quality Management District (BAAQMD) Clean Air Plan 2010. This assumption was reviewed and approved by San Diego Air Pollution Control District staff. The assumption of \$37,900 per metric ton is applied to estimates of tons of CO₂ emitted produced by EMFAC.

1.2.4.5 Safety Benefits

This valuation of safety is intended to capture the benefits and costs associated, respectively, with reductions or increases in vehicle accidents by severity.

Collision Type Calculation

Vehicle accidents are not directly output or forecast by the SANDAG activity-based model. Rather, forecasts of regional network link volumes are used to generate estimates of vehicle miles travelled. These forecasts were used in conjunction with San Diego-specific VMT-based accident rates by severity prepared by SANDAG staff using California state SWITRS data to produced estimates of accidents by severity.

Collision Type Monetization

Fatality Collisions

Fatality collisions are proposed to be calculated based on the recent United States Department of Transportation (U.S. DOT) "Guidance on Treatment of the Economic Value of a Statistical Life (VSL)," dated June 17, 2015. This valuation is based on extensive recent empirical studies, and is defined as the additional cost that individuals would be

willing to bear for improvements in safety (that is, reductions in risks) that, in the aggregate, reduce the expected number of fatalities by one. The proposed valuation of fatality collisions is \$9.4 million. This valuation is applied to an estimate of total fatality collisions derived from San Diego-specific collision rates and SANDAG activity-based model outputs.

Injury Collisions

The previously mentioned U.S. DOT “Guidance on Treatment of the Economic Value of a Statistical Life” is also a source for information about the valuations of injuries by severity level, using a factor that is applied to the VSL. The severity levels range from AIS 1 (minor) to AIS 6 (fatal). For valuation of injuries for the project-level cost-effectiveness criteria, the level AIS 2 (moderate) was selected, which is associated with a factor of 0.47. This results in a proposed valuation of injury collisions of \$441,800. This valuation is applied to an estimate of total injury collisions derived from San Diego-specific collision rates and SANDAG activity-based model outputs.

Property Damage Only (PDO) Collisions

The valuation of property damage only collisions is based on the California Department of Transportation’s “Life-Cycle Benefit-Cost Analysis Economic Parameters 2012” (dot.ca.gov/hq/tpp/offices/eab/benefit_cost/LCBCA-economic_parameters.html). The proposed valuation of PDO collisions is \$10,200. This valuation is applied to an estimate of total PDO collisions derived from San Diego-specific collision rates and SANDAG activity-based model outputs.

1.2.4.6 Reliability Benefits

The valuation of reliability is intended to capture the benefits associated with more predictable travel times, which reduces the need for travelers to include additional buffer time in their schedules. This additional buffer time is referred to as “Total Equivalent Delay.”

Total Equivalent Delay Calculation

The formula for calculating Total Equivalent Delay is from the SHRP2 L05 research report “Incorporating Reliability Performance Measures into the Transportation Planning and Programming Processes: Technical Reference.” Total Equivalent Delay is calculated using activity-based model network link outputs. The congested and free flow travel times for each link are the key inputs used to first calculate the 80th and 50th percentile travel time indices. These indices are then used to calculate travel time equivalents, which are in turn converted to total equivalent delay. The steps are as follows:

1. For each alternative, calculate recurring mean TTI (travel time index)
 - a. Travel time index = t / t_0
 - b. t = average travel time per unit distance (hours / mile) - this can be calculated at the link level from loaded model networks
 - c. t_0 = free flow travel time per unit distance (hours / mile) - this can be calculated at the link level from free flow model networks
2. Calculate Adjusted recurring mean TTI (TTIm)
 - a. $TTIm = 1.0274 * TTI^{1.2204}$
 - b. Cap TTIm at value of 3.0

3. Calculate the 80th and 50th percentile TTI
 - a. $TTI_{80} = 1 + 2.1406 * \ln(TTI_m)$
 - b. $TTI_{50} = TTI_m^{0.8601}$
4. Calculate travel time equivalents
 - a. $TTI_e = TTI_{50} + a * (TTI_{80} - TTI_{50})$
 - b. a represents is the Reliability Ratio (VoR / VoT), which was conservatively set = 1.0 (meaning minutes of reliability are equivalent to minutes of travel time).
5. Compute total equivalent delay
 - a. $TotalEquivalentDelay = ((TTI_e / Freeflowspeed) - (1 / free\ flow\ speed)) * VMT$

Total Equivalent Delay Monetization

Total Equivalent Delay is a measure in minutes, and thus for consistency, this time is valued the same as travel time minutes. In the absence of other information, it is assumed that the value of this reliability measure is the same as the value of time.

Table P.7

Total Equivalent Delay Monetization

Market Segment	Value-of-time (\$ / hour)
Personal travel	\$11.39
Heavy duty trucks	\$43.20
Medium duty trucks	\$30.00
Light duty trucks	\$30.00
Commercial vehicles	\$30.00

1.2.4.7 Physical Activity Benefits

Physical activity benefits represent health care cost savings and improved productivity associated with physical activity. The activity-based model can provide forecasts of transportation-related physical activity, such as time spent walking, biking, or walking to transit.

Physical Activity Calculation

The total amount of transportation-related physical activity is calculated for each individual person in the regional synthetic population by summarizing (for all trips made by the person) the total time spent walking, biking and walking to transit.

Physical Activity Monetization

The valuation of the health care cost savings and improved productivity associated with physical activity on a per-minute basis was based on the assumptions provided by SANDAG staff. In 2006, the California Center for Public Health Advocacy, and Chenoweth & Associates, issued a report entitled “The Economic Costs of Overweight, Obesity, and Physical Inactivity Among California Adults” that included San Diego-specific information estimating an annual

benefit of \$1,100 (in 2010\$) on a per person basis of transitioning from an inactive lifestyle (<30 minutes physical activity/day) to an active lifestyle (>30 minutes physical activity/day). Assuming that an average person would need to increase their physical activity by 15 minutes to achieve this threshold, the \$1,100 / year can be divided by 5475 minutes / year (15 minutes * 365 days / year) to produce an initial estimate of \$0.20 / minute. Further research revealed estimates from \$0.01 / minute to \$0.25 / minute. SANDAG staff determined an appropriate range of \$0.03 / minute - \$0.04 / minute. Ultimately a conservative figure of \$0.0325 / minute was used, resulting in a valuation of \$180 / year for each person who exceeded the minimum threshold.

1.2.4.8 Costs of Transportation Investments

The preceding sections have described how the different types of benefits can be monetized. These benefits can then be compared against the monetary costs associated with transportation investments and policies. All of the benefit-cost metrics produced by the BCA tool are based on the relationship between these benefits and costs. Monetary costs can be classified into three primary types: (1) capital costs; (2) operating and maintenance costs; and (3) finance costs. Significantly, all of the benefit-cost metrics incorporate all three types of cost components. All costs were developed by SANDAG.

Capital Costs

Capital costs represent fixed expenses associated with the purchase of equipment, constructions costs, and other one-time expenses, although these expenses may be paid over time through the use of financing. For example, costs associated with purchasing transit vehicles, or expanding physical roadway capacity, are capital costs.

Operating and Maintenance (O&M) Costs

Operating and maintenance costs represent expenses associated with the ongoing use of transportation investments. These costs typically endure for a longer period of time than capital costs or finance cost expenditures. For example, O&M costs may include costs associated with operating transit services or maintaining adequate pavement conditions.

Finance Costs

Major transportation investments are typically financed due to the desire to build the investments in the near term in order to derive benefits as quickly as possible, in advance of an agency having full funding available. Finance costs represent interest and other costs associated with borrowing money.

1.2.4.9 Lifecycle Analysis and Benefit-Cost Analysis Output

The BCA tool allows the user to consider the entire lifecycle of transportation investments by calculating not only the benefits for a single analysis year, but by considering the multiyear stream of benefits and costs, and produces a variety of benefit-cost metrics, including B/C ratios, network present value, and the internal rate of return.

Multi-Year Analysis

A distinguishing feature of the BCA tool is that all benefit-cost metrics reflect the multiyear stream of benefits and costs as well as the effects of inflation and discounting. The benefits are primarily derived directly from SANDAG activity-based model outputs although in some cases, such as emissions, the benefits pivot off of other analysis tools. The user identifies the start and end years for the analysis, as well as interim years. If users have activity-based model outputs for the start and end years, these may be specified, but they are not required. Start and end years can be earlier or later than any given model output years. However, the user must have activity-based model output for any interim years specified.

Interpolation and Extrapolation

The BCA tool produces benefit-cost metrics for every individual year between the start and end years identified by the user. However, the tool does not require that the user have model outputs for every individual year. Instead, for any

year for which no modeled data is available, the benefits and costs are extrapolated using available model data. For interim years that fall between any two modeled analysis years for which model data is available, results are interpolated between these two years. For interim years that fall between the analysis start year and the first modeled analysis year, results are interpolated between 0 (i.e., the base and the build are the same) and this first modeled analysis year. For interim years that fall between the last modeled analysis year and the end year, results are extrapolated linearly to the end year, using the prior modeled analysis year results.

Inflation and Discounting

Discounting provides a method for valuing what a future sum of money would be valued at in today's dollars. The discount rate reflects the "time value of money." Money that is invested, rather than spent, in the one year will be worth more in the future year – in the next year (assuming a positive return on investment). In contrast, inflation represents the fact that the currency values generally decline over time – a dollar today will purchase more than a dollar tomorrow. Both inflation and discounting must be considered when calculating a multiyear stream of benefits and costs, as both will influence the final output BCA metrics. The BCA tool allows the user to specify both inflation and discount rates. Note, however, that the activity-based model outputs are in constant base year dollars.

II. The Regional Plan Economic Impact Analysis

The transportation investments proposed for the Regional Plan will impact the regional economy in two ways: (1) the investments themselves provide an economic infusion to the firms that construct and operate the transportation system, the firms that support them, their employees, and the general economy; and (2) the improved transportation system itself reduces transportation costs and allows companies better access to suppliers, customers, partners, and employees; and allows residents better access to jobs, education, and other amenities. The San Diego Forward Economic Impact Analysis measures both.

The transportation network envisioned by the Regional Plan is about providing more transportation choices for the growing San Diego region over the next 35 years.

First, transit projects will be built to reduce congestion to provide access for San Diegans. Five new trolley lines will be added to the three we have today, and existing trolley lines will run with greater frequency. Thirty-two new *Rapid* bus lines will be added to provide longer-distance bus service with fewer stops, similar to light rail transit, but at a fraction of the cost. SPRINTER and COASTER rail lines will run more frequently. Four new streetcar lines will be added in and around Downtown San Diego and beach communities. Local buses will see service frequencies increase and intermodal transit centers will allow commuters and other travelers to connect between modes with ease. These transit improvements create a high-frequency transit system that reaches a dramatically larger portion of San Diego, and supports denser development.

Second, the highway system will be improved; primarily through the use of a flexible system that incorporates "managed lanes." Managed lanes make more efficient use of limited right-of-way that limits the expansion of freeways, and include:

- Express Lanes, which serve buses, carpools, and clean-air vehicles, but which also allow people driving alone to pay a fee to avoid congestion (fees are used to support transit along the same corridor)
- Carpool lanes, or High-Occupancy Vehicle (HOV) Lanes, that are exclusively for carpools and transit vehicles
- Transit-Only Lanes, exclusively for transit vehicles

The Regional Plan calls for almost 600 miles of managed lanes, as opposed to adding less than 90 miles of general purpose lanes. Managed lanes will serve all major highway corridors in the region: I-5, I-15, I-805, SR 78, SR 52, SR 94, and SR 54. Other operational improvements will allow San Diego to stretch its highway infrastructure.

Third, the Regional Plan is investing in more than 275 new miles of regional bikeways that will form a complete and connected regional system. In addition there will be many, many local bike projects that are not included in the plan, but will connect to the regional network. Hundreds of pedestrian safety and traffic calming projects are also called for in the plan, including Safe-Routes-to-School and Safe-Routes-to-Transit programs, which will transform the many areas in the San Diego region for people on foot and on bikes.

Lastly, the Regional Plan will use emerging technology to keep the transportation system operating at its most efficient. This means supporting real-time transit and highway information, shared-use mobility (e.g., Car2go, Uber, Lyft, bikeshare), and other technologies (such as driverless vehicles) that can add capacity to the transportation system without expensive infrastructure.

II.1 Economic Impact of Transportation Investments

Public-sector spending on transportation infrastructure can support significant job and income growth, both directly by creating jobs in construction and operations, and indirectly through purchases of vehicles, equipment, and other supplies. Infrastructure spending can also result in induced (or “multiplier”) economic effects, as workers spend their incomes on goods and services, creating additional jobs and income throughout the economy.

Estimates of the total economic impact of transportation infrastructure spending vary from study to study. The following are examples of recent findings:

- In 2007, the Federal Highway Administration (FHWA) estimated that every \$1 billion of highway spending supports 27,800 jobs. However, due to increases in construction material costs and wages, changes in worker productivity, and other factors, the FHWA now considers this estimate out-of-date and likely too high.⁵
- A 2009 study of public transit spending found that every \$1 billion in spending on transit capital (e.g., building infrastructure, purchasing vehicles and equipment) and operations (e.g., paying drivers and other workers) supports an estimated 36,000 jobs for a year. In addition, each dollar of transit investment is estimated to support a \$1.80 increase in gross domestic product, which in turn generates \$0.48 in federal, state, and local tax revenues.⁶
- A 2010 review of data on the job creation impacts of the American Recovery and Reinvestment Act (ARRA) found that investing in public transportation produced twice as many jobs per dollar as investing in highways. The study found that in the first ten months after the ARRA was signed, every \$1 billion spent on public transportation created or retained 16,419 job-months, while every \$1 billion spent on highway infrastructure projects created or retained 8,781 job-months.⁷
- In 2011, the Council of Economic Advisors estimated that \$1 billion on transportation infrastructure spending (whether on transit or highways) supports 13,000 jobs for a year based on macroeconomic analysis and experience from the ARRA.⁸

A 2014 update to the 2009 Weisbrod and Reno study found that \$1 billion in spending on transit capital (e.g., building infrastructure, purchasing vehicles and equipment) and operations (e.g., paying drivers and other workers) supports an estimated 21,800 jobs for a year. In addition, each dollar of transit investment is estimated to support a \$0.70 increase in gross domestic product, which in turn generates \$0.43 in federal, state, and local tax revenues.⁹

SANDAG used the TranSight model from Regional Economic Models, Inc. (REMI) to estimate economic impacts. The model uses an input-output framework to show how transportation expenditures flow through the economy to generate jobs and output. For example, if a construction firm is awarded a \$1 billion contract to build a trolley line, that company hires employees, and the \$1 billion and the jobs that it generates are termed “direct” impacts. Then, in the course of building the trolley lines the firm will buy trucks, materials, hire surveying firms and other types of support; if these purchases are made within San Diego County, they are “indirect” impacts. In addition, the employees of these firms spend their wages on housing, food, entertainment, etc. Again, the portion of these purchases made in San Diego County represents “induced” impacts. Together, these are termed “multiplier effects” because they multiply the impact of direct spending.

The Regional Plan will inject \$52.5¹⁰ billion directly into the economy between now and 2050. That \$52.5 billion results in additional indirect and induced impacts of \$46.3 billion, for a total of \$98.8 billion in output. In an average year, this represents \$2.7 billion in increased GRP, and 11,200 jobs.

II.2 Economic Impact of an Improved Transportation System

In the long-term, the primary goal of most new transit and highway investments is to improve accessibility; that is, make it faster and easier for households and firms to access resources and services, including (for individuals and households) jobs, education, health care, shopping, and recreation, and (for firms) labor, customers, distributors, raw materials, and professional services. Improved accessibility can have multiple economic benefits, including direct benefits for transportation system users, workers, businesses, and transportation agencies, as well as broader benefits for regional economic competitiveness. Table P.8 summarizes the types of economic benefits that can result from investments in transportation infrastructure, including the direct beneficiaries and the potential benefits for the overall regional economy.

By reducing household transportation costs and making it easier for workers to access employment, education, health care, and other destinations, transportation investments can contribute to a more skilled, productive workforce, and free up consumer spending for other goods and services. Transportation investments can also reduce the amount of time and money that firms spend on goods movement and other transportation activities, resulting in increased productivity, stronger profits, new jobs, higher worker wages, and faster economic growth (i.e., GRP). In effect, transportation investments bring people and businesses closer to one another, resulting in reduced costs.

An additional result can be “agglomeration economies,” or, the benefits that result when firms and workers cluster together, including the ability for businesses to more easily share suppliers and distributors, access skilled workers, and transfer knowledge.¹¹ Some types of transportation improvements (such as new transit investments) may further support agglomeration economies and result in other benefits (such as reduced service costs for local governments) by facilitating more efficient, higher-intensity land use patterns. Higher densities have been shown to support increased productivity and economic growth; for example, research by the Federal Reserve has shown that cities with higher employment densities tend to have more patents per capita, all else being equal.¹² Finally, investments that result in reduced congestion, less time spent in traffic, safer roads, or improved environmental quality, contribute to a higher quality of life – an important factor in attracting new households and businesses to a city or region.¹³

Table P.8

Potential Economic Benefits of Transportation Investments

Type of Benefit	Description	Direct Beneficiaries	Regional Economic Benefits
Short-term spending impacts	Job and income growth as a result of spending on transportation capital, maintenance, and operations	Workers, businesses	New jobs and higher wages
Reduced congestion	Reduced traffic congestion on roadways	Users	Increased productivity; improved quality of life; increased regional attractiveness for new households and businesses
Consumer savings	Reduced consumer transportation costs, including vehicle operation/ownership costs	Users	Additional household spending on non-transportation goods and services
Access to economic opportunity	Improved access to jobs, education, health care, and other destinations	Users	More educated and productive work force; increased regional attractiveness for new households and businesses
Agglomeration economies and increased productivity	Productivity gains from improved access for employers to workforce and customers and positive spillovers related to more concentrated land use patterns; reduced employee turnover	Businesses	New jobs and higher wages; increased regional attractiveness for new households and businesses
Road safety	Savings from reduced per capita traffic crash rates, reduced need for emergency services	Users	Improved quality of life; increased regional attractiveness for new households and businesses
Environmental quality	Reduced pollution emissions and habitat degradation	Everyone	Improved quality of life; increased regional attractiveness for new households and businesses
Facility cost savings	Reduced costs on other transportation facilities, such as roads and parking	Public agencies	Frees up funding for other uses or reduced tax rates
Efficient land use	More compact development, reduced sprawl; potential savings on the cost of providing infrastructure and services	Everyone, public agencies	Stronger neighborhoods, higher tax revenues
Higher property values and new development	Increased property values and new, higher-intensity development, reflecting the accessibility benefits of transportation investments	Property owners, developers	Stronger neighborhoods, higher tax revenues

Source: Strategic Economics

To gauge the economic impacts described above, SANDAG used the TranSight tool from REMI. TranSight is used to evaluate the economic effects of changes to the transportation system. Using the outputs of transportation modeling, TranSight allows the user to investigate the impact of different transportation scenarios on jobs, income, costs, and other economic variables by sector.

For past plans, SANDAG has used the IMPLAN model to estimate economic impacts of the construction and O&M expenditures in the plan; for the Regional Plan, using the TranSight tool allows us to combine that analysis of direct investment impacts with an analysis of the effects of a more efficient transportation system in the long-term.

The TranSight model takes relatively simple transportation demand outputs (vehicle-miles traveled, vehicle-hours traveled, and trips) and translates those outputs into commodity accessibility, commuting costs, and transportation costs that can be converted into indices that are used to measure the impact of the transportation improvements in the San Diego region, which is modeled by REMI. As part of this process, a benefit-cost analysis is conducted for factors such as time savings and emissions costs, the benefits of which feed into the transportation indices.

Since SANDAG had already built a custom BCA tool to calculate benefits directly from the agency’s activity-based travel model (ABM), it was necessary to ensure that the TranSight BCA benefit calculations were consistent with the BCA tool outputs. In practice, it was decided that the best way to achieve this consistency was to incorporate the more-detailed outputs of the SANDAG BCA tool by by-passing the initial steps of the TranSight model, and have the BCA tool calculate the TranSight benefit inputs directly.

The results from TranSight are presented in Table P.9. They show that the impacts of improvements in the transportation network increased over time, which makes sense as the transportation investments are not fully realized until 2050 and, in the absence of new transportation infrastructure, the region’s traffic and other transportation challenges would deteriorate over time. By 2035, transportation investments are beginning to have a markedly positive effect on the economy.

Table P.9
Results of TranSight Analysis

	Total Change	Relative Change
2020		
Employment	11,867	1.0%
GRP	\$2.0 billion	1.2%
2035		
Employment	48,033	3.6%
GRP	\$13.1 billion	5.3%
2050		
Employment	91,480	4.3%
GRP	\$34.1 billion	8.9%
Average		
Employment	52,524	2.5%
GRP	\$12.2 billion	4.2%

II.3 Methodology

This section presents a summary of the approach and methodology used to estimate the economic impacts of the Regional Plan. The analysis used REMI’s TranSight software to carry out this analysis, inputs from the benefit-cost analysis, as well as costs from construction, maintenance and operations estimates for the Regional Plan.

II.3.1 Description of the REMI Model

While traditional forms of economic impact analysis address only employment effects and other multiplier effects as a result of construction and operations of proposed projects, in the case of transportation investments, additional economic benefits are expected to result over the long-term as a result of efficiency benefits in the region from transportation improvements. In order to capture the comprehensive economic benefits of the Regional Plan, SANDAG used TranSight, a dynamic economic impact modeling system created by Regional Economic Models, Inc. (REMI), for comprehensive evaluation of transportation systems.

REMI has developed several dynamic economic modeling tools to analyze government policy proposals and provide information on the economic effects of policies prior to implementation. TranSight is the leading tool for evaluation of the total economic effects of transportation systems, and can integrate travel demand modeling with the REMI economic impact model to demonstrate how transportation contributes to economic competitiveness. The model is constructed with data from a wide range of economic and transportation topical areas, includes key econometric estimates and integrates inter-industry transactions, long run equilibrium features, and new economic geography.

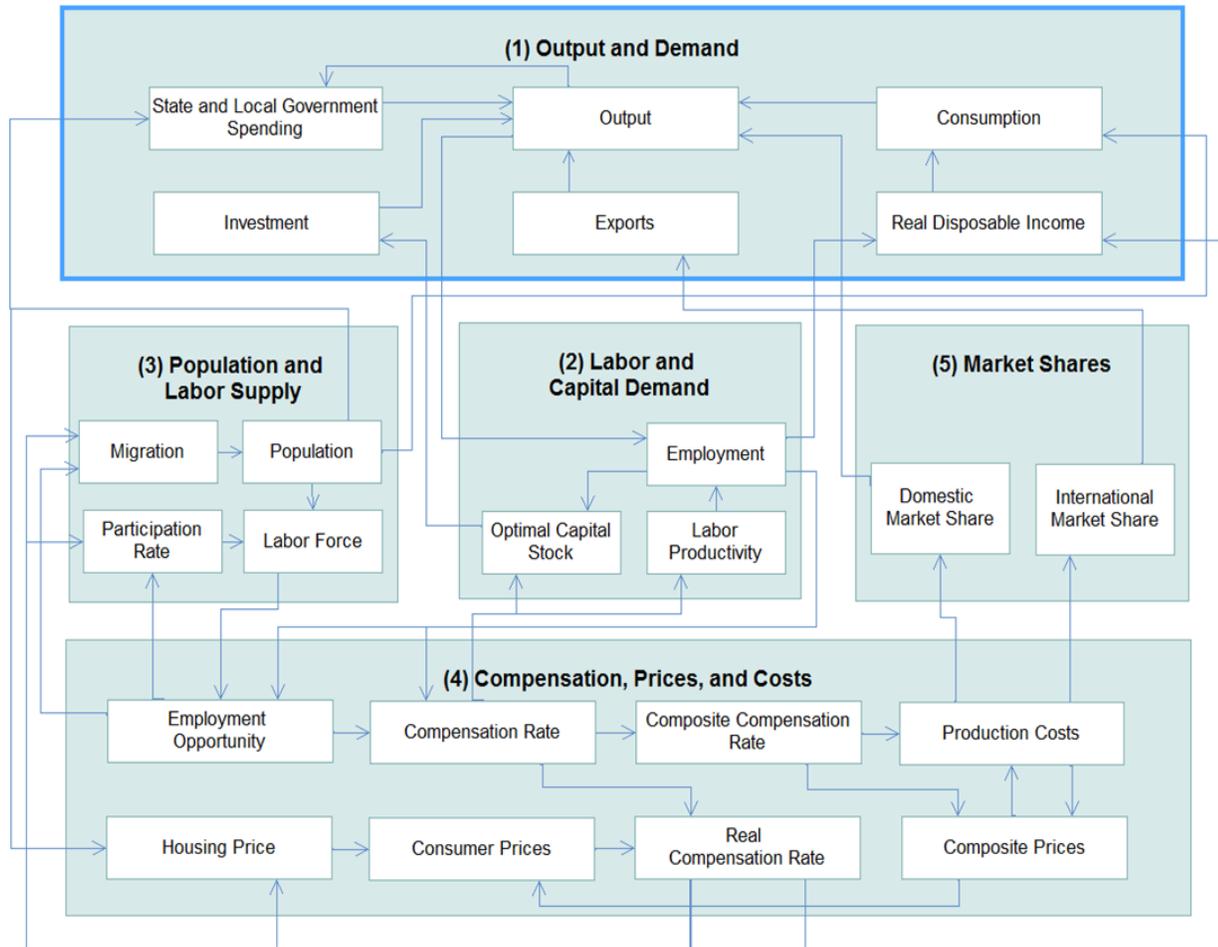
The TranSight model includes:

- Substitution among factors of production in response to changes in relative factor costs.
- Migration responses to changes in expected income and employment opportunity.
- Access to regional and national consumer commodities, and exposure to positive and negative amenities.
- Labor participation rate responses to changes in real wage and employment conditions.
- Wage rate responses to labor market changes.
- Consumer consumption responses to changes in real disposable income and commodity prices.
- Local, regional, and market shares responses to changes in regional production costs and in agglomeration economics.

The output of this model includes such key economic indicators as employment by industry, output and value added by industry, personal income, population, and many more (see Figure P.4 for detail on REMI model blocks).

Figure P.4

REMI Model Overview



Source: REMI

II.3.2 Framework for Analysis

There are a number of important assumptions underlying the REMI analysis. Key assumptions for this analysis include:

- **Geographic area:** This analysis covers San Diego County.
- **Time frame:** Analysis begins in 2014 and extends to 2050.
- **The No-Build Scenario:** The no-build scenario forgoes the vast majority of the transportation investments proposed in the Regional Plan, and therefore result in much higher congestion and far fewer public transit options than the Plan scenario.
- **Baseline population and employment figures:** The model was run using both the REMI standard values for population and employment, and adjusting those values to be consistent with SANDAG forecasts. The results using the SANDAG forecast were moderately higher, so to be conservative, the REMI baseline values were used.
- **Costs and units:** All costs and dollar amounts are shown in constant 2015 dollars.
- **Restriction of economic migration in REMI model:** To be consistent with the SANDAG demographic forecast, the model has been set to restrict economic migration, which is defined as the flow of people under age 65 into the region in response to economic and amenity factors. This restriction lowers the modeled overall impact of the transportation investments. Variables (such as emissions and safety are pecuniary benefits) are included in the

amenity term; the amenity term accounts for non-economic, quality of life factors, and this is modeled in the context of economic migration. Therefore, although these variables are included in the model, they do not contribute to economic impacts because no economic migration can be realized in the model.

- Exclusion of Benefits from Reliability: Benefits from the reliability of the transportation network have been excluded because they are not easily accounted for in REMI due to the independent development of the BCA tool by SANDAG and because they represent a small share of total benefits as determined by the SANDAG BCA tool. The BCA tool will be discussed in more detail in the Sources of Inputs and Data section.

II.3.3 Source of Inputs and Data

Three primary data sources were used for this analysis. All three sources were from the SANDAG modeling activities or from the Regional Plan-related activities.

- BCA Tool: As described in the previous section, to understand the potential impacts of the Regional Plan on the region, SANDAG created a Benefit-Cost Analysis (BCA) tool. The BCA tool uses the outputs of the SANDAG activity-based travel model to monetize and aggregate the benefits of the plan. This analysis provides information on topics such as how much time and money drivers and transit riders will save, and how much safer, healthier, and cleaner our system becomes as the Plan is implemented. Inputs in the areas of vehicle operating costs, residential and non-residential commuter benefits, truck mobility benefits, emissions benefits, and safety benefits were used in the analysis. Inputs from the more sophisticated SANDAG BCA were used for consistency with the BCA, and precluded the use of TranSight's travel-demand modeling functions.
- Population and Employment: Both REMI defaults and SANDAG population and employment growth projections were incorporated into the baseline scenario for the period 2014 to 2050. While SANDAG forecast values would be consistent with other SANDAG analyses, they resulted in moderately higher economic results; therefore, to be conservative, population and employment estimates generated by the REMI model were used.
- Capital costs and maintenance: In addition, SANDAG also provided estimates of both capital costs and maintenance and operations (O&M) costs for the investments proposed in the Regional Plan under the Regional Plan scenario, by year, over the period 2014 to 2050.

II.3.4 REMI TranSight Model Inputs

Total economic impact is a result of many factors at play in the region. Though transportation-related spending and benefits affect different sectors of the economy, they are all similar in terms of the core components that drive their impact on the regional economy. The specific policy variables used to evaluate the variety of impacts to the economy created by the Regional Plan investments are described in the following section and are grouped by type.

Construction Costs

These costs only occur one time, though they do take place over a number of years. One time construction inputs were modeled in TranSight as follows:

- Construction costs were input as exogenous final demand for the construction sector
- Debt service associated with construction costs has been input as negative government spending

Operations and Maintenance Costs

Transportation

Operation and maintenance of transportation infrastructure includes both spending associated with highways and transit in the region. Transportation operations and maintenance inputs were modeled in TranSight as follows:

- Highway-related operations and maintenance spending was input as exogenous final demand for the construction sector
- Transit- related operations and maintenance spending was input as exogenous final demand in the transit and ground passenger transportation sector
- No local contracting policies that would impact location of jobs confirmed, so no model adjustments were made to take this into account

Vehicle Operating Costs

Vehicle operations and maintenance expenditures include spending on both fuel and repairs. Vehicle operations and maintenance inputs were modeled in TranSight as follows:

- Net value for automobiles and trucks was used
- Expenditures were divided in the following shares:
 - Fuel: 60%
 - Repair: 40%
- Both were input in the consumer spending category under the demand model block, and entered as negative values
- The total of these values was entered as consumption reallocation to all other goods and services, and entered as a positive value

Mobility Impacts

Residential Commuters

Benefits to residential commuters result over the period due to transportation investments in the Regional Plan. Residential commuter benefits were input in TranSight as follows:

- Residential commuters benefits were input as Effective Distance Policy Variables
 - Benefits were input as share and entered in negative format
- Note that the share of commute and non-commute aggregate costs is based on the aggregate totals costs by year multiplied by the share of benefits by type (commute / non-commute). It is possible to make additional changes in the BCA tool that compute a raw value, but the time intensity of this activity was prohibitive.
 - Also note that the values for 2012 through 2020 were interpolated

Residential Non-Commuters

Benefits to residential non-commuters result over the period due to transportation investments in the Regional Plan. Residential non-commuter benefits were input in TranSight as follows:

- Residential non-commuter benefits were input as Effective Distance as Policy Variables
 - Benefits were input as share and entered in negative format
- Note that the share of commute and non-commute aggregate costs is based on the aggregate totals costs by year multiplied by the share of benefits by type (commute / non-commute). It is possible to make additional changes in the BCA tool that compute a raw value, but the time intensity of this activity was prohibitive

- Also note that the values for 2012 through 2020 were interpolated by RSG, which was retained to develop the BCA tool

Truck Mobility

Benefits to truck mobility result over the period of analysis due to transportation investments in the Regional Plan. Truck mobility benefits were input in TranSight as follows:

- Truck mobility benefits from the BCA were input into REMI as transportation costs
 - Benefits were input as share and entered in negative format

Other Impacts Considered

Reliability

Reliability benefits were considered for use, and tested extensively before removal from the analysis. Reliability benefits were input as a negative share of accessibility costs, and were tested at various levels of overall benefits as well. Due to differences in the structures of the REMI and BCA tools, the relationship between the BCA model outputs and REMI policy variables was not able to be sufficiently confirmed to enable the incorporation of reliability benefits. This decision was supported by the BCA tool's assessment of reliability benefits as a small share of total benefits.

Emissions

Benefits from emissions reductions were entered in TranSight using the non-pecuniary amenity variable and entered as a positive amenity benefit. However, no impact from these benefits was calculated due to the restriction of the model's response to economic migration, where amenities are operationalized in TranSight.

Safety

Safety benefits, called Accidents in the BCA tool, were entered in TranSight using the non-pecuniary amenity variable and entered as a positive amenity benefit. However, no impact from these benefits was calculated due to the restriction of the model's response to economic migration, where amenities are operationalized in TranSight.

III. Economic Competitiveness Analysis

III.1 Research and Report on the State of the Practice

Introduction

As part of the economic competitiveness analysis (ECA) for the Regional Plan, AECOM and Strategic Economics were commissioned to prepare a literature review to evaluate how transportation investments affect the region from the following perspectives:

- Economic competitiveness
- Economic shift
- Fiscal implications of urban forms

The literature review on *economic competitiveness* provides a conceptual overview and empirical evidence of the effects of transit and highway investments on local and regional economic competitiveness. The literature review on *economic shift* discusses shift in the spatial, temporal, and industrial context, with a focus on industry shifts from transportation and highway investments. The literature review on *fiscal implications of urban form* discusses changes in a local government's revenues and costs with respect to its degree of density in urban form.

The purpose of this literature review is to provide the analytic background to develop a process to evaluate how alternative transportation investments are enhancing or hindering trade industry clusters in the region. Additional cluster mapping tasks will further facilitate this effort.

Summary Findings

Transportation investments create many regional economic benefits, including contributing to improved quality of life, helping to attract new businesses and households, expanding households' access to employment opportunities and other destinations, and supporting higher property values and tax revenues. Transportation investments can also influence development patterns by attracting development to areas that are more cost-effective to service, have fewer environmental impacts, or are in need of economic regeneration. A transportation investment can also shift jobs temporally, spatially, and across industries. However, the most significant impact of a strong regional transportation network is to reduce the amount of time and money that firms and households spend on transportation.

Another impact of transportation investment is the creation of agglomeration economies, or the ability for businesses to more easily share suppliers and distributors, access skilled workers, and transfer knowledge. In turn, these agglomeration benefits can result in increased productivity, stronger profits, new jobs, higher worker wages, and faster economic growth (i.e., gross regional product [GRP]).

Transportation investments that facilitate efficient, higher-intensity land use patterns—and particularly the development of high-density employment centers—are likely to contribute to agglomeration-related economic growth. This requires coordinated land use policies and infrastructure investments. Although some highway and other road improvements may be necessary to support growth in existing, high-intensity employment centers, transit can be a powerful force in facilitating density and economic agglomeration by serving as a focal point for higher-intensity development, mitigating congestion impacts, and expanding firms' access to a skilled workforce. These higher-intensity land use patterns are also found to have positive benefits from a fiscal perspective, as the economies of scale in development reduce costs of providing public services. Finally, a growing body of research is exploring how compact land use patterns facilitate more walking and biking, resulting in public health benefits that also have economic benefits for society and employers. A regional transportation program that balances transit and highway improvements to create an integrated, multimodal transportation network, and support higher-intensity, more efficient land use patterns, is a key component of maintaining and growing a prosperous, equitable regional economy.

III.1.1 Economic Competitiveness

Regions and communities have many different economic development goals, including job growth, increased household incomes, improved productivity, business and household attraction, expanded employment opportunities for low- and moderate-income households, and higher property values and tax revenues. Transportation investments can contribute to many of these goals, both in the short-term (through the economic impacts of infrastructure spending), and in the long-term (by improving accessibility). This section provides an overview of the short- and long-term economic impacts associated with transportation investments in general. The following sections provide additional empirical evidence on the specific, longer-term benefits of transit and highway investments for economic competitiveness.

Short-Term Economic Impacts of Infrastructure Investment

As noted in the previous section on economic impacts, public-sector spending on transportation infrastructure supports significant job and income growth, both directly by creating jobs in construction and operations, and indirectly through purchases of vehicles, equipment, and other supplies. Infrastructure spending also results in

induced (or “multiplier”) economic effects, as workers spend their incomes on goods and services, creating additional jobs and income throughout the economy. See the previous section for detailed analysis of these effects.

Long-Term Economic Benefits of Transportation Investments

In the long-term, the primary goal of most new transit and highway investments is to improve accessibility; that is, make it faster and easier for households and firms to access resources and services, including (for individuals and households) jobs, education, health care, shopping, and recreation, and (for firms) labor, customers, distributors, raw materials, and professional services. Improved accessibility can have multiple economic benefits, including direct benefits for transportation system users, workers, businesses, and transportation agencies, as well as broader benefits for regional economic competitiveness. Again, these effects are explored in detail in the previous section on economic impacts.

As noted in the previous section, additional result can be “agglomeration economies,” or, the benefits that result when firms and workers cluster together, including the ability for businesses to more easily share suppliers and distributors, access skilled workers, and transfer knowledge.¹⁴ Some types of transportation improvements (such as new transit investments) may further support agglomeration economies and result in other benefits (such as reduced service costs) for local governments by facilitating more efficient, higher-intensity land use patterns. Higher densities have been shown to support increased productivity and economic growth; for example, research by the Federal Reserve has shown that cities with higher employment densities tend to have more patents per capita, all else being equal.¹⁵ Finally, investments that result in reduced congestion, less time spent in traffic, safer roads, or improved environmental quality, contribute to a higher quality of life – an important factor in attracting new households and businesses to a city or region.¹⁶

The economic benefits associated with transportation investments come primarily from faster and easier access to destinations (i.e., improved accessibility and time savings), rather than from additional travel (or increased mobility). Although vehicle travel is a critical component of economic success for households, firms, and regions, additional driving may eventually lead to diminishing marginal economic benefits due to increased congestion, the high cost of expanding road and parking facilities, and rising fuel prices.¹⁷ Indeed, states where residents drive less (i.e., states with lower vehicle miles travelled [VMT] per capita) tend to have higher per capita GRPs, while at the metro area level there is no clear relationship between per capita VMT and GRP.¹⁸ In addition, while expanding road capacity may lead to short-term decreases in traffic congestion, these gains may be partially offset by increases in demand as travelers shift routes, times, and modes of travel to take advantage of the new capacity.¹⁹ Moreover, some transportation improvements—for example, a new highway in a previously undeveloped area—have the potential to reduce densities, which could result in reduced agglomeration economies and undermine productivity.²⁰

The difference between economic growth and redistribution is another important consideration in understanding the relationship between transportation investments and regional economic competitiveness. New jobs or businesses, development, or higher property values around a new transit stop or freeway on-ramp do not necessarily indicate that the investment has caused regional economic growth. In some cases, transportation investments may redistribute economic activity that would have happened anyway. However, to the extent that transportation investments lead to a more efficient distribution of activity—for example, by facilitating more compact development and new investment in existing neighborhoods—redistribution may still have a positive impact on the regional economy.

III.1.3.1 Economic Impacts of Public Transit Investments

Public transit investments are associated with a wide range of economic, social, and environmental benefits that can contribute to a region’s overall economic competitiveness. Some of these benefits can be valued in monetary terms,

but many are difficult to quantify or have not been studied extensively. This section reviews the literature on the economic benefits of transit, providing monetary or other quantitative estimates as available.

Note that most of the literature on the economic impacts of transit has focused on rail – particularly commuter and light rail systems. Only a few studies have examined the economic benefits of bus rapid transit and streetcar systems, primarily through the lens of land use and property value impacts. These studies are discussed below.

User Benefits

Providing alternatives to driving can reduce the amount that households spend on transportation, freeing up income for households to spend on education, job training, and other goods and services that may have a larger economic impact.

The cost of owning and operating a car is substantial, ranging from \$6,000 to \$12,000 a year, on average.²¹ Providing alternatives to driving can help reduce this expenditure. On average, households living in auto-dependent neighborhoods spend 25 percent of their income on transportation, while households living in neighborhoods where they can easily walk, bike, or take transit to access jobs and other daily needs spend just 9 percent.²² Households can spend this transportation savings on other goods and services that may have larger economic impacts. For example, one study estimated that every \$1 million of spending shifted away from fuel expenditures to other consumer goods adds 4.5 new jobs to the U.S. economy, and every \$1 million of spending shifted away from general vehicle costs (e.g., vehicle purchase, maintenance, insurance) adds 3.6 jobs to the economy.²³ While a shift in consumer spending, say from fuel purchase, insurance, car financing, and maintenance to other consumer goods and services may be considered a transfer of economic activity, for a local region, the economic activity may be greater if the goods and services purchased have a higher local multiplier effect.

Savings from reduced transportation costs are particularly important for low- and moderate-income households, which tend to spend a higher share of their household income on transportation.

For example, transportation accounts for 55 percent of household expenditures for an average very low-income household, compared with less than 9 percent for an average high-income household.²⁴ Low- and moderate-income households that can spend less on transportation will have more money to invest in education or job training, build wealth, and save for homeownership, creating long-term benefits for both individual households and the economy a whole.

Transit investments can also improve low-income households' access to jobs and other important destinations.

Numerous studies have shown that transportation access is a significant factor in determining the economic opportunities available to low-income households. Access to a vehicle, in particular, can help households find and maintain employment, and is associated with more time worked and higher earnings.²⁵ The empirical evidence on the effectiveness of transit in improving employment outcomes is mixed, possibly reflecting the decentralization of employment in many U.S. metro areas (discussed below) and the ineffectiveness of many of the nation's transit systems in connecting low-wage workers to jobs.²⁶ However, transit access is critical for households without cars, and several studies have shown a positive relationship between transit access and employment. For example, a recent study of housing choice voucher recipients found that improved transit access was associated with maintaining employment and had a positive effect on earnings, although the effect of auto ownership on employment outcomes was greater.²⁷ University of Minnesota researchers found that the introduction of the Hiawatha Line in the Twin Cities region led to significant increases in the number of jobs that low-wage workers in the region could reach within a 30-minute travel time. The completion of the Hiawatha Line was also associated with increases in the number of low-wage workers commuting to transit-served areas, suggesting that the light rail line led to real economic benefits for low-wage workers.²⁸

Congestion, Road Safety, and Environmental Benefits

Households living near transit travel fewer vehicle miles per day.

A recent analysis found that California households living within 0.5 miles from a rail, ferry, or high-frequency bus station logged 25 to 30 percent fewer VMT per day in 2013 than households of similar incomes living more than 0.5 miles away from transit. Households, and particularly low- and moderate-income households, living within 0.25 miles of transit tend to drive even less. The analysis showed that low- and moderate-income households (those earning less than 120 percent of area median income) living within 0.25 miles of transit had 50 to 60 percent fewer VMT than households of the same income levels living more than 0.5 miles from a transit station. Higher-income households (earning more than 120 percent of area median income) living within 0.25 miles of transit had approximately 37 percent fewer VMT than higher-income households living more than 0.5 miles away from transit.²⁹ The reduction in VMT has other economic benefits associated with improved air quality and associated health benefits.

Bus and rail transit help reduce peak-period traffic and alleviate congestion.

United States transit riders traveled approximately 56 billion miles on public transportation systems in 2011. The Texas Transportation Institute's Urban Mobility Report estimates that if these travelers had driven instead, commuters would have spent an additional 865 million hours in traffic in 2011, consuming 450 million more gallons of fuel and resulting in additional \$20.8 billion (or 15% increase) worth of travel delays and fuel consumption.³⁰ Note, however, that the Urban Mobility Report has been criticized for over-stating both travel times and the economic costs of traffic congestion.³¹

Public transit tends to be much safer than auto use.

The American Public Transportation Association (APTA) estimated that between 2002 and 2006, the rate of fatal accidents per transit passenger mile was 1/25th the rate of fatal accidents per highway passenger mile.³² Improved road safety directly benefits drivers and results in local government savings on police, health, and emergency services.

Enhanced transit service can result in environmental benefits such as reduced air pollution and greenhouse gas emissions.

These benefits accrue broadly to society, and are difficult to value monetarily. One recent U.C. Davis study estimated that the cost of climate-change-related damage from automobiles is approximately three times the cost of damage from rail transit per passenger mile traveled, and 1.4 to 1.5 times the cost of damage from bus transit.³³

Employment and Productivity Impacts

A high-quality transit system can make a region more competitive in attracting new workers and businesses.

Frequent, convenient, and reliable public transit is increasingly seen as a critical component of a high quality of life, and is one of the factors that many households and firms consider in determining where to locate. In a 2014 survey, 81 percent of Millennials (people born in the 1980s and 1990s) and 77 percent of Baby Boomers (people born between 1946 and 1964) polled agreed that "affordable and convenient transportation alternatives to the car are at least somewhat important when deciding where to live and work."³⁴ Like workers, businesses are also increasingly choosing locations based on factors such as local quality of life and the productivity and education levels of the local workforce.³⁵

Firms in the high-tech industry and other sectors that require skilled labor are especially likely to locate in places with high-quality transit.

Firms in knowledge-based industries (e.g., professional, scientific, information, and financial services) are less tied to factors such as the cost of transportation and other inputs, and more likely to choose locations based on quality of life

for workers.³⁶ Reflecting the value that these types of employers place on proximity to transit, employment near transit stations tends to be highly concentrated in knowledge-based industries. A recent study by the Center for Transit-Oriented Development (CTOD) of employment trends in 40 United States regions with fixed-guideway transit systems (rail and bus rapid transit) found that, in 2009, knowledge-based industries accounted for nearly 30 percent of employment within a 0.5-mile radius of transit stations, compared to 20 percent of total regional employment.³⁷

Transit has helped stabilize existing urban neighborhoods, even as population and employment overall have decentralized.

During the 2000s, U.S. metropolitan areas experienced continued decentralization of employment, with jobs in nearly all industries continuing to shift away from the urban core toward the suburbs (although jobs in some knowledge-based industries, such as finance, insurance, information, and professional and scientific services, are more centralized than in other industries).³⁸ Households have also continued to shift to the suburbs, although recent research indicates that in the last several years, many major cities have grown faster than their suburbs for the first time in decades.³⁹ Despite the overall trend toward decentralization, however, the CTOD study of employment trends found that established transit station areas—defined as the 0.5-mile radius around transit stations built prior to 2000—retained their share of total regional employment between 2002 and 2009.⁴⁰ A separate analysis of six metropolitan areas that opened light rail systems in the 1980s (Buffalo, Portland, Sacramento, San Diego, San Jose, and Pittsburgh) found that these metro areas experienced slower declines in the share of the urbanized area’s population located in the center city, compared to other regions of the country.⁴¹

By improving accessibility and facilitating the concentration of employment, public transit investments have the potential to facilitate agglomeration economies and support increased productivity.

Transit can support agglomeration in two ways. First, transit investments can expand transportation capacity while limiting the need for new parking and roadway infrastructure, enabling higher-intensity development, higher building occupancy, and more concentrated employment centers. Second, transit investments can expand firms’ access to skilled workers by reducing travel times and creating new transportation alternatives for workers who are either transit dependent or prefer to commute by transit rather than drive.⁴² Economists and transportation planners have only recently begun to measure the agglomeration-related benefits of transit. A study from the United Kingdom suggests that productivity improvements related to increasing the effective density of employment (i.e., by decreasing travel times) could increase the benefits of a major urban rail project by as much as 25 percent over standard cost-benefit measures.⁴³ A recent study of transit and agglomeration economies in more than 300 metropolitan areas in the United States estimated that a 10 percent increase in transit service (measured as the number of bus and rail seats or rail miles per capita) corresponds with increased wages totaling \$1.5 to \$1.8 million per year in an average region. The study found that transit service improvements enable increased wages by allowing for higher central city employment densities, thus supporting greater productivity.⁴⁴

Improved transit access is also associated with reduced employee turnover.

A preliminary study on employee turnover and bus rapid transit in six states in the Upper Midwest found that employee turnover rates were lower in counties with access to bus rapid transit, with employee turnover rates decreasing by 0.02 percent to 0.03 percent for each dollar increase in per capita operating spending on bus rapid transit. The authors calculate that the reduced employee turnover related to bus transit access resulted in reduced business costs totaling \$5.3 to \$6.1 million a year for the manufacturing industry in the six states studied, and \$1.7 to \$1.9 million for the retail industry.⁴⁵

Property Value, Development, and Other Land Use Impacts

Transit investments can help support higher property values, resulting in higher tax revenues for local governments.

A large body of research has shown that property owners and renters are willing to pay a premium to locate where they can take advantage of the improved accessibility and other benefits provided by transit.⁴⁶ For example, a recent series of studies on property values around San Diego's rail transit stations found that, all else being equal, a condominium located within 0.25 miles of a rail station was worth 16 percent more than a condominium located 1 mile away from a station; a single-family home located within 0.25 miles of a rail station was worth 6 percent more than one located 1 mile away.⁴⁷ Property value premiums were generally higher near transit stations located in more pedestrian-oriented neighborhoods⁴⁸ and in higher-density zoning districts.⁴⁹

Transit can help attract and enable new, higher-intensity development.

Transit access can improve the marketability of new residential units or commercial space, resulting in higher sales prices and/or rents that can help make higher-intensity development more financially feasible. Transit can also serve as a rationale for local governments to allow higher intensities (resulting in increased development revenues) and reduced parking requirements (resulting in decreased construction costs).⁵⁰ Indeed, real estate developers see transit as key priority for future investment. In a recent Urban Land Institute (ULI) survey, 71 percent of private developers ranked improved public transit services (bus and rail) in the region where they work as "one of the very top priorities" or "high priority" for infrastructure improvements over the next ten years.⁵¹ In general, transit improvements appear to have the greatest impact on property values and new development when the corridor or system significantly improves residents' access to employment and other destinations; provides frequent, high-quality regional service; and is combined with local zoning and land use regulations that facilitate transit-oriented development (TOD), especially in walkable, mixed-use neighborhoods.⁵²

Although most studies have focused on light rail and commuter rail investments, recent research has found that bus rapid transit and streetcar lines can also promote higher property values and new development.

Recent studies of Pittsburgh's and Boston's bus rapid transit systems found that, all else being equal, a single-family home located 100 feet away from a Pittsburgh East Busway station is worth approximately \$9,745 more than a property located 1,000 feet away,⁵³ and a condo located 100 feet away from a Boston Silver Line station is worth \$45 per square foot more than a condo located 1,000 feet away.⁵⁴ An early study of new bus rapid transit lines in Cleveland, Ohio; Eugene, Oregon; and Kansas City, Missouri found significant amounts of new public and private investment underway, including new development by hospitals and universities in Cleveland and Eugene, and a \$150 million federal grant for urban reinvestment in Kansas City. The study concluded that bus rapid transit projects with dedicated rights-of-way and other substantial physical infrastructure can serve as focal points for attracting new development, particularly if located near major institutions and/or employment centers and paired with supportive land use policies and development incentives.⁵⁵ A comparative study of 21 North American light rail and bus rapid transit lines also found that transit lines located adjacent to downtowns or other major destinations had the strongest impact on development, while lines located adjacent to highways or other barriers had a more limited impact.⁵⁶ Studies in Portland, Seattle, and Tampa have also found that the introduction of new streetcar lines was associated with increases in surrounding property values and significant new development.⁵⁷

Transit can facilitate more efficient land use patterns, resulting in reduced facility and service costs for local governments.

High-quality transit service can assist in fostering more compact development and reduced suburban sprawl. A recent review of 17 studies comparing the fiscal impacts of smart growth (i.e., compact, mixed-use) development to traditional suburban development patterns found that, on average, upfront capital costs for new infrastructure systems (e.g., roads, sewer, water) were 38 percent lower for smart growth than for traditional suburban development scenarios. In addition, providing ongoing police, ambulance, and fire services cost an average of 10 percent less in smart growth developments than in conventional suburban developments.⁵⁸

Economic Impacts of Highway Investments

The introduction of a national highway system had a transformative effect in many regions and on the U.S. economy as a whole, dramatically reducing travel time for goods and people. However, as the nation’s highway system has matured and transportation costs have declined over time, the marginal economic benefits associated with continued highway investment appear to have diminished significantly.⁵⁹ Today, many regions, including San Diego, are focused on maintaining and managing the existing highway system to improve performance, making only limited capacity expansions. Accordingly, this section focuses on the economic impacts of highway preservation and maintenance, demand management, and incremental capacity expansions.

Because the primary goal of these types of highway investments is improved mobility rather than economic development, the literature on economic impacts is relatively limited and the results are somewhat mixed. Many of the economic benefits that have been measured accrue directly to drivers or transportation agencies, rather than to the regional economy as a whole. However, to the extent that highway investments result in quality of life improvements—for example, through reducing congestion or improving roadway safety or ride quality—they can be expected to contribute to a region’s overall economic competitiveness.

Highway Preservation and Maintenance

Highway maintenance can have direct benefits for drivers, including reduced vehicle operations and maintenance costs, and improvements in ride quality, traffic flow, and safety.

One estimate found that poorly maintained pavement can add 17 percent to the per-mile cost of operating and maintaining a personal vehicle.⁶⁰ Road conditions have also been shown to have a significant impact on crash rates, vehicle speeds, and drivers’ perception of comfort and safety.⁶¹

Preventive maintenance can result in long-term savings for the public sector.

The average age of infrastructure in the U.S. Interstate Highway system is more than 45 years, and much of the existing infrastructure is structurally deficient. The collapse of the Interstate 35W (I-35W) Mississippi River bridge in Minneapolis in 2007 demonstrates the high cost of inadequate spending on maintenance; retrofitting the bridge could have saved 13 lives and avoided hundreds of injuries, and would have cost significantly less than the cost of rushing to build a replacement (which was estimated at \$250 million).⁶² Less dramatically, several studies suggest that transportation agencies can minimize long-term pavement maintenance costs by intervening before the pavement deteriorates significantly. For every \$1 spent on preventive pavement maintenance, studies suggest that agencies can save between \$4 and \$10 in the long-term on rehabilitation.⁶³

Demand Management

Transportation demand management strategies can reduce congestion and maximize the capacity of existing facilities, improving quality of life and postpone the need for costly capacity expansions.

Transportation demand management strategies can include signals on freeway on-ramps to smooth traffic flow, encouraging transit use and carpooling, converting lanes to high-occupancy vehicle (HOV) or high-occupancy/toll (HOT) lanes, and implementing other forms of congestion pricing.⁶⁴ Although there are few studies to date on the economic impacts of demand management, these strategies have the potential to significantly reduce congestion and maximize the efficient use of existing facilities. The Texas Transportation Institute estimates that existing transportation management treatments—including eliminating rapidly removing vehicle crashes, improved signal coordination, and electronic toll systems—reduced traffic delays by 7 percent in U.S. urban areas in 2011, resulting in traffic delay and fuel price savings valued at \$8.5 billion.⁶⁵ A review of 24 HOT lane conversions and other highway pricing projects sponsored by the FHWA found that almost all projects succeeded in keeping the managed lanes congestion free, while bringing some relief to adjacent lanes and improving the efficiency of traffic flow on the

highway overall.⁶⁶ SANDAG is proposing a robust transportation demand management (TDM) program as a part of the Regional Plan.

Congestion pricing, and other types of user fees, can generate revenue to help cover program costs and provide funding for transit or other improvements to further manage demand.

Many pricing programs generate revenue to cover operations, maintenance, and enforcement; fund additional highway infrastructure; and/or pay for transit improvements.⁶⁷ For example, revenue from the I-15 Express Lane program in San Diego has been used to subsidize commuter bus service and help pay for operations, maintenance, and enforcement of the Express Lane program.⁶⁸

Pricing programs may have a disproportionate impact on low-income drivers.

Although pricing programs may have a disproportionate impact on low-income drivers, several congestion pricing programs have successfully addressed potential equity issues. For example, the I-10 and I-110 Congestion Relief Demonstration Program in Los Angeles—a pilot program to convert carpool lanes to HOT lanes—waives fees and provides toll credits for low-income commuters, allows carpools to ride free, and includes enhanced transit service.⁶⁹

Capacity Expansions

As a region's population grows, new highway lanes and other capacity expansions may be necessary to meet increased travel demand.

According to research by the Texas Transportation Institute, roadway capacity expansions are correlated with a reduced rate of congestion increases. Between 1982 and 2011, metropolitan areas (where travel demand grew significantly faster than road capacity) experienced larger increases in congestion than regions where capacity more or less kept pace with demand.⁷⁰ However, metro areas with greater increases in congestion and travel demand also tended to experience greater economic growth, suggesting that congestion may be a reflection of a strong economy as much or more than a lack of capacity. The Urban Mobility Report has also been criticized for misrepresenting the relationship between traffic volume and capacity.⁷¹

Empirical studies of the economic impacts of highway expansion projects have found mixed results.

Most of the literature on the regional economic impacts of highway investments has focused on the relationship between productivity and the overall density of the highway network. The literature suggests that more developed highway networks may be associated with small positive effects on productivity and economic growth, especially in the manufacturing sector and other industries that are highly dependent on transportation, although the benefits have declined over time.⁷² A few studies have looked more closely at the impacts of capacity expansions, with mixed results. For example:

- A study by Chandra and Thompson used data on highway expansions and county employment to evaluate the relationship between earnings and interstate highway construction between 1969 and 1993, focusing on projects located outside of metropolitan areas. The analysis found that while earnings rose significantly in counties that received new highway investments, those increases were offset by decreased earnings in adjacent counties, resulting in a net effect that was essentially zero.⁷³
- A recent study of the impacts of highway expansions on population change in the 1980s and 1990s in Wisconsin found that while highway expansions are associated with population growth in rural and suburban areas, there were no statistically significant effects in urban areas. Among other factors, these findings may reflect the redistributive effect of highway expansions (e.g., improved highway access facilitates households moving from urban to suburban neighborhoods) and the fact that highways can have greater negative effects (e.g., pollution, noise) on quality of life in more densely populated urban neighborhoods.⁷⁴

- A study by Iacono and Levinson analyzed employment and earnings following the completion of four highway expansion projects in urbanized areas of Minnesota, including new bypasses around the cities of Brainerd and Willmar. The study found that, after controlling for state and national economic trends, and other factors, there was no statistically significant evidence that the highway expansions affected earnings or employment in the counties or towns where the improvements were implemented.⁷⁵

III.1.2 Economic Shift

The goal of the ECA is to investigate the broader economic effects of transportation improvements on the San Diego economy. As part of this effort, this literature review covers the “economic shift” resulting from transportation investments. The economic shift is defined in this report as the phenomenon that a transportation investment can shift jobs temporally, spatially, and across industries and sectors. This literature review briefly explores the spatial and temporal effects of transportation investments, with an in-depth focus on industrial shifts. Economic impacts of public transit investments can contribute to a regional economic shift due to the different relationships that various industries have to the transportation network, and thus the disproportionate benefits that accrue to certain industries.

This literature review explores the above trends by identifying and summarizing existing research on the economic shift resulting from transit and highway investments. Scholarly articles were identified that spoke to the theoretical underpinnings of several aspects of economic shifts. Additionally, AECOM identified four examples of economic shifts resulting from transportation investments in the United States. Industry and government publications were selected that exhibited a change in dominance of particular industries directly attributed to the investment in a transit or highway investment.

Defining Temporal, Spatial, and Industrial Impacts

The following findings relate to three types of economic shifts: (1) temporal; (2) spatial; and (3) industrial. Transportation investments can shift resources temporally as a region experiences different economic shifts in the short-term versus the long-term. Economic shifts can also be considered as a shift in resources from one region to another, such as from state to state. In addition, an economic shift of industries can occur when transportation investments affect certain industries differently than others.

The construction of a transportation project has a short-term benefit of job creation and longer-term costs and benefits that accrue to users of the system and taxpayers. Short-term economic gains accrue to a region from temporary construction jobs. Short-term benefits have historically been a strategy to spur economic recovery. For example, the Golden Gate and San Francisco–Oakland Bay Bridges were both built during the Great Depression, in part, to create jobs. In the long-term, transportation investments lower the costs of personal commuting and goods movement, which increases economic productivity. Short-term transportation investment can result in a short-term increase in jobs, but financing shifts the burden of payment onto taxpayers into the future.⁷⁶

Spatial economic shifts can occur due to market competition across geographies. Wachs (2011) cites an example of the Alameda Corridor freight rail project that improved connectivity from the Ports of Los Angeles and Long Beach to freight rail. Although this spurred regional economic efficiency, the investment likely redirected growth from the Ports of Seattle and Oakland.⁷⁷ This example illustrates the concept that an investment from a larger geography to a smaller geography can affect competitive industries in other geographies. Transportation policies can also affect the degree of industry dispersion or agglomeration. Low shipping costs lead to a greater incidence of importation and less local production, especially in the agricultural sector.⁷⁸

Transportation improvements have shifting effects that drive economic growth and redistribute resources among industries. A transportation investment benefits businesses’ accessibility to customers, employees, and goods, which certain industries value over others. In terms of the opportunity cost of transportation investment, government

spending invests resources in industries that benefit from a transportation improvement, but doing so shifts resources away from activities that would have been financed in the absence of the transportation investment.⁷⁹

Although this literature review primarily focuses on the industrial shift, literature frequently discusses the industrial shift in tandem with temporal or spatial effects.

Economic Impacts of Public Transit Investments

This section highlights the spatial economic impacts of a public transit investment and the different industrial economic shifts in the short- and long-term. Following this discussion is a collection of case studies on the industrial shift in four United States metropolitan areas: (1) Cleveland; (2) Atlanta; (3) central Massachusetts; and (4) Silicon Valley in California.

Spatial Shift

Spatial agglomeration refers to the phenomenon of productivity benefits from clustering similar and complementary activities. Improvements in public transportation services can facilitate spatial agglomeration economies by clustering similar and complementary activities around transit terminals. Clustering activity may provide increased efficiency through reduced labor cost, improved communication, lower infrastructure costs, increased interaction with similar businesses, and face-to-face contact with specialized labor. Large cities often cannot accommodate downtown worker flow through parking and road capacity alone, and must rely on transit to transport workers to downtown.⁸⁰

Chatman and Noland (2014) explored the agglomeration effects of transit in more than 300 U.S. metropolitan areas. These researchers found that transit service improvements enabled increased wages by allowing for higher central city employment densities. This, in turn, improved accessibility to a more diverse labor market, increased information exchange, and facilitated industrial specialization.⁸¹

Temporal and Industrial Shift

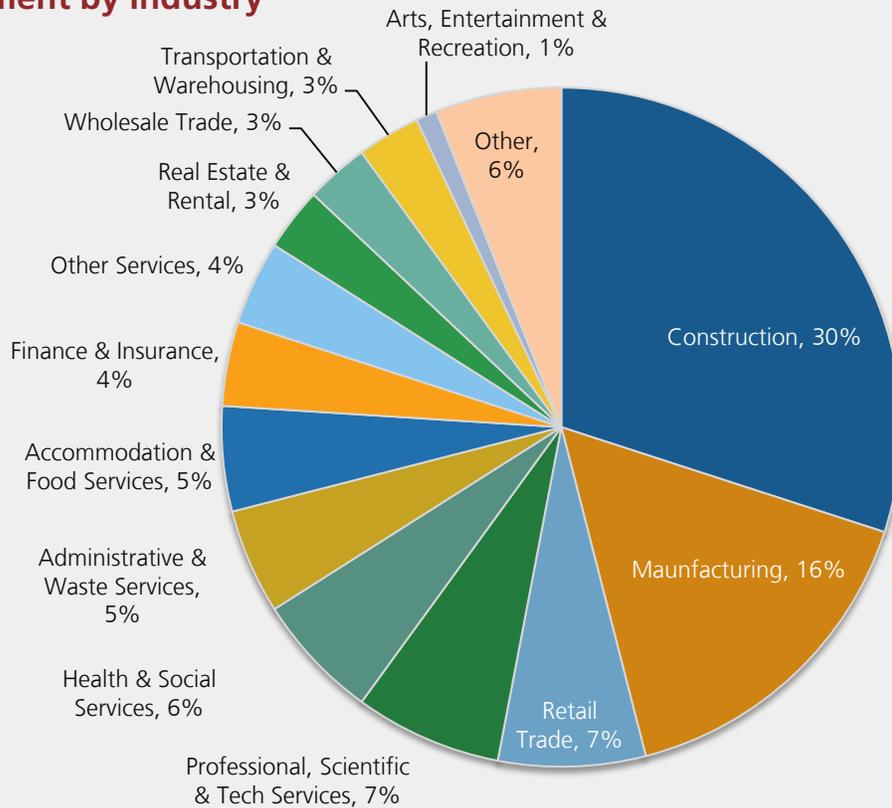
This section discusses the short-term effects of transportation investments in terms of direct, indirect, and induced economic impacts. In the short-term, transportation investment directly and temporarily shifts an economy to manufacturing, construction, and transit operation industries. The longer-term shifts outside of the transportation industry itself occur due to the values that different industries place on transit-adjacent land. It is important to distinguish between temporary and lasting economic impacts to understand the full implications of transportation investments.

Short-Term Industrial Shifts

Capital and operations spending on public transportation leads to what economists refer to as direct, indirect, and induced economic impacts. Weisbrod and Reno (2014) identify direct effects of public transit investments as effects on workers and businesses engaged in manufacturing vehicles and equipment, constructing guideways and stations, and operating services. Indirect effects are effects on supplier industries, which include workers in industries supplying engines, equipment parts, and materials that feed into building vehicles, guideways, and stations. Induced effects include the re-spending of worker income on consumer goods and services.⁸²

In 2014, Weisbrod and Reno updated a 2009 study that quantified the economic effects of public transit investment per billion dollars of federal investment by industry. Job impacts discussed in Section 1.1, Economic Competitiveness, of this report can be disaggregated in terms of capital versus continual operation, as well as in terms of industry. These expenditures create a temporary economic shift in the form of an increased share of manufacturing and construction jobs, and a long-term economic shift to a greater share of direct public transportation jobs. Figure P.5 dissects national job impacts by industry group, showing direct, indirect, and induced employment effects per \$1 billion of investment in public transit.

**Figure P.5
Employment Added per \$1 Billion of Public Transit Capital
Investment by Industry**



Source: Weisbrod and Reno, Economic Impact of Public Transit Investment, 2014 update

Long-Term Industrial Shifts

In the long-term, investment in public transit has shifting effects on certain commercial industries. With respect to market access, transit access increases employee and client accessibility to commercial businesses.⁸³ After reviewing the literature, AECOM identified instances of economic shifting from transit investments on the manufacturing, construction, business services, retail trade, household services, and automobile industries, which are discussed in detail below.

Industries differ from each other with respect to sensitivity to changes in accessibility. According to Graham (2007, 2012), the productivity of firms increases with accessibility to a major economic center. Graham found that the change in productivity with accessibility, which is defined as the elasticity of productivity,⁸⁴ varies between industries. The highest elasticity of productivity is in business services, finance, telecommunication, and transport, followed by retail trade and accommodation. The elasticity of productivity is lower in manufacturing and construction industries.⁸⁵

Accessibility improvements influence the rent that firms are willing to pay in different ways, depending on their relationship to different types of trips; thus, accessibility changes the industrial structure of lands. Manufacturing and storage activities tend to move to new, lower-cost locations at the sacrifice of access to transit. These industries are replaced by business services, retail trade, and other household services that place a higher monetary value on transit accessibility to customers and clients. The business services industry is a communication-intensive industry in which a firm can gain competitive advantage with better business mobility.⁸⁶

In terms of the tourism industry, investments in walking, biking, and train travel can give an area a competitive advantage as opposed to highway investment. High levels of investment in expanding highways and parking facilities

can reduce a city's attractiveness as a tourist destination. In general, increasing overall transportation system efficiency and affordability can leave tourists with more money to spend on regional tourism services. Cheaper, more convenient local travel can make a city a more attractive destination.⁸⁷ This point was mentioned specifically by the San Diego Tourism Authority in a focus group conducted for this Economic Analysis.

Examples of Ancillary Impacts from Transportation Investments

Several specific case studies illustrate the role of transit in catalyzing growth in and sustaining existing businesses in regional clusters. Four examples from the United States illustrate the economic shift toward sectors that public transit can support. These cases were selected to discuss the relationship of sectors that are also prominent in the San Diego economy to various transit investments.

Cleveland Euclid Corridor/HealthLine

Public and private investments catalyzed an economic transformation along Euclid Avenue in Cleveland in the health, biomedical, and technology industries, generated in part by a new bus rapid transit system, the HealthLine. Euclid Avenue travels from Cleveland's Central Business District for nine miles past prominent institutions such as Cleveland State University (CSU) and the Cleveland Clinic. In the 1980s, the Northeast Ohio Areawide Coordinating Agency designated Euclid Avenue as a "priority corridor for transit investment" as institutions along Euclid Avenue such as the Cleveland Clinic, University Hospital, and CSU grew in prominence and size.

Euclid Avenue needed extensive transportation and infrastructure, and after considering technical and financial aspects of the project, and city and stakeholder support, the Greater Cleveland Regional Transit Authority and its partners developed the bus rapid transit system. The largest employers on the route, the Cleveland Clinic and University Hospitals, purchased naming rights for \$6.5 million in 2008, indicating the value that these medical industry employers placed on branding a transit line to support medical businesses.

Local officials and plans indicate that this transit investment was designed to boost the local economy, which experienced an uptick in health and technology investment. The Mid-Town Tech Park benefitted from a \$10.7 million Section 108 loan and \$4 million in New Market Tax Credits toward a \$25 million renovation. A biomedical lab signed a 10-year lease for the first floor of the building. Additionally, Hemingway Properties invested \$2.9 million to lease space to incubator businesses. The Warner-Swasey Building was a tool factory that is now planned to be an office, lab, and warehouse space supporting 360 jobs.⁸⁸

Atlanta: "Medline" Cluster

Atlanta has been recognized by Jones Lang LaSalle as one of ten regions with an emerging life sciences cluster because of its strong research institutions and hospitals. The "Medline" cluster is located approximately 5 miles northeast of downtown Atlanta, and is a 7-mile corridor that encompasses the U.S. Center for Disease Control (CDC) headquarters, Emory University, the Veteran's Administration Medical Center, and DeKalb Medical Center.

The Metropolitan Atlanta Rapid Transit Authority (MARTA) operates the Avondale MARTA station located near the existing cluster, but the station is not within walking distance of most of the area's employment. There is not available right-of-way to expand or retrofit the roadway system to serve these medical facilities, so, in 2009, MARTA and the Clifton Corridor Transportation Demand Management Association explored ways to improve transit along the corridor from Lindbergh Station to Avondale Station to serve medical destinations in the corridor.⁸⁹

Clifton Corridor light rail investment is considered a catalyst of future economic shift toward biomedical and technology clusters. A spokesperson for the Atlanta Chamber of Commerce stated that the long-term growth of Emory University would be limited without light rail transit and that the area Emory-CDC area "could reach greater potential with the realization of light rail."⁹⁰ Furthermore, plans for area redevelopment call for "green" buildings and

transportation options, attracting millennial-generation knowledge workers and new biotech and health care industries. The Atlanta Regional Council's traffic demand model indicates the diminishing ability for highways to support the biomedical and tech cluster, while transit accessibility does not diminish over time.⁹¹ Authors argue that transit plays a role in sustaining an existing cluster, encouraging future investment in the cluster, and spurring further agglomeration effects.

Route 128 Central Corridor

The Route 128 Central Corridor is a 12.6-mile segment between I-90 and Route 3 North in Massachusetts. The corridor runs through the communities of Weston, Waltham, Lincoln, Lexington, and Burlington. This region is a major employer in Massachusetts, home to premier technology companies in proximity to area universities and Hanscom Air Force Base, and a magnet for high technology and supporting industries. However, with the rapid growth of the high-technology industry along Route 128 from the 1960s to the present, the area has increasingly experienced traffic congestion that will discourage future economic development and degrade the quality of life for residents and commuters.⁹²

Future job growth, while beneficial for economic vitality, threatens to exacerbate traffic problems. Additionally, approximately 50 developments have been either recently completed or proposed for completion over the next decade, with the potential to create thousands of new jobs.⁹³ The Route 128 Central Corridor Plan addresses the impacts of increased traffic volumes and seeks to reduce single-occupancy trips, preserve quality of life, and ensure mobility. The Massachusetts Area Planning Commission also noted that suburban businesses might find it more difficult to attract young people who do not want to own cars. Therefore, two of the three principal recommendations of the Route 128 Corridor Plan are building on existing transit service in the corridor and creating a new Fitchburg Lane/Route 128 MultiModal Transit Center.⁹⁴ Leaders in corridor communities agree that corridor mobility and improved transit options are necessary to maintain economic growth in high technology and supporting sectors.⁹⁵

Silicon Valley Cluster

Silicon Valley is dominated by the tech industry: in 2010, 68 out of the top 75 companies in Silicon Valley were tech firms. Silicon Valley is also home to venture capital firms that specialize in computer and internet technology. Prominent research institutions, and the draw of urban life in San Francisco, attract a well-educated and highly skilled market.⁹⁶

One unique aspect of transit in the concentrated tech cluster in Silicon Valley is the level of investment from private companies to provide transit services. Google provides 380 shuttle runs per day throughout the peninsula. Google's buses are equipped with WiFi, and employees use their travel time to prepare for work. Genentech spent \$10 million for transit service so it could remain in the tech cluster rather than choose a more affordable site with highway access.⁹⁷ Employers provide shuttle services to promote transit as a greener mode of transportation, to fill service gaps, to recruit and retain workers, to reduce demand for parking spaces, and to fulfill mandatory planning stipulations on development.⁹⁸ Although these investments signal the importance of transit to a high-tech work force, as firms continue to develop in industry clusters, some may not be able to afford the investments that Genentech and Google have made.⁹⁹ That pattern has spurred an economic shift toward larger companies that benefit from economies of scale in providing transportation options, and in opening satellite campuses in downtown San Francisco.

Economic Impacts of Highway Investments

This section details two key findings from a comprehensive literature review on theoretical aspects of the economic impacts of highway investments. The first finding is that highway expenditures tend to spur economic growth,

especially in retail and manufacturing employment. Another key finding is that highway investments are linked with general industrial diversification.

Construction of a highway may be associated with small positive effects on productivity and economic growth, but research indicates that a more dominant effect is that new highways rearrange economic activity, at least in non-metropolitan regions. Chandra and Thompson (2000) found that highway investment could help specific industries in the region gain a competitive advantage over other regions of the country. Researchers found that construction of a new interstate highway raised economic growth, as measured by total earnings,¹⁰⁰ in counties through which the highway directly passed. These counties experienced an increase in earnings in the manufacturing, retail trade, services, transportation, and public utilities industries. However, adjacent counties were found to experience a reduction in retail trade and government earnings due to the highway's opening. Chandra and Thompson's research suggests that effects may be different in metropolitan areas. Manufacturing might be expected to grow and retail losses may not occur in highway-adjacent metropolitan counties, while the opposite may occur in non-adjacent areas. However, there is potential for new highways in metropolitan areas to lead to net increases in economic activity.¹⁰¹

Research has found that an increase in highway stocks is associated with reductions in manufacturing costs. Nadiri and Mamuneus (1991) found infrastructure investment to have a strong, significant relationship to reducing the cost of production for 12 United States manufacturing industries from 1956 to 1986.¹⁰² Holleyman (1996) found an increase in highway supply to be associated with modest cost reductions. A possible explanation for this cost reduction is that highway investment might substitute for private capital, labor, and purchased services.¹⁰³ The decrease in manufacturing input costs are factors contributing toward a manufacturing economy.

Research also indicates that higher levels of highway investment are related to general industrial diversification. As an economy develops, the agricultural sector of the economy (as a percentage of total employment) begins to shrink, allowing for greater employment share in other industries.¹⁰⁴ Horst and Moore analyzed the linkage between highway investment and economic diversification in Louisiana. Using two-digit North American Industry Classification System (NAICS) employment data, researchers calculated a summary index of industrial diversity for each parish (county) in Louisiana, and drew correlations with the type of road present in the parish: interstate, divided highway, and major thoroughfare. Results indicate that highway quality is associated with industrial diversification in rural counties.¹⁰⁵

III.1.3 Fiscal Implications of Urban Forms

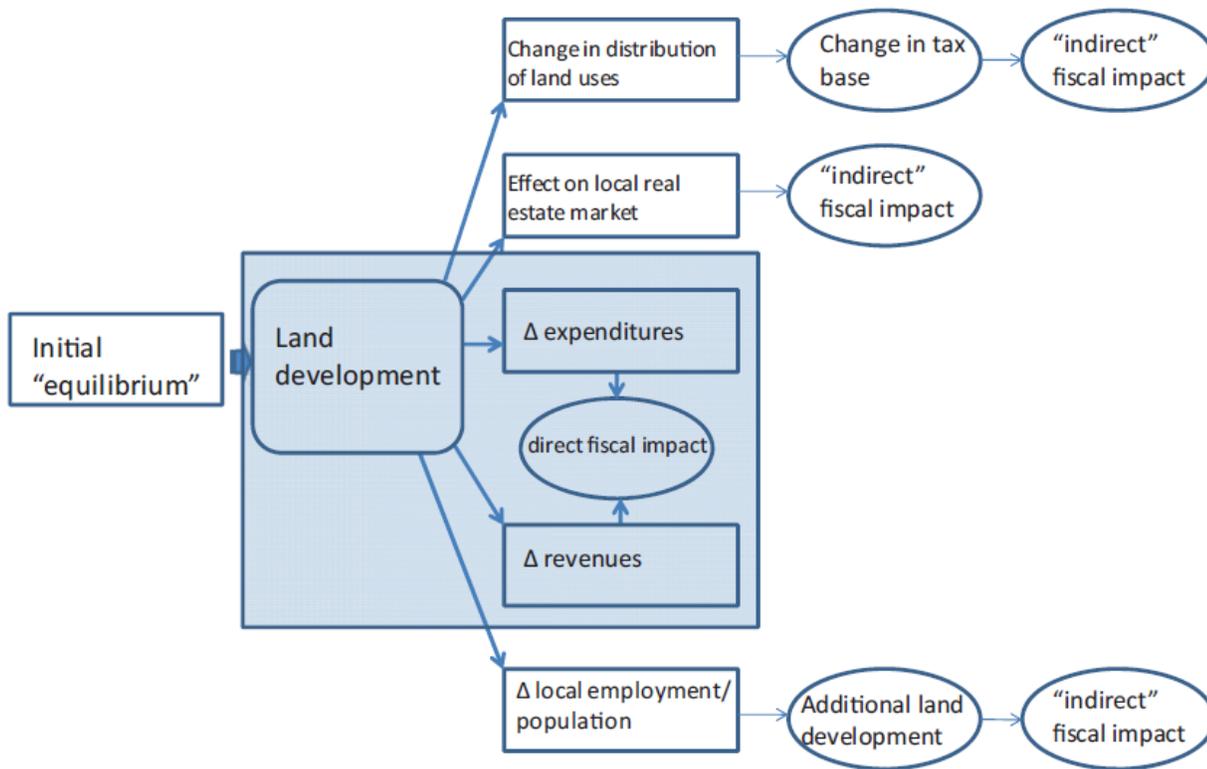
This literature review first presents a conceptual model of direct and indirect fiscal impacts of land development. The literature review then explores the different effects of sprawl on a city's budget. Increased urban sprawl increases the cost of public services. Additionally, local governments tend to underestimate these costs when compared to short-term tax revenue flows, which may have an effect on local zoning patterns.

Fiscal Implications Conceptual Model

In 2013, Paulson presented a conceptual model to understand and trace the effects of land development on municipal expenditures and revenues (Figure P.6). This review and model can serve as a basis for evaluating fiscal projections for land development proposals. Direct fiscal impacts, which are conceptualized by the shaded square in Figure P.6, are measured in most fiscal impact analysis techniques. Direct fiscal impacts include the changes in revenue and expenditures that a government entity experiences due to any land development. Those impacts are only a subset of the range of indirect fiscal impacts that would likely be expected to result from land development within a community, such as the change in distribution of land uses, effects on the local real estate market, and changes in the ratio of jobs to population.¹⁰⁶

Figure P.6

Conceptual Road Map of Land Development and Fiscal Change



Source: Paulsen, K. (2013). The Effects of Land Development on Municipal Finance

Sprawl and Cost of Services

A lengthy body of literature has explored the effects of low-density, sprawling development on the cost of city services. The following studies are among the body of evidence linking the degree of sprawl to increasing the cost of city services.

Urban sprawl may undermine economies of scale for services such as police protection and public education by lowering the density of individual consumers. Public goods and services are priced according to their average as opposed to their marginal cost, and land developers have little motivation to help maintain a cost-effective urban form. The location of new development continues to be determined by land speculation and potential for profit instead of its impact on public welfare. One outcome of these factors is that growth is subsidized and financed through property tax revenues.^{107, 108}

Carruthers (2002) found that low-density, spatially expansive, development patterns lead to greater costs because of the large investments required to extend roadways and other types of infrastructure that transmit water, sewage, electricity, and other services long distances to reach relatively fewer numbers of people.¹⁰⁹ Carruthers and Ulfarsson (2003) expanded on this research with an analysis of the relationship between the physical and political structure of 282 metropolitan counties. Twelve separate measures of public expenditure were reviewed: (1) total direct; (2) capital facilities; (3) roadways; (4) other transportation; (5) sewerage; (6) trash collection; (7) housing and community development; (8) police protection; (9) fire protection; (10) parks; (11) education; and (12) libraries. Researchers provided empirical evidence of how urban sprawl raises the cost of providing public services.¹¹⁰

Later research by Carruthers and Ulfarsson (2007) uses a series of spatial econometric models to evaluate 10 measures of spending: (1) total direct; (2) education; (3) fire protection; (4) housing and community development; (5) libraries; (6) parks and recreation; (7) police protection; (8) roadways; (9) sewerage; and (10) solid waste disposal. The results of the analysis indicate that low-density, spatially extensive development patterns are more expensive to finance with public revenue sources. Researchers have found variation in how the density and the spatial extent of development influence different types of services. Research findings strongly suggest that the reasoning behind fiscally motivated, anti-sprawl smart growth policy frameworks is sound.¹¹¹

Lieske, et al. (2011) quantified a relationship between the cost of public services and urban form. The researchers developed an econometric model for the cost of public safety provision as applied to a county in the Mountain West region of the United States. The research includes a spatial index to represent the pattern of the built environment disaggregated by land use as an explanatory variable for input cost. The results of their research indicate that residential development is a statistically significant variable in the cost function of local government expenditures on public services.¹¹²

Sprawl and Property Taxes

Changes in a city's urban form affect a local government's fiscal health. Property taxes have been shown to increase or decrease sprawl, depending on the substitutability of housing with other goods. Additionally, different development types have an effect both on urban sprawl and on fiscal health. The following research conclusions can be derived from literature on urban form and property tax flows.

Brueckner and Kim (2003) explored the theoretical connection between property tax and urban sprawl, exploring the degree to which property taxes spurred sprawl or density. The researchers found two effects acting in opposite directions. The first effect the authors proposed was that property taxes have a depressing effect on physical development, thereby reducing population density. This in turn spurs the spatial expansion of cities. Meanwhile, a countervailing effect is that property taxes can motivate smaller dwelling unit sizes, raising densities and contracting cities. The authors compare the dominance of these effects with respect to the elasticity of substitution, or the sensitivity of demand (of a good) as a function of how price changes for that good's substitutes. Analysis shows that higher property taxes lead a city to contract when members of the city can easily substitute housing space for other goods or, more specifically, when the elasticity of substitution between housing and other goods is high. On the other hand, property tax encourages urban sprawl when the elasticity of substitution is low.¹¹³

An Environmental Protection Agency (EPA) report on Smart Growth (2009) breaks down the effects of property tax in property development decision-making at the local government level. The EPA argues that, in general, communities underestimate the needs of development in the long run. The EPA shows that residential development tends to have a negative impact on local budgets. However, since tax revenues accrue in the short-term, and resident occupancies increase over time, this long-term negative effect is sometimes overlooked. Lukermann and Kane examined practices in ten suburban communities in the Twin Cities metropolitan area and found that some jurisdictions have enacted restrictive zoning codes that do not permit small lots, and this encourages sprawl.¹¹⁴ The EPA also recognizes that retail, commercial, industrial, and agricultural uses generally provide positive net tax revenues. A successful business retention strategy focuses on whether new employment will benefit current residents or bring in employees from outside with new needs for local services.¹¹⁵

III.2 Mapping of Existing Industry Clusters and Transportation

The Regional Plan will provide guidance for the level, location, and timing of investment in transportation infrastructure in the San Diego region. Investment in transportation infrastructure will influence the ability of employers to access and retain their workforce talent, receive and export supplies, and reach consumer markets as transportation investments influence the competitiveness of an area. Contributors to competitiveness include the level of effort required to live, work and move throughout the region measured both in time and in cost, affecting productivity.

This analysis evaluates how potential transportation investments may facilitate or hinder traded industry clusters. Traded industry clusters are the foundation of the region's export-oriented economic base. The goods and services they provide bring revenue into the region that then gets recycled throughout the region. They are the critical one-third of the economy on which the other two-thirds depends. Traded industry clusters are also of interest because most are linked with innovation and the future economic trajectory of a region, and tend to pay higher than average wages. As the region invests in transportation infrastructure, benefits will vary across the region affecting some industries differently than others. To examine these effects, this report explores how transportation investments resulting in time savings may affect traded industry clusters in the region within several key transportation corridors.

This analysis also examines how transportation investments utilize employment capacity in strategically targeted job centers. Evaluation of the links between job centers with the most capacity for growth and those communities in the region where the workforce lives, particularly where unemployment and underemployment rates are higher, provides insights as to how the transportation system may leverage job center capacity to improve economic outcomes for the San Diego Region's residents.

Finally, the analysis explores housing price points in the San Diego Region consistent with employee wages associated with the industry clusters, and if transportation investments effectively connect affordable workforce housing to their associated industries. Affordable housing is a key consideration for employees considering a job in the San Diego Region and directly affects a firm's ability to attract and retain a skilled workforce.

III.2.1 Comparison of Cluster Locations and Time Savings Output

Introduction

Industry clusters are interdependent groups of businesses concentrated in several similar or complementary industries. In addition to being interdependent and concentrated, traded industry clusters are also oriented toward the outside economy, exporting goods and services that bring money into a region. Industry clusters are fundamental to the region's economic development. They can provide higher wages than other non-cluster industries, may be linked with innovation, and influence how the region's economy may grow and change in the future.

By examining how transportation travel times will change under the Regional Plan scenarios along corridors where traded industry clusters are now located, it is possible to develop an understanding of how key employers' access to critical labor and capital inputs will be affected. While longer commute times for workers and slower access to goods and/or services could hinder the growth of some of these sectors if access is decreased, more rapid travel for workers and goods movement improves productivity and supports the San Diego Region's industry clusters.

In the San Diego Region, SANDAG has identified 14 industry clusters that are the foundation to the region's economic base. These clusters comprised about 27 percent of the region's employment as of 2010. As a group, traded cluster jobs pay wages that are about 12 percent higher than the regional average. The targeted traded industry clusters, in alphabetical order, include:¹¹⁶

- Action Sports Manufacturing

- Advanced Precision Manufacturing
- Aerospace, Navigation, Maritime Technologies
- Apparel Manufacturing
- Biomedical Devices and Products
- Biotechnology and Pharmaceuticals
- Cleantech
- Entertainment and Hospitality
- Fruits and Vegetables
- Horticulture
- Information and Communications Technology
- Publishing and Marketing
- Specialty Foods and Microbreweries
- Uniformed Military¹¹⁷

In the San Diego Region, industry clusters are also expected to support the long-term economic competitiveness across the region through cooperation, competition, and agglomeration economies in the areas of research and workforce development. Given their importance to the region's future economic opportunities, this analysis seeks to understand how transportation investments may support industry clusters in the San Diego Region.

III.2.1.1 Methodology

As part of the SANDAG Benefit-Costs Analysis (BCA) for Regional Plan scenarios, SANDAG calculated time savings from transportation investments in highway and transit for 11 transportation corridors in the San Diego Region. These corridors are presented in Table P.10. In order to select the applicable corridors for analysis of industry clusters, AECOM overlaid employment in the SANDAG traded industry clusters in the region by ZIP Code, based on the employment data contained in the SANDAG *Traded Industry Clusters in the San Diego Region* report, with the 11 corridors analyzed in the BCA. Using the geographic distribution of this employment, the corridors that serve major employment concentrations were identified (see Figure P.8 and Figure P.10). These selected corridors are denoted with an asterisk (*) in the following table, and 6 of the 11 corridors were analyzed in the BCA. These key corridors are numbered 1 through 6 in the analysis, in sequential order, based on the list presented below, with the original corridor names maintained.

Table P.10**Select Corridors Analyzed for Cluster Locations and Time Savings Output**

SANDAG Route Number	Report Route Number	Route
1	1	Oceanside to Downtown San Diego*
2	2	Escondido to Downtown San Diego*
3	3	El Cajon to Kearny Mesa*
4	4	Mid-City to UTC *
5	n/a	Western Chula Vista to Mission Valley
6	n/a	Carlsbad to Sorrento Mesa
7	5	Oceanside to Escondido*
8	6	San Ysidro to Downtown San Diego*
9	n/a	Otay Ranch to UTC
10	n/a	Pala/Pauma to Oceanside Transit Center
11	n/a	SR 67 (Ramona) to Downtown San Diego

Source: SANDAG. (2012). Traded Industry Clusters in the San Diego Region.

*: selected for analysis based on employment concentration along corridor

These 6 key corridors cover the majority of area covered by the 11 corridors utilized in the SANDAG BCA that also capture large employment centers (see Figure P.8 and Figure P.10). The corridor from western Chula Vista to Mission Valley (excluded) is in large part covered by the corridor from San Ysidro to Downtown San Diego (included), while the corridor from Carlsbad to Sorrento Mesa is entirely captured by the corridor from Oceanside to Downtown San Diego Corridor. The corridor from Pala/Pauma to Oceanside Transit was excluded due to its low numbers of industry cluster employment.

To examine time savings, AECOM individually defined travel times using the two primary modes of travel on the selected corridors, automobiles and transit. AECOM defined automotive corridors (displayed in Figure P.7) as the area within one mile of a highway or major road, as listed by SANGIS datasets with the same names between the starting and ending traffic analysis zones, or TAZs, of each corridor. Figure P.8 displays the extent of the six auto corridors utilized for this study, which capture ZIP Codes with large numbers of industry cluster employment. Some ZIP Codes with significant shares of industry cluster employment, such as those north of SR 56 and south of SR 78, were not captured by the SANDAG BCA as no major roadways transverse this area.

AECOM defined transit corridors (displayed in Figure P.9) as the area within a one-half mile radius of transit stops on routes used to determine time savings from the SANDAG BCA. The transit routes represent the shortest time to travel from each transit corridor's starting and ending Transit Access Point, or TAP. Therefore, some routes represent express routes with limited stops, and as such, the BCA data are limited to representing routes with lower accessibility to jobs to capture time savings. Several express routes have parallel transit routes with additional stops. AECOM selected a one-half mile radius around transit stops as transit stops typically have smaller capture areas than roadways, factoring in the small distances pedestrians typically commute to and from a transit stop. Figure P.10 presents these transit corridors compared to concentrations of industry cluster employment.

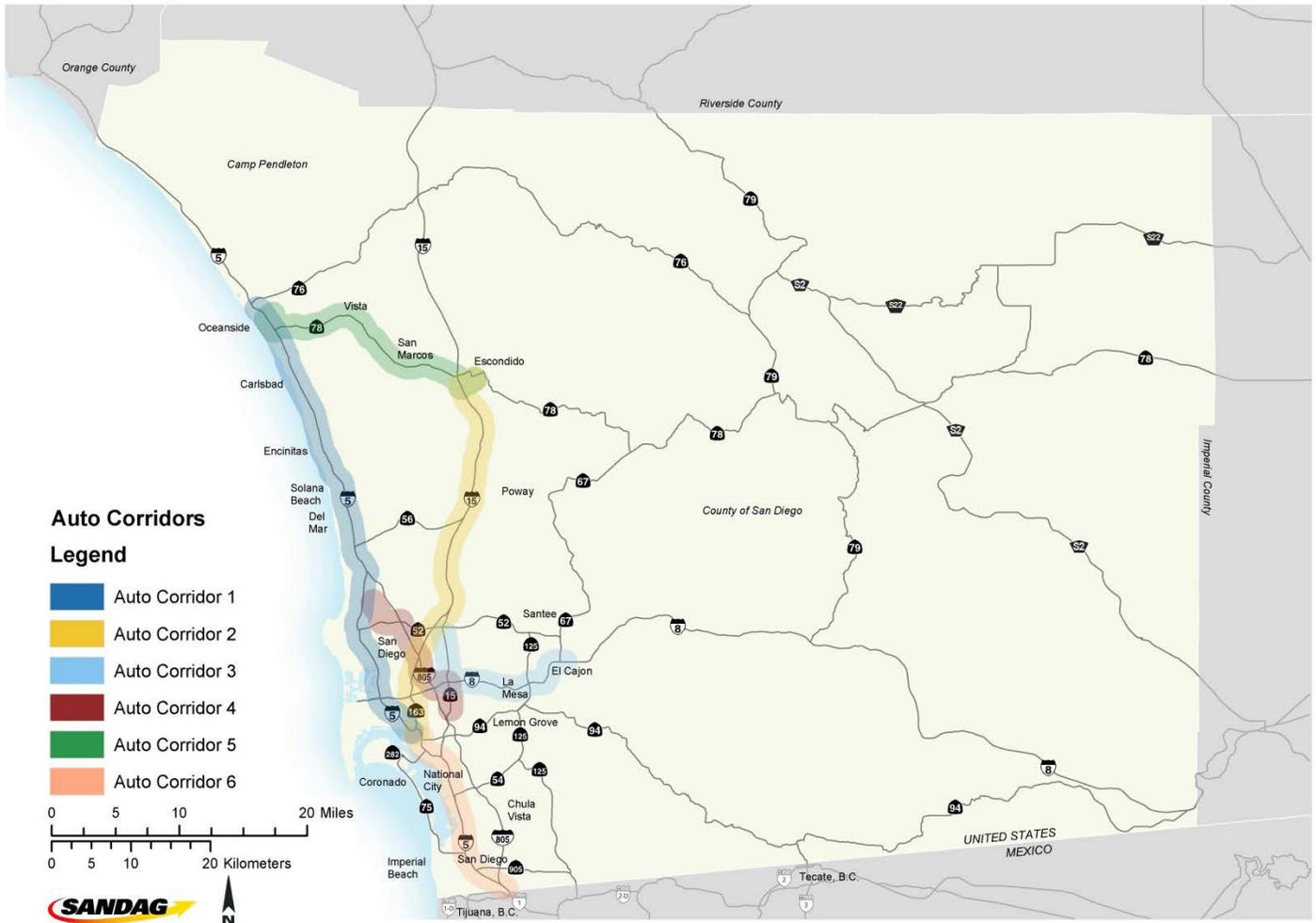
To examine employment, AECOM gathered employment totals for each industry cluster by ZIP Code from 2010 estimates. Distribution across the ZIP Code was assumed to be evenly distributed as no information on distribution within the geography exists. Employment totals presented in this analysis do not include employment outside of traded industry clusters, such as the large numbers of persons employed at California State University at San Marcos or the UC San Diego because they are not included in any of the 13 industry clusters for which SANDAG produces ZIP Code level employment estimates.¹¹⁸

To observe visible trends in geospatial variation in cluster employment shares at a regional scale, AECOM grouped these data into larger, aggregated geographies. Employment by industry cluster is represented in pie charts that represent total employment in each aggregated geography. The size of the pie chart is correlated with the amount of employment in the corresponding area along the corridor.

Due to constraints on the data available at SANDAG, no forecast of employment at the level of detail needed for cluster identification is available. However, the benefits to clusters given the forecast changes in highway and transit access are discussed. Although it is unknown whether clusters will stay concentrated in their current locations or otherwise maintain current characteristics, the goal of the analysis is to identify the impact of transportation on industry clusters rather than create a forecast of industry cluster characteristics. As a result, the analysis addresses the likely impacts to clusters of improved automotive and transit access to productive inputs, such as labor and goods, rather than on the cluster's location, size, or other characteristics.

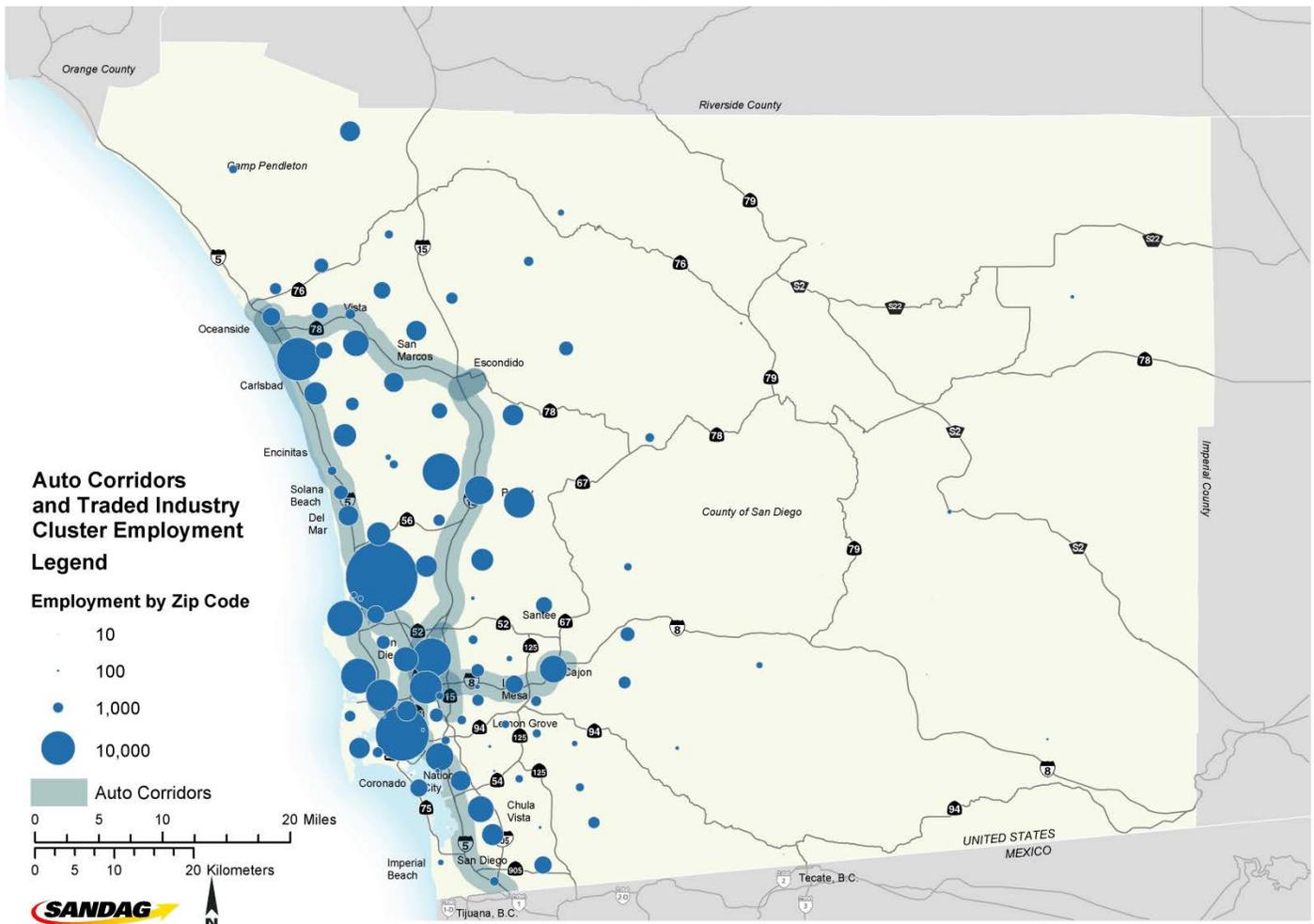
Finally, AECOM calculated travel times on each corridor based on the difference between existing travel times and the proposed travel times under the SANDAG 2050 revenue-constrained scenario and grouped the data into categories bearing a unique color based on the amount of time saved across the six corridors selected for analysis. All travel times are peak travel times, which reflect the highest-demand periods for these corridors.¹¹⁹

Figure P.7
Key Automotive Corridors



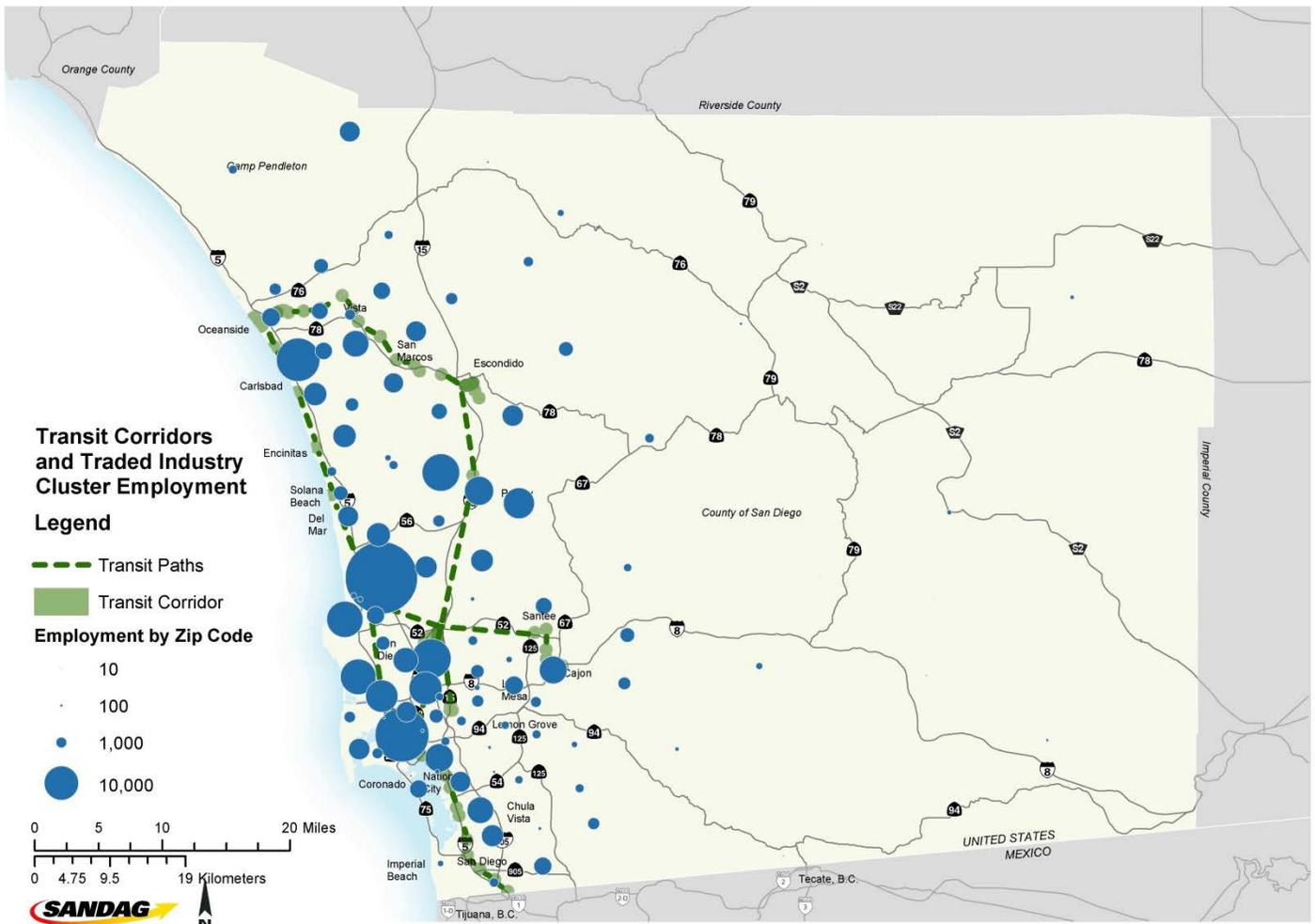
Sources: SANDAG; ESRI; AECOM November 2014.

Figure P.8
Automotive Corridors and Traded Industry Cluster Employment, 2010



Sources: SANDAG Employment Inventory (2010); ESRI; AECOM November 2014.

Figure P.10
Transit Corridors and Traded Industry Cluster Employment, 2010



Sources: SANDAG Employment Inventory (2010); ESRI; AECOM November 2014.

III.2.1.2 Analysis

The San Diego region is expected to add approximately 1 million residents by 2050, which would result in a total of approximately 4.1 million residents.¹²⁰ To understand how the transportation system would perform given the needs of the region's residents in 2050, AECOM examined commute times in key automotive and transit corridors that serve the region's industry clusters and compared these to a 2012 baseline under two scenarios.

The first scenario is based on no additional investment in transportation infrastructure to 2050, known as the no-build (NB) scenario for both automotive and transit corridors.

The second scenario is based on the level of investment identified in the SANDAG Unconstrained Transportation Network—a network designed to meet all of the region's needs—that is then limited by revenue availability and project priorities to 2050. This scenario is known as the revenue-constrained (RC) scenario.

Time Savings Results Overview

Across both automotive and transit corridors, travel times are higher under the no-build scenario as compared to the revenue-constrained scenario. Under the revenue-constrained scenario, travel times in automotive corridors decrease less than the travel time decrease on key transit corridors. Under the revenue-constrained scenario, travel time decreases by 0.3 minutes, or 1.3 percent, over all key automotive corridors, while it decreases by 23.5 minutes, or 34.7 percent, over all key transit corridors. Under the no-build scenario, travel times increase by 16.1 percent or 6 minutes on key automotive corridors, while travel times decrease by 1.4 percent or 1.1 minutes on key transit corridors.

Automotive Corridor Time Savings

Under the no-build scenario, travel time on all six automotive corridors would increase by 2.5 to 8.4 minutes per corridor as the number of users increases without additional roadway investments. This represents an increase in travel time of six minutes on average across all automotive corridors examined. In percentage terms, travel time increases under the no-build scenario range from 7 percent to over 25 percent, with an average 16.1 percent on all automotive corridors.

Under the revenue-constrained scenario, travel time would decrease by 0.4 to 2.2 minutes on all corridors except one where travel time would still increase compared to the 2012 baseline. Average travel time across all corridors under this scenario would decrease by 31 seconds and in percentage terms, travel times across all corridors would decrease by 1.3 percent. In the case of Corridor 2: Escondido to Downtown San Diego, where travel time would increase from the 2012 baseline, it increases by 2.8 minutes less than that it would under the no-build scenario.

See Table P.11: Average Travel Time and Time Savings from 2012 to 2050 on Key Automotive Corridors for additional information on corridor routes and resulting automotive commute time performance under both scenarios. The BCA measured average travel time in minutes for peak periods, door-to-door, for automotive transportation and stop-to-stop for transit.¹²¹

Table P.11

Average Travel Time and Time Savings from 2012 to 2050 on Key Automotive Corridors

Corridor	Average Travel Time (min.)			Travel Time Change (min.)			
	2012	2050 NB Scenario	2050 RC Scenario	2012 - 2050 NB Scenario	% Change	2012 - 2050 RC Scenario	% Change
1 Oceanside - Downtown San Diego	64.7	73.1	62.5	8.4	13.0%	-2.2	-3.4%
2 Escondido - Downtown San Diego	55.6	61.9	59.2	6.4	11.5%	3.6	6.5%
3 El Cajon - Kearny Mesa	30.3	36.6	29.9	6.3	20.9%	-0.4	-1.2%
4 Mid-City - UTC	29.9	37.5	29.8	7.6	25.3%	-0.1	-0.5%
5 Oceanside - Escondido	35.8	38.3	34.5	2.5	7.0%	-1.4	-3.9%
6 San Ysidro - Downtown San Diego	25.8	30.7	24.4	4.9	18.8%	-1.4	-5.3%
Average	40.4	46.4	40.0	6.0	16.1%	-0.3	-1.3%

1/ Transit Times are measured from stop-to-stop and do not include initial wait time or access to boarding/alighting stops.

Source: San Diego Forward: the Regional Plan Average travel time (peak periods) by mode for selected corridors (in minutes door-to-door for auto, stop-to-stop for transit) (Draft table).

Transit Corridor Time Savings

The no-build scenario would result in travel times remaining relatively stable across key transit corridors, with an average time decrease of 1.1 minutes across all corridors. The largest increase in travel time is estimated to be 6.5 minutes on Corridor 3: El Cajon to Kearny Mesa, while the largest decrease in travel time is forecast to occur on Corridor 2: Escondido to Downtown San Diego and is equal to 7 minutes. Although the average travel time is decreasing across transit corridors in the no-build scenario, the share of this savings is quite small -1.4 percent over 2012 baseline travel times.

In contrast, transit times are expected to fall by 34.7 percent on average across all corridors under the revenue-constrained scenario compared to the 2012 baseline, or by more than 33 percent more than under the no-build scenario. This average travel time change results from travel time decreases on all corridors, which range from savings of 4.1 to 45.7 minutes. On average, travel time is forecast to decrease by 23.5 minutes under the revenue-constrained scenario, with a maximum decrease in travel time of 45.7 minutes on Corridor 4: Mid City to UTC. Corridor 1: Oceanside to Downtown San Diego would experience the least change in travel time with a decrease in travel time of 4.1 minutes.

See Table P.11: Average Travel Time and Time Savings from 2012 to 2050 on Key Automotive Corridors and Table P.12: Average Travel Time and Time Savings from 2012 to 2050 on Key Transit Corridors for additional information on corridor routes and resulting transit commute time performance under both scenarios.

Table P.12

Average Travel Time and Time Savings from 2012 to 2050 on Key Transit Corridors

Corridor	Average Travel Time (min.)			Travel Time Change (min.)			
	2012	2050 NB Scenario	2050 RC Scenario	2012 - 2050 NB Scenario	% Change	2012 - 2050 RC Scenario	% Change
1 Oceanside - Downtown San Diego	95.3	95.2	91.2	-0.1	-0.1%	-4.1	-4.3%
2 Escondido - Downtown San Diego	76.1	69.1	62.1	-7.0	-9.2%	-14.0	-18.4%
3 El Cajon - Kearny Mesa	74.4	80.9	36.7	6.5	8.8%	-37.8	-50.7%
4 Mid-City - UTC	77.1	71.1	31.4	-6.0	-7.8%	-45.7	-59.3%
5 Oceanside - Escondido	72.0	71.9	45.4	-0.2	-0.3%	-26.6	-37.0%
6 San Ysidro - Downtown San Diego	33.8	33.8	20.8	0.0	0.0%	-13.0	-38.6%
Average	71.5	70.3	47.9	-1.1	-1.4%	-23.5	-34.7%

1/ Transit Times are from stop-to-stop and do not include initial wait time or access to boarding/alighting stops.

Source: San Diego Forward: the Regional Plan Average travel time (peak periods) by mode for selected corridors (in minutes door-to-door for auto, stop to stop for transit) (Draft table).

Potential Travel Time Change Impacts

By examining how travel times are projected to change under the Regional Plan scenarios along corridors where industry clusters are located, it is possible to understand how access to critical labor and capital inputs may be affected. While longer commute times for workers and slower access to goods could hinder the development and growth of some of these sectors as access is decreased, more rapid access to labor and/or capital may also support growth and development in the Region's industry clusters as it decreases the costs to supply and distribute these resources.

Under the no-build scenario, it would be more difficult for residents to access job centers throughout the San Diego region and more difficult for firms to access labor and goods needed for their activities as a result of increased travel times on automotive corridors. Under the revenue-constrained scenario, which yields decreased travel times compared to the no-build scenario on both automotive and transit corridors, improved access to goods and labor would result in the region, with a corresponding increase in ease of access to jobs by residents.

Impacts in Automotive Corridors

As discussed above, travel times would increase under the no-build scenario in the key automotive corridors, while travel times under the revenue-constrained scenario would decrease slightly across most corridors. Because travel time is a factor in the ability of a firm to access critical inputs, such as labor and materials, the revenue-constrained scenario would enable firms in key corridors to access critical inputs. Automotive Corridors 1 and 6, and the industry clusters they serve, would benefit most from improved access resulting from decreased travel time, while clusters in Corridor 2 would still benefit under the revenue-constrained scenario compared to the no-build scenario, but is projected to experience an increase in travel time compared to the 2012 baseline.

Automotive Corridor 1: Oceanside to Downtown San Diego will have the largest time savings at 2.2 minutes in 2050. This corridor currently serves about 72,000 employees who work in the corridor, who are concentrated in the Entertainment and Hospitality Cluster (52.0%), Information and Communications Technologies (ICT) Cluster (19.9%), and the Biotech Cluster (11.1%). In percentage terms, Corridor 6: San Ysidro to Downtown San Diego will experience

the largest reduction in travel time at 5.3 percent compared to the 2012 baseline. Today, this corridor serves an estimated 19,000 workers with the highest concentration in the Entertainment and Hospitality Cluster (53.3%), and ICT Cluster (5.3%).

Despite the fact that Corridor 2: Escondido to Downtown San Diego is forecast to experience an increase of 3.6 minutes in travel time compared to 2012, it would still benefit under the revenue-constrained scenario as travel time will increase by 2.8 minutes less than under the no-build scenario. This corridor now contains concentrations of workers in the Entertainment and Hospitality Cluster (51.2%), ICT Cluster (23.7%), and Flight, Navigation and Maritime Cluster (10.1%). Total cluster employment in this corridor is just under 40,000.

Other corridors' travel times will remain close to current travel times under the revenue-constrained scenario, with travel time decreases of 0.1 to 0.4 minutes in Corridors 3, 4, and 5. Table P.13 summarizes current employment by cluster in the San Diego Region.

Industries clustered along key automotive corridors stand to benefit from improved travel times that result in improved access to critical inputs, particularly labor, in the revenue-constrained scenario compared to the no-build scenario. Benefits would result from improved access to labor and goods that is driven by more rapid passenger and freight vehicle movement on key automotive corridors. Of the 13 industry clusters in the Region, 8 currently have more than 47 percent of their employment along these key automotive corridors.

Today, Cleantech has the highest concentration of employment located along the key automotive corridors at just over 72 percent of its Regional employment in this area. Other clusters with a high share of their Regional employment located in the key automotive corridors are: Publishing and Marketing at 68.0 percent; Entertainment and Hospitality at 61.6 percent; Flight, Navigation, and Maritime at 60.4 percent; ICT at 54.6 percent; Action Sports at 52.7 percent; Biotechnology and Pharmaceuticals at 49.2 percent; and Biomedical Devices and Products at 47.2 percent.

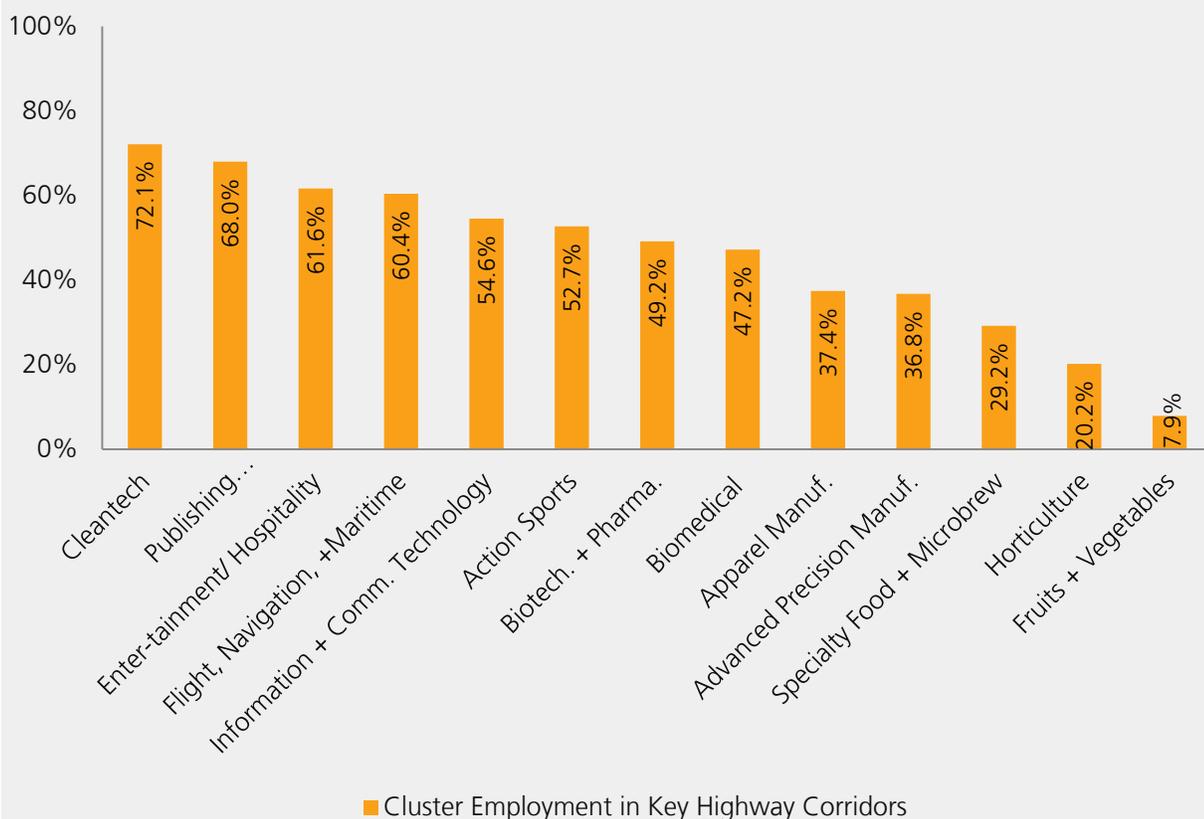
Table P.13
Summary of Employment by Cluster within
Selected Automotive Corridors in San Diego Region¹²²

Area	Total Region		1 Oceanside - Downtown San Diego		2 Escondido - Downtown San Diego		3 El Cajon - Kearny Mesa		4 Mid City - UTC		5 Oceanside - Escondido		6 San Ysidro - Downtown San Diego		Total Corridors	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	% of Region
Action Sports	4,153	1.3%	1,209	1.7%	116	0.3%	38	0.2%	34	0.2%	725	5.3%	69	0.4%	2,189	52.7%
Advanced Precision Manufacturing	3,538	1.1%	185	0.3%	172	0.4%	336	1.9%	60	0.3%	322	2.4%	226	1.2%	1,301	36.8%
Apparel Manufacturing	3,461	1.1%	273	0.4%	109	0.3%	155	0.9%	54	0.2%	369	2.7%	335	1.7%	1,295	37.4%
Biomedical Services + Devices	10,813	3.3%	2,724	3.8%	365	0.9%	157	0.9%	537	2.4%	1,095	8.1%	225	1.2%	5,104	47.2%
Biotechnology + Pharma.	22,825	7.1%	7,968	11.1%	768	2.0%	199	1.1%	1,241	5.6%	951	7.0%	96	0.5%	11,223	49.2%
Cleantech	7,485	2.3%	1,505	2.1%	1,364	3.5%	856	4.8%	1,023	4.6%	408	3.0%	243	1.3%	5,399	72.1%
Entertainment + Hospitality	148,774	46.0%	37,405	52.0%	19,871	51.2%	8,577	48.0%	9,740	43.6%	5,815	42.9%	10,310	53.3%	91,718	61.6%
Flight, Navigation, + Maritime	31,216	9.7%	3,474	4.8%	3,915	10.1%	2,342	13.1%	2,358	10.6%	469	3.5%	6,309	32.6%	18,868	60.4%
Fruits + Vegetables	4,301	1.3%	67	0.1%	93	0.2%	32	0.2%	20	0.1%	107	0.8%	20	0.1%	339	7.9%
Horticulture	5,838	1.8%	407	0.6%	80	0.2%	<10	0.0%	<10	0.0%	659	4.9%	21	0.1%	1,179	20.2%
Information + Comm.																
Technology	67,201	20.8%	14,317	19.9%	9,187	23.7%	4,154	23.3%	5,971	26.7%	2,012	14.8%	1,018	5.3%	36,660	54.6%
Publishing + Marketing	11,999	3.7%	2,421	3.4%	2,643	6.8%	916	5.1%	1,289	5.8%	481	3.5%	410	2.1%	8,161	68.0%
Specialty Food + Microbrew	1,554	0.5%	18	0.0%	122	0.3%	95	0.5%	<10	0.0%	153	1.1%	59	0.3%	454	29.2%
Total	323,168	100%	71,976	100%	38,805	100%	17,881	100%	22,340	100%	13,667	100%	19,341	100%	183,889	n/a

Although the remaining five clusters do not have as significant of a share of their employment concentrated in these corridors (see Figure P.11: Share of Regional Cluster Employment in Key Automotive Corridors), four of the remaining five still have more than 20 percent of their employment located in the key automotive corridors. Only the Fruits and Vegetables cluster has less than a 20 percent share of employment in the key automotive corridors, which is in part a result of the cluster's need for significant quantities of arable land as a critical input. This requirement means that firms in this cluster are often located away from other land uses that have a more even mix of production inputs. Since the industry clusters use both labor and goods as inputs, they would all become more competitive from improved access. However, clusters will use labor and goods in different ratios which indicates that they all may not benefit equally from improved access given differences in the concentration of inputs.

The difference in benefit results from the fact that each cluster has a unique profile for the shares of these inputs. This profile will influence how each cluster would benefit from improvements. For example, the Entertainment and Hospitality Cluster relies heavily on labor, while the ICT Cluster requires a more balanced profile of inputs between goods and labor. Since automotive corridors improve access to both goods and labor, the ICT Cluster would benefit from reduced travel time for both of these inputs whereas the Entertainment and Hospitality Cluster would primarily benefit from improved access to labor.

Figure P.11
Share of Regional Cluster Employment in Key Automotive Corridors



Sources: SANDAG (2012). Traded Industry Clusters in the San Diego Region, ESRI, AECOM November 2014.

It should be noted that although there is a high concentration of entertainment and hospitality employment across all key automotive corridors, this is partially due to the inclusion of restaurant workers that serve both local residents and tourists. As a result, although the number and concentration of workers included in this cluster is relatively high, not all of the employment in this cluster meets the definition of being export oriented since workers serving tourists would be considered export oriented while those serving residents would not meet this definition.

Impacts in Transit Corridors

As introduced in the [Potential Travel Time Change Impacts](#) section, travel times are forecast to decrease slightly under the no-build scenario in the key transit corridors, while travel times under the revenue-constrained scenario are forecast to decrease more significantly across all corridors. On transit corridors, reduced travel time is primarily a factor contributing to the ability of a firm to access labor, as opposed to automotive corridors which provide access to both labor and goods. Under the revenue-constrained scenario, access to labor would improve for industry clusters located in these corridors, which includes workers from all clusters.

Comparison to Automotive Corridors

It should be noted that the amount of cluster employment is lower in transit corridors as compared to automotive corridors. This is a result of two factors. The first is that a relatively small number of industry cluster employees work within a one-half mile radius of transit stations, which is the capture area for a transit stop. This radius is based on the small distances pedestrians typically commute to and from a transit stop. The second factor is that SANDAG calculates travel times using the fastest route. This means that many routes identified as ‘fastest option’ are express routes that omit interim stations and, as a result, leave out employees that cannot alight onto express routes at these stations, though they do have access to regular service.

In addition, cluster employment totals within a transit commute-shed do not include employees using privately-implemented “last mile” solutions such as employer-operated shuttles, bike share, point-to-point car rentals, and other methods that are increasingly used to extend the capture area of transit stops to nearby employment areas. Last mile solutions are likely to be more commonly implemented as the gap between automobile and transit travel times becomes shorter in the future—such as on Corridors 2, 4, and 6, where transit travel times range from 3.6 minutes faster to 2.9 minutes longer as compared to highway travel time—and where technology reduces the cost of these options.

Impacts inside the Traditional Transit Corridor

Using the half-mile definition of the catchment area for transit corridors, Transit Corridor 3: El Cajon to Kearny Mesa and Transit Corridor 4: Mid City to UTC is projected to experience time savings of over 30 minutes under the revenue-constrained scenario. Transit Corridor 4: Mid-City to UTC is projected to experience the greatest time savings under the revenue-constrained scenario at nearly 46 minutes, or just less than 60 percent of total travel time. The reduction in travel time along this corridor is supported by the planned light rail extension to UTC. The corridor contains about 7,700 industry cluster employees, with its largest share of employment in the ICT Cluster. Employment in the ICT cluster accounts for 38 percent of cluster employment in the corridor, with the next largest concentration of employment in the Entertainment and Hospitality Cluster, which comprises 21 percent of the corridor’s cluster employment.

Transit Corridor 3: El Cajon to Kearny Mesa is projected to experience the next-greatest time savings under the revenue-constrained scenario at nearly 38 minutes, cutting total travel time in half. The top three traded industry clusters in Transit Corridor 3: El Cajon to Kearny Mesa are: (1) ICT (32.1%); (2) Entertainment and Hospitality (23.5%); and (3) Flight, Navigation and Maritime (22.5%).

Transit Corridor 1: Oceanside to San Diego is estimated to serve about 10,400 cluster employees, and is projected to experience relatively low transit time reduction with total travel time remaining at over 90 minutes under the revenue-constrained scenario. Although the 2050 transit travel time forecast is lower than the 2012 travel time, it is still more than 30 percent longer than highway travel time. A transit travel time that is significantly higher than highway travel time is likely to act as a deterrent to the use of transit between Oceanside and San Diego, and does not support improved access to labor for industries along this corridor.

Time savings benefits accrue to transit users that use any portion of the trunk line. Cluster employment is again dominated by Entertainment and Hospitality near corridor transit stations, with significant shares in Information and Communications Technologies and Flight, Navigation, and Maritime industries. Note that the employment does not include employment outside of traded industry clusters, such as the large share of university employment at California State University at San Marcos or UC San Diego.

Industries clustered along transit stations would benefit from significantly improved travel times. Flight, Navigation, and Maritime has the highest concentration of employment located along the key transit corridors at just over 17 percent of its Regional employment in this area. Other clusters with a high share of their Regional employment located in the key transit corridors are Cleantech at 16.8 percent, ICT and Entertainment and Hospitality at 11.1 percent each, Publishing and Marketing at 10.8 percent and Advanced Precision Manufacturing at 10.3 percent. The Fruits and Vegetables and Horticulture clusters have less than 5 percent of Regional employment within key transit corridors, as roadway access and large areas of land are much more important inputs to these industries than transit access that provides only access to labor.

Impacts beyond the Traditional Transit Corridor

Despite the smaller amount of cluster employment captured in the key transit corridors as compared to key automotive corridors, there are two reasons to believe that travel time improvements in transit corridors are beneficial to the Region's industry clusters. One reason is that last mile solutions expand the reach of transit to a larger area, which results in a larger capture area of cluster employment. Next, research on the long-term economic effects of transportation investments illustrates that transit hubs can act as focal points around which industry clusters consolidate and grow.

First, although fewer employees are forecast to be served within key transit corridors as compared to key highway corridors—in part due to smaller capture areas—the key transit corridors are parallel to the key highway corridors. This indicates that clusters along, but just outside of, key transit corridors should also benefit from travel time improvements given private implementation of last mile solutions discussed previously. By extending the capture area of a transit stop to one mile (from half of a mile) and within the range of last mile solutions, the key transit corridors would encompass nearly three times the current number of cluster employees.¹²³ Employees in this expanded corridor capture area are concentrated in the clusters of Entertainment and Hospitality (48%), ICT (20%), and Flight, Navigation, and Maritime (13%).

However, although clusters near to, but outside of, key transit corridors are likely to benefit from shorter travel times at a scale beyond those in Table P.14, the benefits from reduced travel time will be more limited than those provided by reduced travel times on automotive corridors. This is because transit routes primarily provide access to labor, whereas the key automotive corridors also provide access to goods as they are also traveled by freight-bearing vehicles.¹²⁴ So even if the same number of cluster employees access key transit routes through last-mile solutions and the inclusion of interim stops, transit improvements would still provide more limited benefits than automotive corridor improvements since improved goods movement is not a primary result of transit activities.

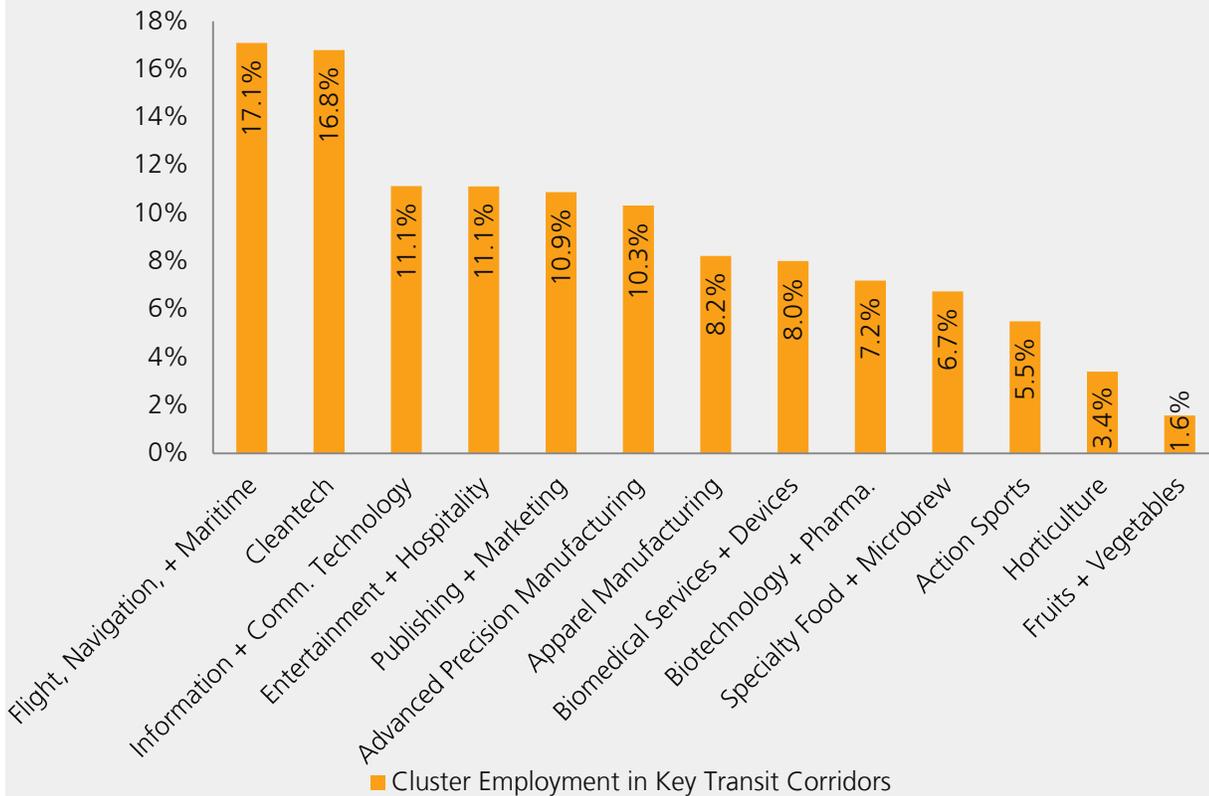
Next, the literature review on economic shifts due to transportation investment suggests that over time transit stops can serve as focal points around which industry clusters can agglomerate for economic efficiencies. Case studies show that transit can support growth in biotechnology, biomedical, and high-tech industries that would not otherwise be achievable by additional road capacity.¹²⁵ Because transit corridors are projected to experience greater time savings than automotive corridors, transit will be a relatively more attractive transportation option in the future than at present, all other factors held constant. This indicates that transit improvements can support continued growth and

agglomeration economies in clusters such as Biotechnology and Pharmaceuticals, Biomedical Devices and Products, and ICT in the Region.

Table P.14
Summary of Employment by Cluster within
Key Transit Corridors in San Diego Region

Area	Total Region		1 Oceanside - Downtown San Diego		2 Escondido - Downtown San Diego		3 El Cajon - Kearny Mesa		4 Mid City - UTC		5 Oceanside - Escondido		6 San Ysidro - Downtown San Diego		Total Corridors	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	% of Region
Action Sports	4,153	1.3%	126	1.2%	<10	0.1%	18	0.4%	<10	0.1%	51	2.2%	20	0.3%	228	5.5%
Advanced Precision Manufacturing	3,538	1.1%	20	0.2%	<10	0.1%	211	4.7%	30	0.4%	34	1.5%	65	0.9%	365	10.3%
Apparel Manufacturing	3,461	1.1%	29	0.3%	<10	0.0%	100	2.2%	17	0.2%	36	1.5%	103	1.5%	285	8.2%
Biomedical Services + Devices	10,813	3.3%	336	3.2%	14	0.4%	46	1.0%	271	3.5%	138	5.9%	61	0.9%	866	8.0%
Biotechnology + Pharma.	22,825	7.1%	781	7.5%	22	0.6%	64	1.4%	663	8.6%	96	4.1%	17	0.2%	1,642	7.2%
Cleantech	7,485	2.3%	238	2.3%	91	2.4%	261	5.9%	537	7.0%	29	1.2%	102	1.5%	1,258	16.8%
Entertainment + Hospitality	148,774	46.0%	5,819	55.8%	2,797	74.0%	1,044	23.5%	1,586	20.6%	1,308	56.3%	3,989	56.9%	16,543	11.1%
Flight, Navigation, + Maritime	31,216	9.7%	572	5.5%	203	5.4%	999	22.5%	1,388	18.0%	107	4.6%	2,067	29.5%	5,337	17.1%
Fruits + Vegetables	4,301	1.3%	<10	0.1%	20	0.5%	<10	0.0%	<10	0.0%	36	1.6%	<10	0.1%	68	1.6%
Horticulture	5,838	1.8%	51	0.5%	10	0.3%	<10	0.0%	<10	0.0%	132	5.7%	<10	0.0%	199	3.4%
Information + Comm. Technology	67,201	20.8%	2,044	19.6%	431	11.4%	1,427	32.1%	2,926	38.0%	252	10.8%	401	5.7%	7,482	11.1%
Publishing + Marketing	11,999	3.7%	408	3.9%	178	4.7%	212	4.8%	265	3.4%	82	3.5%	161	2.3%	1,306	10.9%
Specialty Food + Microbrew	1,554	0.5%	<10	0.0%	<10	0.1%	64	1.4%	<10	0.0%	21	0.9%	12	0.2%	105	6.7%
Total	323,168	100.0%	10,430	100.0%	3,781	100.0%	4,446	100.0%	7,699	100.0%	2,322	100.0%	7,005	100.0%	36,684	n/a

Figure P.12
Share of Regional Cluster Employment in Key Transit Corridors



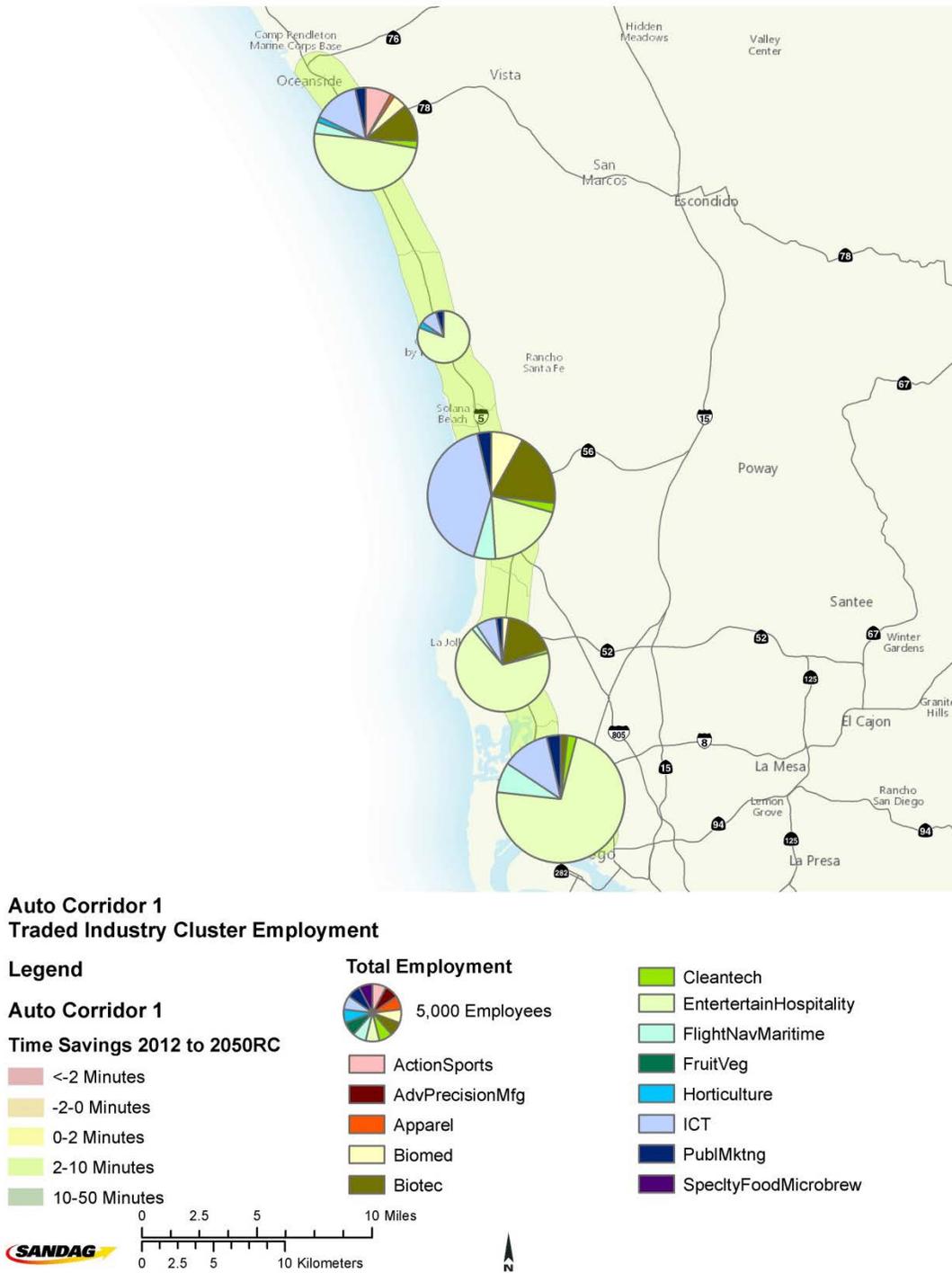
Sources: SANDAG (2012). Traded Industry Clusters in the San Diego Region, ESRI, AECOM November 2014.

Industry Cluster and Corridor Maps

The following map figures provide a detailed picture of the industry cluster employment concentrations within the key highway and transit corridors in San Diego. Maps display pie charts that vary by size of employment cluster in a given corridor subarea. Each slice represents the proportion of employment within each traded industry cluster by section of automotive or transit corridor, respectively.

Figure P.13

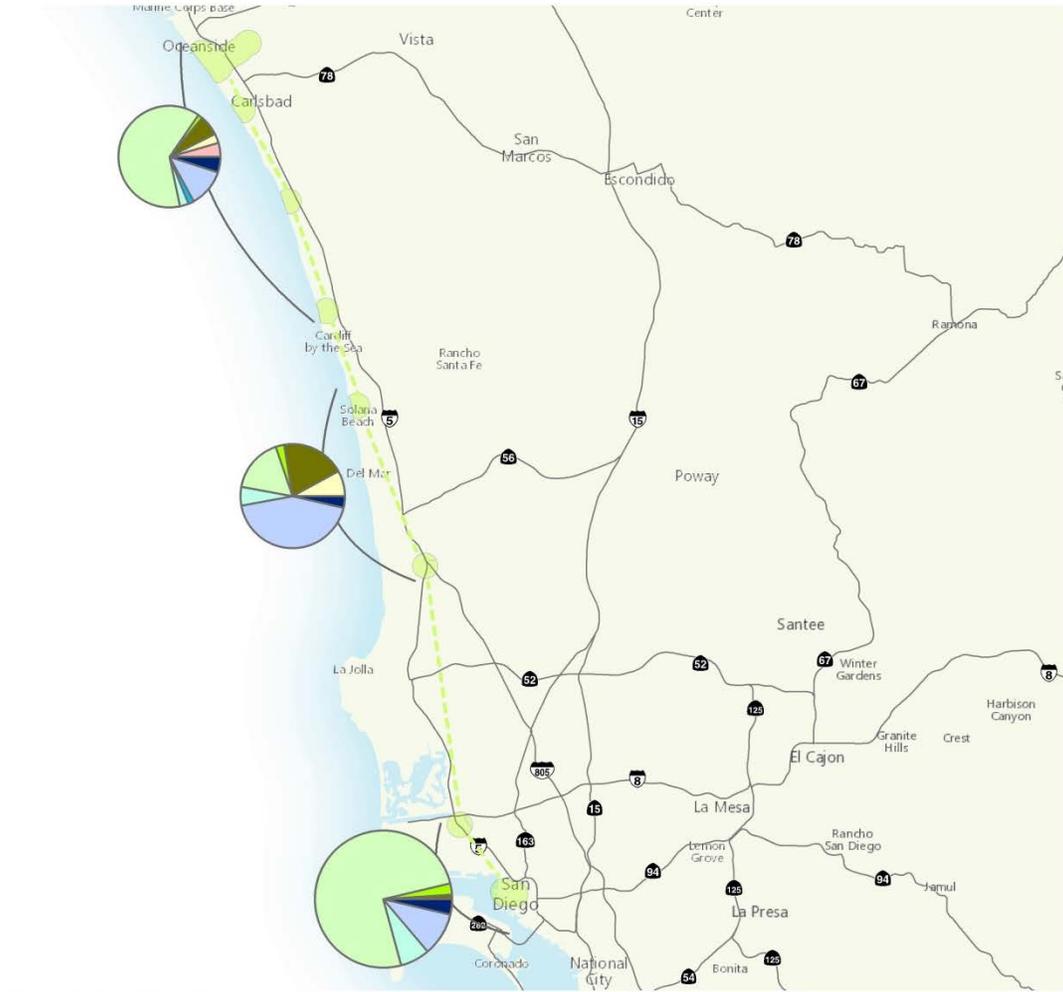
Auto Corridor 1 Traded Industry Cluster Employment



Sources: SANDAG Employment Inventory (2010); ESRI; AECOM November 2014.

Figure P.14

Transit Corridor 1 Traded Industry Cluster Employment



Transit Corridor 1 Traded Industry Cluster Employment

Legend

Transit Corridor 1

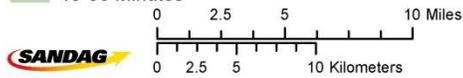
Time Savings 2012 to 2050RC

- <-2 Minutes
- 2-0 Minutes
- 0-2 Minutes
- 2-10 Minutes
- 10-50 Minutes

Total Employment

- 1,000 Employees
- ActionSports
- AdvPrecisionMfg
- Apparel
- Biomed
- Biotec

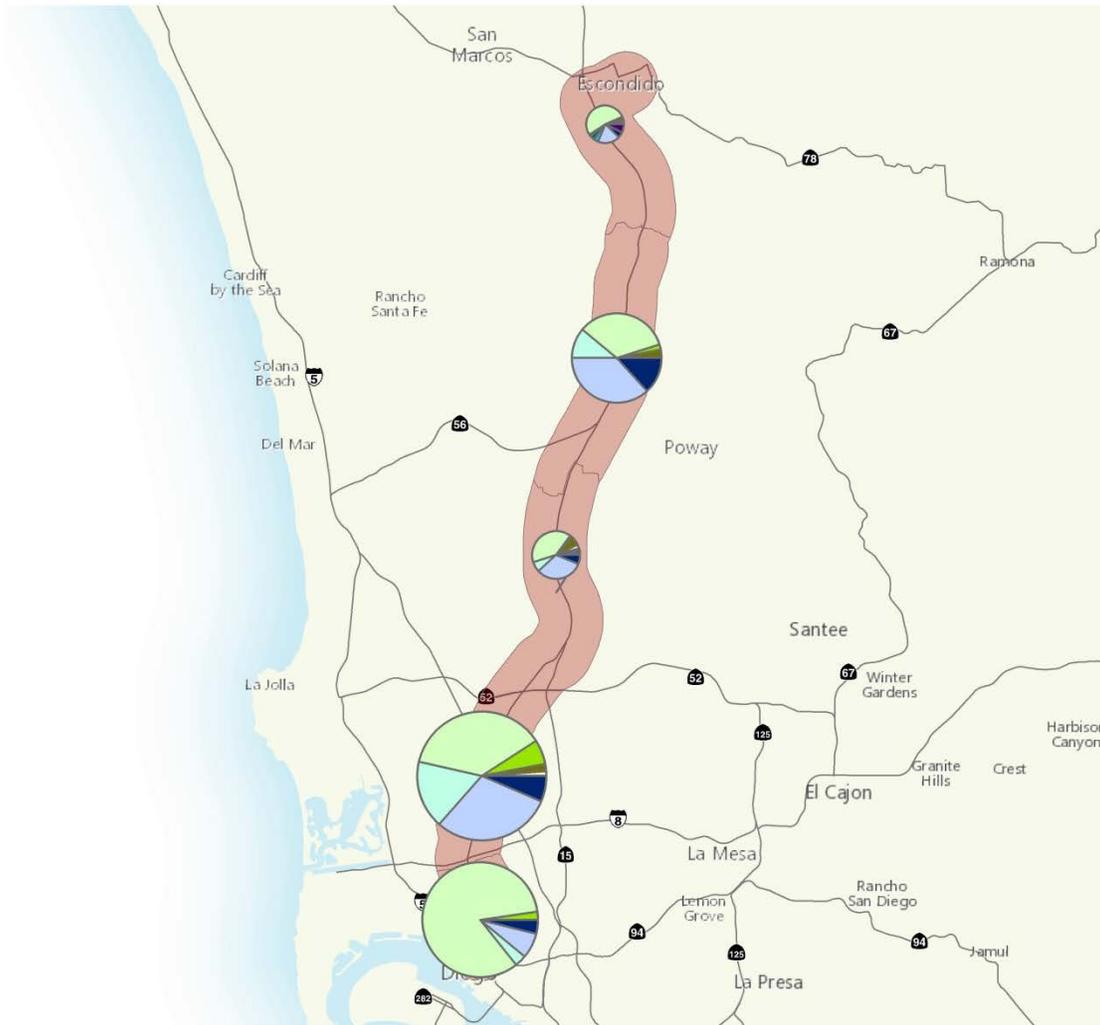
- Cleantech
- EntertainHospitality
- FlightNavMaritime
- FruitVeg
- Horticulture
- ICT
- PubIMktnng
- SpecityFoodMicrobrew



Sources: SANDAG Employment Inventory (2010); ESRI; AECOM November 2014.

Figure P.15

Auto Corridor 2 Traded Industry Cluster Employment



Auto Corridor 2 Traded Industry Cluster Employment

Legend

Auto Corridor 2

Time Savings 2012 to 2050RC

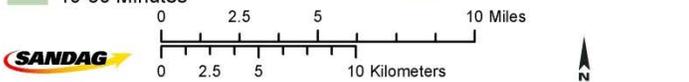
- <-2 Minutes
- 2-0 Minutes
- 0-2 Minutes
- 2-10 Minutes
- 10-50 Minutes

Total Employment



- ActionSports
- AdvPrecisionMfg
- Apparel
- Biomed
- Biotec

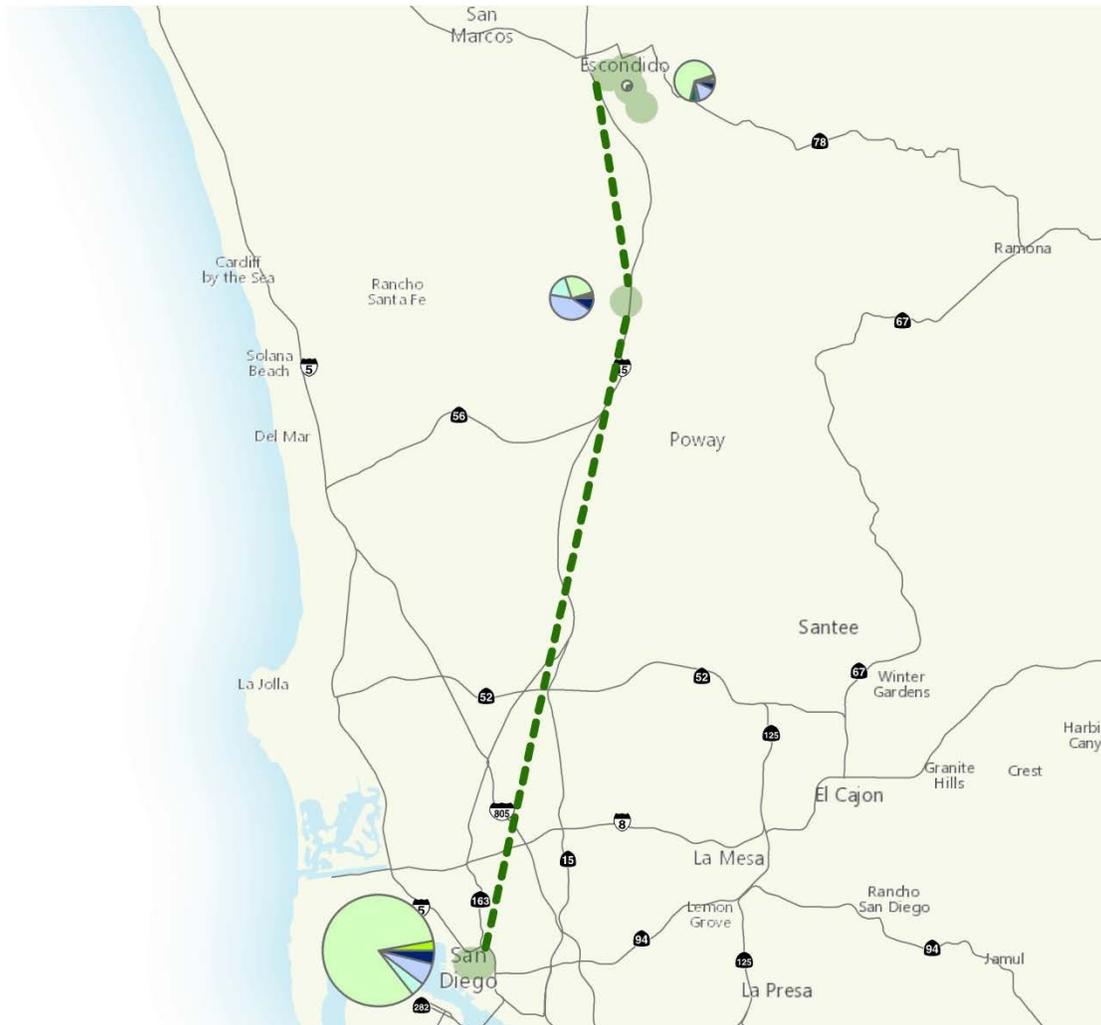
- Cleantech
- EntertainHospitality
- FlightNavMaritime
- FruitVeg
- Horticulture
- ICT
- PubIMktng
- SpectyFoodMicrobrew



Sources: SANDAG Employment Inventory (2010); ESRI; AECOM November 2014.

Figure P.16

Transit Corridor 2 Traded Industry Cluster Employment



Transit Corridor 2 Traded Industry Cluster Employment

Legend

Transit Corridor 2

Time Savings 2012 to 2050RC

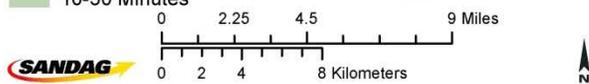
- <-2 Minutes
- 2-0 Minutes
- 0-2 Minutes
- 2-10 Minutes
- 10-50 Minutes

Total Employment



- ActionSports
- AdvPrecisionMfg
- Apparel
- Biomed
- Biotec

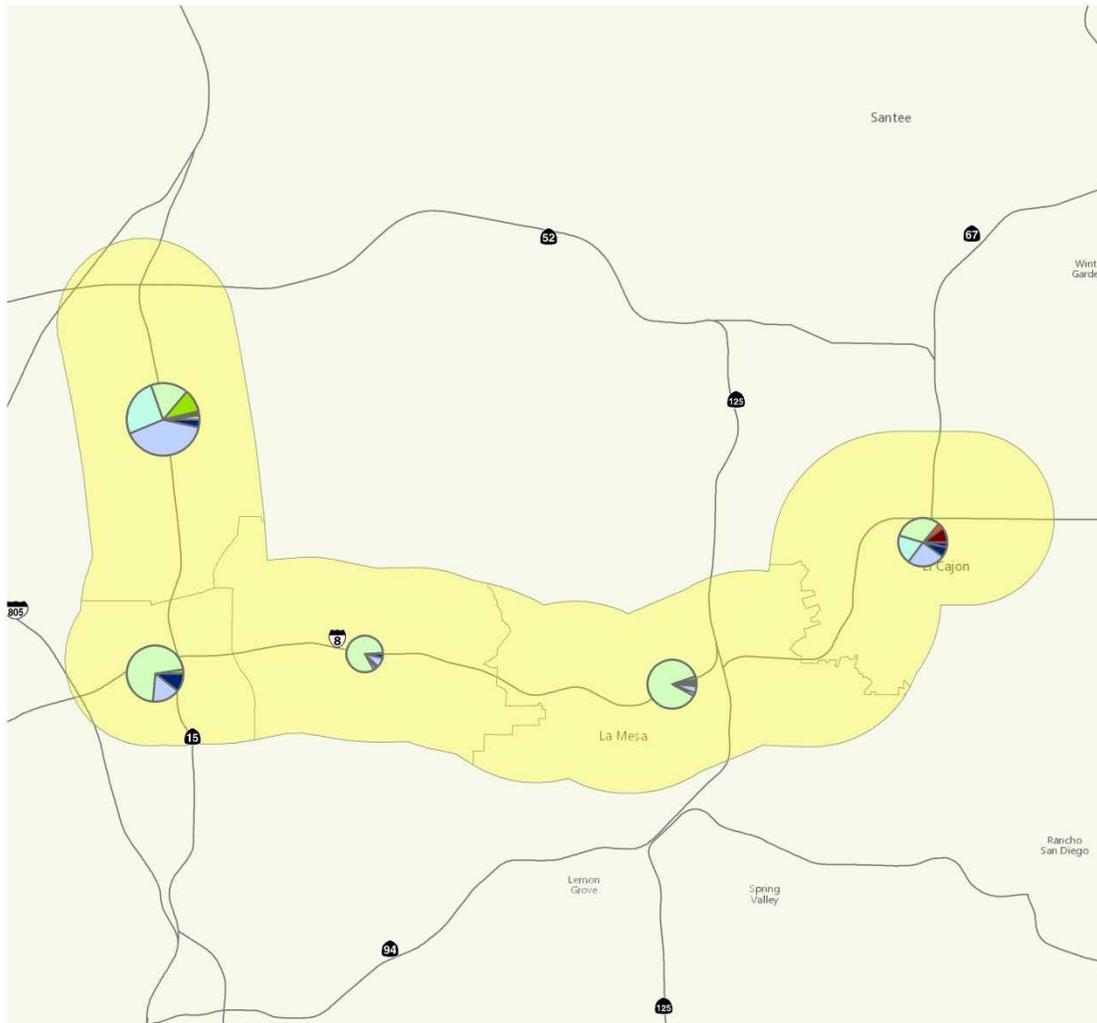
- Cleantech
- EntertainHospitality
- FlightNavMaritime
- FruitVeg
- Horticulture
- ICT
- PubIMktng
- SpeciallyFoodMicrobrew
- Transit Path



Sources: SANDAG Employment Inventory (2010); ESRI; AECOM November 2014.

Figure P.17

Auto Corridor 3 Traded Industry Cluster Employment



**Auto Corridor 3
Traded Industry Cluster Employment**

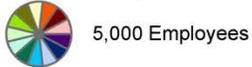
Legend

Auto Corridor 3

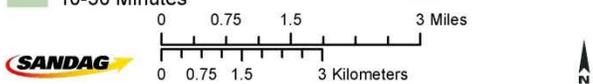
Time Savings 2012 to 2050RC

- <-2 Minutes
- 2-0 Minutes
- 0-2 Minutes
- 2-10 Minutes
- 10-50 Minutes

Total Employment



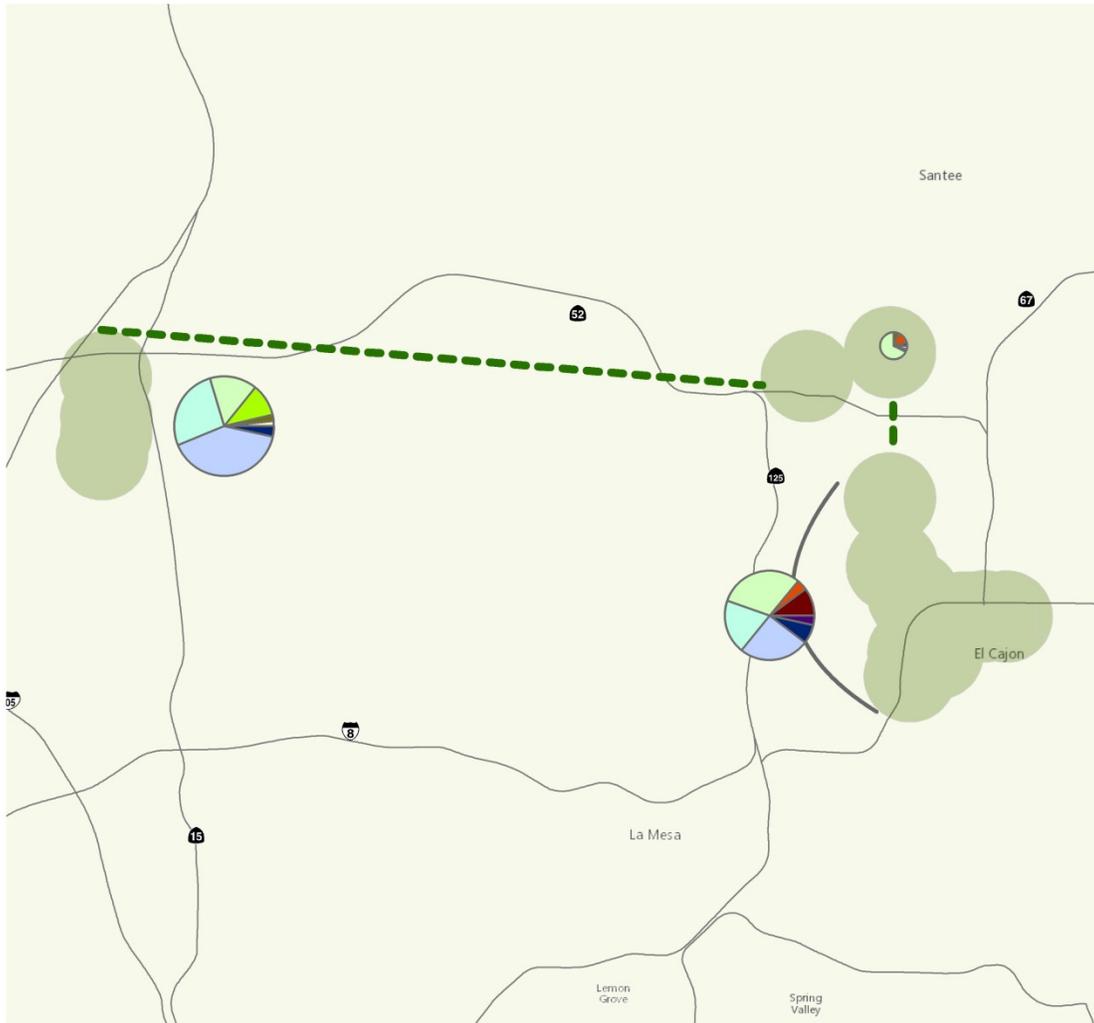
- ActionSports
- AdvPrecisionMfg
- Apparel
- Biomed
- Biotec
- Cleantech
- EntertainHospitality
- FlightNavMaritime
- FruitVeg
- Horticulture
- ICT
- PublMktng
- SpectlyFoodMicrobrew



Sources: SANDAG Employment Inventory (2010); ESRI; AECOM November 2014.

Figure P.18

Transit Corridor 3 Traded Industry Cluster Employment



**Transit Corridor 3
Traded Industry Cluster Employment**

Legend

Transit Corridor 3

Time Savings 2012 to 2050RC

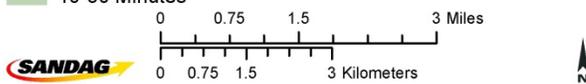
- <-2 Minutes
- 2-0 Minutes
- 0-2 Minutes
- 2-10 Minutes
- 10-50 Minutes

Total Employment



- ActionSports
- AdvPrecisionMfg
- Apparel
- Biomed
- Biotec

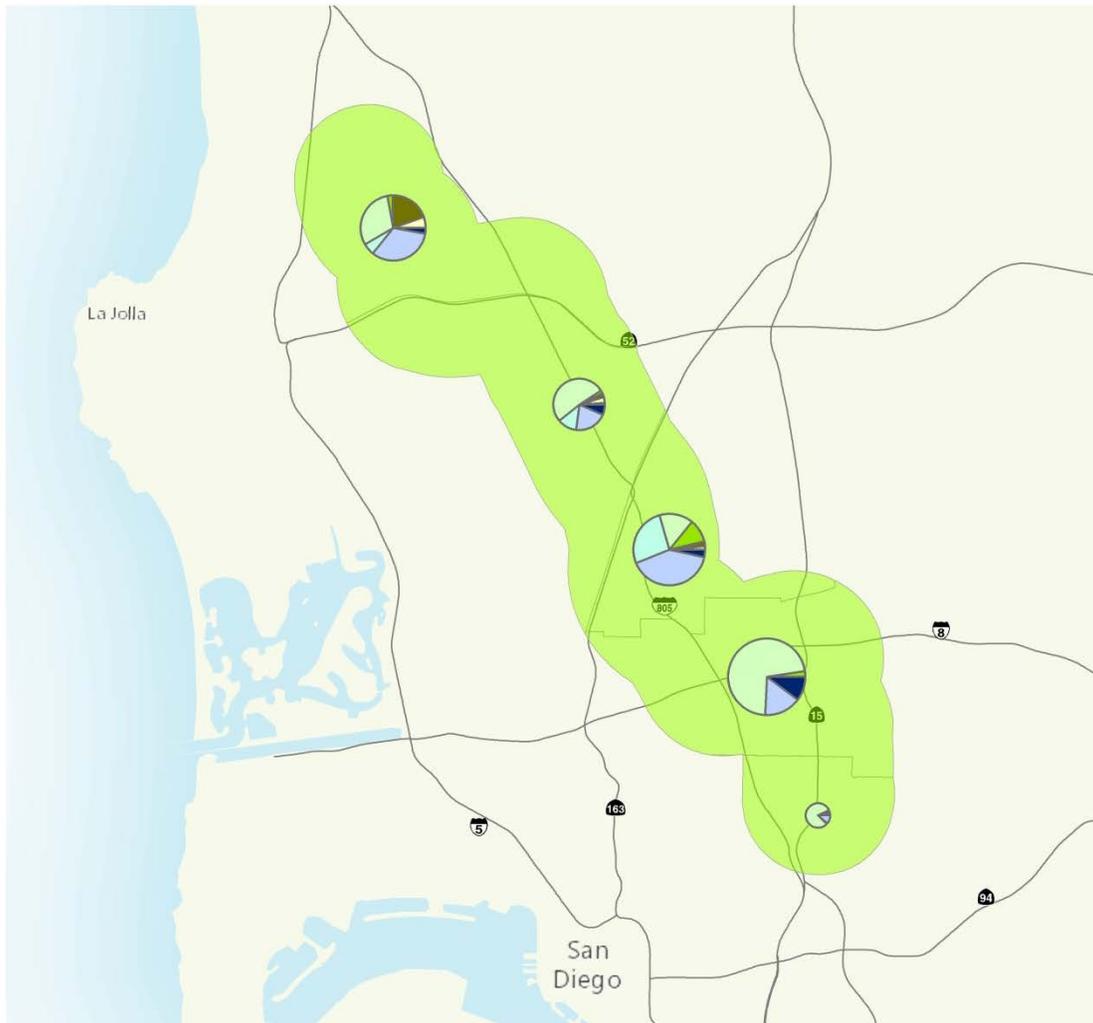
- Cleantech
- EntertainHospitality
- FlightNavMaritime
- FruitVeg
- Horticulture
- ICT
- PubIMktng
- SpecityFoodMicrobrew
- Transit Path



Sources: SANDAG Employment Inventory (2010); ESRI; AECOM November 2014.

Figure P.19

Auto Corridor 4 Traded Industry Cluster Employment



**Auto Corridor 4
Traded Industry Cluster Employment**

Legend

Auto Corridor 4

Time Savings 2012 to 2050RC

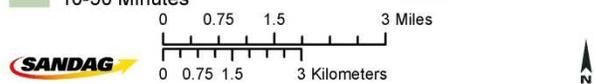
- <-2 Minutes
- 2-0 Minutes
- 0-2 Minutes
- 2-10 Minutes
- 10-50 Minutes

Total Employment



- ActionSports
- AdvPrecisionMfg
- Apparel
- Biomed
- Biotec

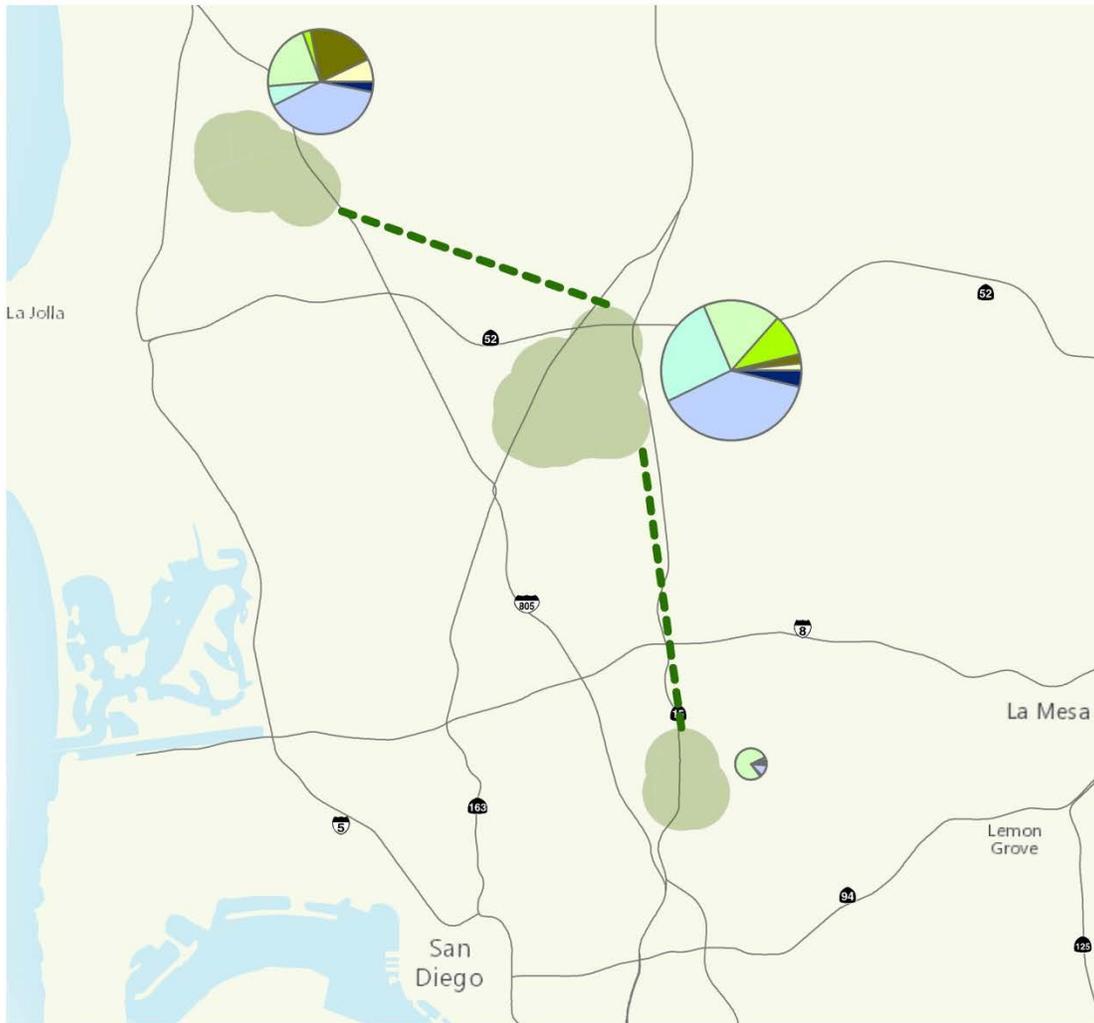
- Cleantech
- EntertainHospitality
- FlightNavMaritime
- FruitVeg
- Horticulture
- ICT
- PubIMktng
- SpecityFoodMicrobrew



Sources: SANDAG Employment Inventory (2010); ESRI; AECOM November 2014.

Figure P.20

Transit Corridor 4 Traded Industry Cluster Employment



**Transit Corridor 4
Traded Industry Cluster Employment**

Legend

Transit Corridor 4

Time Savings 2012 to 2050RC

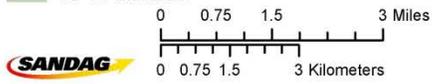
- <-2 Minutes
- 2-0 Minutes
- 0-2 Minutes
- 2-10 Minutes
- 10-50 Minutes

Total Employment



- ActionSports
- AdvPrecisionMfg
- Apparel
- Biomed
- Biotec

- Cleantech
- EntertainHospitality
- FlightNavMaritime
- FruitVeg
- Horticulture
- ICT
- PublMktng
- SpeclyFoodMicrobrew
- Transit Path



Sources: SANDAG Employment Inventory (2010); ESRI; AECOM November 2014.

Figure P.21

Auto Corridor 5 Traded Industry Cluster Employment



Auto Corridor 5 Traded Industry Cluster Employment

Legend

Auto Corridor 5

Time Savings 2012 to 2050RC

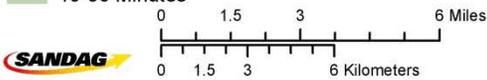
- <-2 Minutes
- 2-0 Minutes
- 0-2 Minutes
- 2-10 Minutes
- 10-50 Minutes

Total Employment

5,000 Employees

- ActionSports
- AdvPrecisionMfg
- Apparel
- Biomed
- Biotec

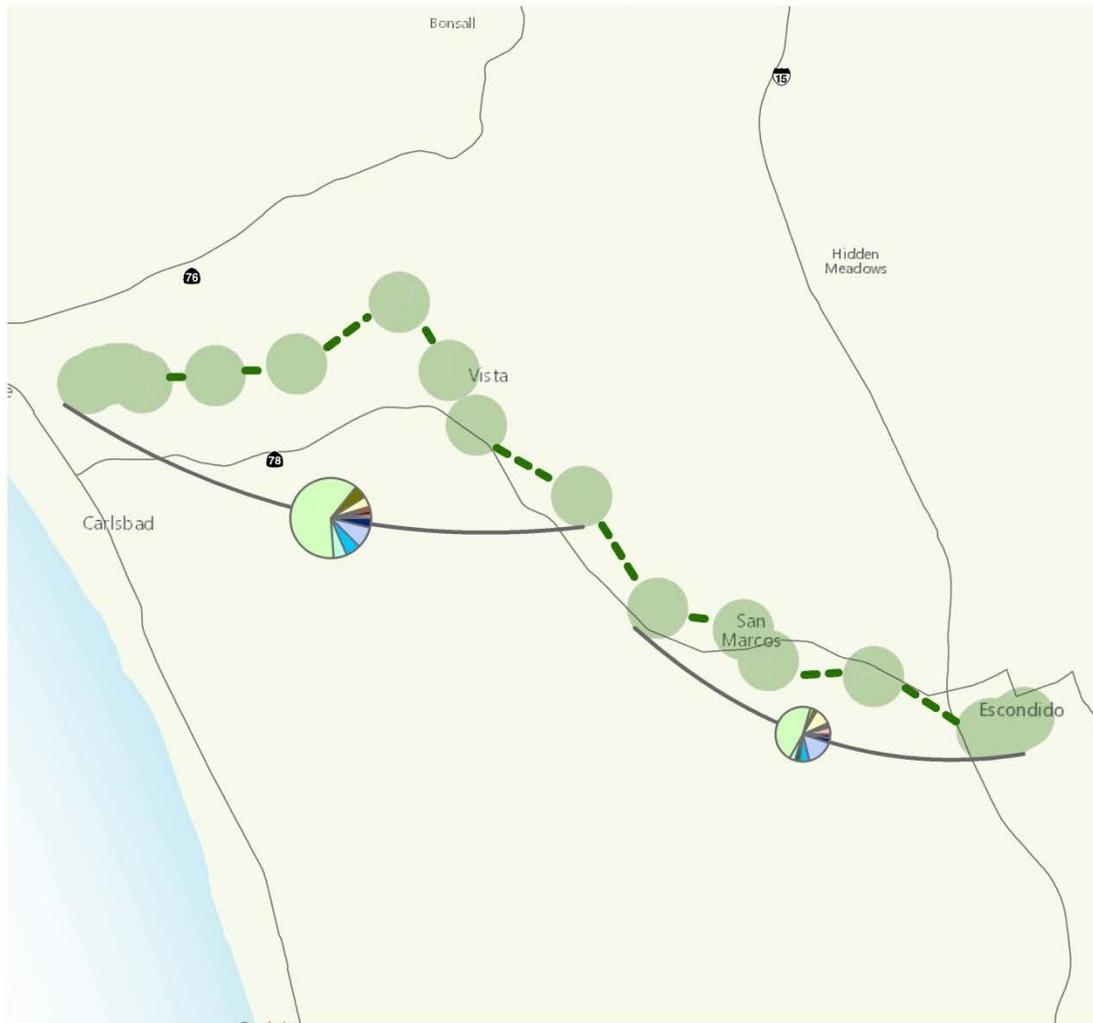
- Cleantech
- EntertainHospitality
- FlightNavMaritime
- FruitVeg
- Horticulture
- ICT
- PublMktng
- SpectlyFoodMicrobrew



Sources: SANDAG Employment Inventory (2010); ESRI; AECOM November 2014.

Figure P.22

Transit Corridor 5 Traded Industry Cluster Employment



Transit Corridor 5 Traded Industry Cluster Employment

Legend

Transit Corridor 5

Time Savings 2012 to 2050RC

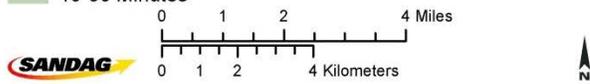
- <-2 Minutes
- 2-0 Minutes
- 0-2 Minutes
- 2-10 Minutes
- 10-50 Minutes

Total Employment



- ActionSports
- AdvPrecisionMfg
- Apparel
- Biomed
- Biotec

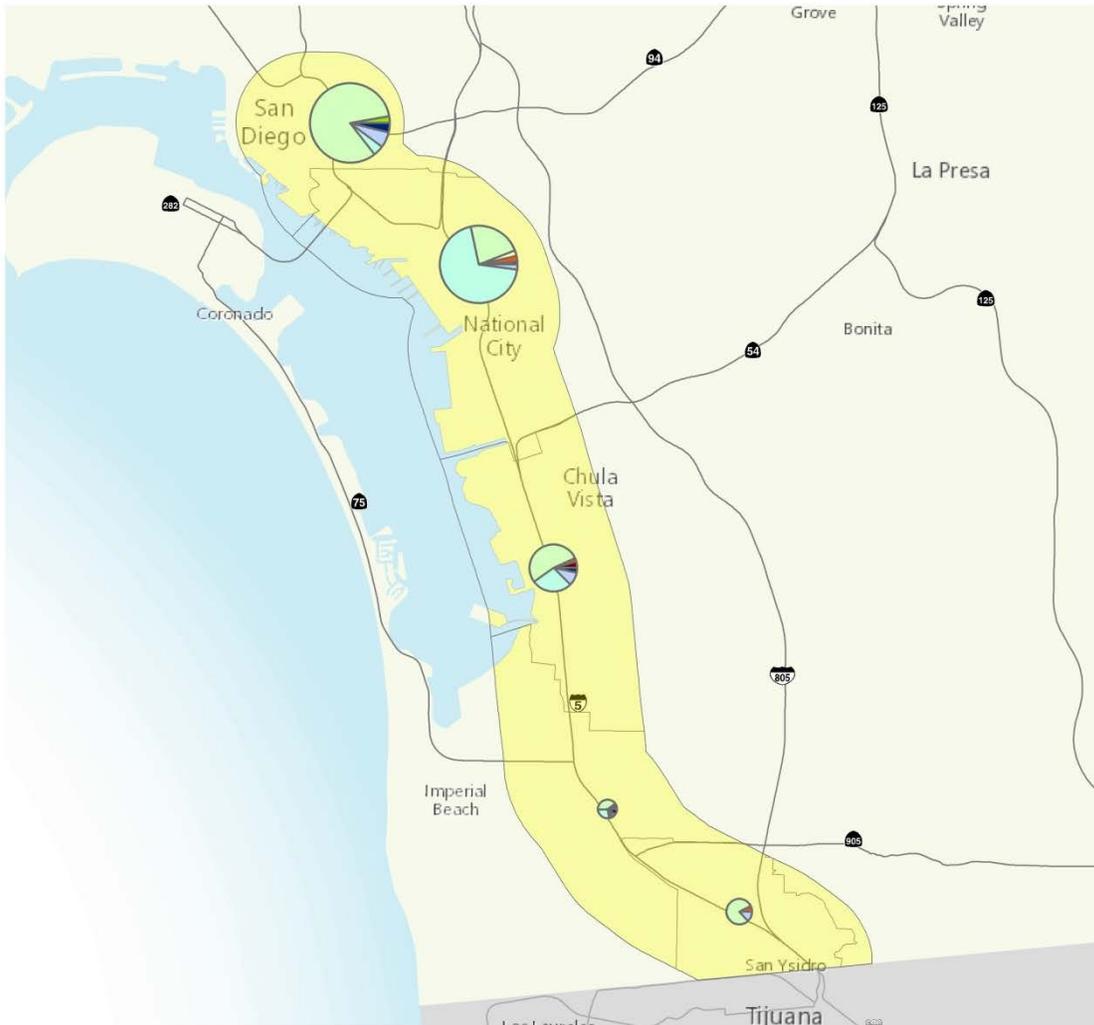
- Cleantech
- EntertainHospitality
- FlightNavMaritime
- FruitVeg
- Horticulture
- ICT
- PublMktng
- SpeclyFoodMicrobrew
- Transit Path



Sources: SANDAG Employment Inventory (2010); ESRI; AECOM November 2014.

Figure P.23

Auto Corridor 6 Traded Industry Cluster Employment



Auto Corridor 6 Traded Industry Cluster Employment

Legend

Auto Corridor 6

Time Savings 2012 to 2050RC

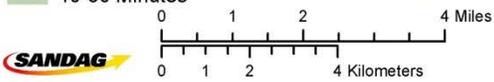
- <-2 Minutes
- 2-0 Minutes
- 0-2 Minutes
- 2-10 Minutes
- 10-50 Minutes

Total Employment



- ActionSports
- AdvPrecisionMfg
- Apparel
- Biomed
- Biotec

- Cleantech
- EntertainHospitality
- FlightNavMaritime
- FruitVeg
- Horticulture
- ICT
- PubIMktng
- SpecityFoodMicrobrew



Sources: SANDAG Employment Inventory (2010); ESRI; AECOM November 2014.

Figure P.24

Transit Corridor 6 Traded Industry Cluster Employment



Transit Corridor 6 Traded Industry Cluster Employment

Legend

Transit Corridor 6

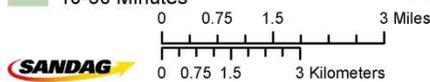
Time Savings 2012 to 2050RC

- <-2 Minutes
- 2-0 Minutes
- 0-2 Minutes
- 2-10 Minutes
- 10-50 Minutes

Total Employment

- 1,000 Employees
- ActionSports
- AdvPrecisionMfg
- Apparel
- Biomed
- Biotec

- Cleantech
- EntertainHospitality
- FlightNavMaritime
- FruitVeg
- Horticulture
- ICT
- PubIMktng
- SpecityFoodMicrobrew
- Tranist Path



Sources: SANDAG Employment Inventory (2010); ESRI; AECOM November 2014.

III.3 Analysis of Supportable Housing Prices, and Housing Capacity

III.3.1 Introduction

This section examines supportable housing prices based on wages in the Region's industry clusters and the Region's capacity to provide housing in key transportation corridors that serve industry clusters. These two analyses provide information on the supply and demand in the housing market specific to the Region's key industry clusters.

Workforce housing that is affordable¹²⁶ at market rates is a key consideration for employees and firms in the region as it supports both employers' ability to attract talented workers and supports residents' access to employment. In addition, adequate supply of housing for employees in industry clusters can also expand the export economy base in San Diego. To understand housing price points at an affordable share of income for workers in the region's industry clusters, AECOM used the clusters' wage distribution to develop an estimate of supportable housing price points in key corridors.

In addition to the wage and housing price analysis, AECOM also assessed housing supply along key corridors to determine capacity for housing growth along key corridors that provide access to employment in key industry clusters.

III.3.2 Methodology

AECOM gathered employment and wage data from the SANDAG report on Traded Industry Clusters in the San Diego region to develop a dataset on wages by industry. The report includes the average annual wage of each traded industry cluster.

Both wages and the share of workers in each cluster were used as inputs to determine housing price-point ranges for each transportation corridor. Note that the estimates in this work are based only on the transportation corridors analyzed (see Figure P.25 and Figure P.26 for transportation corridors) in the previous sections. This is an important consideration since many of the Region's workers can and do choose to live further from transportation corridors. Automotive corridors were defined as a one mile radius of a major road or highway, while transit corridors were defined as one-half of a mile of a transit stop. This is especially true for automotive corridor users who drive on smaller roads to reach major roads and highways and for transit users who drive or use last-mile solutions to arrive at transit stops.

Next, AECOM associated average annual wages with the proportion of employment in each section of the corridor. From the SANDAG wage data by cluster, AECOM estimated the price of an affordable house based on a 30-year mortgage and a 5 percent interest rate, excluding costs such as HOA, taxes, and insurance using the common underwriting standard that allows for a maximum of 30 percent of income be spent on housing.¹²⁷ Because this calculation is based on a single wage earner and households may have more than one wage earner, AECOM adjusted the supportable home price to reflect this economic reality. This adjustment estimates the average number of wage earners per household in the region, and uses household income to estimate supportable housing price, rather than the individual income, based on each cluster's average wage. Using the U.S. Census Bureau's American Community Survey 2010 estimate of persons in the labor force and number of households in San Diego County, AECOM estimated that there are 1.43 workers per household in the region.

Note that both wages and housing prices used in this analysis are from 2010, which means that these figures reflect the recession that began in 2007. While the recession ended in 2009, effects from this event on wages and prices are still present in 2010 data.

Housing supply capacity was measured for each corridor based on data available by MGRA from the SANDAG SR 13 forecast. SANDAG developed its housing capacity data based on the land use plans of local jurisdictions. These data represent the capacity for new housing units, which are calculated based on inputs such as parcel size, current and planned land use, constraints on development or redevelopment, and other characteristics. This analysis assumes maintenance of current and planned regulation that informs the current and forecast data.

AECOM compared housing capacity to the projected change in housing units from 2012 to 2050. Results reflect available capacity for projected housing unit growth by key transportation corridor.

AECOM assumed housing supply capacity to be constant within each MGRA in a given year as this is the most detailed area for which data is available. AECOM overlaid corridors on the housing capacity layer in GIS and clipped them to fit the underlying MGRA. For MGRAs that did not fall completely within the corridor boundary, the percent of total area within the corridor was applied to the capacity in that MGRA. For example, for a MGRA with 10 housing units of capacity of which 70 percent is within the corridor boundary, AECOM would assume a capacity of 7.

III.3.3 Supportable Home Purchase and Rental Price Analysis

This section will examine supportable home purchase prices and rental prices resulting from cluster wages in the region.

Supportable Home Price Analysis

In the San Diego region, average wages vary widely by industry cluster which results in wide variation in supportable housing purchase prices from cluster to cluster. Table P.15 summarizes average annual industry wages and supportable housing prices and payments for individuals and households in the San Diego Region.

The Entertainment and Hospitality Cluster has the lowest supportable housing price of about \$145,000 due to average wages that are low compared to other clusters. Entertainment and Hospitality Cluster employment comprises approximately 45 percent of total regional cluster employment,¹²⁸ which means that the supportable housing price for nearly half of the region's cluster workers for housing is approximately \$145,000 at the household level.¹²⁹ However, as mentioned in other parts of this analysis and in Footnote 129, this cluster differs from other clusters in that it is not strictly export-oriented as well as that some workers in this cluster are employed part-time.¹³⁰ The part-time status of these workers means that they may be working in more than one business and/or in more than one cluster, which may result in lower average wages estimates in the cluster since it is difficult to identify the same cluster worker in several different jobs and assign multiple sources of income to that worker, as well as to assign income to part-time cluster workers that may be from other sources.

Table P.15

Average (Mean) Cluster Wages and Home Price Supported by Cluster Wages, 2010

Industry	2010 Wage	Home Price Supported by Average Cluster Wage	
		Individual	Household
Action Sports	\$65,300	\$304,105	\$435,442
Advanced Precision Mfg	\$51,800	\$241,235	\$345,420
Apparel Mfg	\$30,400	\$141,574	\$202,717
Biomed	\$99,500	\$463,376	\$663,499
Biotech	\$107,000	\$498,303	\$713,512
Cleantech	\$87,400	\$407,025	\$582,812
Entertainment and Hospitality	\$21,800	\$101,523	\$145,370
Flight, Navigation, and Maritime	\$79,300	\$369,303	\$528,799
Fruit and Vegetable	\$26,900	\$125,274	\$179,378
Horticulture	\$29,100	\$135,520	\$194,049
Information and Communications Tech.	\$94,400	\$439,625	\$629,491
Publishing and Marketing	\$56,600	\$263,588	\$377,428
Specialty Food and Microbrew	\$43,500	\$202,581	\$290,073
<i>Total Regional Cluster Employment</i>	<i>\$56,000</i>	<i>\$260,794</i>	<i>\$373,427</i>
<i>Regional Employment, All Industries</i>	<i>\$50,700</i>	<i>\$236,112</i>	<i>\$338,085</i>

* assumes a 30-year loan at 5% interest, \$0 HOA, does not include associated costs such as utilities, taxes or insurance.

Sources: SANDAG, Current Employment Inventory (2010); SANDAG, Traded Industry Clusters in the San Diego Region, AECOM 2014.

Wages in the Fruit and Vegetable cluster, and the Horticulture cluster, are also among the lower-paying wages in the region's industry clusters at less than \$30,000 per year. These wages result in a supportable housing price of under \$200,000 for households working in the cluster. The average wage in the Apparel Manufacturing Cluster of \$30,400 is also lower than the average wage in the region and the average wage in the region's clusters. The average wage in this cluster results in a supportable housing price of just over \$202,000 for households. This value is very close to the supportable housing price of households in the Fruit and Vegetable and Horticulture clusters and, in total, four of the region's clusters have supportable housing prices for households of about \$200,000 or under.

The region's median home price for all homes for sale in 2010 was \$407,000,¹³¹ which is at least twice the supportable housing price for households in the lowest-wage clusters. In addition to the clusters discussed above, wages in the Publishing and Marketing Cluster, the Advanced Precision Manufacturing Cluster, and the Specialty Food and Microbreweries Cluster result in a supportable housing price that is lower than the regional median home price at \$377,400, \$345,400 and \$290,000 respectively.

The average wage in the Publishing and Marketing Cluster and the Advanced Precision Manufacturing Cluster are both above the \$50,700 average wage for all employment in the region, though these clusters' wages still result in a supportable housing price below the region's median home price of \$407,000. This indicates that on average, wages earned by individuals and households in these clusters would likely enable the purchase of housing only below the median home price in the region.

The relationship between the median housing price of \$407,000 indicates that households in these clusters may be challenged to find residences to buy that are within their budgets in the region. If they hope to purchase homes, they would be inclined to purchase homes that are valued below the median price in the region, which tend to be re-sales of older homes, homes further from the core of the region where land costs are lower, with fewer nearby amenities, and smaller units. In addition, many household may consider renting housing instead. This factor may be a constraint

on the region’s ability to support and expand these clusters, as workers in these clusters may look for work in other clusters with higher wages, or leave the region for other areas with more housing options given industry wages.

Table P.16
Regional Median Home Price and Housing Prices Supported by Cluster Wage, 2010

Industry	Supportable Home Price Household
Biotech	\$713,512
Biomed	\$663,499
Information and Communications Tech.	\$629,491
Cleantech	\$582,812
Flight, Navigation, and Maritime	\$528,799
Action Sports	\$435,442
Median Home Price	\$407,000
Publishing and Marketing	\$377,428
Regional Cluster Employment Average	\$373,427
Advanced Precision Mfg	\$345,420
Regional Employment Average	\$338,085
Specialty Food and Microbrew	\$290,073
Apparel Mfg	\$202,717
Horticulture	\$194,049
Fruit and Vegetable	\$179,378
Entertainment and Hospitality	\$145,370

Assumes a 30-year loan at 5 percent interest, \$0 HOA, does not include associated costs such as utilities, taxes or insurance. Sources: SANDAG, Current Employment Inventory; SANDAG, Traded Industry Clusters in the San Diego Region, U.S. Census Bureau American Community Survey.

By contrast, jobs in the Biotechnology, Biomedical Services and Products, and Information and Communications Technologies clusters provide mean wages above \$90,000. This wage yields a supportable home price of more than \$600,000, which is more than triple the supportable home price resulting from the Entertainment and Hospitality Cluster wages. Wages in the Cleantech and Flight, Navigation and Maritime clusters are also above the regional cluster wage average of \$56,000. These wages result in a supportable home price greater than \$500,000. Given the region’s median home price of \$407,000, the region is well-positioned to offer opportunities to purchase homes to workers in these two clusters.

Wages in the Action Sports cluster result in a supportable home price of about \$435,000, which is also above the region’s median home price. This wage and associated supportable home price also indicate that the region is well-positioned to offer opportunities to purchase homes to workers in this cluster.

Supportable Rental Price Analysis

Rental housing is a common alternative to purchasing housing in the region, with approximately 46 percent of the region's housing units being occupied by renters.¹³² Although rental and purchase prices are correlated, rental payments are expected to differ from home purchase prices based on a variety of factors in the housing and financial markets.¹³³

In the San Diego region, the median rental price for housing in 2010 was \$1,249.¹³⁴ By using the supportable monthly payment for housing as established based on wages by cluster and applying that to a rental context for households, this number can also be used as a supportable monthly rental price for each industry cluster. As illustrated in Table P.17: Regional Median Rental Price and Rental Payment Supported by Average Cluster Wage, 2010, nine clusters pay wages that translate into a supportable monthly rental price that are greater than the median rental price in the region.

In descending order, these nine clusters are: (1) Biotechnology; (2) Biomedical Devices and Products; (3) Information and Communications Technology; (4) Cleantech; (5) Flight, Navigation and Maritime; (6) Action Sports; (7) Publishing and Marketing; (8) Advanced Precision Manufacturing; and (9) Specialty Food and Microbreweries. The average wage for cluster workers and for regional employment also yield a supportable monthly rental payment that is higher than the median rental price, indicating that rental housing in the region is likely to be accessible to these clusters.

However, the monthly supportable rental payment for four clusters is still below the median rent in the region. These wages in these clusters also resulted in supportable home prices below the median home price in the region. These clusters, in descending order, are: (1) Apparel Manufacturing; (2) Horticulture; (3) Fruit and Vegetable; and (4) Entertainment and Hospitality. The supportable monthly rental payment for households in these clusters ranges from \$161 to \$469 less than the median rental housing price.

Similar to the discussion in the supportable housing price section (above) of supportable payments in relation to the regional median prices, a median rental price above a supportable rental payment indicates that households in these clusters may be challenged to find residences that are within their budgets in the region. Workers in these clusters, as well as some workers earning wages below the median in other clusters, are likely to have less access to rental units in the region. They will tend to rent units below the median rental price. These units are likely to be located farther from homes further from the core of the region with fewer nearby amenities, where land costs are lower, older units, and/or be smaller units. This factor may be a constraint on the region's ability to support and expand these clusters, as workers in these clusters may look for work in other clusters with higher wages, or leave the region for other areas with rental prices that are more financially and geographically accessible given industry wages.

Table P.17

Regional Median Rental Price and Rental Payment Supported by Average Cluster Wage, 2010

Industry	Monthly Rental Payment Supported by Average Cluster Wage Household
Biotech	\$3,830
Biomed	\$3,562
Information and Communications Tech.	\$3,379
Cleantech	\$3,129
Flight, Navigation, and Maritime	\$2,839
Action Sports	\$2,338
Publishing and Marketing	\$2,026
<i>Regional Cluster Employment Average</i>	<i>\$2,005</i>
Advanced Precision Mfg	\$1,854
<i>Regional Employment Average</i>	<i>\$1,815</i>
Specialty Food and Microbrew	\$1,557
<i>Median Rental Price</i>	<i>\$1,249</i>
Apparel Mfg	\$1,088
Horticulture	\$1,042
Fruit and Vegetable	\$963
Entertainment and Hospitality	\$780

Assumes a 30-year loan at 5% interest, \$0 HOA, does not include associated costs such as utilities, taxes or insurance. Sources: SANDAG, Current Employment Inventory; SANDAG, Traded Industry Clusters in the San Diego Region, U.S. Census Bureau American Community Survey, AECOM 2014.

III.3.3.1 Corridor-level Findings

This section presents findings on supportable housing purchase prices and rental payments in the key transportation corridors, with automotive corridors presented first followed by a discussion of findings in transit corridors. See Figure P.25: Key Automotive Corridors for a map of the automotive corridors and Figure P.26: Key Transit Corridors for a map of the transit corridors.

Automotive Corridor Findings

Table P.18 displays the distribution of industry cluster employment within each automotive corridor, the average wage, supportable housing purchase price, and supportable monthly rental payment based on wage distribution at the corridor level. Supportable housing prices at the corridor level are the result of examining the income of workers in the targeted industry clusters that can be allotted for housing based on the 30 percent standard of affordability,¹³⁵ not the market rate price of housing within the corridors.

As stated in the methodology section, the extent of an automotive corridor is one mile from a major road or highway. This means that although any worker in the region may drive through an automotive corridor to arrive at a work, the analysis only considers the cluster employment in the area within one mile of major roads or highways. This is an important consideration since in some corridors, a larger share of retail locations may be positioned along major roads and highways, while the larger area may be dominated by outlying office locations. See Figure P.25: Key Automotive Corridors for a map of the automotive corridors discussed here.

The average wage across all clusters in the region of \$56,000 yields a supportable home price of about \$360,000¹³⁶ given an affordability standard of 30 percent and the average number of earners per household in the region. Automotive Corridor 6: San Ysidro to Downtown San Diego has the lowest average annual wage of about \$48,000, and thus can support an average home price of about \$320,000. Supportable housing prices in Automotive Corridors 1, 3, and 5 are all similar in the range of \$355,000 to \$365,000. Automotive Corridor 4: Mid City to UTC has the highest average annual wage of just over \$59,000 and can support an average home price of approximately \$393,000, approximately 23 percent higher than Automotive Corridor 6: San Ysidro to Downtown San Diego. Corridor 2: Escondido to Downtown San Diego has the second lowest average annual wage after Corridor 6: San Ysidro to Downtown San Diego at \$52,264. This wage yields a supportable housing price of approximately \$349,000 and a supportable rental payment of \$1,871.

All automotive corridors have a high concentration of Entertainment and Hospitality cluster workers. As discussed previously, the Entertainment and Hospitality cluster is likely to include firms and workers that do not meet the strict requirement for export orientation as compared other clusters. However, these businesses and workers are difficult to separate, though the inclusion of these businesses likely overstates the size of this cluster. This likely overstatement results in lower supportable housing price and rental payment estimates than would result with a decreased presence of the cluster in these corridors.

In addition to this consideration, some workers in the Entertainment and Hospitality cluster are employed part time.¹³⁷ The part-time status of these workers means that they may be working in more than one business and/or in more than one cluster, which may result in lower average wages estimates in the cluster since it is difficult to identify the same cluster worker in several different jobs and assign multiple sources of income to that worker, as well as to assign income to part-time cluster workers that may be from other sources.

No automotive corridors have a housing price supported by average cluster wage that is higher than the region's median housing price of \$407,000, though Automotive Corridor 4: Mid City to UTC comes to within approximately \$15,000 of the regional median price. This fact indicates that the average worker in these corridors, on average, may have difficulty in purchasing half of the region's housing,¹³⁸ and may be limited to purchasing housing farther from the urban core or smaller houses. To the extent that workers in higher wage clusters and workers who earn above their cluster's average wage differ from the average, they may be more able to purchase housing at or above the region's median price.

However, all corridors' supportable monthly rental payment is above the median rental price in the region of \$1,249, which puts a broad range of rental housing in the region within reach of the average cluster worker in all automotive corridors.

Table P.18

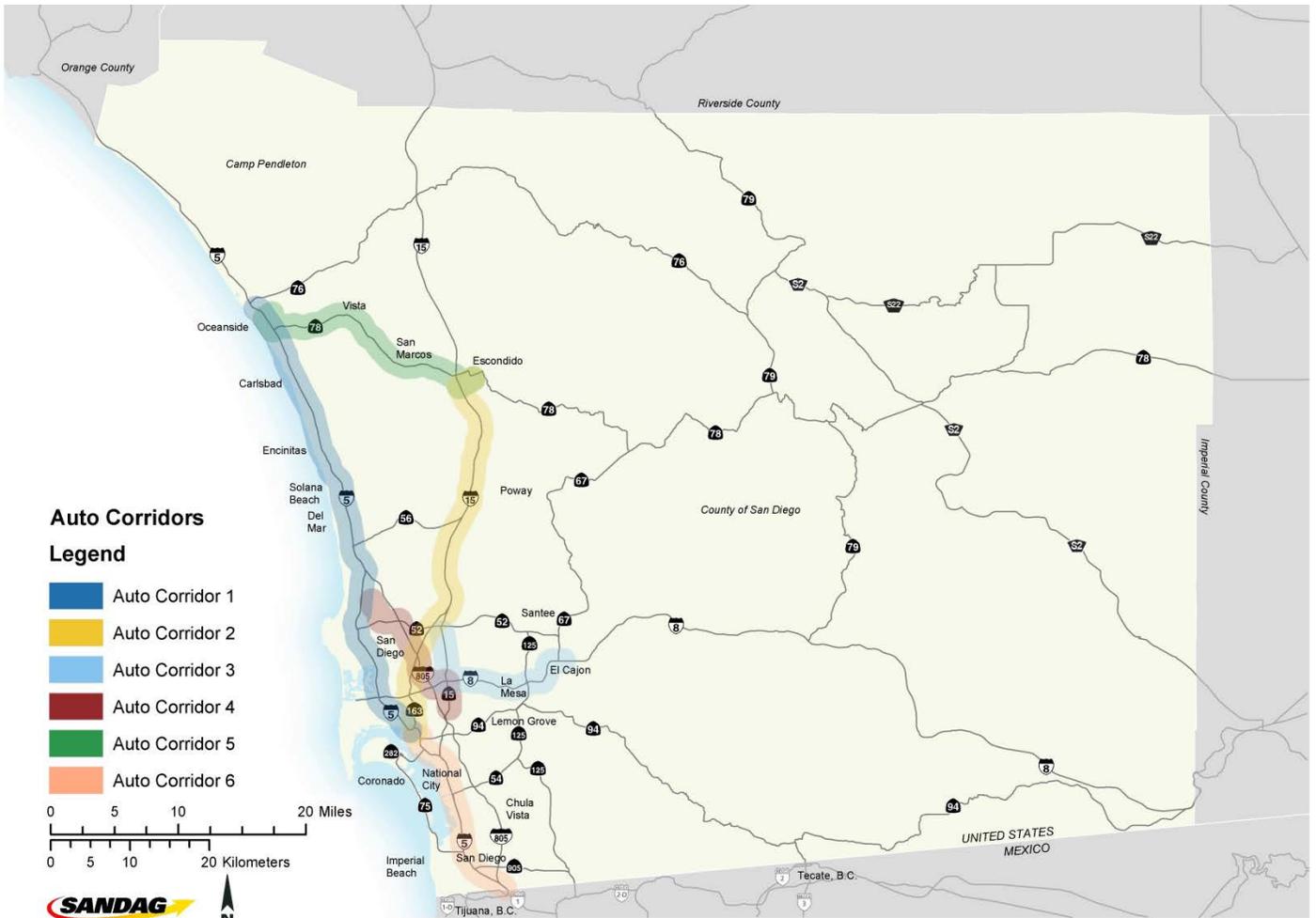
Average Affordable Housing Price and Share of Industry Cluster Employment by Automotive Corridor

Traded Industry Cluster	Share of Total Cluster Employment						Regional Total Cluster Employment
	1	2	3	4	5	6	
	Oceanside - Downtown San Diego	Escondido - Downtown San Diego	El Cajon - Kearny Mesa	Mid City - UTC	Oceanside - Escondido	San Ysidro - Downtown San Diego	
Action Sports	2%	0%	0%	0%	5%	0%	1%
Advanced Precision Mfg	0%	0%	2%	0%	2%	1%	1%
Apparel Mfg	0%	0%	1%	0%	3%	2%	1%
Biomed	4%	1%	1%	2%	8%	1%	3%
Biotech	11%	2%	1%	6%	7%	0%	7%
Cleantech	2%	4%	5%	5%	3%	1%	2%
Entertainment and Hospitality	52%	51%	48%	44%	43%	53%	46%
Flight, Navigation, and Maritime	5%	10%	13%	11%	3%	33%	10%
Fruit and Vegetable	0%	0%	0%	0%	1%	0%	1%
Horticulture	1%	0%	0%	0%	5%	0%	2%
Information and Communications Tech.	20%	24%	23%	27%	15%	5%	21%
Publishing and Marketing	3%	7%	5%	6%	4%	2%	4%
Specialty Food and Microbrew	0%	0%	1%	0%	1%	0%	0%
<i>Average Corridor Wage</i>	<i>\$54,824</i>	<i>\$52,264</i>	<i>\$53,646</i>	<i>\$59,065</i>	<i>\$53,919</i>	<i>\$48,001</i>	<i>\$56,000</i>
<i>Average Supportable Home Price (household)*</i>	<i>\$365,588</i>	<i>\$348,516</i>	<i>\$357,728</i>	<i>\$393,865</i>	<i>\$359,549</i>	<i>\$320,084</i>	<i>\$360,115</i>
<i>Average Supportable Rental Payment (household)</i>	<i>\$1,963</i>	<i>\$1,871</i>	<i>\$1,920</i>	<i>\$2,114</i>	<i>\$1,930</i>	<i>\$1,718</i>	<i>\$1,933</i>

Sources: Traded Industry Clusters in the San Diego Region-SANDAG; SANDAG Employment Inventory (2010); ESRI; AECOM November 2014.

* assumes a 30-year loan at 5% interest, \$0 HOA; does not include associated costs such as utilities, taxes or insurance.

Figure P.25
Key Automotive Corridors



Sources: SANDAG; ESRI; AECOM November 2014.

Transit Corridor Findings

Transit corridors exhibit a wider range of wages, supportable housing purchase prices, and supportable monthly rental payments than the ranges seen in automotive corridors. See Table P.19 for the distribution of industry cluster employment within each transit corridor as well as the average wage and supportable home purchase price and monthly rental payments associated with each corridor. Note that supportable housing prices at the corridor level are the result of examining the income of workers in the targeted industry clusters that can be allotted for housing based on the 30 percent standard of affordability,¹³⁹ not the market rate price of housing within the corridors.

See Figure P.26: Key Transit Corridors for a map of the transit corridors. As discussed in the methodology section, the extent of a transit corridor is one half-mile from a transit stop. This means that although any transit rider in the region may use a stop, or travel in a corridor, the analysis only considers the cluster employment in the area within one-half mile of a transit stop. This is an important consideration since some corridors may capture a larger share of retail locations, such as those located near transit stops, compared to the overall area, which may be dominated by outlying office locations that transit-adjacent retail is positioned to serve.

Transit Corridor 2: Escondido to Downtown San Diego exhibits the lowest average annual wage of about \$37,000, and can support an average home price of about \$249,000 and a monthly rental payment of just over \$1,300. In contrast, Transit Corridor 4: Mid City to UTC has the highest average annual wage of nearly \$76,000, can support a monthly rental payment over \$2,700 based on wages, and has an average supportable home price of approximately \$505,000. This supportable home price is over twice as high as the average supportable home price in Transit Corridor 2: Escondido – Downtown San Diego, which is dominated by employment in the Entertainment and Hospitality Cluster. Transit Corridor 4: Mid City – UTC also exhibits variation from other corridors in employment shares as it has the lowest share of Entertainment and Hospitality employment at 21 percent.

As discussed previously, the Entertainment and Hospitality cluster is likely to include firms and workers that do not meet the strict requirement for export orientation as compared other clusters. However, these businesses and workers are difficult to separate, though the inclusion of these businesses likely overstates the size of this cluster. This likely overstatement results in lower supportable housing price and rental payment estimates than would result with a decreased presence of the cluster in these corridors.

In addition, some workers in the Entertainment and Hospitality cluster are employed part-time.¹⁴⁰ The part-time status of these workers means that they may be working in more than one business and/or in more than one cluster, which may result in lower average wages estimates in the cluster since it is difficult to identify the same cluster worker in several different jobs and assign multiple sources of income to that worker, as well as to assign income to part-time cluster workers that may be from other sources.

Despite this effect, two transit corridors, Transit Corridor 3: El Cajon to Kearny Mesa, and Transit Corridor 4: Mid City to UTC, have a supportable housing price based on average cluster wages that is higher than the region's median housing price of \$407,000. This indicates that the average worker in the these two transit corridors are likely to have a wide range of housing for purchase available to them given their income, while those in other corridors may be limited in their access to housing for purchase that is affordable given their income. These workers may be limited to smaller or older units, and those located in areas away from the urban core or other amenities. In addition, the supportable monthly rental payment for all corridors is above the median rental price in the region of \$1,249, which puts rental housing in the region within reach of cluster households in transit corridors.

Table P.19

Average Affordable Housing Price and Share of Total Traded Industry Cluster Employment by Transit Corridor

Traded Industry Cluster	Share of Total Cluster Employment						Regional Total Cluster Employment
	1	2	3	4	5	6	
	Oceanside - Downtown San Diego	Escondido - Downtown San Diego	El Cajon - Kearny Mesa	Mid City - UTC	Oceanside - Escondido	San Ysidro - Downtown San Diego	
Action Sports	1%	0%	0%	0%	2%	0%	1%
Advanced Precision Mfg	0%	0%	5%	0%	1%	1%	1%
Apparel Mfg	0%	0%	2%	0%	2%	1%	1%
Biomed	3%	0%	1%	4%	6%	1%	3%
Biotech	7%	1%	1%	9%	4%	0%	7%
Cleantech	2%	2%	6%	7%	1%	1%	2%
Entertainment and Hospitality	56%	74%	23%	21%	56%	57%	46%
Flight, Navigation, and Maritime	5%	5%	22%	18%	5%	30%	10%
Fruit and Vegetable	0%	1%	0%	0%	2%	0%	1%
Horticulture	0%	0%	0%	0%	6%	0%	2%
Information and Communications Tech.	20%	11%	32%	38%	11%	6%	21%
Publising and Marketing	4%	5%	5%	3%	4%	2%	4%
Specilty Food and Microbrew	0%	0%	1%	0%	1%	0%	0%
<i>Average Corridor Wage</i>	\$51,573	\$37,335	\$67,673	\$75,793	\$44,722	\$46,138	\$56,000
<i>Average Supportable Home Price* (household)</i>	\$343,903	\$248,964	\$451,267	\$505,415	\$298,224	\$307,662	\$360,115
<i>Average Supportable Rental Payment (household)</i>	\$1,846	\$1,336	\$2,422	\$2,713	\$1,601	\$1,652	\$1,933

Sources: Traded Industry Clusters in the San Diego Region-SANDAG; SANDAG Employment Inventory (2010); ESRI; AECOM November 2014.

* assumes a 30-year loan at 5% interest, \$0 HOA, does not include associated costs such as utilities, taxes or insurance.

Automotive and Transit Corridor Comparison

Table P.20: Average Wage, Affordable Housing Payment, and Supportable Housing Price by Corridor table summarizes the average supportable home prices and monthly rental payments by corridor for the San Diego region by automotive and transit corridor. There is wide variation within automotive and transit corridors as well as variation between corridor types. In general, home purchase prices in automotive corridors in the range of \$300,000 to \$400,000 were supportable based on the region's cluster wages in 2010, while supportable housing purchase prices in transit corridors range from as low as \$249,000 to as high as \$505,000. This higher variation is a partial result of the smaller areas captured in transit corridors, as well as the fact that housing prices in these smaller areas are also likely to include the price impacts of increased access to transportation and smaller unit sizes in high-density areas. Supportable rental prices were also more varied than those in automotive corridors, but similar to supportable rental payments in automotive corridors, all were above the region's median rental payment of \$1,249.

For a visual representation of these data by automotive and transit corridor, see Figure P.27 and Figure P.28.

Table P.20
Average Wage, Affordable Housing Payment, and Supportable Housing Price by Corridor

		All Clusters	Household	
			Supportable Housing Price	Supportable Rental Payment
	2010 Average Annual Wage	\$56,000	\$373,427	\$2,005
Automotive	1 Oceanside - Downtown San Diego	\$54,824	\$365,588	\$1,963
	2 Escondido - Downtown San Diego	\$52,264	\$348,516	\$1,871
	3 El Cajon - Kearny Mesa	\$53,646	\$357,728	\$1,920
	4 Mid City - UTC	\$59,065	\$393,865	\$2,114
	5 Oceanside - Escondido	\$53,919	\$359,549	\$1,930
	6 San Ysidro - Downtown San Diego	\$48,001	\$320,084	\$1,718
Transit	1 Oceanside - Downtown San Diego	\$51,573	\$343,903	\$1,846
	2 Escondido - Downtown San Diego	\$37,335	\$248,964	\$1,336
	3 El Cajon - Kearny Mesa	\$67,673	\$451,267	\$2,422
	4 Mid City - UTC	\$75,793	\$505,415	\$2,713
	5 Oceanside - Escondido	\$44,722	\$298,224	\$1,601
	6 San Ysidro - Downtown San Diego	\$46,138	\$307,662	\$1,652

Sources: Traded Industry Clusters in the San Diego Region-SANDAG; U.S. Department of Housing and Urban Development; ESRI; AECOM December 2014.

* assumes a 30-year loan at 5% interest, \$0 HOA, does not include associated costs such as utilities, taxes or insurance.

Figure P.27

Supportable Home Price Based on Industry Cluster Wages by Automotive Corridor



Sources: SANDAG, Traded Industry Clusters in the San Diego Region; ESRI; AECOM November 2014.

III.3.3.2 Housing Unit Growth Capacity Analysis

In a region that is projected to grow by approximately 1 million people by 2050 to a population of about 4.4 million, additional homes are needed within corridors to connect employees to their destinations and supply key industry clusters with workers.¹⁴¹ Most corridors have enough capacity for the additional housing units needed to accommodate the SANDAG forecast number of households in 2050, but two transportation corridors may have difficulties in accommodating the forecast number of households. A potential shortage of capacity along key transportation corridors would mean that access to transportation improvements along these corridors may not benefit as many of the region's residents and workers as it could. Increases in supply will help relieve costs, while shortages in supply will tend to increase costs.

See Table P.23: Household Change and Capacity for Additional Housing Units by Corridor for information on households and housing unit capacity for each automotive and transit corridor.

Automotive Corridors

Among automotive corridors, Automotive Corridor 2: Escondido to Downtown San Diego is projected to experience the largest increase in housing units from 2012 to 2050 of about 53,000. This corridor also has the largest capacity as of 2012 to accommodate nearly 63,000 additional units. Automotive Corridor 4: Mid City to UTC is projected to have the smallest increase in housing units of about 23,000 under current forecasts. However, this corridor is projected to have sufficient capacity for forecasted growth and households in this corridor are well-positioned to benefit from travel time improvements along it, including access to cluster employment along the corridor. See Table P.21: Average Travel Time and Time Savings from 2012 to 2050 on Key Automotive Corridors for travel time savings forecast on key automotive corridors.

Automotive Corridor 5: Oceanside to Escondido has the smallest housing unit capacity in 2012 at 15,000 units. Due to its current low capacity, this corridor may lack 9,000 housing units in 2050 to accommodate the forecast increase in the number of households, potentially increasing home and rental prices. Automotive Corridor 6: San Ysidro to Downtown San Diego is also forecasted to have a shortage of about 7,000 housing units, signifying that the corridor may not be positioned to accommodate the forecasted household growth by 2050 under current plans. In addition, the benefits of reduced travel time on the corridor (see Table P.21: Average Travel Time and Time Savings from 2012 to 2050 on Key Automotive Corridors) expected under the revenue constrained scenario will be accessible by fewer households. These households are expected to have better access to cluster employers under the revenue constrained scenario than under the no-build scenario.

The corridor forecast to have the highest capacity for additional housing unit growth is the Automotive Corridor 3: El Cajon - Kearny Mesa with nearly 13,000 more housing units forecasted than are predicted to be needed in 2050. Travel time improvements on this corridor are forecasted to be approximately 1.4 percent lower in 2050 than current travel times, so these households will have good access to cluster employers located along this corridor.

Table P.21

Average Travel Time and Time Savings from 2012 to 2050 on Key Automotive Corridors

Corridor	Average Travel Time (min.)			Travel Time Change (min.)			
	2012	2050 NB Scenario	2050 RC Scenario	2012 - 2050 NB Scenario	% Change	2012 - 2050 RC Scenario	% Change
1 Oceanside - Downtown San Diego	64.7	73.1	62.5	8.4	13.0%	-2.2	-3.4%
2 Escondido - Downtown San Diego	55.6	61.9	59.2	6.4	11.5%	3.6	6.5%
3 El Cajon - Kearny Mesa	30.3	36.6	29.9	6.3	20.9%	-0.4	-1.2%
4 Mid-City - UTC	29.9	37.5	29.8	7.6	25.3%	-0.1	-0.5%
5 Oceanside - Escondido	35.8	38.3	34.5	2.5	7.0%	-1.4	-3.9%
6 San Ysidro - Downtown San Diego	25.8	30.7	24.4	4.9	18.8%	-1.4	-5.3%
Average	40.4	46.4	40.0	6.0	16.1%	-0.3	-1.3%

1/ Transit Times are measured from stop to stop and do not include initial wait time or access to boarding/alighting stops.

Source: San Diego Forward: the Regional Plan Average travel time (peak periods) by mode for selected corridors (in minutes door to door for auto, stop to stop for transit) (Draft table).

Transit Corridors

Despite the relatively small capture area within transit corridors, the scale of household growth is close to the scale of automotive corridor growth. All transit corridors exhibit capacity in excess of household growth, though one corridor provides only slightly more than would be required. Households in these corridors are generally expected to experience travel time improvements on the transit corridors where they are located, and be able to access cluster employer locations along these corridors. See Table P.22: Average Travel Time and Time Savings from 2012 to 2050 on Key Transit Corridors for travel time changes forecast by corridor.

SANDAG forecasts that Transit Corridors 2, 5, and 6 may nearly double in the number of households between 2012 and 2050. Despite this growth, these transit corridors are expected to be able to accommodate this increase in households as well as provide additional capacity of several thousand housing units after 2050. Transit Corridor 6: San Ysidro to Downtown San Diego is projected to experience the largest increase in households from 2012 to 2050 of about 22,000. This corridor also has the largest capacity as of 2012 of nearly 30,000 additional units.

Transit Corridor 3: El Cajon to Kearny Mesa is projected to have the smallest increase in households of about 5,000 by 2050, but has enough capacity for the level of household growth forecast by 2050. Growth in Transit Corridor 3 is just less than that forecast in Transit Corridor 4: Mid City to UTC, where an increase of approximately 6,400 households is expected to take place. Transit Corridor 4: Mid City to UTC has the lowest excess capacity in 2050 for additional housing units at just over 300 units. Due to a slim margin by which the corridor's housing unit capacity exceeds forecast household growth, this corridor may still have insufficient capacity to accommodate growth if household growth is slightly higher than forecast.

Table P.22

Average Travel Time and Time Savings from 2012 to 2050 on Key Transit Corridors

Corridor	Average Travel Time (min.)			Travel Time Change (min.)			
	2012	2050 NB Scenario	2050 RC Scenario	2012 - 2050 NB		2012 - 2050 RC	
				Scenario	% Change	Scenario	% Change
1 Oceanside - Downtown San Diego	95.3	95.2	91.2	-0.1	-0.1%	-4.1	-4.3%
2 Escondido - Downtown San Diego	76.1	69.1	62.1	-7.0	-9.2%	-14.0	-18.4%
3 El Cajon - Kearny Mesa	74.4	80.9	36.7	6.5	8.8%	-37.8	-50.7%
4 Mid-City - UTC	77.1	71.1	31.4	-6.0	-7.8%	-45.7	-59.3%
5 Oceanside - Escondido	72.0	71.9	45.4	-0.2	-0.3%	-26.6	-37.0%
6 San Ysidro - Downtown San Diego	33.8	33.8	20.8	0.0	0.0%	-13.0	-38.6%
Average	71.5	70.3	47.9	-1.1	-1.4%	-23.5	-34.7%

1/ Transit Times are from stop to stop and do not include initial wait time or access to boarding/alighting stops.

Source: San Diego Forward: the Regional Plan Average travel time (peak periods) by mode for selected corridors (in minutes door to door for auto, stop to stop for transit) (Draft table).

III.3.3.3 Housing Capacity and Supportable Price Points by Corridor

Finally, Table P.24: Housing Unit Capacity and Supportable Price Points by Key Transportation Corridor provides information on housing unit capacity by corridor, and the supportable housing price for households working in these corridors’ clusters. Although supportable housing prices are likely to be different in the future when additional housing units are added, these figures are presented side by side to provide some insight into current demand that may be translated into future construction.

Table P.23

Household Change and Capacity for Additional Housing Units by Corridor

		Households			Capacity (housing units)		
		2012	2050	Change	2012	2050	
		Auto-motive	1	Oceanside - Downtown San Diego	130,600	166,292	35,692
	2	Escondido - Downtown San Diego	119,245	172,701	53,457	62,663	9,206
	3	El Cajon - Kearny Mesa	69,982	95,402	25,420	38,029	12,608
	4	Mid City - UTC	81,414	104,551	23,136	28,080	4,944
	5	Oceanside - Escondido	72,414	97,030	24,616	15,376	-9,240
	6	San Ysidro - Downtown San Diego	75,391	110,498	35,107	28,135	-6,973
Transit	1	Oceanside - Downtown San Diego	26,285	41,024	14,738	18,606	3,868
	2	Escondido - Downtown San Diego	18,032	34,511	16,479	21,227	4,748
	3	El Cajon - Kearny Mesa	10,083	15,329	5,246	11,013	5,767
	4	Mid City - UTC	19,157	25,552	6,394	6,721	327
	5	Oceanside - Escondido	14,752	27,615	12,863	15,376	2,513
	6	San Ysidro - Downtown San Diego	24,895	47,747	22,852	29,999	7,147

Sources: Sources: SANDAG SR13 Forecast, ESRI, AECOM November 2014.

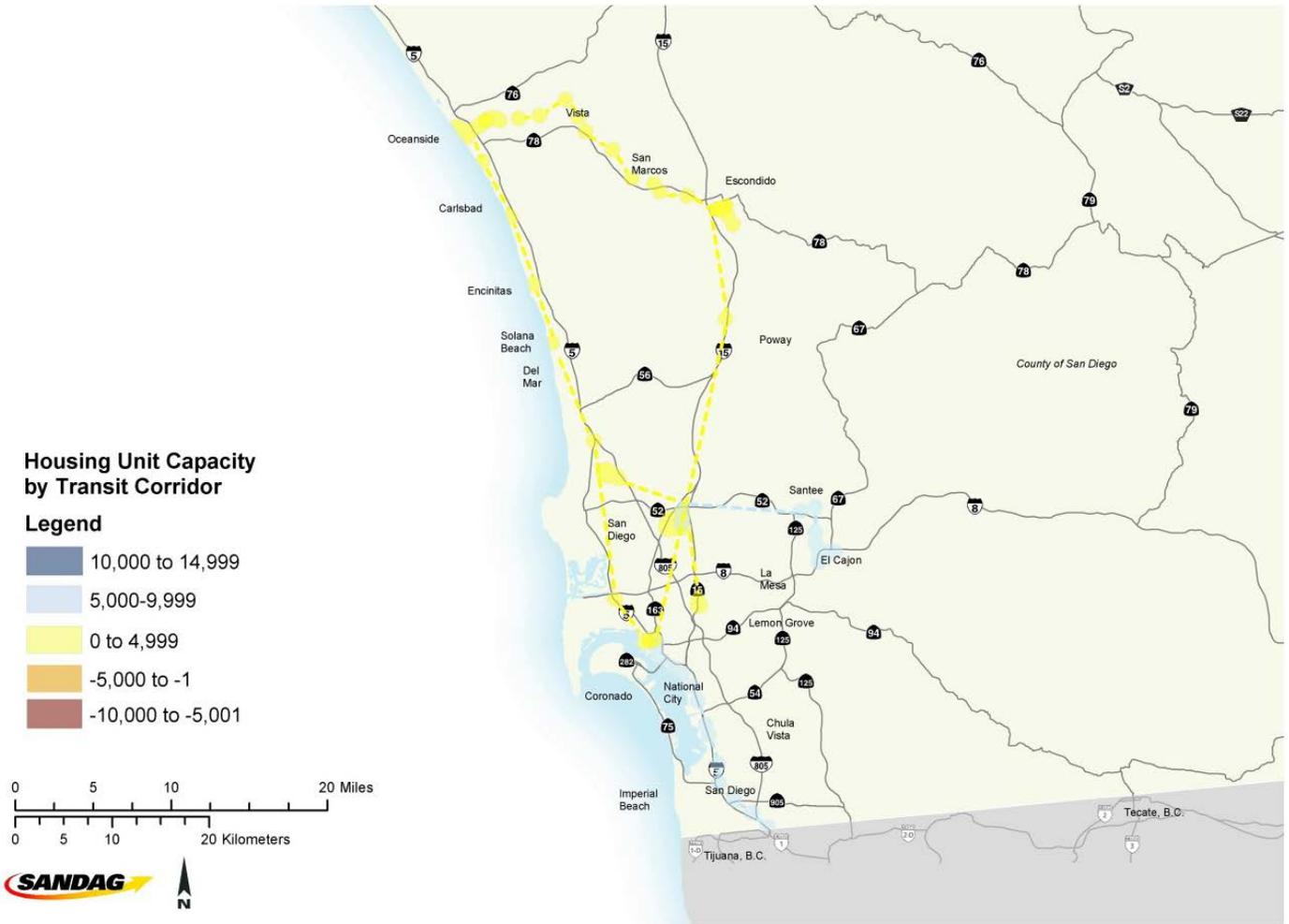
Table P.24

Housing Unit Capacity and Supportable Price Points by Key Transportation Corridor

		Capacity (housing units)	Supportable Housing Price (household)	
		2050	2010	
Automotive	1	Oceanside - Downtown San Diego	11,888	\$365,588
	2	Escondido - Downtown San Diego	9,206	\$348,516
	3	El Cajon - Kearny Mesa	12,608	\$357,728
	4	Mid City - UTC	4,944	\$393,865
	5	Oceanside - Escondido	-9,240	\$359,549
	6	San Ysidro - Downtown San Diego	-6,973	\$320,084
Average		3,739	\$357,555	
Transit	1	Oceanside - Downtown San Diego	3,868	\$343,903
	2	Escondido - Downtown San Diego	4,748	\$248,964
	3	El Cajon - Kearny Mesa	5,767	\$451,267
	4	Mid City - UTC	327	\$505,415
	5	Oceanside - Escondido	2,513	\$298,224
	6	San Ysidro - Downtown San Diego	7,147	\$307,662
Average		4,062	\$359,239	

Sources :SANDAG SR 13 Forecast, ESRI, U.S. Census Bureau, AECOM November 2014.

Figure P.30
2050 Capacities for Housing Units in Transit Corridors



Sources: SANDAG SR13 forecast; ESRI; AECOM November 2014.

III.4 Interviews with Stakeholders and Industry Representatives

As part of the Economic Competitiveness Analysis for San Diego Forward: The Regional Plan, SANDAG and AECOM conducted a series of focus group interviews with stakeholders, representing non-profit organizations, local governments, business and trade associations, economic development organizations, public agencies, utilities, educational institutions, and private sector employers.

Groups engaged were:

- SANDAG Military Working Group
- Hospital Association of San Diego and Imperial Counties
- San Diego BID Council
- Sempra
- Biocom
- San Diego Housing Federation
- San Diego Tourism Authority
- Port Tenants Association
- San Diego Workforce Partnership
- San Diego Chamber of Commerce
- Community Based Organizations
- City Economic Development Group
- EDC Group
- SANDAG Border Group
- Research and Non-Governmental Organizations
- University and Higher Education Organizations

The purpose of the sessions was to gather targeted, specific feedback on transportation needs and priorities among key regional stakeholders and build an understanding of diverse agency, employer, and community perspectives on the relationship between transportation investments, urban form, and economic competitiveness.

Comments generally reflected an understanding that improved transit system connectivity and higher density in the form of Transit Oriented Development (TOD) will play an important role in accommodating the region's growth and maintaining its future economic competitiveness. The purpose of this summary is to provide an overview of the main themes that emerged from these discussions.

Transportation improvements and related changes in urban form produce economic benefits for employers, workers, and the region overall.

Several stakeholders recognized that improved transit connectivity and TOD could generate tangible economic benefits for individual households, as well as the region. More affordable and convenient transportation and housing options increase disposable income, which can then circulate through the broader economy. The compact land use patterns associated with TOD also enable the more efficient use of existing infrastructure. Large employers (specifically

the hospitals and the Port) acknowledged parking and traffic congestion-related constraints on current business activity and future growth.

- Housing near transit enables more disposable income
- The connection between housing and the economy need to be clarified: less money spent on housing means more spent elsewhere in the economy
- Density means better utilization of infrastructure
- Accessibility is a key to success
- Parking and transportation are a current and future constraint on growth
- Parking in particular is a big issue at all hospitals

Denser development and active city and town centers are a positive.

Multiple stakeholders cited the value of walkable neighborhoods and active streets. They viewed an accessible and connected urban form as a draw for tourists and local businesses, as well as a lifestyle amenity to attract and retain talent, particularly among younger workers, who prefer vibrant urban settings.

- Density downtown is a plus for the tourism industry and a plus to attract talent
- The street is an asset
- Residential growth and creative uses of streetscapes (e.g., town center/promenade) are helpful to local businesses
- There is a desperate need for investment in street infrastructure
- Making streets attractive is business booster
- Younger employees want more city life
- The beach is not enough (for college students)
- Job mobility and sector agglomeration is critical for those seeking advancement in the tech sector. Employees in the tech sector want live close to downtown.

Connecting affordable housing, jobs, and transit is important to employers and residents.

Job access remains a challenge for many employees, especially low- to moderate-income workers traveling to jobs north of I-8. Feedback reflected the importance of having affordable, convenient transportation choices available to the region's workforce. Stakeholders also saw increased mobility options as a way to improve economic opportunity for residents living in city neighborhoods that lack strong connections to jobs and education.

- Want options across incomes and options for families; support housing near transit
- In long-term, housing will affect our competitiveness
- Reasonable rents in areas with easy transit options is important
- Affordability is a big concern, as is access to high frequency transit
- Affordable housing is a huge issue for employers
- For San Diego to compete, housing costs need to be addressed

- Emergency needs are addressed, but long-term, housing affordability will affect our competitiveness
- Service industry workers in some communities currently face long travel times to jobs
- Transit and transportation affordability is important for economic recovery for low-income people, have few resources, need to get to work
- Must bring transit to current job centers, while developing downtown employment as well

Transit investments are a positive but the current transit system is not yet a viable alternative to automobile use outside of a few areas.

Stakeholders generally recognized the importance of future transit investments but also noted that the system's current transit options are not convenient enough to entice people away from their automobiles.

- Transit system is not robust enough to forgo cars/parking, even downtown
- MTS service not good enough to draw people out of cars
- In other places in country, employers see lesser need for cars, translating into lower wages
- In other places, people often get vouchers for transit; incentives are needed

Improving connectivity across the U.S./Mexican border is an economic and transportation priority.

Multiple stakeholders emphasized the economic benefit of improved transportation links and the efficient movement of people and goods between California and Baja California. The economy of Tijuana and the greater Baja California region have benefited from employment opportunities across the border in the San Diego region, and our region has benefited from employment opportunities in Baja California. Mexico has taken several steps to bolster economic development along its northern border, such as the creation of the maquiladora program (or in-bond industry). The maquiladora industry is a big source of employment opportunities in Baja California and in the San Diego region; you only have to look at the large number of transnational corporations with sister facilities north of the border. Employment in the maquiladora industry in Baja California doubled between 1991 and 2004. In Tijuana, employment in the sector reached its peak in 2008 with more than 200,000 people employed. Since then, employment growth has decreased slightly, and there are now about 150,000 people employed by 560 maquiladora companies in Tijuana. That number represents 11 percent of Mexico's total number of manufacturing plants.

- Want to expand manufacturing partnerships with Tijuana
- Have cross-border value chains
- Envision another tolled border crossing
- The border itself is, and can be, a huge economic engine
- Planning must be cross-border
- Cross-border tourism opportunities are not well integrated
- Connecting coaster to border is great opportunity. Transit connections to South County can help downtown seem more like the center.
- Long wait times at border

There is strong interest in developing mobility hubs.

Several stakeholders specifically embraced the concept of mobility hubs and saw potential for implementation in San Diego. Comments identified regional airports as anchors for multiple modes (Lindbergh, Gillespie, Tijuana, Brown, Palomar), along with urban neighborhoods/corridors.

- Support public-private mobility hubs including rideshare
- Universal transportation account would be a way to pay for last mile services
- The Tijuana airport and Brown Field need transit connections
- Also important to connect to airport with better service than current shuttle
- Mobility hubs could be a big positive

There is support for increased rail and freight capacity, including a rail line east.

Stakeholders cited the potential economic contribution of increased infrastructure to support goods movement.

- Would like to see additional freight traffic through San Diego, which means more truck trips
- Need flyover to get cargo off the waterfront. Previous flyover failed due to funding.
- Need more rail: I-15 rail corridor to Barstow, double-tracking
- Need larger truck infrastructure/facilities (e.g., tunnels)
- Need warehouses close to shipyards to reduce truck travel
- Want to separate freight and people movement, grade separation
- Lack of an active east-west rail line is a critical weakness
- Rail improvements are critical
- Rail needs to be expanded north and connected east
- South County needs to improve goods movement and truck capacity; streets in Otay Mesa and San Ysidro are insufficient

Active transportation can play an important role in expanding access and enhancing quality of life in communities.

Stakeholders, particularly community-based and university groups expressed strong support for more active transportation investment as part of the broader transportation network. Feedback specifically cited areas with deficient active transportation infrastructure and noted interest among residents in using safe walking and biking options.

- In Logan Heights, there is a lack of active transportation investment, as well as connections to other neighborhoods
- Communities are eager to use active transportation options
- Lack of active transportation facilities, both in San Ysidro and in Tijuana, is a hindrance
- UC San Diego area is not pedestrian friendly

The clustering of industries affects transportation access and opportunities for connectivity.

The health care and biotech sectors emphasized the importance of locating facilities in proximity to capitalize on interdependencies and pooled resources. However, such clustering can pose congestion challenges. Stakeholders noted that these industry clusters are unlikely to relocate so transportation strategies must consider how to improve the connectivity of existing or new job centers.

- Physical clustering of hospitals is important, despite competition for patients. Access difficult at Sharp Memorial, Sharp Mary Birch, Rady Children’s and University, especially in morning.
- Companies want to locate close to one another, to UCSD, and on Sorrento Mesa/golden triangle. Clustering of Biocom businesses is critical, even to the point of synced schedules.
- The locations of the industry clusters will NOT move. The link between urban form and economic prosperity needs to be fully articulated; job centers need to be built/re-built to be transit-friendly/transit-ready.

III.5 Case Studies for Analysis of the Economic Competitiveness Effects of Transportation Investments

This literature review presents three case studies of transportation investments in the United States that have facilitated significant economic development. These case studies were selected to examine the economic impacts and associated changes in competitiveness resulting from a variety of transportation infrastructure improvements that may be considered and/or implemented by SANDAG through the agency’s Regional Plan to 2050. Each case study provides information on the transportation investment in the context of the metropolitan area, the cost, financing strategy, extent and timing of the transportation infrastructure developed, and information on the economic impacts attributed to the operation of the transportation infrastructure examined. The following list summarizes the three case studies selected for discussion, highlighting different types of transportation investments in various market and land use contexts.

Denver Southeast Corridor

This light rail line connects downtown Denver with the Southeast Business District, one of the region’s most significant and fastest growing suburban employment centers. Since the line opened in 2006, the corridor has attracted rapid job growth in knowledge-based industries such as information, finance, insurance, real estate, and professional and scientific services.¹⁴² The light rail line has also made the surrounding areas (which have historically been predominantly commercial) more attractive for residential development, in part by expanding access to downtown Denver’s cultural and entertainment resources to the southeast suburbs.¹⁴³

Bellevue Transit Center Expansion and Downtown Access Improvements

This project, completed in 2002, doubled the number of bus bays at the Bellevue Transit Center, provided a new HOV/bus interchange with direct access to the transit center from I-405, and improved two additional interchanges from I-405 to downtown Bellevue. These investments helped to support significant job and population growth in the downtown, and helped the City of Bellevue realize the goals of its downtown plan.¹⁴⁴ The project is part of a broader Master Plan to reduce congestion on I-405 through multimodal improvements, including capacity expansions and a new bus rapid transit line. Completion of the Master Plan is anticipated to produce travel time savings valued at \$569 million a year.¹⁴⁵

Portland Streetcar

Since the Portland Streetcar opened in 2001, the area within two blocks of the alignment has received more than \$3.5 billion in private investment, including 10,000 housing units and 5.4 million square feet of commercial space. The streetcar alignment has also experienced a significant increase in property values.¹⁴⁶ The Portland Streetcar case

study illustrates the role that transit investments, combined with other public sector interventions, can play in creating a more attractive environment for private investment in a former industrial/warehouse district.

III.5.1 Denver’s Southeast Corridor: The Transportation Expansion (T-REX) Project

Context

In the early 1990s, the Denver Regional Council of Governments (DRCOG), the Colorado Department of Transportation (CDOT), the Denver Regional Transportation District (RTD), the Federal Transit Administration (FTA), and the Federal Highway Administration (FHWA) began to study the worsening congestion along Interstates 25 and 225 in the Denver region, known as the southeast corridor.

I-25 and I-225 connect downtown Denver with the Denver Tech Center – a suburban-style office development to the south that is the region’s second largest employment center, after downtown – as well as some of the region’s most affluent and fastest growing suburbs. Early studies found that the southeast corridor had already exceeded its maximum traffic volume capacity of 180,000 vehicles per day, and traffic would continue to worsen as a projected 150,000 new jobs were added to downtown and the Tech Center over the next 20 years.¹⁴⁷

In order to address congestion and create the capacity to serve future growth, the agencies recommended a major multimodal project, including widening the freeways by several lanes and creating a 19-mile light rail line running adjacent to or in the median of I-25 and I-225.

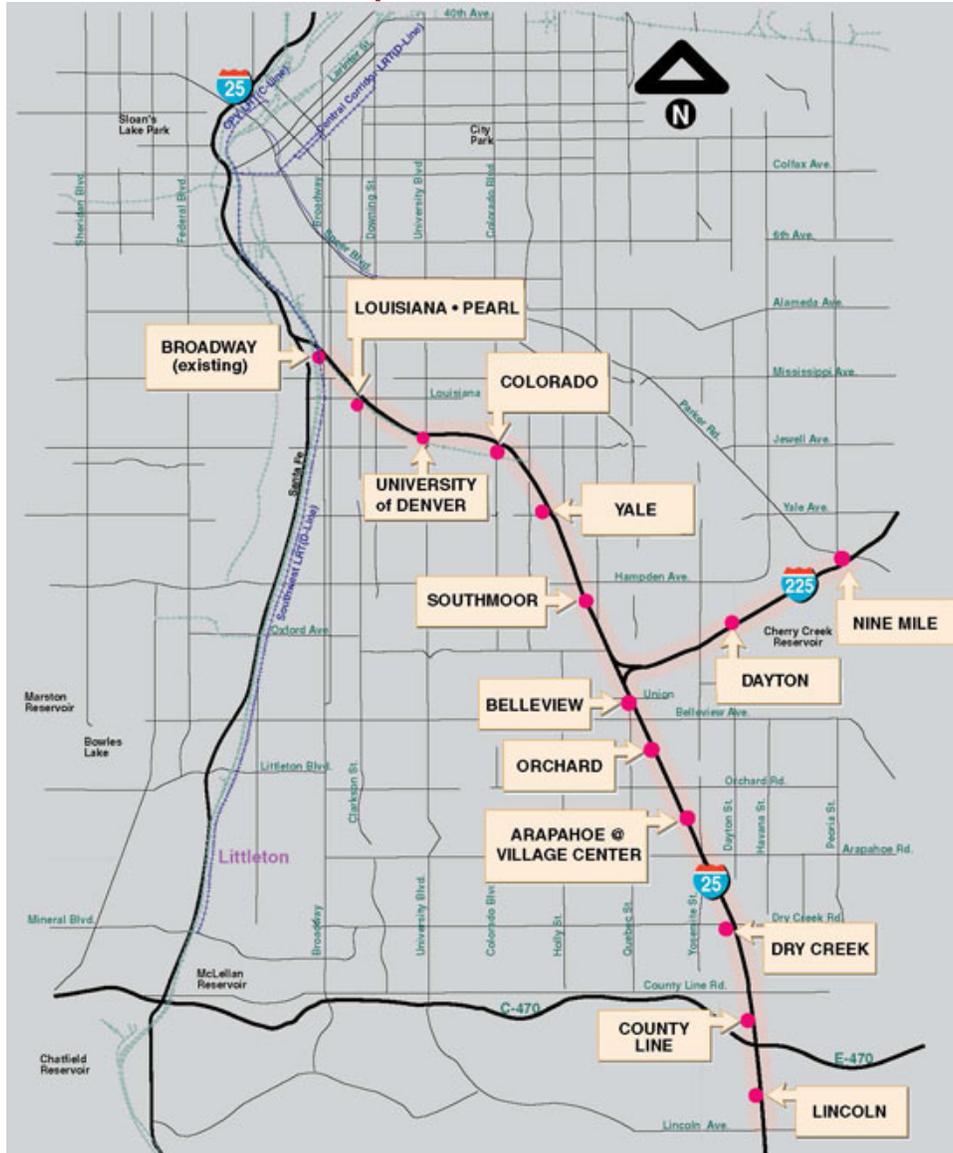
T-REX and the Southeast Light Rail Corridor

The \$1.67 billion highway improvement and light rail project was named the Transportation Expansion (T-REX) Project, and managed jointly by CDOT and RTD. The project was funded by two voter-approved bond issuances that – by providing upfront funding for the entire project – allowed T-REX to move forward with a comprehensive design-build contract for the completion of the project as a whole, rather than in segments.¹⁴⁸ Project goals included minimizing inconvenience to the public, staying within the \$1.67 billion budget for the entire program, and meeting or beating the operational deadline of June 2008.¹⁴⁹

Construction of T-REX was completed in 2006, ahead of schedule and within budget. The light rail line consists of 19 miles of light rail running within the median or adjacent to I-25 and I-225, with 13 light rail stations in Denver, Greenwood Village, Centennial, Arapahoe County, Lone Tree, and unincorporated Douglas County. Twelve of the 13 stations have park-and-ride lots.

Although the Southeast Light Rail Corridor does not extend to downtown Denver, riders can continue onto the Central Corridor, which provides service to the downtown, without transferring. Trains run every 10 minutes during peak commute hours, and every 15 minutes during off-peak hours and weekends. In addition to building the light rail line and widening I-25 and I-225, T-REX also included several new bridges and interchanges, improved drainage, enhanced bike and pedestrian access, and transportation management elements.¹⁵⁰

Figure P.31
Southeast Corridor Map



Source: RTD, January 2013, rtd-denver.com/FF-SoutheastCorridor.shtml.

Economic Impacts

Summary of Economic Impacts Findings

Economic impacts from T-REX occurred in three major categories: (1) employment, (2) development, and (3) support for transit. Employment effects focus on knowledge-based industries and employment attraction. Development effects include general development of commercial and hotel development, and residential development.

Economic Impacts Findings

Employment

Employment Growth + Knowledge-based Industries

Since the project was completed, the southeast corridor has attracted rapid job growth, particularly in knowledge-based industries such as information, finance, insurance, real estate, and professional and scientific services. Between 2002 and 2009, the Southeast Light Rail Corridor (defined as the area within a half-mile of the light rail stations) accounted for approximately two-thirds of all the new jobs created in the Denver region.

Job growth has been concentrated in the six stations that serve the Tech Center, and has occurred primarily in the information, finance and insurance, real estate, professional and scientific services, and management sectors.¹⁵¹

Employment Attraction

While the corridor would likely have attracted significant job growth and development in the absence of the light rail improvements, the light rail line has helped make the southeast corridor more attractive for employers. The market for new development in the corridor was already strong prior to the T-REX project, and the Denver Tech Center was projected to experience major employment growth.

However, employer surveys suggest that transit accessibility makes the area more attractive for employers. A 2012 survey of business owners along the Southeast Light Rail Line found that transit accessibility ranked third among the top factors that employers considered in selecting a location.¹⁵²

Development

New development

Between 2002 and 2010, over 6,000 new housing units, 2.5 million square feet of new commercial development, and 470 new hotel rooms were developed in the corridor.¹⁵³ Most of the new residential development has taken the form of higher-intensity multi-family projects.

Residential Development

The light rail line also made the surrounding areas more attractive for residential development, in part by expanding access to downtown Denver's cultural and entertainment resources to the southeast suburbs.¹⁵⁴ Several analyses of development patterns along the corridor have concluded that the introduction of light rail service helped change the perception of the light rail station areas from highway-oriented job centers, to places that could potentially attract residents as well.¹⁵⁵ An increase in population around station areas was also seen around stations along the nearby Southwest Corridor light rail corridor (see Figure P.32: Population Change in Station Areas along Southwestern Corridor), which was completed before the Southeast Corridor light rail line.

As a result of new residential development, the number of residents living in the six southern-most stations that serve the Tech Center (Bellevue, Orchard, Arapahoe at Village Center, Dry Creek, County Line, and Lincoln) increased from 2,300 in 2000, to 8,300 in 2010.¹⁵⁶

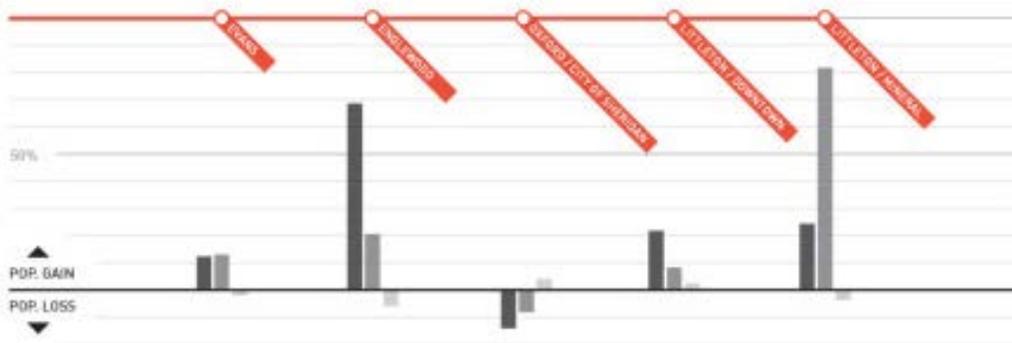
Figure P.32

Population Change in Station Areas along Southwestern Corridor

Population Change

STATION AREAS, 2000 - 2010

WITHIN 0.5 MILE OF STATION
BETWEEN 0.5 AND 1 MILE OF STATION
BETWEEN 1 AND 1.5 MILES OF STATION



Source: Transportation Research Board, Visualization Committee, 2012.

Support for Transit

The success of the project helped create political support for additional light rail expansions. The success of the Southeast Corridor Light Rail Line helped create momentum for RTD's FasTracks program, which voters approved in 2004. FasTracks is funded in part by a voter-approved regional sales tax measure, and will result in 122 miles of new commuter rail and light rail, and 18 miles of bus rapid transit. The FasTracks program includes a planned \$207 million, 2.3-mile extension of the Southeast Line south on I-25 that is expected to begin construction in 2016.

Impressed by the success of the original Southeast Line in supporting economic development, the City of Lone Tree, Douglas County, and Denver South Transportation have agreed to commit \$35 to \$40 million to the extension to close a funding gap.¹⁵⁷

Figure P.33

The Louisiana & Pearl Light Rail Station on Denver's Southeast Corridor



Source: Alison Nemirow, 2010.

Lessons Learned

Two major lessons can be drawn from the experience of light rail development in the Denver metropolitan area. By using transportation investments to concentrate key industries and ensuring that development locations are available, transportation investments can enable the development of economic clusters that benefit from proximity to one another while also providing access to work locations for residents.

- Under the right conditions, transportation investments can focus and grow development around key transportation access nodes, such as stations: that the Southeast Light Rail Line connects major existing employment centers in a strong market area has helped attract and concentrate new development in close proximity to transit.
- Transportation investments should be planned with attention to future development: The light rail corridor runs immediately adjacent and in the median of major freeways, which has limited development opportunities and created last mile connectivity challenges.

In the context of the SANDAG region, events in Denver resulting from light rail development can provide insight on how transportation investments can serve as economic drivers, and illustrate that transit planning should consider whether there is land available for uses that are likely to be supported by transit development, such as transportation connections to stations and commercial or higher-density residential development.

III.5.2 Eugene-Springfield, Oregon: Emerald Express (EmX) Bus Rapid Transit System

Context

In the mid-1990s, Lane Transit District (LTD) began evaluating ways to improve the region's transportation system to better meet the needs of the growing Eugene-Springfield metropolitan area. The agency examined several transportation alternatives and concluded that light rail was not a cost-effective alternative given the metropolitan area's low population density and relatively small population.¹⁵⁸

LTD instead focused its efforts on bus rapid transit (BRT) because it achieves many of the same benefits of light rail for a reduced cost, and can be phased-in based on funding availability and other factors. This decision resulted in Lane County's Regional Transportation Plan, which envisions the future build-out of a 60-mile BRT system.¹⁵⁹

Emerald Express BRT

The first phase of the Emerald Express (EmX) bus rapid transit line opened in January 2007, connecting the downtowns of Eugene and Springfield, along Franklin Boulevard. The route also serves the University of Oregon and Sacred Heart Medical Center.

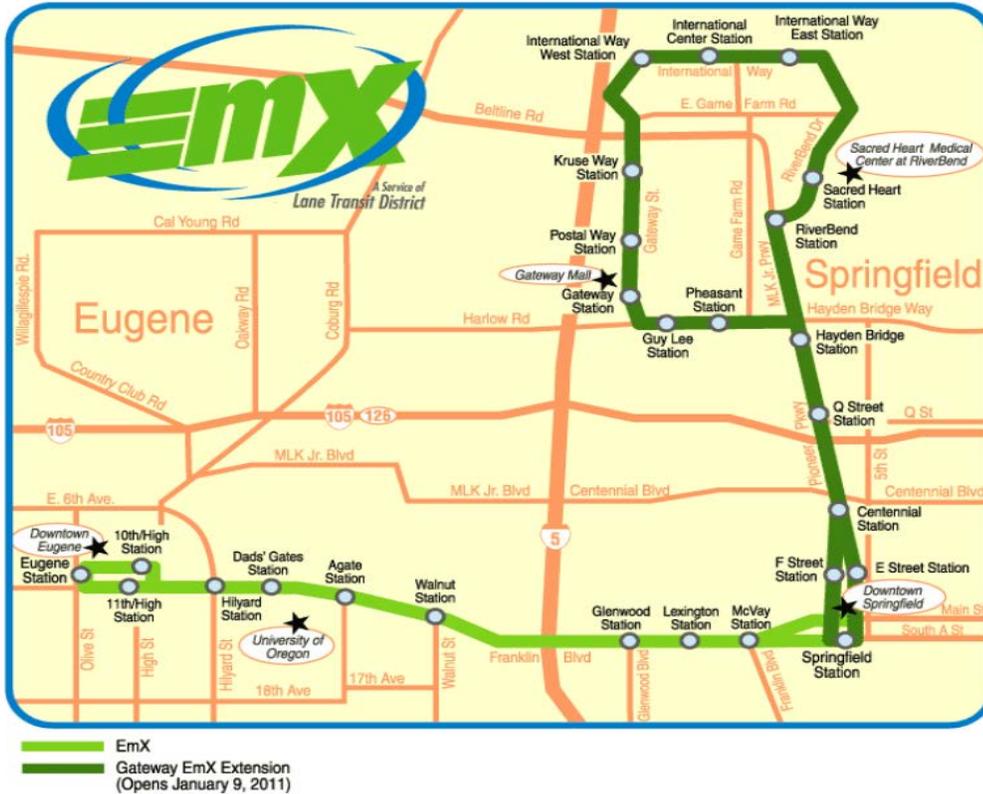
In January 2011, a 7.8-mile extension opened between Springfield Station and the Gateway area to the north. This extension provides connections to a regional employment center, a regional medical center, and a major shopping center. As of 2010, 30 percent of the region's employment was located within a half-mile radius of a BRT station.¹⁶⁰

EmX has 10 minute headways during the weekday and runs every 15 to 30 minutes at night and on the weekends. Buses operate on a mix of dedicated lanes in mixed traffic and separated running ways, and have priority at traffic signals.¹⁶¹

The first phase of EmX along Franklin Boulevard cost approximately \$25 million to build, with the federal government contributing 80 percent of capital costs.¹⁶² The second phase to the Gateway area cost approximately \$37 million, with the federal government again contributing 80 percent of the funds.¹⁶³

A third segment that would provide service to West Eugene has been stalled for several years due to community concerns about cost and neighborhood impacts, but is expected to start construction in 2015.¹⁶⁴ The third phase is expected to cost \$95.6 million and will be funded by \$75 million from the Federal Small Starts program and \$20.6 million from State of Oregon lottery funds.¹⁶⁵

Figure P.34
EmX System Map



Source: Institute for Sustainable Communities, 2012.

Economic Impacts

Summary of Economic Impacts Findings

Economic impacts are identified in the areas of employment and development. For employment, impacts are in the areas of job growth, and interactions with anchor institutions such as universities and hospitals. Impacts to development are new development, and the challenges to development.

Economic Impacts Findings

Employment

Job Growth

The system attracted significant job growth during the 2000s, even as the rest of the metropolitan region lost employment. *Nelson, et al.* compared employment change between 2004 and 2010 for areas within a quarter-mile of the EmX stations, between a quarter- and half-mile of the stations, and the remainder of the metropolitan region. Overall, the number of jobs in the metropolitan area outside of the BRT station areas fell by 5 percent during this time period.

In contrast, the number of jobs increased by about 10 percent within a quarter-mile of the stations, and remained stable within a quarter- to a half-mile of the stations. Within the quarter-mile station areas, the information, real

estate, management, administration, education, health care, lodging and food sectors all experienced employment growth of more than 10 percent.¹⁶⁶

Interaction with Anchor Institutions

Anchor institutions have catalyzed recent development along EmX, though the amount of development activity attributable to the BRT line is uncertain.

The University of Oregon provided land for the EmX running way, and has recently built significant student housing and a new arena along the corridor. EmX is heavily used by students whose tuition covers the cost of a bus pass and who use BRT to access retail, dining, and entertainment destinations in downtown Eugene.

Figure P.35
EmX Station, University of Oregon



Source: Flickr user Wolfram Burner, 2010.

In 2008, a new Sacred Heart Medical Center facility opened along the Gateway extension. The new facility has attracted medical clinics and office buildings. However, these buildings were not designed to leverage the potential created by EmX, consisting of 2 to 3 story heights and large surface parking lots.

Development

New Development

Early studies have found that the original (Franklin Boulevard) EmX line has attracted some new development. As of 2012, local officials estimated that construction projects worth a total of \$100 million were underway in downtown Eugene near the Franklin line, including a boutique hotel, office space renovations, and a community college expansion.¹⁶⁷

Development Challenges: Structural Barriers

Development is also constrained by small lot sizes, which require developers to negotiate with multiple property owners in order to assemble a parcel large enough for higher-density projects to be cost effective.

Development Challenges: Transit-Oriented Development

The potential for TOD has been constrained by low market values. Eugene-Springfield was hit hard by the recession and experienced very little new construction in the immediate years after EmX began operations. While there has been improvement in the local economy, lease rates remain low relative to construction costs.

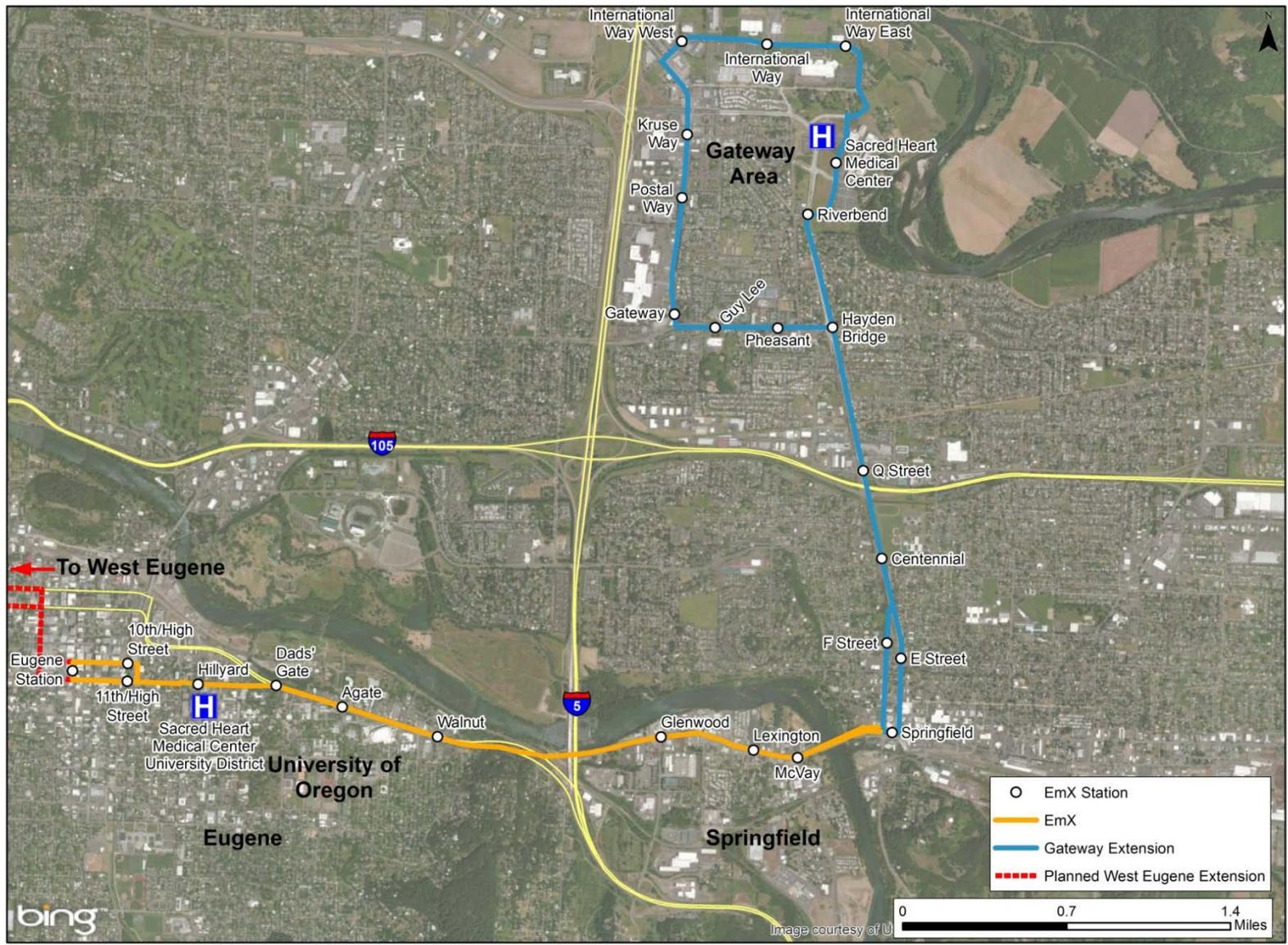
Lessons Learned

Even in a slower growth area and in areas with lower populations, BRT can serve as a viable transit option that still acts as a catalyst for growth around key transportation nodes. BRT development can help to concentrate employment in the same way as other more costly transit alternatives, which can support and encourage development in slower growth areas.

- In smaller regions or corridors with lower population densities, BRT can serve as a cost-effective transportation alternative to rail.
- Early studies of BRT show that, like rail, BRT lines can help concentrate employment growth and development around transit stations, even in a slower-growing economy like the Eugene-Springfield metro area.

In the context of the San Diego region, these lessons may provide insight on the potential impact of BRT transit options in lower-density areas, such as those in the eastern part of the region, and provide infrastructure for economic growth and clustering in these areas.

Figure P.36
Aerial Map of Eugene-Springfield EmX Alignment



III.5.3 Portland's Pearl District: The Portland Streetcar

Context

The area now known as the Pearl District developed around the Spokane, Portland & Seattle Railway during the first half of the 20th century. Located just north of downtown, the area became known as the Northwest Industrial Triangle and functioned as the epicenter of warehousing and manufacturing activity in Portland. However, the railway left in 1970, and by the 1980s the district was characterized by a mix of abandoned warehouses, vacant parcels and surface parking lots, and low-cost artist workspaces and cafés.¹⁶⁸

In the early 1980s, the City of Portland began focusing its planning efforts on redeveloping the Pearl District. After an urban design study in the early 1980s, the City Council adopted the 1988 Central City redevelopment plan, which included a provision to establish a streetcar-circulator loop connecting both sides of the Willamette River and all of the Central City districts.¹⁶⁹

As plans for a streetcar developed in the early 1990s, the City of Portland negotiated a development agreement with Hoyt Street Properties (HSP), which owned 40 acres adjacent to the planned alignment. As part of the development agreement, the City of Portland agreed to fund important public improvements, including removing an overhead ramp that bisected HSP's properties and building the streetcar and a neighborhood park.

In return, HSP dedicated right-of-way to the streetcar, donated land for the park, agreed to meet affordable housing goals, and committed to building higher-density residential and commercial uses (131 units/acre, up from 15 to 87 units/acre).¹⁷⁰ The developer later stated that the higher densities would not have been feasible without the improved access provided by the streetcar.¹⁷¹

The Portland Streetcar

In 1997, the City of Portland began construction on a 2.4-mile streetcar line to connect the Pearl District to major employment centers including the Downtown and Portland State University. Funding for the \$54 million streetcar project came from a variety of federal, state, and local resources. Just over half of the cost was covered by bonds backed by parking revenues. The City secured a \$900,000 Federal Housing and Urban Development grant that supplemented local funding. Additional funding came from tax increment financing (\$7.5 million) and a local improvement district (\$9.6 million) that surrounded the route alignment.¹⁷²

The first phase of the streetcar opened for service in 2001. The system has since been expanded to include two lines spanning 14.7 miles, connecting the Pearl District to major employment centers, educational, cultural and civic destinations, and central neighborhoods on both sides of the Willamette River.

The streetcar runs every 14 minutes during weekdays between 10 a.m. and 7 p.m., and every 15 to 20 minutes on mornings, nights, and weekends. Ridership has grown steadily as the system has expanded, reaching 4.5 million in 2014.¹⁷³

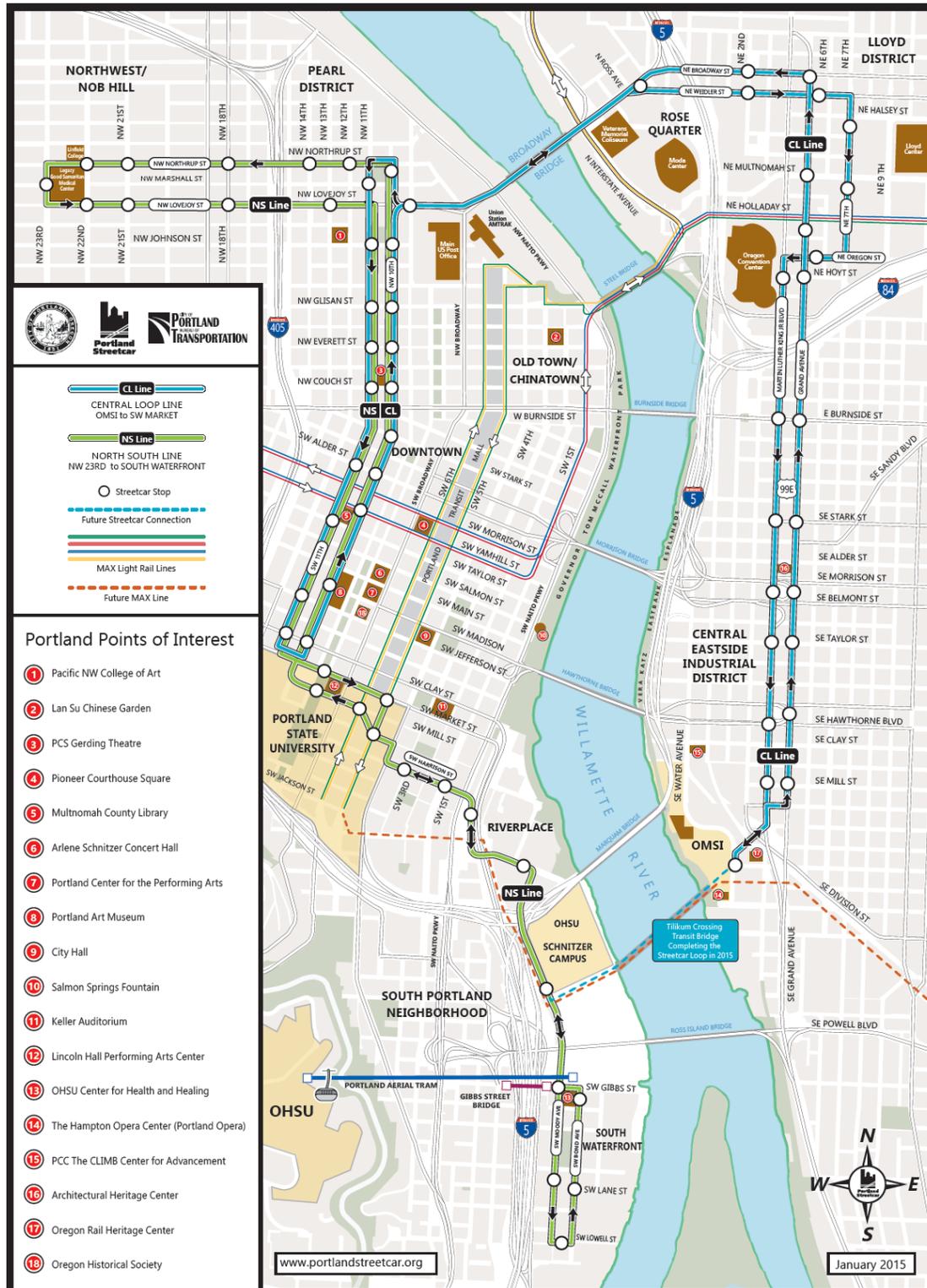
Figure P.37

Businesses and Property Developers in the Pearl District use the Streetcar to brand the Neighborhood



Source: Center for Transit-Oriented Development

**Figure P.38
Portland Streetcar Alignment, 2015**



Source: portlandstreetcar.org

Economic Impacts

Summary of Economic Impacts Findings

Economic impacts are in development, business and retail. Development findings include information on new and high-intensity development, as well as mixed-use development. Business and retail findings include impacts on pedestrian traffic, marketing, and tourism and hospitality benefits.

Economic Impacts Findings

Development

New Development and High Intensity Development

The streetcar alignment has attracted significant new, high-intensity development since the alignment was identified in 1997. Since the Portland Streetcar opened in 2001, the area within two blocks of the alignment has received over \$3.5 billion in private investment, including 10,000 housing units and 5.4 million square feet of commercial space.¹⁷⁴

A 2005 study¹⁷⁵ found that between 1997 and 2004, 55 percent of all new development within the Portland Central Business District (CBD) occurred within one block of the streetcar. In comparison, prior to 1997, land located within one block of the streetcar alignment captured only 19 percent of all development in CBD.

New development near the streetcar is also higher intensity. Between 1997 and 2004, new development was built to higher densities, averaging 90 percent of the maximum FAR. Before 1997, in the blocks adjacent to the alignment, existing buildings averaged 34 percent of the allowable floor area ratio (FAR). This increase in development and densities appears to be tied to the streetcar, with developers building more intensively in order to take advantage of the higher values achieved by properties adjacent to the streetcar line.

Mixed-use Development

Due in part to the high quality transit service provided by the Portland Streetcar, developers are able to construct mixed-use projects with reduced parking ratios. Where financially feasible, reduced parking can have a significant impact on a developer's costs. In 1995, most developers built the maximum amount of parking allowed for their residential projects. Over time, that ratio dropped, reflecting a reduced market demand for parking spaces. More recent residential projects in the Pearl District average 0.95 spaces per unit parking; there are several examples of successful residential projects with no on-site parking at all.¹⁷⁶

Business and Retail Benefits

Pedestrian Traffic

The streetcar has contributed to a significant increase in pedestrian activity and successful retail in the Pearl District. Michael Powell, owner of Powell's Books, was one of the few local merchants in the area prior to the construction of the streetcar. At the time, the pedestrian traffic passing by his storefront averaged between 40 and 50 people per hour. As of 2010, more than 400 pedestrians passed the Powell's Books entrance every hour. Since 1995, the Pearl Business Association has grown from eight members to around 450, with 90 percent of the stores locally owned.¹⁷⁷

Marketing

The streetcar has also proven to be a valuable marketing tool for many businesses. As of 2010, the streetcar had been featured in over 450 business brochures produced by businesses along the line.¹⁷⁸ Approximately 100 businesses participate in the Portland Streetcar's sponsorship program, which provides businesses with opportunities to sponsor a streetcar or a platform stop location, advertise in the Portland Streetcar's "Off the Rails" map of dining, retail and services near the stations, and participate in other sponsorship opportunities.¹⁷⁹

Tourism and Hospitality Benefits

The streetcar has proven to be valuable for attracting visitors and supporting the local hospitality industry. A new Northwest boutique hotel was named “Inn at Northrup Station” and features real-time arrival equipment in the lobby announcing the streetcar schedule. The hotel also sponsors the adjacent station. Other hotels, including the Governor Hotel, the Mark Spencer Hotel, and Residence Inn by Marriott participate in the Portland Streetcar sponsorship program and use the streetcar as a distinguishing factor in their marketing.¹⁸⁰

Lessons Learned

As well as providing more traditional benefits, transportation investments can support private investment and high-density development, with significant benefits for employment, industry, and commerce. Transportation investments can be used to focus private investment in areas which otherwise may not be attractive to private investors. In addition, transit investment can enable higher density development that both results from lesser need to dedicate space to cars, and higher property values from access to transportation.

- Transit investments, combined with other public sector place-making interventions, can play an important role in creating a more attractive environment for private investment – in the case of the Portland Streetcar, helping to transform a former industrial/warehouse district.
- Transit investment can also help facilitate an increase in development intensities, by spurring developers to building more intensively in order to take advantage of higher property values and by reducing the need to build high-cost parking spaces.

In the SANDAG region, this type of transportation investment may be able to contribute to urban revitalization in urban areas or regional business districts, as well as increase density near transit-accessible locations.

III.6 Bibliography

III.6.1 References on the Economic Impacts of Transportation Investments

Several existing sources provide additional data and information specifically designed to be used in measuring economic impacts of transportation investments. The following guidebooks may be particularly helpful for modeling purposes:

- Weisbrod, Glen, and Arlee Reno. Economic Impact of Public Transportation Investment. American Public Transportation Association, October 2009. Available at apta.com/resources/reportsandpublications/Documents/economic_impact_of_public_transportation_investment.pdf.
- Forkenbrock, David J, and Glen E Weisbrod. Guidebook for Assessing the Social and Economic Effects of Transportation Projects. Washington, D.C.: Transportation Research Board, 2001.
- Litman, Todd. Evaluating Transportation Economic Development Impacts: Understanding How Transport Policy and Planning Decisions Affect Employment, Incomes, Productivity, Competitiveness, Property Values and Tax Revenues. Victoria Transport Policy Institute, August 18, 2010. Available at vtpi.org/econ_dev.pdf.

III.6.2 General Bibliography for Literature Review

AAA. Your Driving Costs, 2013. Available at newsroom.aaa.com/wp-content/uploads/2013/04/YourDrivingCosts2013.pdf.

American Planning Association. Investing in Place: Two Generations' View on the Future of Communities, May 2014. Available at planning.org/policy/polls/investing/pdf/pollinvestingreport.pdf.

Barnes, Gary, and Peter Langworthy. The Per-Mile Costs of Operating Automobiles and Trucks. Minnesota Department of Transportation, 2003. Available at conservancy.umn.edu/handle/11299/909.

Belzer, Dena, Sujata Srivastava, and Mason Austin. Transit and Regional Economic Development. Center for Transit-Oriented Development, May 2011. Available at reconnectingamerica.org/resource-center/browse-research/2011/transit-and-regional-economic-development/.

Brookings Institution, HDR, Re-Connection America, and RCLCO. Value Capture and Tax-Increment Financing Options For Streetcar Construction. Washington D.C., July 2009.

Carlino, Gerald, Satyajit Chatterjee, and Robert Hunt. Urban Density and the Rate of Invention. Federal Reserve Bank of Philadelphia. Available at [spol.unica.it/didattica/paci/Economia%20applicata%20avanzata%20\(1mod\)/carlino%20et%20al.%202006.pdf.%20Accessed%20June%2026,%202014](http://spol.unica.it/didattica/paci/Economia%20applicata%20avanzata%20(1mod)/carlino%20et%20al.%202006.pdf.%20Accessed%20June%2026,%202014).

Center for Neighborhood Technology, Smart Growth America, and U.S. PIRG. What We Learned from the Stimulus, January 5, 2010. Available at http://www.smartgrowthamerica.org/documents/010510_whatwelearned_stimulus.pdf.

Center for Neighborhood Technology, and Virginia Tech. Housing & Transportation Cost Trade-Offs and Burdens of Working Households in 28 Metros, July 2006. Available at <http://www.nhc.org/media/documents/chp-pub-hl06-cnt-report.pdf?phpMyAdmin=d3a4afe4e37aae985c684e22d8f65929>.

- Center for Transit-Oriented Development. *Realizing the Potential: Expanded Housing Opportunities Near Transit*, May 2007. Available at <http://www.reconnectingamerica.org/resource-center/books-and-reports/2007/realizing-the-potential-expanding-housing-opportunities-near-transit-2/>.
- . *Trends in Transit-Oriented Development, 2000-2010*. Federal Transit Administration, May 2014.
- Chandra, Amitabh, and Eric Thompson. "Does Public Infrastructure Affect Economic Activity? Evidence from the Rural Interstate Highway System." *Regional Science and Urban Economics* 30, no. 4 (July 2000): 457–90. doi:10.1016/S0166-0462(00)00040-5.
- Chapple, Karen, and Carrie Makarewicz. "Restricting New Infrastructure: Bad for Business in California?," 2010. Available at <http://www.escholarship.org/uc/item/5rx2z17b.pdf>.
- Chatman, D. G., and R. B. Noland. "Transit Service, Physical Agglomeration and Productivity in US Metropolitan Areas." *Urban Studies*, August 1, 2013. doi:10.1177/0042098013494426.
- Chatman, Daniel G., and Robert B. Noland. "Do Public Transport Improvements Increase Agglomeration Economies? A Review of Literature and an Agenda for Research." *Transport Reviews* 31, no. 6 (2011): 725–42. doi:10.1080/01441647.2011.587908.
- Chi, Guangqing. "The Impacts of Highway Expansion on Population Change: An Integrated Spatial Approach." *Rural Sociology* 75, no. 1 (March 2010): 58–89. doi:10.1111/j.1549-0831.2009.00003.x.
- Cortright, Joe. *Driven Apart: How Sprawl Is Lengthening Our Commutes and Why Misleading Mobility Measures Are Making Things Worse*. CEOs for Cities, September 2010. Available at <http://www.ceosforcities.org/research/driven-apart/>.
- Delucchi, Mark A., and Donald R. McCubbin. "External Costs of Transport in the U.S." *Institute of Transportation Studies*, January 1, 2010. Available at <http://www.escholarship.org/uc/item/13n8v8gq>.
- Dowall, David E, and Jan Whittington. *Making Room for the Future: Rebuilding California's Infrastructure*. San Francisco, Calif.: Public Policy Institute of California, 2003.
- Downs, Anthony. *Still Stuck in Traffic: Coping with Peak-Hour Traffic Congestion*. Brookings Institution Press, 2005.
- Duncan, Michael. "Comparing Rail Transit Capitalization Benefits for Single-Family and Condominium Units in San Diego, California." *Transportation Research Record: Journal of the Transportation Research Board* 2067 (December 1, 2008): 120–30. doi:10.3141/2067-14.
- . "The Impact of Transit-Oriented Development on Housing Prices in San Diego, CA." *Urban Studies* 48, no. 1 (January 1, 2011): 101–27. doi:10.1177/0042098009359958.
- . "The Synergistic Influence of Light Rail Stations and Zoning on Home Prices." *Environment and Planning A* 43, no. 9 (2011): 2125–42. doi:10.1068/a43406.
- E.D Hovee & Company, LLC. *Streetcar-Development Linkage: The Portland Streetcar Loop*. Portland, February 2008.
- Eric Hovee, and Rick Gustafson. "Streetcar Development Linkage: The Portland Streetcar Loop." presented at the TRB/APTA Light Rail & Streetcar Conference, Portland, OR, 2012.
- Fan, Yingling, Andrew Guthrie, and Rose Teng. *Impact of Twin Cities Transitways on Regional Labor Market Accessibility: A Transportation Equity Perspective*. University of Minnesota Center for Transportation Studies, June 2010. Available at <http://www.cts.umn.edu/Publications/ResearchReports/reportdetail.html?id=1940>.

- Faulk, Dagney, and Michael Hicks. "The Impact of Bus Transit on Employee Turnover: Evidence from Quasi-Experimental Samples." Washington, D.C., 2013. Available at http://www.frbatlanta.org/documents/news/conferences/13resilience_rebuilding_paper_Faulk.pdf.
- Fogarty, Nadine, and Mason Austin. Rails to Real Estate: Development Patterns along Three New Transit Lines. Center for Transit-Oriented Development, March 2011. Available at <http://www.ctod.org/portal/node/2302>.
- Fogarty, Nadine, Nancy Eaton, Dena Belzer, and Gloria Ohland. Capturing the Value of Transit. Center for Transit-Oriented Development, November 2008. Available at <http://www.reconnectingamerica.org/resource-center/books-and-reports/2008/capturing-the-value-of-transit-3/>.
- Fogarty, Nadine, Sujata Srivastava, Amanda Gehrke, Alison Nemirow, and Mason Austin. Downtowns, Greenfields, and Places in Between: Promoting Development Near Transit. Center for Transit-Oriented Development, May 2013. Available at http://www.ctod.org/pdfs/20130528_DntnsGreenfieldsEtc.FINAL.pdf.
- Forkenbrock, David J, and Glen E Weisbrod. Guidebook for Assessing the Social and Economic Effects of Transportation Projects. Washington, D.C.: Transportation Research Board, 2001.
- Freemark, Yonah. "Have U.S. Light Rail Systems Been Worth the Investment?" Atlantic Cities, April 10, 2014. Available at <http://www.theatlanticcities.com/commute/2014/04/have-us-light-rail-systems-been-worth-investment/8838/>.
- Frey, William H. "Demographic Reversal: Cities Thrive, Suburbs Sputter." The Brookings Institution, June 29, 2012. Available at <http://www.brookings.edu/research/opinions/2012/06/29-cities-suburbs-frey>.
- Galloway, Colin, and Rachel MacCleery. Infrastructure 2014: Shaping the Competitive City. Washington D.C.: Urban Land Institute, 2014.
- Graham, Daniel J. "Agglomeration, Productivity and Transport Investment." Journal of Transport Economics and Policy (JTEP) 41, no. 3 (September 1, 2007): 317–43.
- Hook, Walter, Stephanie Lotshaw, and Annie Weinstock. More Development for Your Transit Dollar: An Analysis of 21 North American Transit Corridors. Institute for Transportation & Development Policy, September 2013. Available at http://www.itdp.org/documents/ITDP_MORE_DEVELOPMENT_924.pdf.
- Iacono, Michael, and David Levinson. "Case Studies of Transportation Investment to Identify the Impacts on the Local and State Economy," January 2013. Available at <http://www.conservancy.umn.edu/handle/11299/146923>.
- Kahn, Matthew E., and David M. Levinson. Fix It First, Expand It Second, Reward It Third: A New Strategy for America's Highways. Hamilton Project/Brookings Institution, 2011. Available at http://www.brookings.edu/~media/research/files/papers/2011/2/highway%20infrastructure%20kahn%20levinson/02_highway_infrastructure_kahn_levinson_paper.pdf.
- Kneebone, Elizabeth. Job Sprawl Revisited: The Changing Geography of Metropolitan Employment. Brookings Institution, April 2009. Available at http://www.brookings.edu/~media/Research/Files/Reports/2009/4/06%20job%20sprawl%20kneebone/20090406_jobsprawl_kneebone.PDF.
- Kooshian, Chuck, and Steve Winkelman. Growing Wealthier: Smart Growth, Climate Change and Prosperity. Center for Clean Air Policy, January 2011. Available at http://www.growingwealthier.info/docs/gw_summary.pdf.

- Lemer, Andrew C, National Cooperative Highway Research Program, American Association of State Highway and Transportation Officials, National Research Council (U.S.), and Transportation Research Board. Public Benefits of Highway System Preservation and Maintenance. Washington, D.C.: Transportation Research Board, 2004.
- Litman, Todd. Evaluating Transportation Economic Development Impacts: Understanding How Transport Policy and Planning Decisions Affect Employment, Incomes, Productivity, Competitiveness, Property Values and Tax Revenues. Victoria Transport Policy Institute, August 18, 2010. Available at vtpi.org/econ_dev.pdf.
- Los Angeles County Metropolitan Transportation Authority. "Metro Express Lanes." Accessed May 2, 2013. Available at <http://www.metro.net/projects/expresslanes/>.
- Meyer, Eugene L. "Tysons, a Northern Virginia Crossroads, Waits Impatiently for the Train." The New York Times, June 24, 2014. Available at <http://www.nytimes.com/2014/06/25/business/Tysons-Awaits-Metro-Silver-Line.html>.
- Nelson, Arthur C., and Reid Ewing. BRT and Economic Development: Case Study of the Eugene-Springfield, Oregon BRT System. Metropolitan Research Center, University of Utah, September 6, 2012.
- Pendall, Rolf, Christopher Hayes, Arthur George, Zach McDade, Casey Dawkins, Jae Sik Jeon, Eli Knapp, Evelyn Blumenberg, Gregory Pierce, and Michael Smart. Driving to Opportunity: Understanding the Links among Transportation Access, Residential Outcomes, and Economic Opportunity for Housing Voucher Recipients. Urban Institute, March 2014. Available at <http://www.urban.org/UploadedPDF/413078-Driving-to-Opportunity.pdf>.
- Perk, Victoria. "Land Use & Property Value Impacts of BRT." presented at the 5th National Bus Rapid Transit Conference, Las Vegas, NV, August 20, 2012. Available at <http://www.onlinepubs.trb.org/onlinepubs/conferences/2012/BRT/Perk.pdf>.
- Peterson, Sarah Jo, and Rachel MacCleery. When the Road Price Is Right: Land Use, Tolls, and Congestion Pricing. Urban Land Institute, 2013. Available at http://www.uli.org/wp-content/uploads/2013/03/When-the-Road-Price-is-Right_web_F.pdf.
- Salvesen, David, and Henry Renski. The Importance of Quality of Life in the Location Decisions of New Economy Firms. Center for Urban and Regional Studies, January 2003. Available at unc.edu/depts/curs/curs-pdf-downloads/recentlyreleased/neweconomyreport.pdf.
- Schrank, David, Bill Eisele, and Tim Lomax. "TTI's 2012 Urban Mobility Report." Texas A&M Transportation Institute. The Texas A&M University System, 2012. Available at <http://www.media.miamiherald.com/smedia/2013/02/04/18/40/K7J8w.So.56.pdf>.
- Sizer, Scott. "Fairfax County, VA Transportation Funding Sources." presented at the FTA - Value Capture Roundtable, June 6, 2013.
- Smart Growth America. Building Better Budgets: A National Examination of the Fiscal Benefits of Smart Growth Development, May 2013. Available at <http://www.smartgrowthamerica.org/documents/building-better-budgets.pdf>.
- Susan Jones Moses and Associates. "Bellevue Transit Center, Bellevue, WA." Transportation Project Impact Case Studies, 2008. Available at <http://www.tpics.us/>.

- Tomer, Adie, Elizabeth Kneebone, Robert Puentes, and Alan Berube. Missed Opportunity: Transit and Jobs in Metropolitan America. Brookings Institution, May 2011. Available at http://www.allthingslocalnola.info/yahoo_site_admin/assets/docs/Transit_and_Jobs_in_Metropolitan_America_Report.332121451.pdf.
- TransForm, and California Housing Partnership Corporation. Why Creating and Preserving Affordable Homes Near Transit Is a Highly Effective Climate Protection Strategy, May 2014. Available at <http://www.chpc.net/dnld/AffordableTODResearch051514.pdf>.
- U.S. Department of Transportation. "Notice of Funding Availability for the Department of Transportation's National Infrastructure Investments under the Consolidated Appropriations Act, 2014." Federal Register, March 3, 2014. Available at <http://www.federalregister.gov/articles/2014/03/03/2014-04627/notice-of-funding-availability-for-the-department-of-transportations-national-infrastructure#footnote-3>.
- U.S. Department of Transportation Federal Highway Administration. "Employment Impacts of Highway Infrastructure Investment," June 9, 2014. Available at <http://www.fhwa.dot.gov/policy/otps/pubs/impacts/index.htm>.
- United States Government Accountability Office. BRT: Projects Improve Transit Service and Can Contribute to Economic Development. Report to the Committee on Banking, Housing, and Urban Affairs, U.S. Senate. United States Government Accountability Office, July 2012.
- US Department of Transportation, and Federal Highway Administration. Value Pricing Pilot Program: Lessons Learned, 2008.
- Victoria A. Perk, Martin Catalá,. Land Use Impacts of Bus Rapid Transit: Effects of BRT Station Proximity on Property Values along the Pittsburgh Martin Luther King, Jr. East Busway. U.S. Department of Transportation Federal Transit Administration, Office of Research, Demonstration and Innovation (TRI), December 2009.
- Wardrip, Keith. Public Transit's Impact on Housing Costs: A Review of the Literature. Insights from Housing Policy Research. Center for Housing Policy, August 2011. Available at http://www.nhc.org/media/documents/TransitImpactonHsgCostsfinal_-_Aug_10_20111.pdf.
- Washington State Department of Transportation. "I-405 Congestion Relief and Bus Rapid Transit Projects- Project FAQs." Available at wsdot.wa.gov/Projects/i405/corridor/faq.htm. Accessed June 13, 2014.
- Weisbrod, Glen, and Arlee Reno. Economic Impact of Public Transportation Investment. American Public Transportation Association, October 2009. Available at http://www.apta.com/resources/reportsandpublications/Documents/economic_impact_of_public_transportation_investment.pdf.

III.6.3 Bibliography on Fiscal Impacts

- AECOM, Economic Impact Analysis of the Los Angeles Streetcar.
- AECOM, ICF Consulting, HLB Decision Economics, and Louis Berger Group (2001). Freight Benefit/Cost Study: Compilation of the Literature. Presented to Federal Highway Administration.
- American Public Transportation Association (2013). The Role of Transit in Support of High Growth Business Clusters in the U.S.
- Brueckner, J.K., 2000. Urban sprawl: Diagnosis and remedies. *International Regional Science Review* 23, 160-171.

- Brueckner, J. K., & Kim, H. A. (2003). Urban sprawl and the property tax. *International Tax and Public Finance*, 10(1), 5–23.
- Carruthers, J. I. (2002). The impacts of state growth management programs: a comparative analysis. *Urban Studies*, 39(11), 1959–1982.
- Carruthers, J. I., & Ulfarsson, G. F. (2003). Urban sprawl and the cost of public services. *Environment and Planning B*, 30(4), 503–522.
- Carruthers, J. I., & Ulfarsson, G. F. (2008). Does smart growth matter to public finance? *Urban Studies*, 45(9), 1791–1823.
- Chandra, A., & Thompson, E. (2000). Does public infrastructure affect economic activity? Evidence from the rural interstate highway system. *Regional Science and Urban Economics*, 30(4), 457–490.
- Chatman, D. G., & Noland, R. B. (2014). Transit Service, Physical Agglomeration and Productivity in U.S. Metropolitan Areas. *Urban Studies*, 51(5), 917–937.
- Economic Impact of Visitor Expenditures on the Vermont Economy — 2007, Vermont
- Graham, D. (2007), Agglomeration Economies and Transport Investment. Joint Transport Research Centre. Discussion Paper No. 2007-11; Graham, D. (2012). Wider economic benefits of transport investment and the role of agglomeration. A slide presentation. Imperial college London.
- Holleyman, Chris, *Industry Studies of the Relationship Between Highway Infrastructure Investment and Productivity, Logistics and Transportation Review*, (pp. 93-117), 1996.
- Horst, T., & Moore, A. (2003). Industrial diversity, economic development, and highway investment in Louisiana. *Transportation Research Record: Journal of the Transportation Research Board*, 1839(1), 136–141.
- International City/County Management Association and Anderson, Geoff (1998). *Why Smart Growth: A Primer*. ICMA – Smart Growth Network
- Joseph Gyourko and Todd Sinai (2001). *The Spatial Distribution of Housing-Related Tax Benefits in the United States*, NBER Working Paper.
- Lee, D.b. (1981). Land Use Planning as a Response to Market Failure. *The Land Use Policy Debate in the United States* pp 149-164
- Lieske, S. N.; McLeod, D. M.; Coupal, R. H.; Srivastava, S. K. (2012). Determining the relationship between urban form and the costs of public services. *Environment and Planning B: Planning and Design* 39(1) 155–173.
- Litman, T. (2010). *Evaluating transportation economic development impacts*. Victoria Transport Policy Institute, 8.
- Lukermann, Barbara and Kane, Michael. *Land Use Practices: Exclusionary Zoning, De Facto or De Jure: An Examination of the Practices of Ten Suburban Communities in the Twin Cities Metropolitan Area*, Minneapolis, Center for Urban and Regional Affairs, University of Minnesota, April 1994.
- Metropolitan Area Planning Council, *Route 128 Central Corridor Plan*.
- Metropolitan Area Planning Council, *Route 128 Central Corridor Project*. MAPC website, retrieved Aug 19, 2014 at <http://www.mapc.org/smart-growth/route128>

Metsaranta, et. al. (2014). The wider economic impacts of transport investments. Bothnian Green Logistic Corridor Project.

Nadiri, Ishaq and Mamuneas, Theofanis (1994). The Effect of Public Infrastructure and R&D capital on the Cost Structure and Performance of U.S. Manufacturing Industries, *Review of Economics and Statistics*, Vol. 76, No. 1, (pp. 22-37)

Partnership for Sustainable Communities. Transit as Transformation: The Euclid Corridor in Cleveland

Paulsen, K. (2013). The Effects of Land Development on Municipal Finance.

San Francisco County Transportation Authority, Final SAR08/09-2 Strategic Analysis Report on the Role of Shuttle Services in San Francisco's Transportation System, June 28, 2011.

Telephone conversation with Dave Williams, V.P. of Transportation, Atlanta Regional Chamber, May 29, 2013. Conducted for American Public Transportation Association (2013). The Role of Transit in Support of High Growth Business Clusters in the U.S.

Voith, R., & Gyourko, J. (2002). Capitalization of federal taxes, the relative price of housing, and urban form: density and sorting effects. *Regional Science and Urban Economics*, 32(6), 673-690.

Wachs, M (2011). Transportation, Jobs, and Economic Growth. Access, 38. University of California Transportation Center

Weisbrod, G. and Reno, A (2009). Economic Impact of Public Transit Investment. American Public Transportation Association.

Weisbrod, G; Cutler, D; Duncan, C; Reno, A. (2014). Economic Impact of Public Transit Investment, 2014 Update. American Public Transportation Association.

III.6.4 Sources for Case Studies in Economic Competitiveness

Fogarty, Nadine, and Mason Austin. *Rails to Real Estate: Development Patterns along Three New Transit Lines*. Center for Transit-Oriented Development, March 2011. <http://www.ctod.org/portal/node/2302>.

Fogarty, Nadine, Sujata Srivastava, Amanda Gehrke, Alison Nemirow, and Mason Austin. *Downtowns, Greenfields, and Places in Between: Promoting Development Near Transit*. Center for Transit-Oriented Development, May 2013. http://www.ctod.org/pdfs/20130528_DntnsGreenfieldsEtc.FINAL.pdf.

Moler, Steve. "Colossal Partnership: Denver's \$1.67 Billion T-REX Project." *Public Roads* 65, no. 2 (October 2001). <http://www.fhwa.dot.gov/publications/publicroads/01septoct/trex.cfm>.

RTD. "Facts and Figures - Southeast Corridor Light Rail Line," January 2013. <http://www.rtd-denver.com/FF-SoutheastCorridor.shtml>.

———. *T-REX Transit Oriented Development Lessons Learned Report*, September 2007. <http://www.rtd-fastracks.com/media/uploads/main/TREX-TOD-LL.pdf>.

Sadler, Bill, and Elizabeth Wampler. *Enhancing Economic Opportunity through Transit: Lessons Learned from Denver's Southeast Light Rail Line*. Reconnecting America & Mile High Connects, March 2013. <http://www.reconnectingamerica.org/assets/Uploads/20130329EnhancingEconomicOpportunityThroughTransitSELineReportFINAL.pdf>.

Transportation Research Board. Visualization in Transportation Committee ABJ95, Data Visualization Student Challenge. January 24, 2014.

Whaley, Monte. "RTD Wins Key Partners to Extend Southeast Rail Extension." *The Denver Post*, August 3, 2014. http://www.denverpost.com/news/ci_26266097/rtd-wins-key-partners-extend-southeast-rail-extension.

Center for Transit-Oriented Development. *Trends in Transit-Oriented Development, 2000-2010*. Federal Transit Administration, May 2014.

Crowley, Michael. *The Emerald Express: Overcoming Growing Pains and Opposition to Bus Rapid Transit*. Institute for Sustainable Communities, n.d.

Greenstreet, Ltd., Anderson + Bohlander, Strategic Economics, Parsons Brinckerhoff, "Value Capture Case Studies," Transit Oriented Development Strategic Plan, prepared for Indianapolis Metropolitan Planning Organization, 2015 (forthcoming).

Lane Transit District. "EmX." Accessed February 18, 2015.

<http://www.ltd.org/search/showresult.html?versionthread=d38519362672c662c61a9300c1dd78be>.

———. "West Eugene EmX." Accessed February 18, 2015.

<http://www.ltd.org/search/showresult.html?versionthread=6d1c10a45e6252b7dd05ef6580c442d3>.

Nelson, Arthur C., and Reid Ewing. *BRT and Economic Development: Case Study of the Eugene-Springfield, Oregon BRT System*. Metropolitan Research Center, University of Utah, September 6, 2012.

Pioneer Parkway EmX BRT. "Pioneer Parkway EmX BRT: Springfield, OR," November 2007.

United States Government Accountability Office. *BRT: Projects Improve Transit Service and Can Contribute to Economic Development*. Report to the Committee on Banking, Housing, and Urban Affairs, U.S. Senate. United States Government Accountability Office, July 2012.

U.S. Federal Transit Administration. *The EmX Franklin Corridor BRT Project Evaluation*, April 2009.

———. "West Eugene EmX Extension: Eugene, Oregon," December 2011.

http://www.fta.dot.gov/documents/OR_Eugene_West_Eugene_Emerald_Express_Profile_final_pdf.pdf.

Adams, Sam, and Michael Powell. *Portland Streetcar Development Oriented Transit*. Portland Office of Transportation and Portland Streetcar, Inc., April 2008. <http://www.portlandstreetcar.org/node/30>.

Fogarty, Nadine, Sujata Srivastava, Amanda Gehrke, Alison Nemirow, and Mason Austin. *Downtowns, Greenfields, and Places in Between: Promoting Development Near Transit*. Center for Transit-Oriented Development, May 2013.

Eric Hovee, and Rick Gustafson. "Streetcar Development Linkage: The Portland Streetcar Loop." presented at the TRB/APTA Light Rail & Streetcar Conference, Portland, OR, 2012.

"History of the Pearl District." *Explore The Pearl*. Accessed February 17, 2015.

<http://www.explorethepearl.com/about-the-pearl/history-of-the-pearl-district/>.

"Portland Streetcar." Accessed February 18, 2015. <http://www.portlandstreetcar.org/node/30>.

Quick, Vicki. "Development Agreements: Leveraging Private Investment for Public Good." In *Street Smart: Streetcars and Cities in the Twenty-First Century*. Reconnecting America, 2009.

Strategic Economics. Memorandum. "Pasadena Streetcar Feasibility, Alignment, and Financing Analysis: Streetcar Case Studies." Memorandum, October 4, 2010.

Endnotes

- ¹ Jobs and GRP from Construction and Operation in 2050 are lower because capital improvements are complete by 2050.
- ² Jobs and GRP from Construction and Operation in 2050 are lower because capital improvements are complete by 2050.
- ³ A job-year is simply one job for one year.
- ⁴ The discount rate is often assumed to be similar to the real rate of return on investment, thus accounting for lost opportunity. This is not to be confused with the effect of inflation, as all costs and benefits in the BCA are “real” or “constant” dollars, eliminating the effects of inflation.
- ⁵ U.S. Department of Transportation Federal Highway Administration, “Employment Impacts of Highway Infrastructure Investment.”
- ⁶ Weisbrod and Reno, Economic Impact of Public Transportation Investment.
- ⁷ Job-months are calculated by dividing total hours worked by 173. Because transportation projects are of different durations, a job-month is considered a more accurate way to compare employment creation from different projects than job years. Center for Neighborhood Technology, Smart Growth America, and U.S. PIRG, What We Learned from the Stimulus.
- ⁸ U.S. Department of Transportation, “Notice of Funding Availability for the Department of Transportation’s National Infrastructure Investments under the Consolidated Appropriations Act, 2014.”
- ⁹ U.S. Department of Transportation, “Notice of Funding Availability for the Department of Transportation’s National Infrastructure Investments under the Consolidated Appropriations Act, 2014.”
- ¹⁰ This figure represents the costs that can be modeled in this analysis; not all costs of the Plan can be accounted for in the I-O model, such as land acquisition, or purchases made outside of San Diego County (e.g., rail cars).
- ¹¹ Iacono and Levinson, “Case Studies of Transportation Investment to Identify the Impacts on the Local and State Economy”; Belzer, Srivastava, and Austin, Transit and Regional Economic Development.
- ¹² Carlino, Chatterjee, and Hunt, Urban Density and the Rate of Invention.
- ¹³ Litman, Evaluating Transportation Economic Development Impacts: Understanding How Transport Policy and Planning Decisions Affect Employment, Incomes, Productivity, Competitiveness, Property Values and Tax Revenues; Forkenbrock and Weisbrod, Guidebook for Assessing the Social and Economic Effects of Transportation Projects.
- ¹⁴ Iacono and Levinson, “Case Studies of Transportation Investment to Identify the Impacts on the Local and State Economy”; Belzer, Srivastava, and Austin, Transit and Regional Economic Development.
- ¹⁵ Carlino, Chatterjee, and Hunt, Urban Density and the Rate of Invention.
- ¹⁶ Litman, Evaluating Transportation Economic Development Impacts: Understanding How Transport Policy and Planning Decisions Affect Employment, Incomes, Productivity, Competitiveness, Property Values and Tax Revenues; Forkenbrock and Weisbrod, Guidebook for Assessing the Social and Economic Effects of Transportation Projects.
- ¹⁷ Litman, Evaluating Transportation Economic Development Impacts: Understanding How Transport Policy and Planning Decisions Affect Employment, Incomes, Productivity, Competitiveness, Property Values and Tax Revenues.
- ¹⁸ Kooshian and Winkelman, Growing Wealthier: Smart Growth, Climate Change and Prosperity.
- ¹⁹ Downs, Still Stuck in Traffic.
- ²⁰ Graham, “Agglomeration, Productivity and Transport Investment.”
- ²¹ AAA, Your Driving Costs.
- ²² Center for Transit-Oriented Development, Realizing the Potential: Expanded Housing Opportunities Near Transit.
- ²³ Litman, Evaluating Transportation Economic Development Impacts: Understanding How Transport Policy and Planning Decisions Affect Employment, Incomes, Productivity, Competitiveness, Property Values and Tax Revenues.
- ²⁴ Center for Neighborhood Technology and Virginia Tech, Housing & Transportation Cost Trade-Offs and Burdens of Working Households in 28 Metros.
- ²⁵ Pendall et al., Driving to Opportunity: Understanding the Links among Transportation Access, Residential Outcomes, and Economic Opportunity for Housing Voucher Recipients.
- ²⁶ Tomer et al., Missed Opportunity: Transit and Jobs in Metropolitan America.
- ²⁷ Pendall et al., Driving to Opportunity: Understanding the Links among Transportation Access, Residential Outcomes, and Economic Opportunity for Housing Voucher Recipients.
- ²⁸ Fan, Guthrie, and Teng, Impact of Twin Cities Transitways on Regional Labor Market Accessibility: A Transportation Equity Perspective.

-
- 29 TransForm and California Housing Partnership Corporation, *Why Creating and Preserving Affordable Homes Near Transit Is a Highly Effective Climate Protection Strategy*.
- 30 Schrank, Eisele, and Lomax, "TTI's 2012 Urban Mobility Report."
- 31 Cortright, *Driven Apart: How Sprawl Is Lengthening Our Commutes and Why Misleading Mobility Measures Are Making Things Worse*.
- 32 Weisbrod and Reno, *Economic Impact of Public Transportation Investment*.
- 33 Delucchi and McCubbin, "External Costs of Transport in the U.S."
- 34 American Planning Association, *Investing in Place: Two Generations' View on the Future of Communities*.
- 35 Salvesen and Renski, *The Importance of Quality of Life in the Location Decisions of New Economy Firms*.
- 36 *Ibid.*; Chapple and Makarewicz, "Restricting New Infrastructure."
- 37 Center for Transit-Oriented Development, *Trends in Transit-Oriented Development, 2000-2010*.
- 38 Kneebone, *Job Sprawl Revisited: The Changing Geography of Metropolitan Employment*.
- 39 Frey, "Demographic Reversal."
- 40 Center for Transit-Oriented Development, *Trends in Transit-Oriented Development, 2000-2010*.
- 41 Freemark, "Have U.S. Light Rail Systems Been Worth the Investment?"
- 42 Belzer, Srivastava, and Austin, *Transit and Regional Economic Development*; Chatman and Noland, "Do Public Transport Improvements Increase Agglomeration Economies?"
- 43 Graham, "Agglomeration, Productivity and Transport Investment."
- 44 Chatman and Noland, "Transit Service, Physical Agglomeration and Productivity in US Metropolitan Areas."
- 45 Faulk and Hicks, "The Impact of Bus Transit on Employee Turnover."
- 46 Wardrip, *Public Transit's Impact on Housing Costs: A Review of the Literature*.
- 47 Duncan, "Comparing Rail Transit Capitalization Benefits for Single-Family and Condominium Units in San Diego, California."
- 48 Duncan, "The Impact of Transit-Oriented Development on Housing Prices in San Diego, CA."
- 49 Duncan, "The Synergistic Influence of Light Rail Stations and Zoning on Home Prices."
- 50 Fogarty et al., *Capturing the Value of Transit*.
- 51 Galloway and MacCleery, *Infrastructure 2014*, 201.
- 52 Wardrip, *Public Transit's Impact on Housing Costs: A Review of the Literature*; Fogarty and Austin, *Rails to Real Estate: Development Patterns along Three New Transit Lines*; Fogarty et al., *Downtowns, Greenfields, and Places in Between: Promoting Development Near Transit*.
- 53 Victoria A. Perk and Martin Catalá, *Land Use Impacts of Bus Rapid Transit: Effects of BRT Station Proximity on Property Values along the Pittsburgh Martin Luther King, Jr. East Busway*.
- 54 Perk, "Land Use & Property Value Impacts of BRT."
- 55 United States Government Accountability Office, *BRT: Projects Improve Transit Service and Can Contribute to Economic Development*.
- 56 Hook, Lotshaw, and Weinstock, *More Development for Your Transit Dollar: An Analysis of 21 North American Transit Corridors*.
- 57 Brookings Institution et al., *Value Capture and Tax-Increment Financing Options for Streetcar Construction*; Eric Hovee and Rick Gustafson, "Streetcar Development Linkage: The Portland Streetcar Loop"; E.D Hovee & Company, *Streetcar-Development Linkage: The Portland Streetcar Loop*.
- 58 Smart Growth America, *Building Better Budgets: A National Examination of the Fiscal Benefits of Smart Growth Development*.
- 59 Iacono and Levinson, "Case Studies of Transportation Investment to Identify the Impacts on the Local and State Economy."
- 60 Barnes and Langworthy, *The Per-Mile Costs of Operating Automobiles and Trucks*.
- 61 Lemer et al., *Public Benefits of Highway System Preservation and Maintenance*.
- 62 Kahn and Levinson, *Fix It First, Expand It Second, Reward It Third*; Lemer et al., *Public Benefits of Highway System Preservation and Maintenance*.
- 63 Kahn and Levinson, *Fix It First, Expand It Second, Reward It Third*.
- 64 Dowall and Whittington, *Making Room for the Future*.
- 65 Schrank, Eisele, and Lomax, "TTI's 2012 Urban Mobility Report."
- 66 U.S. Department of Transportation and Federal Highway Administration, *Value Pricing Pilot Program: Lessons Learned*.

-
- 67 Ibid.
- 68 Peterson and MacCleery, *When the Road Price Is Right: Land Use, Tolls, and Congestion Pricing*.
- 69 Los Angeles County Metropolitan Transportation Authority, "Metro Express Lanes."
- 70 Schrank, Eisele, and Lomax, "TTI's 2012 Urban Mobility Report."
- 71 Cortright, *Driven Apart: How Sprawl Is Lengthening Our Commutes and Why Misleading Mobility Measures Are Making Things Worse*.
- 72 Iacono and Levinson, "Case Studies of Transportation Investment to Identify the Impacts on the Local and State Economy."
- 73 Chandra and Thompson, "Does Public Infrastructure Affect Economic Activity?"
- 74 Chi, "The Impacts of Highway Expansion on Population Change."
- 75 Iacono and Levinson, "Case Studies of Transportation Investment to Identify the Impacts on the Local and State Economy."
- 76 Wachs, Martin (2011). *Transportation, Jobs, and Economic Growth*. Access, 38. University of California Transportation Center.
- 77 Wachs, Martin (2011). *Transportation, Jobs, and Economic Growth*. Access, 38. University of California Transportation Center.
- 78 Litman, T. (2010). *Evaluating Transportation Economic Development Impacts*. *Victoria Transport Policy Institute*, 8.
- 79 Wachs, Martin (2011). *Transportation, Jobs, and Economic Growth*. Access, 38. University of California Transportation Center.
- 80 Weisbrod and Reno, *Economic Impact of Public Transit Investment, 2014 Update* (2014).
- 81 Chatman, D.G., and R.B. Noland (2014). *Transit Service, Physical Agglomeration and Productivity in US Metropolitan Areas*. *Urban Studies*, 51(5), 917–937.
- 82 Weisbrod and Reno, *Economic Impact of Public Transit Investment* (2009); Weisbrod and Reno, *Economic Impact of Public Transit Investment, 2014 update* (2014).
- 83 AECOM, *Economic Impact Analysis of the Los Angeles Streetcar*.
- 84 The percent change in economic productivity divided by the percent change in accessibility. For methodologies for measuring economic productivity and accessibility, see Graham (2007, 2011).
- 85 Graham, D. (2007), *Agglomeration Economies and Transport Investment*. Joint Transport Research Centre. Discussion Paper No. 2007-11; Graham, D. (2012), *Wider Economic Benefits of Transport Investment and the Role of Agglomeration*. A slide presentation. Imperial College, London.
- 86 Metsaranta et al. (2014), *The Wider Economic Impacts of Transport Investments*. Bothnian Green Logistic Corridor Project.
- 87 Litman, T. (2010), *Evaluating Transportation Economic Development Impacts*. *Victoria Transport Policy Institute*, 8.
- 88 Partnership for Sustainable Communities, *Transit as Transformation: The Euclid Corridor in Cleveland*.
- 89 American Public Transportation Association (2013), *The Role of Transit in Support of High Growth Business Clusters in the U.S.*
- 90 Telephone conversation with Dave Williams, V.P. of Transportation, Atlanta Regional Chamber, May 29, 2013, conducted for the American Public Transportation Association (2013), *The Role of Transit in Support of High Growth Business Clusters in the U.S.*
- 91 American Public Transportation Association (2013), *The Role of Transit in Support of High Growth Business Clusters in the U.S.*
- 92 American Public Transportation Association (2013), *The Role of Transit in Support of High Growth Business Clusters in the U.S.*
- 93 Ibid.
- 94 Metropolitan Area Planning Council, *Route 128 Central Corridor Plan*.
- 95 Metropolitan Area Planning Council, *Route 128 Central Corridor Project*. MAPC website, retrieved Aug 19, 2014, at <http://www.mapc.org/smart-growth/route128>.
- 96 American Public Transportation Association (2013), *The Role of Transit in Support of High Growth Business Clusters in the U.S.*
- 97 Ibid.
- 98 San Francisco County Transportation Authority, *Final SAR08/09-2 Strategic Analysis Report on The Role of Shuttle Services in San Francisco's Transportation System*, June 28, 2011.
- 99 Ibid.
- 100 Data collected from BEA's Regional Economic Information System (REIS). Earnings are composed of wages and salaries, other labor income, and proprietors' income.
- 101 Chandra, A., and E. Thompson. (2000). *Does Public Infrastructure Affect Economic Activity? Evidence from the Rural Interstate Highway System*. *Regional Science and Urban Economics*, 30(4), 457–490.

-
- ¹⁰² Nadiri, Ishaq, and Theofanis Mamuneas. (1994). The Effect of Public Infrastructure and R&D Capital on the Cost Structure and Performance of U.S. Manufacturing Industries, *Review of Economics and Statistics*, Vol. 76, No. 1, (pp. 22–37).
- ¹⁰³ Holleyman, Chris. (1996). Industry Studies of the Relationship Between Highway Infrastructure Investment and Productivity. *Logistics and Transportation Review* pp. 93–117.
- ¹⁰⁴ AECOM, ICF Consulting, HLB Decision Economics, and Louis Berger Group (2001). Freight Benefit/Cost Study: Compilation of the Literature. Presented to Federal Highway Administration.
- ¹⁰⁵ Horst, T., and A. Moore. (2003). Industrial Diversity, Economic Development, and Highway Investment in Louisiana. *Transportation Research Record: Journal of the Transportation Research Board*, 1839(1), 136–141.
- ¹⁰⁶ Paulsen, K. (2013). The Effects of Land Development on Municipal Finance.
- ¹⁰⁷ Brueckner, J.K., 2000. Urban sprawl: Diagnosis and remedies. *International Regional Science Review* 23, 160-171.
- ¹⁰⁸ Lee, D.b. (1981). Land Use Planning as a Response to Market Failure. *The Land Use Policy Debate in the United States* pp 149-164
- ¹⁰⁹ Carruthers, J. I. (2002). The Impacts of State Growth Management Programmes: A Comparative Analysis. *Urban Studies*, 39(11), 1959–1982.
- ¹¹⁰ Carruthers, J.I., and G.F. Ulfarsson. (2003). Urban Sprawl and the Cost of Public Services. *Environment and Planning B*, 30(4), 503–522.
- ¹¹¹ Carruthers, J. I., & Ulfarsson, G. F. (2008). Does smart growth matter to public finance?. *Urban Studies*, 45(9), 1791–1823.
- ¹¹² Lieske, S.N., D.M. McLeod, R.H. Coupal, and S.K. Srivastava. (2012). “Determining the Relationship Between Urban Form and the Costs of Public Services” *Environment and Planning B: Planning and Design* 39(1) 155–173.
- ¹¹³ Brueckner, J.K., and H.A. Kim. (2003). Urban Sprawl and the Property Tax. *International Tax and Public Finance*, 10(1), 5–23.
- ¹¹⁴ Lukermann, Barbara, and Michael Kane. (1994). Land Use Practices: Exclusionary Zoning, De Facto or De Jure: An Examination of the Practices of Ten Suburban Communities in the Twin Cities Metropolitan Area, Minneapolis, Center for Urban and Regional Affairs, University of Minnesota, April.
- ¹¹⁵ International City/County Management Association and Anderson, Geoff (1998). Why Smart Growth: A Primer. ICMA – Smart Growth Network.
- ¹¹⁶ SANDAG. (2012). Traded Industry Clusters in the San Diego Region.
- ¹¹⁷ Because this cluster is not influenced by local policy and information available on the cluster are more limited than other clusters, SANDAG does not produce detailed estimates of activity in this cluster in a manner comparable to the Region’s other clusters although it is estimated to employ 100,000 people. As a result of the constraints on data for the Uniformed Military Cluster, it cannot be analyzed in a manner comparable to the other clusters in this report despite its importance in the Region. It is excluded from the foregoing analysis, but for additional discussion on the Uniformed Military Cluster, please see the “Importance of the Defense Sector” section in SANDAG’s 2012 publication, *Traded Industry Clusters in the San Diego Region*.
- ¹¹⁸ SANDAG does not produce zip-code level employment estimates or other data for the Uniformed Military Cluster that are comparable to the data developed for the Region’s other clusters. As a result of the constraints on data for the Uniformed Military Cluster, it cannot be analyzed in a manner comparable to the other clusters in this report despite its importance in the Region. It is excluded from the foregoing analysis, but for additional discussion on the Uniformed Military Cluster, please see the “Importance of the Defense Sector” section in SANDAG’s 2012 publication, *Traded Industry Clusters in the San Diego Region*.
- ¹¹⁹ Corridors 1, 2, and 3 were measured in the morning peak, while Corridor 5 was measured in the afternoon peak.
- ¹²⁰ SANDAG. (2014). 2050 Regional Growth Forecast, SANDAG Data Warehouse. Retrieved from <http://www.profilewarehouse.sandag.org/profiles/fcst/reg999fcst.pdf>
- ¹²¹ Corridors 1, 2, and 3 were measured in the morning peak, while Corridor 5 was measured in the afternoon peak.
- ¹²² Employment totals reported in this section depict different totals than those presented in SANDAG’s *Traded Industry Clusters in the San Diego Region*. The major difference between the two industry cluster totals is that they use different sources. The Traded Industry Clusters report is based on the QCEW for its consistency and reliability. To show trends for custom geographies in this report, SANDAG and AECOM utilized raw data from California Employment Development Department (EDD) which are more granular and better suited for GIS analysis, but available less frequently.
- ¹²³ This change would result in 96,000 employees instead of about 35,700 employees being captured in transit corridors, however, this number is not exact due to overlap in some corridors, notably in Downtown San Diego.
- ¹²⁴ Although some freight movement can be timed to avoid peak times, some freight vehicles travel does still take place during peak times. A decrease in travel time would provide more rapid access to all vehicles traveling at peak times, including freight vehicles.
- ¹²⁵ American Public Transportation Association, *The Role of Transit in Support of High Growth Business Clusters in the U.S.*

-
- ¹²⁶ Although the term “affordable” is often used to describe housing provided at below market rates, this analysis uses the term in the context of what a person or household can afford to pay before it is considered overburdened by the expense. See the section entitled *Why the 30 Percent of Income Standard for Housing Affordability?* in “Who Can Afford To Live in a Home?: A look at data from the 2006 American Community Survey” for more information on the history of this standard. <http://www.census.gov/housing/census/publications/who-can-afford.pdf>
- ¹²⁷ See “Who Can Afford To Live in a Home?: A look at data from the 2006 American Community Survey” for more information on the history of this standard. <http://www.census.gov/housing/census/publications/who-can-afford.pdf>
- ¹²⁸ Traded Industry Clusters in the San Diego Region (2012), SANDAG.
- ¹²⁹ It should be noted that although there is a high concentration of entertainment and hospitality employment across all key automotive corridors, this is partially due to the inclusion of restaurant workers that serve both local residents and tourists. As a result, although the number and concentration of workers included in this cluster is relatively high, not all of the employment in this cluster meets the definition of being export oriented since workers serving tourists would be considered export oriented while those serving residents would not meet this definition.
- ¹³⁰ Up to 50 percent of workers in the Food and Beverage Serving and Related Workers occupation worked part time in their occupation in 2012 per the Bureau of Labor Statistics, U.S. Department of Labor, Occupational Outlook Handbook, 2014-15 Edition, Food and Beverage Serving and Related Workers.
- ¹³¹ 2010 American Community Survey, 1 Year Estimate-Table DP04.
- ¹³² 2010 American Community Survey, 1 Year Estimate-Table S2503.
- ¹³³ These factors include current and expected interest rates as well expected demand for rented and purchased housing. For a discussion on the relationship between rents and housing prices see “Understanding House-Price Dynamics,” in Q2 2011 *Business Review*, Federal Reserve Bank of Philadelphia. For additional discussion on this topic, see “The Long-Run Relationship between House Prices and Rents,” 2004 Finance and Economics Discussion Series, Federal Reserve Board.
- ¹³⁴ 2010 American Community Survey, 1 Year Estimate-Table S2503.
- ¹³⁵ Although the term “affordable” is often used to describe housing provided at below market rates, this analysis uses the term in the context of what a person or household can afford to pay before it is considered overburdened by the expense. See the section entitled *Why the 30 Percent of Income Standard for Housing Affordability?* in “Who Can Afford To Live in a Home?: A look at data from the 2006 American Community Survey” for more information on the history of this standard. <http://www.census.gov/housing/census/publications/who-can-afford.pdf>
- ¹³⁶ This amount does not include additional housing-related costs such as utilities, taxes or insurance; see Methodology section for information on the number of workers per household.
- ¹³⁷ Up to 50 percent of workers in the Food and Beverage Serving and Related Workers occupation worked part time in their occupation in 2012 per the Bureau of Labor Statistics, U.S. Department of Labor, Occupational Outlook Handbook, 2014-15 Edition, Food and Beverage Serving and Related Workers.
- ¹³⁸ Note that the concentration of relatively-low wage Entertainment and Hospitality workers influences this number downward, and that this cluster is likely to contain some workers who do not meet the strict definition for inclusion in a traded industry cluster.
- ¹³⁹ Although the term “affordable” is often used to describe housing provided at below market rates, this analysis uses the term in the context of what a person or household can afford to pay before it is considered overburdened by the expense. See the section entitled *Why the 30 Percent of Income Standard for Housing Affordability?* in “Who Can Afford To Live in a Home?: A look at data from the 2006 American Community Survey” for more information on the history of this standard. <http://www.census.gov/housing/census/publications/who-can-afford.pdf>
- ¹⁴⁰ Up to 50 percent of workers in the Food and Beverage Serving and Related Workers occupation worked part time in their occupation in 2012 per the Bureau of Labor Statistics, U.S. Department of Labor, Occupational Outlook Handbook, 2014-15 Edition, Food and Beverage Serving and Related Workers.
- ¹⁴¹ SANDAG. (2014). 2050 Regional Growth Forecast, SANDAG Data Warehouse. Retrieved from <http://www.profilewarehouse.sandag.org/profiles/fcst/reg999fcst.pdf>
- ¹⁴² Center for Transit-Oriented Development, Trends in Transit-Oriented Development, 2000–2010.
- ¹⁴³ Fogarty and Austin, Rails to Real Estate: Development Patterns along Three New Transit Lines.
- ¹⁴⁴ Susan Jones Moses and Associates, “Bellevue Transit Center, Bellevue, WA.”
- ¹⁴⁵ Washington State Department of Transportation, “I-405 Congestion Relief and Bus Rapid Transit Projects- Project FAQs.”

146 Hovee, Eric, and Rick Gustafson. "Streetcar Development Linkage: The Portland Streetcar Loop."
147 Moler, "Colossal Partnership: Denver's \$1.67 Billion T-REX Project."
148 RTD, *T-REX Transit Oriented Development Lessons Learned Report*.
149 Ibid.
150 RTD, "Facts and Figures - Southeast Corridor Light Rail Line."
151 Center for Transit-Oriented Development, *Trends in Transit-Oriented Development, 2000-2010*.
152 Ibid.
153 Sadler and Wampler, *Enhancing Economic Opportunity through Transit: Lessons Learned from Denver's Southeast Light Rail Line*.
154 Fogarty and Austin, *Rails to Real Estate: Development Patterns along Three New Transit Lines*.
155 Ibid.; Fogarty et al., *Downtowns, Greenfields, and Places in Between: Promoting Development Near Transit*.
156 Center for Transit-Oriented Development, *Trends in Transit-Oriented Development, 2000-2010*.
157 Whaley, "RTD Wins Key Partners to Extend Southeast Rail Extension."
158 Crowley, *The Emerald Express: Overcoming Growing Pains and Opposition to Bus Rapid Transit*.
159 Lane Transit District, "EmX."
160 Center for Transit-Oriented Development, *Trends in Transit-Oriented Development, 2000-2010*.
161 U.S. Federal Transit Administration, "The EmX Franklin Corridor BRT Project Evaluation."
162 U.S. Federal Transit Administration, *The EmX Franklin Corridor BRT Project Evaluation*.
163 Pioneer Parkway EmX BRT, "Pioneer Parkway EmX BRT: Springfield, OR."
164 Lane Transit District, "West Eugene EmX."
165 U.S. Federal Transit Administration, "West Eugene EmX Extension: Eugene, Oregon."
166 Nelson and Ewing, *BRT and Economic Development: Case Study of the Eugene-Springfield, Oregon BRT System*.
167 United States Government Accountability Office, *BRT: Projects Improve Transit Service and Can Contribute to Economic Development*.
168 "History of the Pearl District."
169 Fogarty et al., *Downtowns, Greenfields, and Places in Between: Promoting Development Near Transit*.
170 Quick, "Development Agreements: Leveraging Private Investment for Public Good."
171 Adams and Powell, *Portland Streetcar Development Oriented Transit*.
172 Strategic Economics, "Pasadena Streetcar Feasibility, Alignment, and Financing Analysis: Streetcar Case Studies."
173 "Portland Streetcar."
174 Eric Hovee and Rick Gustafson, "Streetcar Development Linkage: The Portland Streetcar Loop."
175 Ibid.
176 Strategic Economics, "Pasadena Streetcar Feasibility, Alignment, and Financing Analysis: Streetcar Case Studies."
177 Ibid.
178 Ibid.
179 "Portland Streetcar."
180 Strategic Economics, "Pasadena Streetcar Feasibility, Alignment, and Financing Analysis: Streetcar Case Studies."