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16. ABSTRACT

This project is the second phase of a larger effort aimed at developing a group of key indicators, referred to in this document as the Statewide Monitoring System, to track progress toward achieving certain SB 375 goals across California. One of the legislation's goals is to promote better coordination of land-use, housing, and transportation planning with the goal of reducing vehicle miles traveled (VMT) and Greenhouse Gas (GHG) emissions. The proposed Statewide Monitoring System identifies key recent developments by small geographies (i.e. census tracts), which can assist the State to revise and refine policies and programs in response to actual changes in the built environment and intensity of activities, particularly for the scheduled four -year updating cycle of each Metropolitan Planning Organization's regional transportation plan and sustainable communities strategy (SCS). A secondary benefit is that the proposed data can also provide useful information to regional agencies and local governments.

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Developing Statewide Sustainable-Communities Strategies Monitoring System for Jobs, Housing, and Commutes

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Table of Contents

Figures and Tables

Acronyms and Abbreviations

ACS	American Community Survey
Caltrans	California Department of Transportation
CARB	California Air Resources Board
CBD	central business district
CSAs	combined statistical areas
CTPP	Census Transportation Planning Products
DMP	Digital Map Products
FTA	Federal Transit Administration
GC	Great Circle (Distance)
GHG	greenhouse gas
GTFS	General Transit Feed Specification
HCD	California Department of Housing and Community Development
HCV	Housing Choice Voucher
HQTLs	high-quality transit locations
HUD	U.S. Department of Housing and Urban Development
IVC	Imperial Valley College
JHF	jobs-housing fit
LEHD	Longitudinal Employer-Household Dynamics
LIHTC	Low-Income Housing Tax Credit
LODES	Longitudinal Origin Destination Employment Statistics
MAP-21	Moving Ahead for Progress in the 21st Century Act
MPO	metropolitan planning organization
MTC	Metropolitan Transportation Commission
NTD	National Transit Database
OD	origin-destination
OHU	occupied housing unit
PHA	public housing authorities
PMT	person miles traveled
RTPs	Regional Transportation Plans
SAS	Statistical Analysis Systems
SB	Senate Bill
SCAG	Southern California Association of Governments
SCS	sustainable community strategy
SES	socioeconomic status
UI/DI	unemployment insurance/disability insurance
VKT	vehicle kilometers traveled
VMT	vehicles miles traveled

ABSTRACT

This project is the second phase of a larger effort aimed at developing a group of key indicators, referred to in this document as the Statewide Monitoring System, to track progress toward achieving certain SB 375 goals across California. One of the legislation's goals is to promote better coordination of land-use, housing, and transportation planning with the goal of reducing vehicle miles traveled (VMT) and Greenhouse Gas (GHG) emissions. The proposed Statewide Monitoring System identifies key recent developments by small geographies (i.e. census tracts), which can assist the State to revise and refine policies and programs in response to actual changes in the built environment and intensity of activities, particularly for the scheduled four -year updating cycle of each Metropolitan Planning Organization's regional transportation plan and sustainable communities strategy (SCS). A secondary benefit is that the proposed data can also provide useful information to regional agencies and local governments.

Planning processes for implementation of SB 375 and actual changes in development patterns involve relatively long periods of time. The report proposes data that might be used to indicate short-term changes in new housing development, subsidized affordable housing, and net changes in jobs. These changes are assessed against relevant baselines that include occupied housing unit density, jobs-housing fit, access to jobs from residential location, access to high-quality transit locations (HQTLs), and average person miles traveled by workers at job sites. Although the data indicators do not measure vehicle miles traveled (VMT) directly, they indicate short-term, real-world changes in land-use patterns that are shown to affect per capita VMT. The system is useful in demonstrating whether, and to what degree, changing land-use patterns and recent developments support opportunities for greater GHG emissions reductions.

The data, representing the early years following the enactment of SB 375, indicate that for California as a whole, new housing units were relatively less concentrated in all of the following areas: higher density tracts, high job-access tracts, and HQTL areas. The data also shows that net increases in jobs were most concentrated in areas with relatively higher average commutes and more concentrated outside of HQTL areas. The spatial distribution of changes in subsidized affordable housing during the test period (2010-2014) is generally unchanged from the 2010 baseline, thus reproducing the preexisting imbalance of low-earning jobs and affordable housing.

Overall, the statewide results suggest that land-use development and land-use activity during the first part of the decade were largely inconsistent with broader SB 375 goals. These trends reflect changes occurring during the first four-year transportation planning cycle under SB 375, not an assessment of the Regional Transportation Plans adopted during that timeframe. The analysis indicates that there are considerable needs and opportunities for the State to work collaboratively with MPOs and local governments to further implement SCS strategies in order to meet the GHG reduction goals pursuant to SB 375.

EXECUTIVE SUMMARY

Background

This report contains the analytical work and results of an effort to monitor land-use, built environment, transportation patterns and changes that are relevant to Senate Bill 375 (SB 375), the Sustainable Communities and Climate Protection Act of 2008. This legislation is an integral part of California's commitment to offset the adverse effects of climate change by employing coordinated land-use, transportation, and housing strategies to reduce greenhouse gas (GHG) emissions from private automobiles and light trucks by setting and meeting GHG reduction goals. More compact, higher-density development is a key emissions reduction strategy for regions across California. SB 375 also encourages equity by making changes to align affordable housing and transportation planning. Improving spatial access to public transit and locating employment in existing job centers that require shorter commutes are other development-related strategies that are also consistent with SB 375. Given the magnitude of the challenges associated with climate challenge and the resources being dedicated towards reducing GHG emissions, it is critical that the impact of policy-related changes are measured and assessed for their effectiveness in reaching policy and program goals. The results of this report can be used to measure progress and guide necessary modifications of SCS policies and programs toward improving outcomes; however, the monitoring system as currently conceived does not constitute an assessment of the performance of any particular SCS.

The California Department of Transportation (Caltrans) is pursuing the research presented in this report as part of a broader effort to track California's progress toward GHG reduction goals. As required by Senate Bill 150 (Allen), the California Air Resources Board (CARB) has identified approximately twenty metrics to monitor progress on GHG reductions under SB 375 and the strategies utilized to reduce GHG emissions. CARB has also identified accessibility as a topic area in need of further research. This project complements these efforts by researching a method for measuring land-use changes that relate to accessibility and density.[1]

The proposed Statewide Monitoring System documented here represents Phase II of a two-phase effort funded and advised by Caltrans and CARB. Phase I culminated in the construction of the Los Angeles Prototype Monitoring System.[2] This first effort included a literature review to ground the empirical work and extensive assessments and evaluations of data sources and methods. We refer to the previous report throughout this report and, where relevant, point readers to the Phase I report for a more detailed discussion regarding foundational data and methods. Phase II scaled the Los Angeles Prototype Monitoring System to the statewide level to create the Statewide Monitoring System. In addition to scaling up to a larger geography, the Statewide System also incorporates refinements and modifications identified in the Phase I prototype.

While neither the Los Angeles nor Statewide Monitoring Systems measure vehicle miles traveled (VMT), they do measure short-term, real-world changes in land-use patterns that are shown to affect per capita VMT.[3] The system is useful in demonstrating whether, and to what degree, changing land-use patterns and recent developments support opportunities for greater GHG emissions reductions.

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[1] SB 375 also contains other important objectives that are beyond the scope of this project.

[2] For more information on Phase I and to download a copy of the report, see the following link: https://www.arb.ca.gov/research/single-project.php?row_id=65256

[3] Although it is desirable to monitor per capita VMT and associated emissions, there are no readily available data that are reliable, consistent and reasonably accurate for all census tracts in the whole state.

Report Contents

This report describes key elements of the Statewide Monitoring System. As stated above, the monitoring system is designed to track recent developments and short-term changes (four-year changes) in land-use patterns across California. As with the Phase I report, this report evaluates various data sources and indicator-construction methodologies. This report also evaluates data and indicators adopted since the completion of the Phase I and the Los Angeles prototype.

Objectives

The objective of this project is to research and propose a system for monitoring progress toward achieving certain SB 375 goals across the State of California. The project was organized in two phases. Phase I included the initial identification of data, metrics, and indicators, conducted in collaboration with stakeholders and an Advisory Committee. It included also in-depth assessments of available data sources and, finally, resulted in the creation of a prototype monitoring system for Los Angeles County. Phase II included identification of modifications and augmentations to the monitoring system. These refinements were based on lessons learned from the LA prototype, in-depth assessments of new data sources based on lessons learned, and the "scale-up" of the monitoring system to the stateside level.

What Is the Statewide Monitoring System?

Included in the monitoring system is a baseline, constructed from indicators representing the state of land-use patterns and activities when CARB first set regional GHG reduction targets in accordance with SB 375, and the measurement of short-term changes in new housing development, net changes in subsidized affordable housing, and net changes in jobs. "Short-term changes" are those that occur within four years from the baseline. The changes are compared to relevant baselines for occupied housing unit density, jobs-housing fit, access to jobs from residential location, access to high-quality transit locations (HQTLs), and average (mean) person miles traveled (PMT) by workers at a job site. Table E-0-1 summarizes the analyses included in the monitoring system, depicting each indicator and the baseline that will serve as a reference point for evaluating the direction of short-term changes.

During the period from 2010 to 2014, MPOs were at various stages of adopting their first SB 375-compliant SCSs, as indicated in the table in Appendix D, therefore the directionality of changes during this period may or may not have been affected by specific MPO strategies. Still, analysis of these trends provides useful insights that are included in this report.

Table E-0-1: Summary of Monitoring System Baseline Indicators and Short-Term Change Measures

	Short-Term Changes		
Baseline	**New Housing Units**	**Changes in Subsidized Affordable Housing (HCV and LIHTC)[4]**	**Net Change in Jobs**
Occupied Housing Unit Density	✓		
Jobs-Housing Fit		✓	
Access to Jobs from Residential Location	✓		
Access to HQTLs	✓		✓
Average (Mean) PMT at Job Site			✓

Methods

Data Assessment

An extensive assessment of the data and methods was a major and critical step in the research and development of the Statewide Monitoring System. The system is not comprehensive but represents the best available data and most feasible methods, given the project's priorities and the time and resources available. Data limitations are present for the system and should be noted when interpreting findings. The system is not a site-planning tool as data are not precise enough for this geographic granularity; however, the monitoring system can be applied to cities and regions. The Statewide Monitoring System provides some measure of these conditions at small geographies (i.e., census tracts).

The assessment shows some data are relatively more robust, reliable, and consistent than others. For example, because they come from the Census Enumeration, data on occupied housing density are the most reliable and comprehensive. Other measures are subject to variations in collection, reporting, and the effects of outside (non-land-use) changes. Transit data from the General Transit Feed Specification (GTFS) proved to be problematic as we encountered inconsistencies in the reporting practices of agencies and incomplete coverage for stops and schedules. We assessed several sources for employment related-data. Although the data are relatively reliable, the results can be subject to business-cycle effects that reflect macroeconomic changes more than changing land-use patterns. Nonetheless, despite any shortcomings, the Statewide Monitoring System does accomplish a number of key monitoring goals and produces some useful insights.

[4] This analysis only includes changes in subsidized affordable units, both Housing Choice Voucher and Low-Income Housing Tax Credit units, and not market-based affordable rental units. The Housing Choice Voucher Program (formerly known as Section 8) provides rental assistance to very low-income families, the elderly, and the disabled for privately owned housing that participates in the program. The Low-Income Housing Tax Credit is a federal program to encourage the development of affordable housing for low-income households by providing tax incentives to developers. There are many challenges to estimating affordable market rate units, including census rent brackets that are not adjusted for inflation, the difficulties of separating subsidized from unsubsidized units, and reporting errors related to rent in subsidized units.

What Are the Baseline Indicators and How Are They Calculated?

Baseline indicators represent the state of land-use patterns and activities when CARB first set regional GHG reduction targets in accordance with SB 375. The baseline is as a point of comparison for changes occurring four years from this "starting point." The distribution of changes is assessed against the baseline to uncover how much and in what direction changes occurred. The result track land use and travel trends occurring during the timeframe of development for the first wave of SB 375 compliant Regional Transportation Plan and SCS. These trends reflect a "baseline trajectory" that measures changes occurring during the first four-year planning cycle under SB 375, not an assessment of the Regional Transportation Plans adopted during that timeframe.

Table E-0-2 lists the indicators included in the Statewide Monitoring System and a brief explanation of how these indicators were constructed.[5] Note that some of these indicators were identified and piloted via the Los Angeles Prototype completed in Phase I; others reflect changes and refinements based on lessons learned from the prototype and input from the Advisory Committee.[6] With the exception of transit and jobs-housing fit measures, the baseline year is 2010. SB 375 compliant Regional Transportation Plans were adopted in the years 2010-2014.

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[5] The Phase I report (see Chapter 5) and this report (see Chapter 5) include additional, more extensive discussion of methods.

[6] See p.2 for list of Advisory Committee members and their affiliations.

Table E-0-2: Baseline Indicators and Calculation Method

Baseline Indicator	Baseline Year	Calculation Method
Occupied housing unit density	2010	$\frac{\text{Total \# of occupied housing units in a census tract}}{\text{Land area of the census tract in square miles}}$
Jobs-housing fit	2006-2012[7]	$\frac{\text{Total \# of low earnings jobs within 2.5 mile buffer of a census tract}}{\text{Total \# of affordable rental units in buffer}}$
Access to jobs from residential location	2010	Index figure measuring the relative number of jobs accessible by residential location, calculated using an exponential decay method with a state-calibrated parameter (derived by authors)
Access to HQTLs	Most readily available recent data	A quarter-mile buffer around any one or more of the following locations: • Any existing transit rail station; or • A terminal served by a ferry system in major metropolitan areas; or • A location with bus service maintaining average headways of 15 minutes or less during morning peak hours (6:30 am – 8:30 am) on a given weekday
Average (mean) PMT at job site	2010	$\frac{\text{Total commute miles for workers at a job site}}{\text{Total \# of workers at the job site}}$

Results and Conclusions

The data assessment and analysis shows there are some limitations to the data. Additionally, the monitoring system is not meant to be comprehensive but rather representative of key elements of focus for tracking progress toward SB 375 goals. Despite these limitations, the results are useful in identifying the changes that are occurring and for guiding refinements and adjustments to policy.

The results of the project indicate that, with respect to these baseline indicators, land-use development and land-use activity during the first part of the decade have been largely inconsistent with broader SB 375 goals, suggesting that there are considerable needs and opportunities for the State to work collaboratively with MPOs and local jurisdictions to enhance SCS efforts to meet the GHG reduction goals set via SB 375. The findings from this report are consistent with those found in CARB's recent SB 150 report indicating California is not on track to meet the greenhouse gas reductions expected under SB 375 for 2020.[8] The findings from this report add more detail to CARB's SB 150 report by examining development across small geographies that are classified by SCS characteristics. The findings from CARB's SB 150 and this report are not surprising since the analytical period coincides with the initial effort to plan for the implementation of SB 375, particularly in the form of the first wave of RTP/SCS development by MPOs. Thus, many of

[7] Based on two 5-year average datasets: 2006-2010 CTPP for data on job counts by earnings levels and 2008-2012 ACS for information on rental housing units by rent levels

[8] For more information on CARB's SB 150 report and to download a copy of the report, see the following link: https://ww2.arb.ca.gov/resources/documents/tracking-progress

the projects and strategies from the initial effort had not yet been built or otherwise implemented during the analytical period. The results from the analysis provide insights on additional steps to ensure effective subsequent planning and implementation efforts.

Below are the reports' major findings. Compared to the baseline indicators:

- New housing units are relatively less concentrated in the higher density tracts.
- New housing units are relatively less concentrated in high job-access tracts.
- New housing units are relatively less concentrated in HQTL areas.
- Net increases in jobs are less concentrated in job sites with lower average PMT generated by workers.
- Net increases in jobs are relatively less concentrated in HQTL areas.
- The distribution of new/change in subsidized affordable housing is generally unchanged from the baseline, thus reproducing the preexisting imbalance of low-earning jobs and affordable housing.[9]

Given the findings, recommendations for future efforts include[10]:

1. The State should update and refine data to address issues documented in this report to continue monitoring land-use, built environment, transportation patterns and changes relevant to Senate Bill 375 goals. This also includes both updating the analysis and developing new measures to address other elements of SB 375;
2. The State should consider integrating the Statewide Monitoring System and its contents into other existing and ongoing SB 375 monitoring efforts and Statewide data systems (e.g., CARB's ongoing monitoring efforts under SB 150, MAP-21 and CalEnviroScreen);
3. State agencies and metropolitan planning organizations (MPOs) should use findings as part of the larger effort to refine and revise SCSs, policies, and programs;
4. MPOs and local jurisdictions should utilize the monitoring system to track their progress, and the State should encourage regional agencies and local jurisdictions to independently and actively monitor development and SCS implementation efforts;
5. Any entity (e.g., agency, jurisdiction, etc.) that undergoes the development of a monitoring or evaluative system should extensively evaluate the data and methods; this recommendation is also relevant for any future changes or improvements to the monitoring system described herein;
6. For this system or any future evaluation systems, the selection of baselines and indicators should be based both on the technical recommendations of researchers and on priority areas identified by stakeholders;
7. The State should take the lead on setting standards of good practice for the collection and management of data used for a monitoring system; and
8. Future monitoring systems—including future versions of the system described herein—should include more direct and thorough measures for addressing the equity elements of strong regional planning.

[9] This analysis has limitations. It does not capture unsubsidized or market-based affordable housing units (so called "naturally affordable" housing units).

[10] A more detailed discussion of these recommendations is discussed in Chapter 8 ("Conclusion and Recommendations") of this report.

Chapter 1 INTRODUCTION

This report documents the process and results of researching and developing a group of key indicators, collectively referred to in this document as the statewide monitoring system, for tracking changes in the built environment that reflect progress in meeting the GHG reduction goals of SB 375. The monitoring system is designed to provide a broad overview for the state as a whole. It is not a tool for assessing site- or neighborhood-specific planning and projects, although the information potentially could be useful as a preliminary step in studying small geographies.

The system measures changes in new housing units, changes in subsidized affordable housing, and net changes in jobs, and assesses the distribution of these indicators against a baseline of relevant indicators. The Statewide Monitoring System examines key elements of recent real-world changes in the spatial structure of California to help track whether observable developments and changes in land use are consistent with SB 375 goals. The final product, a statewide monitoring system, is not meant to be comprehensive, as there are elements and changes in development that cannot be easily measured. The system examines a few key and specific trends, and is meant to function as a guide for evaluating changes occurring since the implementation of SCSs.

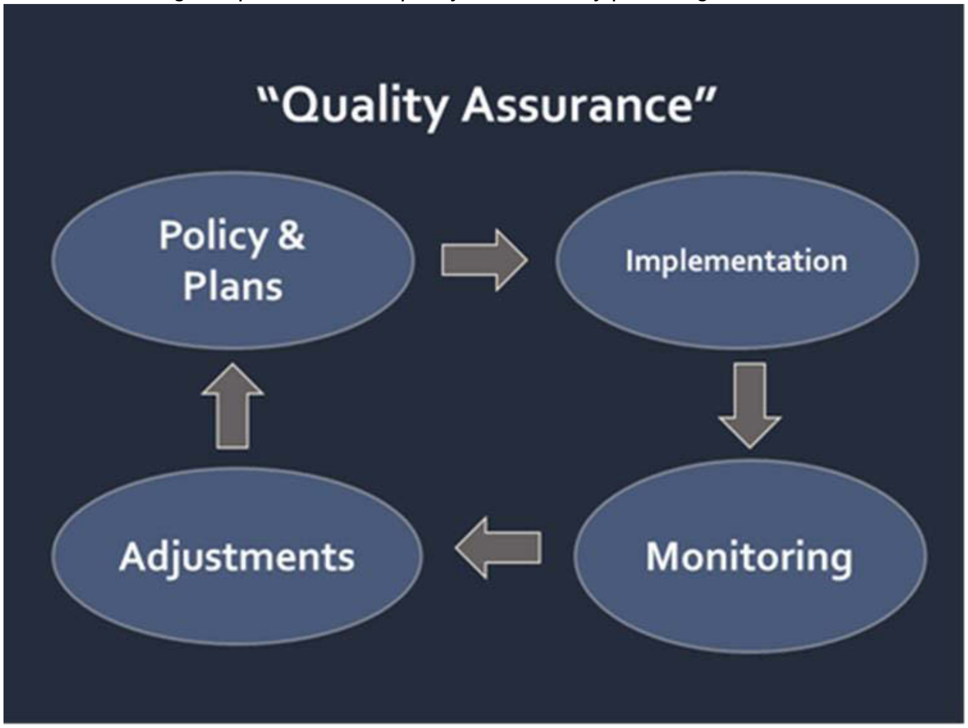
Provided in this report is more detailed information on the Statewide Monitoring System that was developed following the selection of indicators, indices, and data for California.

Background and Process

SB 375 and other policies have promoted better coordination of land use and transportation planning as one approach to reducing VMT and thereby lowering GHG emissions. This approach complements other strategies that seek to reduce GHGs and promote transportation sustainability, such as improvements in vehicle technology and encouraging increased adoption of more efficient vehicles. The SB 375 monitoring system for tracking changes in land-use development and associate outcomes is an integral part of effective practice. Monitoring is a crucial step in the successful implementation of any policy. Without successful implementation strategies, even good policies can fail. Active monitoring can facilitate successful outcomes by providing critical information on progress toward goals and by helping to inform any necessary improvements or course correction to policy (see Figure 1-1).

Figure 1-1: The Role of Monitoring in Policy

Active monitoring can promote better policy outcomes by providing critical information



Source: UCLA Center for Neighborhood Knowledge

Given the range of what is directly and indirectly related to land-use development, there is a wide spectrum of possible dimensions to measure and include in a monitoring system such as this. Additionally, there are a variety of methods for measuring and tracking associated changes. Because time and resources are limited, development of the Statewide Monitoring System is based on prioritized metrics identified through input from an Advisory Committee, CARB, and Caltrans. The baseline includes the following priority areas: occupied housing unit density, jobs-housing fit, access to jobs from residential location, access to HQTLs, and average (mean) PMT at the job site. Short-term changes include new housing units, changes in subsidized affordable housing, and net changes in jobs. The Statewide Monitoring System captures changes in the built environment by monitoring new physical developments through new housing units, and captures changes in the intensity of activities by monitoring net changes in employment and changes in subsidized affordable housing (i.e., can residents afford to live near their work and/or are those jobs that are located in their neighborhoods jobs that residents could take?). The monitoring system focuses on short-term developments (four years out from the baseline line year) for small geographies (census tracts), and uses the timing of initial efforts to formulate SCSs as a starting point for constructing the baseline.

The monitoring system complements other efforts to monitor RTP implementation and progress under SB 375. The Statewide Monitoring System is a systematic source of information to examine current metrics of land-use patterns and inform strategies to meet these targets. For instance, under SB 150 (Allen, Chapter 646, Statutes of 2017), CARB is required to prepare a report every 4 years that "assesses progress made by each metropolitan planning organization in meeting the regional greenhouse gas emission reduction targets set by the state board."[11] The CARB report must "include changes to greenhouse gas emissions in each

[11] For full text of legislation and related requirements, see the following link:

region and data-supported metrics for the strategies utilized to meet the targets… [and] a discussion of best practices and the challenges faced by the metropolitan planning organizations in meeting the targets, including the effect of state policies and funding."[12] CARB's first report was released in November 2018 and includes approximately twenty metrics of progress. Going forward, the analysis detailed in this project could possibly be integrated into that ongoing monitoring effort.

Other complementary efforts are those related to the Moving Ahead for Progress in the 21st Century Act (MAP-21), which requires States and MPOs to establish and use a performance-based approach as part of the statewide and metropolitan transportation planning process. The objective of this program is for States to invest resources in projects that will collectively make progress toward the achievement of national performance goals in seven areas: Safety, infrastructure Condition, Congestion Reduction, System Reliability, Freight Movement and Economic Vitality, Environmental Sustainability, and Project Delivery. The program requires states and MPOs (where applicable) to report to the U.S. Department of Transportation on progress in achieving targets.[13] The part of MAP-21 most relevant to this project is found in its sections on environmental sustainability, where the stated goal is, "to enhance the performance of the transportation system while protecting and enhancing the natural environment."[14]

Most MPOs do not conduct small-area analysis, at least not at the tract level. This report's Statewide Monitoring System fills this gap with tract-level analysis for developments and land uses associated with environmental impacts and sustainability. Additionally, this project is not focused on the performance of the transportation system nor the outcomes of investments, but examines instead how the transportation system is used (e.g. usage as influenced by the geographic patterns of housing and employment).

The statewide monitoring system also complements other tools currently used by public agencies as part of SCS development. For example, MPOs use large-scale regional transportation models (often in conjunction with economic and land-use models) to assess the distant future impacts of major public infrastructure investments. However, although based on some real-world empirical data, these analyses primarily use data to predict what could be expected to occur in the decades ahead. A more critical issue with using data from MPOs to conduct statewide analyses has to do with consistency of data and methods. There are wide differences in analytical practices between MPOs making it impossible to build a statewide SB 375 monitoring system by simply aggregating MPO statistics.

The data and approaches used in the Statewide Monitoring System are based on those tested for Los Angeles in Phase I, and includes refinements adopted based on an assessment of the Los Angeles Prototype. This report includes new information documenting the development of the statewide system. It also pulls from the Phase I report where relevant. For more detailed information on the foundational work conducted in Phase I, please see the Phase I report.[15]

Assessing the Data, Indicators, and Measures

There are many alternative ways of transforming data into indicators and measures, and there are tradeoffs associated with selecting certain data sources and methods over others. In the process of developing the monitoring system and constructing indicators, we found that there were wide variations in the quality of

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https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180SB150. Date accessed: December 14, 2018

[12] Ibid.

[13] For more information, see the Federal Highway Administration MAP-21 factsheet at: https://www.fhwa.dot.gov/map21/factsheets/pm.cfm. Date accessed: December 14, 2018

[14] Ibid.

[15] To download a copy of the Phase I report, see the following link: https://www.arb.ca.gov/research/single-project.php?row_id=65256. Date accessed: December 14, 2018

data (e.g., timing in reporting, errors, inconsistencies), which can then impact the quality of constructed indicators and measures (i.e., errors in data that filter down into erroneous results). We also observed issues with potentially incompatible application of preexisting formulas and parameters toward the construction of accessibility measures. This is especially problematic given the complications of scaling up to the state level as there are wide regional variations.

We are not free of the preceding issues in data and indicator construction. To minimize any flaws in data and shortcomings in methods, we put in corrections when possible, tested alternative methods of indicator construction, and estimated state-specific parameters.

For most indicators, data coverage, accuracy, and consistency are such that we are fairly confident in the validity of our results. For others, where we found shortcomings in the data, results should be viewed with caution. The results of the access to HQTL measure, in particular, are complicated by issues of wide variation in the data collection and reporting practices of agencies and in incomplete coverage of agency stops and schedules in GTFS. These data challenges make the access to HQTLs measures the lowest-quality and most problematic set of results in the monitoring system. Additionally, jobs data and results are subject to business-cycle effects that relate to the state of the economy of the time and not necessarily on land-use development patterns. Contrastingly, as they relied on the relatively robust and complete Decennial Census enumeration, occupied housing unit density measures are the highest-quality measures in the monitoring system.

Despite any shortcomings, however, the Statewide Monitoring System does accomplish a number of key things. The development process included an extensive assessment and evaluation of data sources and methods. In those steps, we were able to identify gaps and apply the results of those evaluations toward dealing with some of the issues in the data. As a result, some of the data used in the Statewide Monitoring System represent the most complete dataset available, based on our knowledge of the field and a review of related studies.

- **Transit Coverage:** To the best of our knowledge, the access to HQTLs indicator constructed for this project is perhaps the most comprehensive access to transit measure available for California. Although we identified some significant gaps in coverage, GTFS remains the most complete data source for statewide transit data. It covers 127 out of California's more than 200 agencies. We did not identify any other access to high-quality transit location measure that has been created at the state level, particularly one that uses a consistent data source, definition and method.
- **Jobs-Housing Fit:** This indicator was assessed and refined to adjust for regional variations in earnings and rental costs across California. Other studies have conducted similar analyses, but most focus only on a single region. To the best of our knowledge, no jobs-housing fit measure exist for the State, particularly one that accounts for regional differences in earnings and rental costs.
- **Addressing Missing Data in Statewide Parcel Dataset:** Our assessment of this data shows that if used without adjustment, thousands of units would be left unaccounted for. We found wide variations in the quality of data and the methods of reporting among counties. These include the underreporting of unit numbers, the reporting of zero units where units should exist, and parcels where the number of units was left blank. We developed a method for imputing the number of housing units to address these major gaps.
- **Customized Accessibility Indicators for California:** Unlike many other analysts who often use parameters from the literature, which may or may not be appropriate for California or for the current time period, we investigated numerous alternative methods, selecting the one that best fits the State.

Results and Findings

Despite any of the preceding data and methodological limitations, the proposed Statewide Monitoring System does yield some useful insights. The system measures three indicators of change (new housing units, changes in subsidized affordable housing, and net change in jobs) compared to baseline indicators (occupied housing unit density, jobs-housing fit, access to jobs by residential location, access to HQTLs, and average PMT at job site). Examining the results of these trends, in relation to desired SB 375-related outcomes, shows that there is still much that can be done.

Although many of the projects and strategies from the first wave of RTP/SCSs would not have their full implementation and effect, overall, recent land-use development and land-use activities are largely inconsistent with VMT-reduction strategies, thus warning that the state may not be on track to meet SB 375 GHG reduction goals.[16] For the state as a whole, the direction (positive progress, negative, or neutral) are summarized in Table 1-1. The results indicate that development during and after the first cycle of SCS planning was not entirely consistent with SB 375 goals. However, we are unable to measure the counterfactual; that is, although results are limited, they could have been worse without SCS-related interventions.

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[16] CARB's SB 150 report does not say much about where and how land use development is occurring. The report finds that in many of the most urbanized regions, land development efficiency (total open space acres developed and total acres developed / 1000 new pop) is down, and the multi-family/single-family ratio is up. The report does address the lack of housing being built.

Table 1-1: Summary of Findings in Relation to SB 375 Goals

	Short Term Changes		
Baseline	**New Housing Units**	**Changes in Subsidized Affordable Housing (HCV and LIHTC)**	**Net Change in Jobs**
Occupied Housing Unit Density	Compared to the baseline, new housing units are relatively less concentrated in the higher density tracts, which is inconsistent with SB 375 goals		
Jobs-Housing Fit		The distribution of new/changes in subsidized affordable housing is similar to the baseline, thus reproducing the preexisting imbalance of low-earning jobs and affordable housing	
Access to Jobs from Residential Location	New housing units are relatively less concentrated in high job access tracts, which is inconsistent with SB 375 goals		
Access to HQTLs	New housing units are relatively less concentrated in HQTL areas, which is inconsistent with SB 375 goals		Net increases jobs are relatively less concentrated in HQTL areas, which are inconsistent with SB 375 goals
Average (Mean) PMT at Job Site			Net increases jobs are less concentrated in job sites with lower average PMT, which is inconsistent with SB 375 goals

The remainder of this report is organized by analytic tasks, as follows:

- Chapter 2 provides a brief summary of the literature review included in the Los Angeles County Prototype Monitoring System report on the conceptual framework and associated metrics of the "5 Ds of Travel Demand." It also includes a review of literature relating to new areas of coverage in the Statewide Monitoring System such as jobs-housing fit.
- Chapter 3 provides an overview of the process, scope, and analytical approach used to construct the baseline and the Statewide Monitoring System.

- Chapter 4 presents an overview of demographics and travel characteristics in California, and also describes the subdividing of California into five regions (for reporting purposes).
- Chapter 5 documents the construction and evaluation of baseline indicators known to be correlated with VMT and GHG emissions—*occupied housing unit density*, *jobs-housing fit*, *access to jobs from residential location*, *access to HQTLs*, and *average (mean) employee PMT at job site*.
- Chapter 6 focuses on the construction of short-term change measures, which include *new housing units*, *changes in subsidized affordable housing*, and *net changes in jobs*.
- Chapter 7 presents results of benchmarking short-term changes against the baseline. The evaluation seeks to provide insights into whether short-term changes in new housing, changes in subsidized affordable housing, and net changes in jobs are moving in the direction of promoting SB 375 goals.
- The final chapter, Chapter 8, summarizes Statewide Monitoring System research efforts and major findings, and offers recommendations for possible future refinements.

Chapter 2 LITERATURE REVIEWS: LAND USE, SPATIAL STRUCTURE, AND TRAVEL; AND MEASURING ACCESSIBILITY

This chapter includes a review of literature conducted to ground the development of the monitoring system and its indicators. It begins with an abbreviated summary of the literature reviews conducted in Phase I for the Los Angeles Prototype Monitoring System, specifically related to the selection of baseline indicators. This includes a review of literature related to the "5 Ds" of travel demand and a review of methods for measuring accessibility. A new addition in Phase II is the inclusion of a brief review of literature on jobs-housing fit, relating to the addition of this new baseline for the Statewide Monitoring System.

Achieving a more sustainable spatial configuration that reduces travel in California is an objective of SB F 375. The monitoring system will track changes in land use and in the geographic structure to evaluate progress toward this goal. The literature review in this report covers the conceptual framework behind the new additions and refinements adopted for the Statewide Monitoring System. The Statewide Monitoring Systems includes the following elements:

Baseline Measures

- Occupied housing unit density
- Jobs-housing fit
- Access to jobs from residential location
- Access to HQTLs
- Average (mean) PMT at job site

Short-Term Changes

- New housing units
- Changes in subsidized affordable housing (low-income housing tax credits [LIHTC] and housing choice vouchers [HCV])
- Net changes in jobs

A review of the literature on travel and land-use effects informed the selection of baseline indicators. The finalized set reflects the priority measures identified in consultation with Caltrans, CARB, and the Advisory Committee and what is technically feasible within the project's awarded resources and stakeholders' practices. This chapter begins with a brief summary of the review of literature conducted for Phase I and the Los Angeles Prototype Monitoring System. The full review covers the links between land use and transportation as a means to reducing GHG, and included two parts: (1) On the "5 Ds" categories of built-environment variables that link spatial patterns and travel demand, the main source of GHG emissions in California, and (2) a review of conceptual approaches to destination accessibility measures, an important component of travel demand and land-use management. Also included in the Phase I report is a review of the literature on calculating accessibility and a survey of MPO practices. Please see the Phase I report for the full review of that literature.

Land Use and Transportation

Nationally, nearly 30 percent of GHG emissions result from transportation sources (US EPA, 2015). In California, this number is even higher.[17] According to the California GHG Emission Inventory, the transportation sector accounted for 37 percent of GHG emissions in 2015 (California ARB, 2017). Of transportation-related GHG emissions, an estimated 75 percent come from passenger vehicles (California ARB, 2015).

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[17] This section is an abbreviated version pulled from the Phase I Los Angeles Prototype Monitoring System report. Please see Phase I report for full literature review.

Given the link between automobile use and GHG emissions, there is interest in reducing VMT to lower emissions, protect the environment, and improve public health. State agencies frequently measure VMT and make the data available to the public, though these estimates tend to only be available for large geographies, such as for cities and counties. Estimating VMT for small geographies, such as census tracts (the unit analysis for this project), takes a considerable amount of work because doing so relies on transportation models and trip origin-destination (OD) data, which are cost exorbitant and labor intensive. Additionally, this project intends to collect "on the ground," empirical data; the use of modeled VMT data from transportation models might not paint an accurate picture of real-world travel behavior changes at small scales.

VMT is nonetheless a convenient proxy to estimate fluctuations in GHG output. Examining changes in VMT alongside other built-environment characteristics can serve as a useful indicator of progress toward GHG emissions goals.

To incorporate SCSs into their Regional Transportation Plans (RTPs) and to ensure appropriate policy objectives, MPOs need to understand how to decrease VMT within their region. Travel is primarily a means to access destinations. Characteristics of travel are thus dependent upon the spatial arrangement of potential destinations and origins, which in turn are a function of the broader built environment. It is critical that MPOs seeking to reduce VMT and associated emissions understand how changes in land use and transportation policy might affect future automobile use through their influence on the built environment. The following literature review summarizes the links between VMT, land use, and transportation, organized around a "5 D" categorization of built-environment variables.

The 5 Ds of Travel Demand

Occupied housing unit density, access to jobs, and access to HQTLs are three of the baseline indicators retained from the Los Angeles Prototype Monitoring System and included in upscaling efforts for the Statewide Monitoring System. These selections are based on findings in the field related to the 5 Ds of Travel Demand, which include density, diversity of land use, design, destination accessibility, and distance to transit.

Density

Development density—measured in terms of employment, population, and/or housing units per unit of area—provides an intuitive land-use predictor for VMT. As origins and destinations are brought closer together, less aggregate driving is required. Density measures also have the advantage of being easy to specify—they can be calculated from population and employment data readily available from the US Census Bureau.

The literature shows moderate associations between density and VMT. Studies have demonstrated that higher employment density (Chatman, 2003), residential density (Chatman, Pickrell, and Schimek, 1999), and parcel density (Fan, 2007) are associated with moderate decreases in VMT. The selection of housing density and job access as baseline indicators, and the measurement of net changes in jobs

Diversity

As with density, land-use diversity is intuitively related to travel behavior. In neighborhoods with high levels of land-use diversity—specifically a wide array of land-use types mixed together—residents can meet a range of daily needs within a relatively small area, reducing their potential VMT. In neighborhoods with a narrower range of uses, each errand may require its own trip to various parts of town, hypothetically fostering greater car dependence and higher per-capita VMT.

A good deal of research has examined the effect of land-use diversity on VMT. Like the relationship between density and automobile use, the relationship between diversity and car travel has been shown to be rather modest in empirical analyses, but associated with slightly less VMT/vehicle kilometers traveled (VKT). Kockelman (1997), using data from the 1990 San Francisco Bay Area travel surveys, found perhaps the strongest connection between land-use diversity and automobile use. Employing both an entropy index and a dissimilarity index, she calculated the elasticities of VKT to be -0.3 and -0.17, respectively. Several studies (Chapman and Frank, 2004; Bento et al., 2003) using only entropy indices found statistically significant associations between VMT/VKT and land-use diversity, however the magnitude of this association was generally far weaker than the effects found by Kockelman.

Combining estimates across a large body of studies, Ewing and Cervero (2010) find an elasticity of -0.09 between land-use entropy and VMT, as well as an elasticity of -0.02 between jobs-housing balance and VMT. Stevens (2017), meanwhile, derives meta-analytic estimates for the same two elasticities, finding land-use mix to have a positive elasticity of 0.11 with respect to VMT, while jobs-housing balance has an elasticity of 0.00.

Design

As was discussed previously, conceptually, the influence of density and land-use diversity on VMT is rather straightforward—higher densities and increased diversity are assumed to make personal vehicle travel less necessary, leading to reductions in VMT. In contrast to the clear conceptual relationship between density, diversity, and VMT, the connection between urban design features and automobile travel is somewhat less obvious. Undoubtedly, certain design characteristics—such as wide sidewalks, short blocks, and well-connected streets—might encourage increased pedestrian travel. However, if these attractive urban design features are not combined with nearby destinations such as shops, schools, and recreational facilities, they may encourage more walking and biking without reducing overall car travel.

Short blocks and frequent intersections are often viewed as encouraging walking. As such, a majority of studies examining urban design elements have focused on their role in mediating walking behavior, rather than on automobile use. Some studies, however, illustrate exceptions to this tendency and find strong associations between certain design characteristics and VMT.[18]

Both the Los Angeles prototype and the Statewide Monitoring System, however, do not include measures of design changes and their relation to VMT.

Destination Accessibility

Like the association between urban design and VMT, the conceptual relationship between destination accessibility and its effect on automobile travel defies simple categorization. Given the complex and potentially contradictory effect that destination accessibility could have on VMT, the manner in which destination accessibility is defined and measured becomes particularly important, and researchers have used a variety of potential measures to characterize different levels of accessibility. Employment locations comprise by far the most prominent destination type in the accessibility literature, though some studies take account of general retail locations, food-based retail, medical centers, and so forth. A second primary distinction is between "place-based" measures, those that measure accessibility to destinations from a fixed location in space, and "people-based" measures, those that measure accessibility to destinations that individuals experience as they move through space over the course of a day. This review focuses on place-based measures of accessibility to employment and retail, as these comprise the large majority of access

[18] Frank and Engelke (2005), Chapman and Frank (2004), and Boarnet, Nesamani, and Smith (2003), e.g., all found elasticities of intersection density and VMT to be at or near -0.1, suggesting an important, if understudied, impact of design in curbing automobile use.

measures in the literature. Even within this subset of measures, however, there exists substantial diversity with respect to how destinations are aggregated into a single metric. Frequently used measures employ three primary techniques (Handy and Niemeier, 1997):

- Nearest-neighbor measures—in which accessibility is calculated according to either the travel time to the nearest potential destination or to the average travel time to some specified number of nearest destinations (e.g., the average travel time by car to the five nearest grocery stores);
- Threshold measures—in which accessibility is calculated according to the total number of potential destinations within a fixed travel time (e.g., the total job sites within a 30-minute transit trip) (Ewing et al., 2008; Cervero and Duncan, 2003, 2006); and
- "Gravity" or decay measures—in which accessibility is calculated by taking the sum of all nearby destinations, with each individual destination weighted by its travel time separation (e.g., a retail outlet located in a traveler's home neighborhood is given full weight, an outlet located in a neighborhood five minutes' drive away is discounted by a factor of two, an outlet located in a neighborhood 15 minutes' drive away is discounted by a factor of 20, and so forth [Kuzmyak et al., 2006; Lund, Wilson, and Cervero 2006; Shen, 2000; Cervero and Kockelman, 1997; Kockelman, 1997]).

Despite the variety of destination accessibility measures, and its ambiguous conceptual relationship with VMT, a good deal of the scholarly research on accessibility has found it to be a strong predictor of automobile travel patterns. For example, several studies using the distance from one's residence to the nearest central business district (CBD) as an accessibility metric have found substantial reductions in VMT associated with high levels of accessibility. Pushkar et al. (2000), for example, found distance to Toronto's CBD to be the strongest built-environment predictor of VKT, with a reduction of 10 kilometers distance from the CBD being associated with almost seven fewer kilometers of household vehicle travel. Likewise, Zegras (2010) and Naess (2006) also found similarly significant reductions in VMT and VKT associated with residential proximity to the CBDs of Santiago, Chile, and Copenhagen, Denmark, respectively. Aggregating across distance to CBD measures, Ewing and Cervero (2010) and Stevens (2017) both find this operationalization of accessibility to be the strongest predictor of VMT, with the former authors estimating an elasticity of -0.22 and the latter estimating elasticities of between -0.34 and -0.63.

Other researchers, using somewhat more complex accessibility measures, have found equally strong connections between destination accessibility and automobile use. In a large-scale study of travel behavior in the San Francisco Bay Area, Cervero and Duncan (2006) measured automobile accessibility for jobs and for retail establishments by calculating the total number of opportunities within four miles of an individual's residence. Their results suggested that a 10 percent increase in the number of accessible jobs was associated with just more than a 3 percent decrease in work-related VMT, while a 10 percent increase in the number of accessible retail destinations was associated with nearly a 2 percent decrease in shopping-related VMT.

Distance to Transit

Because public transportation is for many people the most reasonable substitute for private automobile travel, the theoretical relationship between the last of the 5 Ds—distance to transit—and VMT is rather straightforward. For someone living near a bus stop or a rail station, public transit could be an attractive alternative to automobile travel, and thus be associated with a reduction in personal VMT. Conversely, for those without convenient access to public transportation, using intra-urban bus or rail might not be a reasonable option, leaving the private car as the only viable transportation choice, particularly for medium- to long-distance trips.

Just as the conceptual relationship between distance to transit and VMT is quite intuitive, so too is the way distance to transit is typically measured. Of the studies that include proximity to public transportation as a predictor of VMT, virtually all of them use some form of network distance between an individual's residence and the nearest transit stop. The vast majority of these studies use a simple measure of street network distance (Zegras, 2010; Boarnet et al., 2008; Naess, 2006; Frank and Engelke, 2005; Targa and Clifton, 2005; Bento et al., 2003), while one study uses a quadratic transformation to test for nonlinear associations between distance to transit and VMT (Frank et al., 2008). Vance and Hedel (2007), instead of using street network distance to transit, use minutes walked to a transit stop that, given a constant assumed walking speed, is identical to the more commonly used distance metrics. As with destination accessibility, more advanced measures of access to transit exist in the literature (see Bhat et al. [2005] for a conceptual review). These measures are meant to provide a more meaningful assessment of a given individual's accessibility to transit service, and include areal assessments of transit coverage (McKenzie, 2013; Delbosc and Currie, 2011), as well as measures that take more spatially precise estimates of walking distances (Biba, Curtin, and Manca, 2014), transit service availability at different times of day (Chen et al., 2011), and service frequency (Mamun and Lownes, 2011). The travel behavior findings presented here, however, focus exclusively on simpler distance-to-nearest-stop measures.

Compared to studies investigating the impact of density, diversity, design, and destination accessibility on VMT, research exploring the relationship between distance to transit and automobile use is rather sparse. Only a handful of studies have included distance to public transportation stops as a potential predictor of VMT. The studies that have assessed this relationship, however, have generally shown a connection, with decreases in VMT in areas with high levels of access to transit.

<u>Interpretation of Land-Use Effects on VMT</u>

Difficulties in measuring and isolating the effects of the built environment notwithstanding, there is consensus that the "5 Ds" of the built environment influence VMT and thus GHG emissions and emissions of other pollutants associated with harm to human health, agricultural productivity, natural habitats, etc. Further, there are potentially substantial co-benefits when utilizing multiple VMT-reduction strategies that span across the 5 D elements. At the same time, land use development is an incremental process that occurs over time. As such, the near-term potential for VMT reduction through land-use policy may be limited ("Driving and the built environment," 2009). However, given the potential for greater longer-term VMT reductions, policies supporting sustainability through dense, mixed-use development are a critical priority for CARB and other state agencies that participated in the Advisory Committee, especially given the urgent need for climate change mitigation and the range of co-benefits that compact development can deliver.

Measuring Accessibility

Transportation investments and land use patterns impact one another in an iterative way, but within the context of transportation planning, travel is generally conceptualized as a derived demand. People typically make trips not for the sake of the trip, but for the purpose of reaching a destination.[19] As such, accessibility measures, which quantify the ease by which some set of destinations can be reached, are fundamental for transportation system analysis. In continuing the analysis of the land use–VMT relationship, this section examines more deeply the accessibility (to destinations) dimension of the broader 5 Ds framework to help inform the calculation of associated metrics.

Accessibility measures can be applied to predict travel behavior within systems or to conduct normative transportation system evaluations. In light of this importance, this review aims to provide a thorough inventory of conceptual and methodological approaches to accessibility, understanding what the measures can provide, and evaluating their specific strengths and weaknesses for transportation analysis. This evaluation considers the theoretical and empirical justifications for given accessibility measures, as well as

[19] This section is an abbreviated version pulled from the Phase I Los Angeles Prototype Monitoring system report. Please see Phase I report for full literature review.

what these measures imply for both the factors that support higher levels of accessibility and the effects that accessibility levels have on travel behavior and social and economic outcomes.

Jobs-Housing Fit

In Phase II, the Statewide Monitoring System includes the addition of a jobs-housing fit baseline, adopted as a refinement to Phase I's Los Angeles prototype. As covered earlier in this section and demonstrated by a few studies in particular (Cervero and Duncan, 2006), the concentration/location of housing and employment together can decrease VMT and the GHGs associated with private automobile travel. The addition of the jobs-housing fit baseline allows for an analysis that integrates changing land-use patterns in housing with changes in employment. This review will briefly summarize current work on jobs-housing fit. It begins with defining jobs-housing fit, making a distinction between jobs-housing fit and jobs-housing balance. The review will then examine the relationship between jobs-housing fit and commutes, and the effects of jobs-housing fit as it relates to low-earners and affordable housing.

Jobs-housing balance looks at the relative number of jobs and housing in an area, while jobs-housing fit looks also at the types of jobs and the nature of housing in relation to one another but focuses specifically on low-wage workers. Cervero (1996) found that reaching a jobs-housing balance, on its own does not necessarily lead to shorter commutes or to workers finding jobs within their neighborhoods. A match requires that housing is attainable with the earnings of local workers and that the industries and skill levels are compatible for local residents (Cervero, 1996). Additionally, Benner and Karner (2016) point out that a jobs-housing fit analysis is especially useful in questions of policy because it can help to highlight "jurisdictions and neighborhoods where there is a substantial shortage of affordable housing in relation to the number of low-wage jobs" (883). A jobs-housing fit analysis can reveal the degree of imbalance in an area that may appear balanced if no distinction is made between the types of jobs and housing in the area. Benner and Karner also found that in California, places that have better jobs-housing fit measure also have lower VMT. Levine (1998) in studying choice and residential location finds that commute time is a determinant of residential location and that the availability of affordable housing near job centers is especially influential for low-to-moderate income workers. For Levine, the interpretation of these results is that policies that promote a better jobs-housing balance do not on their own lead to decreased commutes, but that affordable housing and/or employment policies should be enacted with the aim of "improving matches" to increase opportunities for workers to choose shorter commutes (ibid.: 133). Unlike jobs-housing balance, which focuses broadly on all workers, the jobs-housing fit measure specifically focuses on a segment of the workforce, economically disadvantaged workers. It addresses the issue of equity by measuring the imbalance in an area between the number of low-wage workers and the quantity of affordable homes available to these workers.

Several studies have set out to test and measure jobs-housing balance and its relationship with commutes. In a study of the San Francisco Bay Area, Cervero and Duncan (2006) find that jobs-housing balance does reduce travel. In an earlier study, Cervero, Rood, and Appleyard (1998) track accessibility in the same San Francisco region finding that "housing markets are more responsive to the preferences of upper-income workers" and that "residents of low-income inner-city neighborhoods generally face the greatest occupational mismatches" (Cervero, Rood, and Appleyard, 2008: 1259). In a study of the Atlanta region, Sultana (2002) also finds that imbalances are associated with longer commutes. Similarly, Sultana also concludes that results of the conducted study do not demonstrate that a jobs-housing balance will necessarily result in reduced commutes, and they instead suggest that "the cost of housing and housing affordability of workers" is an important factor in the location choices of workers (ibid.: 746). From an equity standpoint, addressing jobs-housing mismatch is an important resource allocation question about how to guide development toward outcomes that address the needs of the most vulnerable workers.

Chapter 3 PROCESS, SCOPE, AND ANALYTICAL APPROACH

This chapter summarizes the process by which the scope and analytical approach for the research project were finalized. It includes a review of the input process, scope, and key elements of Phase II, and a description of the analytical approach.

These elements were finalized with regular input from the Advisory Committee (described in further detail in the following text) and from both Caltrans and CARB. The process of prioritizing the issues and analytical approach was particularly important because there are numerous and varied potential approaches for measuring and monitoring changes. The Statewide Monitoring System includes indicators and methods tested and assessed in Los Angeles prototype. It also includes newly adopted refinements and enhancements to that system. The assessments of previously used indicators and measures are not repeated in full detail here. For more complete discussion of these, please see the Phase I report. This chapter covers the input process, the scope, and analytical approach with a focus on describing changes and refinements introduced since the Los Angeles prototype.

In terms of full scope, the project includes the construction of a baseline and a system of benchmarking to monitor new development and other changes at the four-year time scale. The analysis focuses on the distribution of new housing units, changes in subsidized affordable housing, and net change in jobs across one or more of the baseline indicators, which include occupied housing unit density, jobs-housing fit, access to jobs from residential location, access to HQTLs, and average PMT at the job site. Changes in subsidized affordable housing, the jobs-housing fit baseline, and the average PMT at job-site baseline are newly adopted for the upscaling efforts, based on recommendations made by the team and in discussion with Caltrans, CARB, and the Advisory Committee. Table 3-1 shows the baseline indicators, displays the short-term change measures, and indicates the analyses of change conducted against relevant baselines (as indicated by the check marks).

Table 3-1: Summary of Monitoring System Baselines and Change Measures

	Short-Term Changes		
Baseline	**New Housing Units**	**Changes in Subsidized Affordable Housing (HCV and LIHTC)**	**Net Change in Jobs**
Occupied Housing Unit Density	✓		
Jobs-Housing Fit		✓	
Access to Jobs from Residential Location	✓		
Access to HQTLs	✓		✓
Average (Mean) PMT at Job Site			✓

The final products for this project include a dataset for the Statewide Monitoring System and this Final Report, which includes assessments of data sources and describes the process and methods used to construct the monitoring system.

Input Process

The Statewide Monitoring System represents a prioritized set of focus areas for evaluating changes in land-use patterns as they relate to the SB 375 goals of VMT and GHG reductions from personal automobiles. Given the vast number of potential directions and areas of focus, and given limited time and resources for the Caltrans project contract, the UCLA Center for Neighborhood Knowledge established an Advisory Committee to provide recommendations on indicators, indices, datasets, and analytical methods. The Advisory Committee was comprised of individuals from state agencies directly involved in SB 375 implementation, large and small MPOs, academic and professional experts, and more (see page 2 for a list of Advisory Committee members). Members participated in person or through online meeting platforms. The meetings provided regular opportunities for the research team to report on progress and for the Advisory Committee members and project funders to provide guidance on the direction and methods of research. Additionally, UCLA attended separate consulting meetings with individuals at CARB and Caltrans.

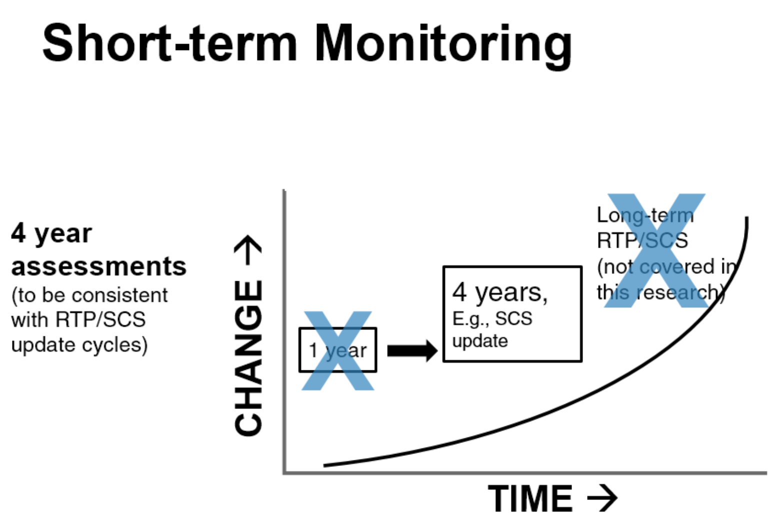
During the prototype efforts, UCLA solicited recommendations from the Advisory Committee on potential indicators related to VMT and GHG emissions. The research team compiled, evaluated, and incorporated these recommendations into a comprehensive list of indicators. The UCLA team also compiled a list of metrics, indicators, and performance measures, based on a review of literature assessing the "5 Ds of Travel Demand" (density, diversity, distance to transit, destination [jobs and retail] access, and design). At the end of this process, housing unit density and accessibility indicators (to jobs, retail, and transit) were identified as the highest priorities for the construction of the baseline.

Upon further assessment of the results of the Los Angeles prototype, together, with Caltrans, CARB, and the Advisory Committee, the team elected to preserve the following measures for the Statewide Monitoring System: housing unit density, access to jobs by residential location, access to transit (with some major refinements), new housing units, and net change in jobs. New additions to the system include the following: changes in subsidized affordable housing, jobs-housing fit baseline, and average PMT at the job-site baseline. Changes and additions are the reflection of recommendations adopted from Phase I efforts.

The baseline serves as the starting point against which changes are evaluated. For short-term changes to measure, the group prioritized new housing units, changes in subsidized affordable housing, and net changes in jobs.

Figure 3-1: Short-Term Monitoring

Short-term monitoring includes an assessment of four-year changes from the baseline



Source: UCLA Center for Neighborhood Knowledge

Scope and Key Elements

The monitoring of new developments and of changes in the short term is guided by findings from the assessment of available and viable data. The system includes a baseline, representing the existing overall characteristics of the studied geography at the baseline year, and includes four-year changes (Figure 3-1) from the baseline year.

What is the baseline?

The baseline functions as a starting point of reference for tracking changes. For most indicators, the baseline year is 2010. For others indicators, where data for 2010 was not available, the baseline is constructed from most readily available data. The year 2010 was selected as the baseline year, in agreement with the CARB, for two primary reasons: (1) 2010 marks the year during which SCS targets were first set; and (2) the 2010 baseline year allows for the use of the 2010 Decennial Census, which makes available data down to the census block level (necessary for construction of local proximity to transit, which is described in later sections). The 2010 year captures the state of the environment following the passage of SB 375 in 2008 and before the adoption and implementation of plans in 2012.

The added advantage of a 2010 baseline is that it coincides with the geographic census boundaries for many datasets used in the construction of the monitoring system—that is, 2010 census tract boundaries are the current boundaries for all data including and after 2010, allowing for smoother comparisons between 2010 and more recent years (2011 and 2014 for short-term changes); using a baseline constructed from data prior to 2010 would require transformation or reallocation of data from old boundaries (2000 census tract boundaries) for comparison to more recent data (which would be in 2010 boundaries).

Why Look at Four-Year (2014) Changes?

SCSs lay out a long-range vision of how housing and transportation plans will support regional GHG emission reductions. They are prepared, updated, reevaluated on four-year cycles.

At What Geographic Level Are Data Analyzed?

The primary small geography for calculating accessibility and for reporting figures is the census tract. For transit accessibility, data are calculated for the smaller block group-level geography. These are standardized geographic units, for which data is available nationwide. Additionally, geospatial data for census tracts are generally publicly available and easily accessible.

What Baseline Indicators Are Evaluated?

1. Occupied housing density—represents residential origin points for trips; describes the location of new housing development;
2. Jobs-housing fit—indicates areas where there is an imbalance of low-paying jobs and affordable housing; can suggest either employment- or housing-related policy adjustments;
3. Access to jobs from residential location—showing residential areas by the relative commutes of their residents;
4. Accessibility to transit—indicates areas with higher opportunities for using alternative modes of transportation (substituting for drive-alone car trips) and for providing mobility options for low-income individuals and households; and
5. Average (mean) PMT of employees at the job site—showing areas by the relative commutes of workers at their job sites.

What Short-Term Changes Are Measured?

1. New housing development—housing units built between 2011 and 2014, showing the location of new development across the state;
2. Changes in subsidized affordable housing—New LIHTC units built between 2011 and 2014, and net changes in available HCV units (2012 to 2016); and
3. Net changes in jobs—number of jobs added (or lost) between 2010 and 2014, showing the location of where these gains and losses are located.

Analytical Approach

Constructing the Baseline

Construction of the Statewide Monitoring System requires a considerable amount of data and calculation. Short-term monitoring requires that data sources satisfy a few key requirements. The team evaluated potential datasets for their consistency and robustness relating to temporal (i.e., are data released frequently enough?) and geographic coverage (i.e., are data available for all Los Angeles, down to the census tract level?). The team also considered the direct (monetary) and indirect (time and labor) costs relating to each data source. Table 3-2 summarizes key considerations and guided the assessment process. Detailed assessments for most of the datasets used here can be found in the Los Angeles Prototype Monitoring System report. This report includes only detailed discussions of the datasets newly adopted for the Statewide Monitoring System.

***Table 3-2: Data Assessment Table*[20]**

DATA CHARACTERISTICS	
Primary Purpose	*Does the dataset contain information that matches the project needs?*
Primary Users	*Who are the primary users of the data (e.g., transporation planners, reseachers)?*
Data Source	*Who are the providers and how accessible? Are the data available to UCLA and CARB and at what cost?*
Aggregated/Microlevel Data	*What is the level of aggregation (e.g., individual records, subtract summary, tract summary, or larger than tract summary)?*
Sample Size for Monitoring System (n)	*How many records captured in the data (all Los Angeles census tracts, all commercial establishments, etc.)?*
DATA QUALITY	
Validity and Reliability	*Are data reported in detail (e.g., crude category versus continuous multidigit)?*
Accuracy and Precision	*Does the data contain inherent error (reporting error, recording error)? Are there biases in the data?*
GEOGRAPHIC	
Coverage	*Are data available for all Los Angeles?*
Resolution (Unit of Analysis)	*Are data available at the census tract level or can it be disaggregated or aggregated into tracts ?*

[20] Cost assessments were also conducted and are available in the Phase I report.

Temporal (In)consistency	*Are variables and geographic boundary the same across time?*
Layer (In)consistency	*Do boundaries align (e.g., redefine boundary, sylizing boundary)?*
PRIVACY ISSUES	
Confidentiality	*Are there issues requiring special clearance for researchers?*
Public Use	*Are data readily available to the public?*
Legal Restrictions	*Are there limits on who has access and how data can be used?*
TEMPORAL	
Date Released	*When was the data released? What is the release schedule for this data?*
Reporting Period	*What years does this data cover?*
Timeliness	*What is the current year of data available? How often are data released?*

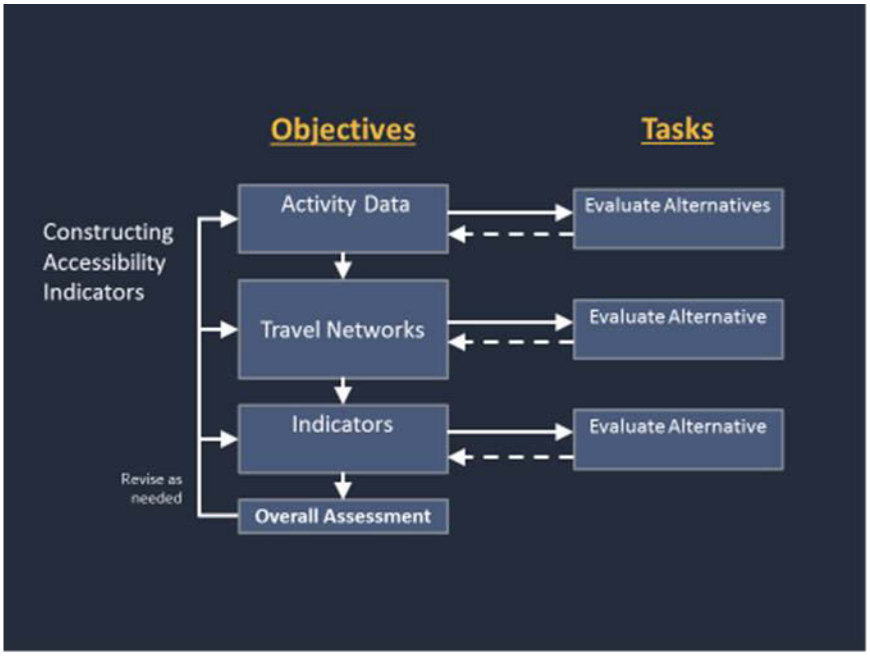
To construct indicators, the team took the following steps to assess and continuously improve measures based on observations. The following is an example of how these steps were implemented for one measure. These steps apply to the construction of other indicators as well:

- Evaluate **activity location** data for viability
  - For example: Does this dataset adequately count all the jobs in California census tracts?
- Match **activity location** to **travel networks**
  - Job counts are assigned to tracts; connecting this to the travel network then tells us how many jobs are within x miles/x travel time of individual tracts.
- Calculate **indicators**
  - For all census tracts, calculate the sum of jobs accessible within x miles/x travel time and apply a parameter to simulate relative desirability/likelihood of traveling to destinations further away.
- **Assess** results, evaluate alternative data sources/networks/calculation methods at each step
  - Do results change if calculations are based on travel times versus travel distance?
  - Does a gravity function (which weighs nearby opportunities more heavily) applied to the accessibility calculation produce results most highly correlated with average commutes for tracts, or does a different function (e.g., inverse, exponential decay) produce results that are closer to observed travel?

In this report, we conduct these assessments for all newly introduced datasets. For more detailed discussion of all other datasets, please see Los Angeles Prototype Monitoring System report.

Figure 3-2-: Process for Evaluating Accessibility Measures

Workflow/process; this illustrates steps taken to assess and continuously improve measures



Source: UCLA Center for Neighborhood Knowledge

<u>Measuring Key New Development and Change</u>

Short-term changes include the addition of new housing units, changes in subsidized affordable housing, and net changes in jobs. The evaluation of changes begins with the categorization of tracts into one of five quintile categories for each baseline indicator. This step places California's tracts in one of five categories ranging from lowest to highest housing unit density (and lowest to highest jobs-housing fit, access to jobs from residential location, access to transit, and average PMT at the job site). From there, the team calculated the distribution of total housing units (or affordable housing or jobs) across categories by taking the sum of all housing units for tracts in each quintile (e.g., total housing units in lowest-density tracts, total housing units in lower-density tracts, total in middle-density tracts). To track changes, these calculations were repeated using new housing units, changes in subsidized affordable housing, and net change in jobs.

Changes are benchmarked using two methods: (1) by looking at the shift in distribution across quintile categories, and (2) by comparing the averages (mean and median) of the baseline distribution to the new/change distribution for select indicators (includes occupied housing unit density, access to jobs, PMT at job site baselines). These evaluations are discussed in further detail in Chapter 7. Table 3-3 summarizes the desired outcomes relating to SCS goals.

Table 3-3: Desired SB 375 Outcomes

Baseline Indicators	Short Term Changes: New Housing Units	Short Term Changes: Changes in Subsidized Affordable Housing (LIHTC and HCV)	Short Term Changes: Net Change in Jobs
Occupied Housing Unit Density	New housing units more concentrated in high-density neighborhoods relative to the baseline		
Jobs-Housing Fit		New subsidized affordable housing more concentrated in neighborhoods lacking affordable housing relative to low-earnings jobs	
Access to Jobs from Residential Location	New housing units more concentrated in high-accessibility neighborhoods relative to the baseline		
Access to HQTLs	New housing units more concentrated in neighborhoods with greater access to HQTLs relative to the baseline		Gains in jobs more concentrated in workplace areas with greater access to HQTLs relative to the baseline
Average (Mean) PMT at Job Site			Gains in jobs more concentrated in workplace areas where PMT generated from commutes is lower relative to the baseline

<u>Internal and External Verification</u>

Throughout the process a system of internal and external verification steps is built in. This includes both internal checks and comparisons to external sources for verification. Internal verification involves layers of checks by the team for consistency of results with known/observed outcomes and with independently calculated results by other team analysts. External verification includes the comparison of team-calculated results with equivalent or parallel data from other reliable sources. An example of this is discussed in Chapter 7 on benchmarking, in the section on methods involved in calculating new units using parcel data.

Chapter 4 CALIFORNIA AND FIVE REGIONS BACKGROUND

This section provides a state-level overview of population and travel-related trends. It begins by outlining changes in population, jobs, and households, followed by a discussion on general housing trends. Also included in this overview section is a snapshot of the California regions created for the Statewide Monitoring System's reporting purposes. It then provides an overview of changing modal choices and evolving travel needs.

There are wide regional variations across California. As a result, it was important to include region-level analysis to recognize the varied characteristics and potential challenges of each region. The Bay Area Megaregion[21] and the Southern California region are the most housing and population dense. They are also home to major job centers in the state. Rural areas make up a huge proportion of the state, but are least dense in people and housing units. Total jobs and affordability also varies across regions. This has implications for the way monitoring system results are calculated and interpreted. This section provides an overview of these regions and their characteristics. Results of analysis using the monitoring system are available for each region and can be found in later chapters and in Appendix C. The investments of specific MPOs were not assessed as part of the analysis.

In general, the state as a whole is growing. At the same time, it is more and more critical that immediate and major action is taken to address growing climate risks and make efforts toward reversing negative trends. As the population grows, needs for housing, jobs, transportation, among others are growing and changing as well. It is incumbent that these needs be met and met in a way that supports the State's climate objectives.

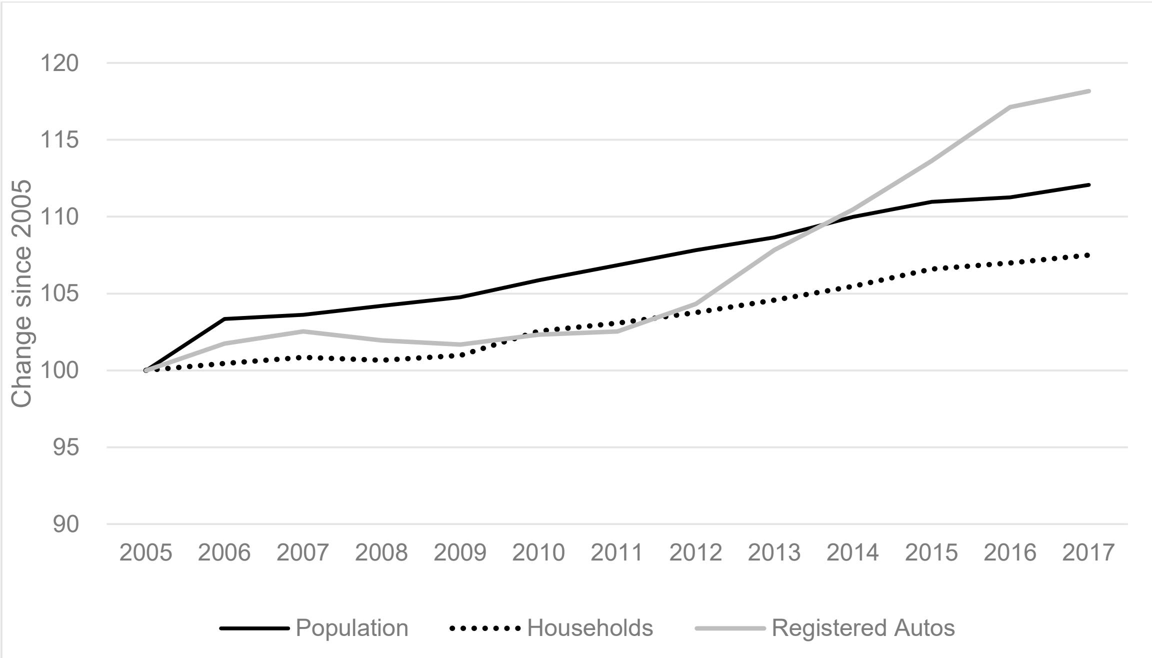
California Population, Jobs & Housing

California is home to over 39.5 million people, roughly 12% of the nation's population, and covers a land area of approximately 155,779 square miles (Census Quickfacts, 2017). The state is comprised of 58 counties and 482 incorporated cities (League of California Cities, 2018) served by over two-hundred separate transit agencies.

As shown in Figure 4-1, California's population has experienced substantial growth between 2000 and 2017, increasing by more than 5.7 million (roughly 17%). Between 2005 and 2017, the population grew by 4.2 million or 12%.

[21] The Bay Area Megaregion includes a broader geography (defined by 15 counties) than what might conventionally be considered the Bay Area (defined as nine counties by MTC). Figure 4-5 shows the counties included in the Megaregion, as well as definitions for the other California regions used for reporting.

Figure 4-1: California Population, Households, and Vehicles (2005 to 2017)



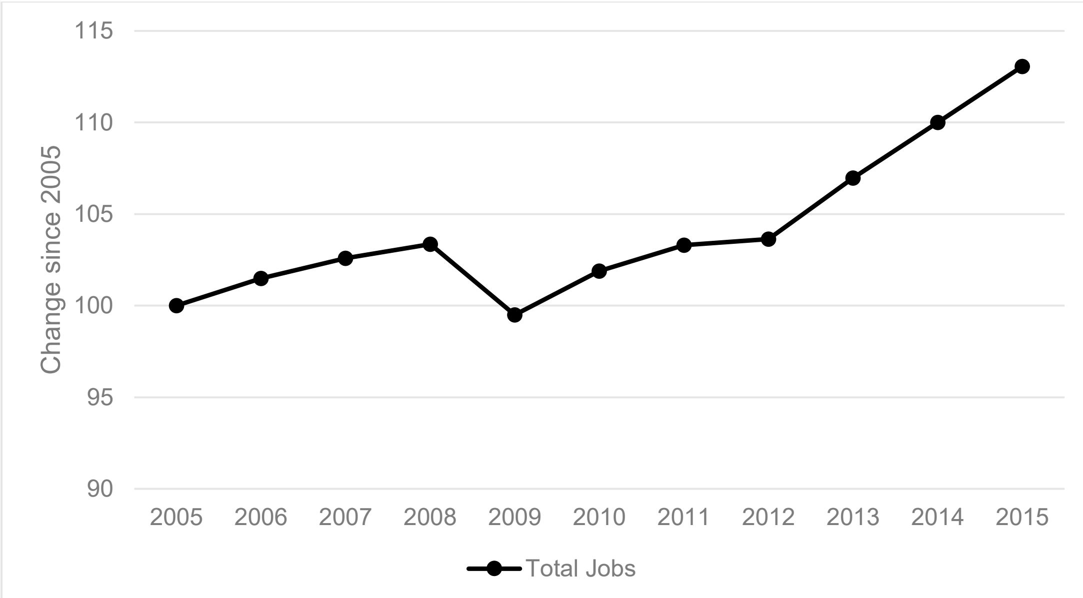
Source: 1-year ACS estimates for the population and households for households; the number of registered autos with a fee paid registration as reported by the Department of Motor Vehicle Forecasting/MIS Section.

Note: Numbers are indexed to the year 2005; values more than 100 represent growth since 2005; while values less than 100 represent decline since 2005

Vehicle ownership is slightly affected by the ups and downs of the business cycle. For instance, the number of registered autos remained stagnant during the Great Recession (2007-2009). Despite these fluctuations, there has been a considerable long-term increase in auto ownership. Between 2000 and 2017, the number of registered automobiles increased at nearly twice the rate of the population (33% compared to 17%) from 19.2 million to over 25.6 million. Between 2005 and 2017, the number of autos increased by 18% and during the short-term period by 8%.

In general, California's population changes parallel its economic growth. The number of jobs in the state increased from 13.8 million in 2002 to over 16 million in 2015 (17%). Between 2005 and 2015 the number of jobs grew by 1.8 million (13%), and during the short-term period of 2011-2014, the state added over 950,000 jobs (6%). The job trends include both short-term fluctuations from the downturn during the Great Recession and long-term secular growth. During the period of recession, California experienced a loss of roughly 440,000 jobs that have since been recovered.

Figure 4-2: California Total Jobs (2005 to 2015)



Source: LEHD 2005-2015

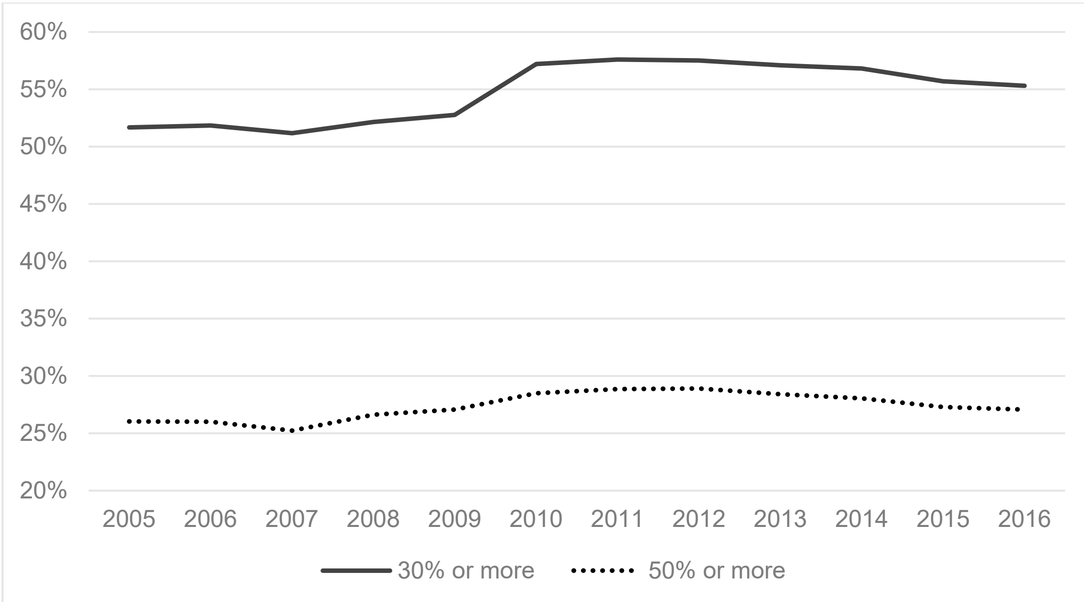
Note: Numbers are indexed to the year 2005; values more than 100 represent growth since 2005; while values less than 100 represent decline since 2005.

One of the goals of SB 375 is to better align affordable housing and transportation planning. Housing affordability reflects the ability of a household to afford to live in a given housing unit due to that unit's price, neighborhood school quality, public safety, and access to jobs and amenities (U.S. Department of Housing and Urban Development (HUD), 2018). Policymakers consider households who spend more than 30 percent of income on housing costs to be housing cost burdened as keeping housing costs below 30 helps ensure that households have enough money to pay for other nondiscretionary costs (HUD, 2018).[22] According to the California Department of Housing and Community Development (HCD), California's homeownership rate is the lowest it has been since the 1940s (2017). In 2014, the majority of Californian renters paid more than 30 percent of their income toward rent and one-third were severely rent-burdened, paying more than 50 percent of income towards rent (HCD, 2017).

Figure 4-3 shows that rent burden at both the 30- and 50-percent thresholds has been increasing since 2005. In 2016, more 55% of Californians were rent burdened while more than one quarter of Californians were severely burdened. These high housing costs have far-reaching policy implications quality of life in California as they relate to health, transportation, education, the environment, and the economy (HCD, 2017).

[22] California's SB 150, which requires reporting by CARB on progress toward GHG emissions reductions, uses a 35 percent threshold.

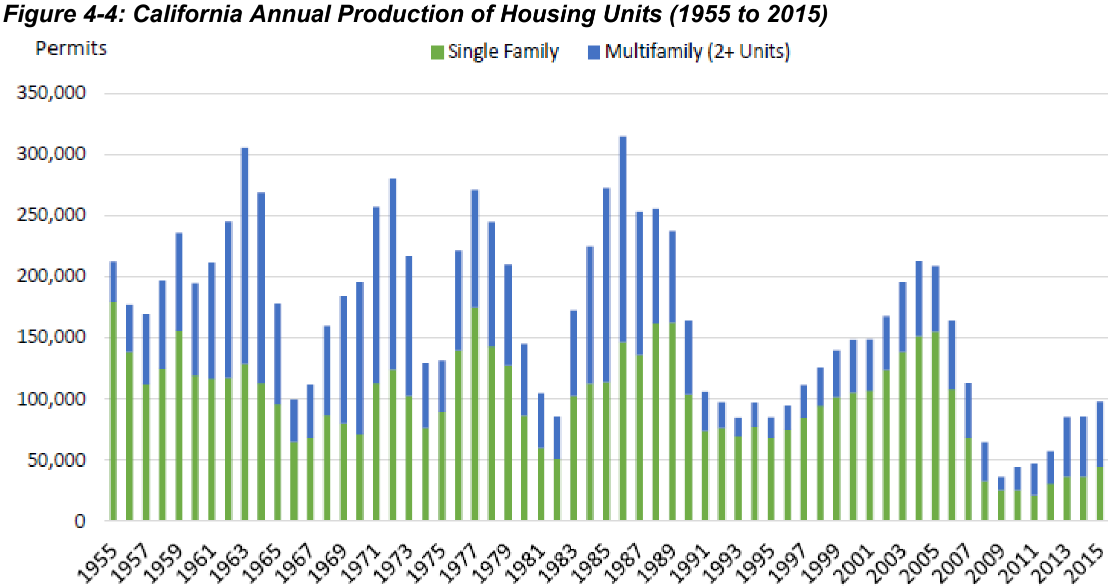
Figure 4-3: California Households Experience Rent Burden



Source: 2005-2016, individual 1-year ACS

A key challenge regarding housing affordability identified is a housing supply that has struggled to keep pace with demand. A recent report from HCD shows that in order to meet projected population and household growth, roughly 180,000 new homes annually need to be built (HCD, 2017:5). Figure 4-4 shows the state has averaged less than 80,000 new homes annually for the past 10 years.

Figure 4-4: California Annual Production of Housing Units (1955 to 2015)



Source: HCD (2017); original data source cited as "Construction Industry Research Board/ California Homebuilding Research Reports 2005, 2013, 2015" (p. 6).

Regional Overview (Population, Housing, Socioeconomics, and Jobs)

Data about population, housing, socioeconomics, and jobs from ACS 2012-16 data was analyzed for the following five regions of California: Rural[23], Bay Area Megaregion, Central Coast, San Joaquin, and Southern California (SoCal).

Some total values were calculated for the State of California as a whole to serve as a point for comparison. The total population of the state is about 39 million, with an ethnoracial composition that is 38.4% Non-Hispanic Whites, 5.6% Blacks, 13.7% Asians, and 38.6% Hispanics. There are 12.8 million occupied housing units, which includes owner- and renter-occupied housing units. California has a total jobs count of about 16 million. The average home value in California is $536,000. The land area of the state is about 156,000 square miles, with a total area of about 164,000 square miles. The occupied housing density for the state as a whole is about 82 occupied housing units per square mile of land area.

Figure 4-5 below depicts the five regions created for the reporting purposes of this report. These do not coincide with MPO boundaries. The grouping was guided by the examining the shared characteristics of counties and through stakeholder input.

[23] Although SB 375 does not apply to most areas of the state which are designated as "rural state" for the purposes of this analysis, they were included in order to achieve a truly state-wide focus for the study.

Figure 4-5: Statewide Monitoring System Five Regions

Table 4-1 below summarizes some key statistics for each region compared to the state as a whole. Southern California and the Bay Area Megaregion house the largest proportion of California's 39 million residents. These are also the regions with the highest density. Rural areas make up about 40% of California's land area and are the least dense in population, jobs, and occupied housing.

Table 4-1: Five California Regions Compared

	California	Southern California	Bay Area Megaregion	San Joaquin	Rural	Central Coast
Total Population	39 million	21.9 million	9.9 million	4.1 million	1.2 million	1.5 million
% of CA		56.6%	25.7%	10.6%	3.2%	3.8%
Total Occupied Housing Units	12.8 million	7.0 million	3.5 million	1.3 million	482,000	486,000
% of CA		55%	27.7%	9.8%	3.8%	3.4%
Total Land Area (sq.mi)	156,000	42,000	13,000	27,000	62,000	11,000
% of CA		27.1%	8.5%	17.5%	40%	7.2%

	California	Southern California	Bay Area Megaregion	San Joaquin	Rural	Central Coast
Occupied Housing Unit Density (sq.mi)	82.2	166.3/sq. mi	267.8/sq. mi	45.9/sq. mi	7.8	43.6
Total Jobs	16.0 million	9.1 million	4.7 million	1.4 million	384,000	575,000
% of CA		56.4%	29.1%	8.4%	2.4%	3.6%

Source: 2012-2016 American Community Survey 5-Year Estimates, 2015 LEHD LODES

Table 4-2 includes additional information on the demographics, socioeconomic and housing characteristics for each of the five regions.

Table 4-2: Demographic, Socioeconomic Status (SES), and Housing Characteristics for California and Five Regions

	California	Southern California	Bay Area Megaregion	San Joaquin	Rural	Central Coast
Demographics						
Total Population	39 million	21.9 million	9.9 million	4.1 million	1.2 million	1.5 million
% Non-Hispanic White	38%	34%	44%	34%	75%	48%
% Black	6%	6%	6%	4%	1%	2%
% Asian	14%	12%	22%	8%	2%	5%
% Hispanic	39%	44%	23%	51%	16%	42%
SES						
Mean Household Income	$91,100	$87,700	$110,800	$61,000	$63,000	$88,800
% Pop. Living in Poverty	16%	16%	12%	23%	18%	15%
Housing						
% Renters	46%	48%	44%	45%	37%	46%
Mean Gross Rent	$1,410	$1,420	$1,570	$1,000	$1,000	$1,450
Mean Home Value	$536,000	$536,000	$668,000	$238,000	$281,000	$617,000
% Rent Burdened*	54%	56%	49%	53%	53%	55%

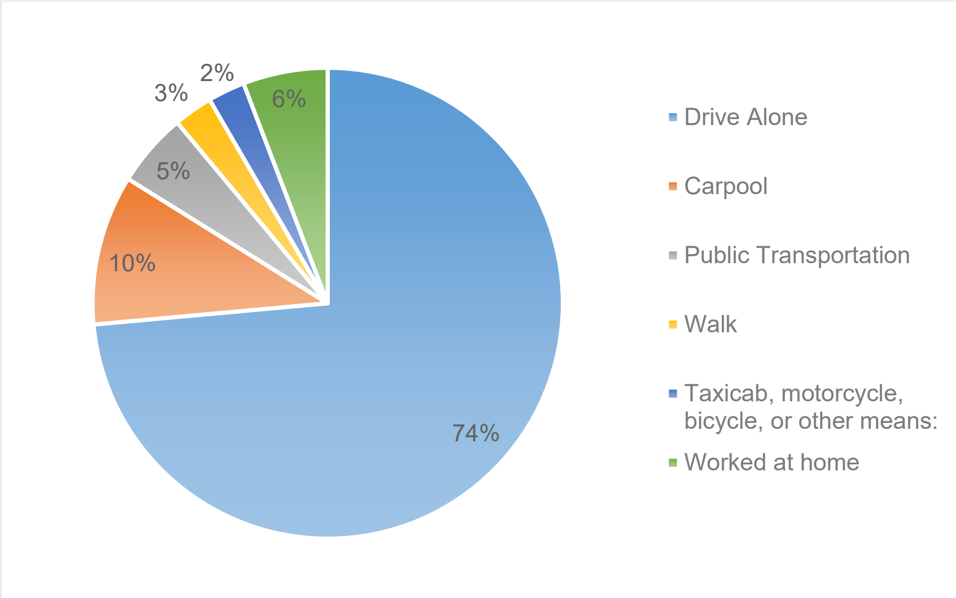
Source: 2012-2016 American Community Survey 5-Year Estimates

Note: Rent burdened defined as renter households paying more than 30% of income towards housing costs; dollar values are in 2016 dollars

Travel Patterns

The preceding population, jobs, and housing trends suggest a state with evolving travel needs. In examining daily commute travel for 2016, Figure 4-6 shows that drive-alone trips account for nearly 75% of commuters in 2015. Over time, the work commute has changed. The number of drive-alone commuters rose by 26% from 2000 to 2015 and by 9% during the short-term period of 2011-2014.

Figure 4-6: California Commute Modal Split (2016)



Source: 2016 1-year ACS

Work-trips are a major contributor of VMT and of accompanying GHG emissions as these trips are taken daily and consistently. With the growth of automobile ownership and shifts in commute modes, total VMT has increased over time. Figure 4-7 shows these trends from 2005 to 2016 along with trends in transit usage. Transit usage rose until the Great Recession, where it began to fall, and has not recovered to previous highs since. Transit usage patterns tend to follow cyclical trends, dipping during times of high unemployment. VMT also declined during times of economic hardship. In addition, it should be noted that recovery from the Great Recession and the 2012 dissolution of redevelopment agencies would have impacted housing data from the analysis period.

Figure 4-7: California Transit Ridership and VMT (2005 to 2016)

Source: Transit Ridership from National Transit Database 2017 Annual Data Tables Time Series Table 2.2; VMT estimates from the CA DOT HPMS.

Note: Numbers are indexed to the year 2005; values more than 100 represent growth since 2005; while values less than 100 represent decline since 2005

The State of California is growing and changing. In this context, it is imperative that needs are met while at the same time progress is being made toward addressing the climate goals of SB 375. This general overview was meant to provide general context, especially around key areas of focus for the Statewide Monitoring System. The succeeding sections detail the process, data, methods, and results of the analysis.

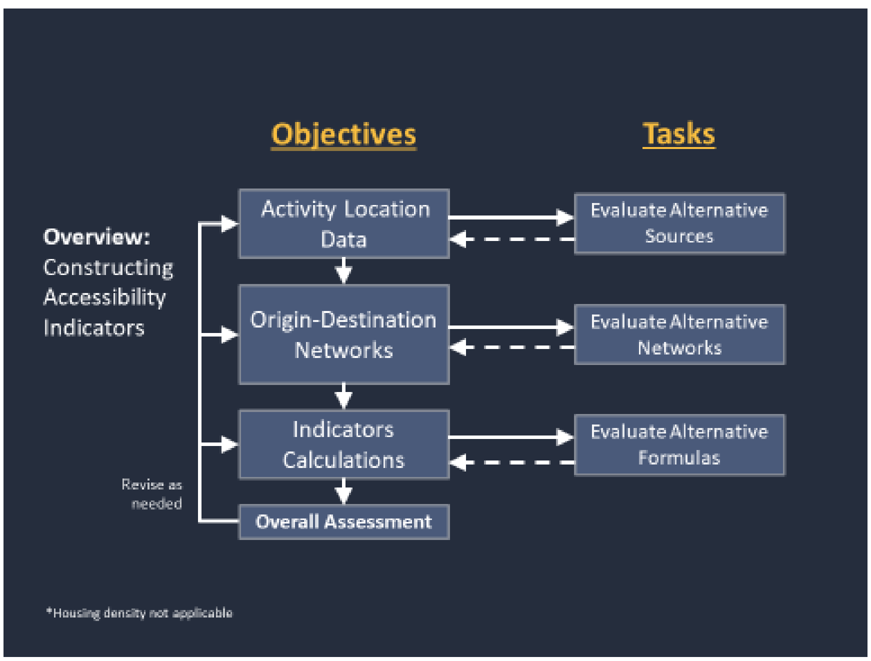
Chapter 5 BASELINE INDICATORS: ASSESSING ALTERNATIVE DATA AND MEASUREMENTS

This chapter summarizes the construction of baseline indicators adopted from Phase I's Los Angeles prototype and documents the construction of Phase II's newly added indicators for the Statewide Monitoring System. The baseline serves as the starting point, against which new developments and changes are measured. It consists of data on occupied housing unit density and measures for jobs-housing fit, access to jobs from residential location, access to HQTLs, and average (mean) PMT at job site. This chapter includes five subsections that cover the following: (1) upscaling street network data, (2) upscaling housing unit density, (3) construction of newly adopted jobs-housing fit baseline, (4) upscaling access to jobs, and (5) upscaling and major refinements adopted for access to HQTLs.

Construction of the baseline involves the assembly and analysis of multiple data sources. Although the baseline does not need to be updated on a yearly basis, the calculation of four-year changes requires data that, ideally, is released and updated annually. Annually available data, in addition to a few other considerations, were key requirements for any data source considered. As illustrated by Figure 5-1, the data and calculation process is iterative; the stages of data assembly, cleaning, calculation, and assessment are conducted continuously, with new insight informing improvements along the way. In the development of the Los Angeles Prototype Monitoring System, we evaluated potential datasets based on their consistency and coverage (both temporal and geographic), and on their costs for access and use. For full assessment of these data, see previous report. The discussion of the baseline and the data assembly and analysis will focus on the challenges, changes, and adjustments that arose in upscaling the sources and methods statewide.

Figure 5-1: Calculating and Refining Baseline Indicators

General process for assembling, analyzing, and assessing data is an iterative process that includes evaluation, verification, and adjustment throughout



Source: UCLA Center for Neighborhood Knowledge

For network data, NAVTEQ/HERE network times are used to calculate the travel time between population-weighted tract centroids and jobs-weighted centroids. The 2010 Census decennial enumeration is the primary source for housing unit data. Jobs-housing fit relies on data from the Census Bureau's American Community Survey (ACS) and Longitudinal Employer-Household Dynamics (LEHD). The access to transit indicator relies on the GTFS. Average PMT at job site is constructed using the Census Transportation Planning Package.

Upscaling Street Network Data

The calculation of accessibility measures requires data for travel between origin points and destination points. This data can take the form of hypothetical/estimated measures of time/distance between points or can be measured by travel along the actual street network. The construction of the final OD dataset involves several data assembly, assessment, and evaluation steps. These include:

1. Assembling population-weighted origin centroids for all tracts in California;
2. Assembling jobs-weighted destination centroids for all tracts in California and all tracts within 100 miles of the California border;
3. Generating network time and network distance measures in ArcGIS; and
4. For missing time/distance measures, fill in gaps by:
    a. Estimating for missing tracts using average of neighboring tracts;
    b. For those where assessment of estimated time was outside of the range of a reasonable estimate, a new time was estimated based on non-network/simplified distance measures (e.g., using as-the-crow-fly distances between tracts or using Manhattan distances between tracts).

Each census tract in California is assigned an origin centroid and a destination centroid. Origin points are **population weighted** while destination points are **jobs weighted**. The use of separate origin and destination points is a refinement adopted from recommendations made after assessing Phase I's Los Angeles prototype efforts.[24]

The HERE Network is constructed by measuring travel along the road network from each origin point in California to every destination in the state and in bordering states within 100 miles of the California border. Including areas outside of California is meant to capture the commutes of Californians who may work just on the other side of the state's border. The distance and time measures between tracts are calculated in ArcGIS using the Business Analyst extension. This step generates a time/distance measure to all possible OD pairs in California.

This step generates a dataset with more than 38 million OD pairs. The first iteration of this dataset includes network measurements (in both time and distance), Great Circle (GC) distances,[25] and Manhattan distances[26] for more than 38 million pairs/potential commutes. This is a large dataset, the size of which slows down the processing and calculation of data. This batch of OD measurements is trimmed down by implementing the following two restrictions:

1. Include only OD pairs where the GC distance is less than or equal to 150 miles.
2. Include only OD pairs where the travel time along the street network is less than or equal to 120 minutes.

These restrictions trim the dataset down to about 22 million measurements. It also drops all pairs that were unsuccessfully routed.

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[24] In the Los Angeles Prototype, population-weighted centroids are used as both origins and destinations.
[25] A GC distance refers to the shortest, "as the crow flies," distance between two points.
[26] A Manhattan distance refers to the distance covered by traveling along a 90-degree angle between two points (e.g., driving to a point in the northeast by traveling east in a straight line and then directly north).

Addressing Missing OD Pairs

Based on previous experience with developing the Los Angeles Prototype Monitoring System, it was anticipated that relying on ArcGIS/HERE alone would not produce a complete dataset for all tracts. In the same exercise for Phase I, for example, the routing tool failed to produce measurements for some larger rural tracts and for tracts where centroids were located in areas near private or non-traversable roads.[27] These missing measurements are estimated using the methods described in the following text. The gaps in measurement fall into one of two categories: those where routing problems were caused at the origin point and those where routing problems were caused at the destination point.

Calculating Network Impedance for Tracts with Missing HERE Network Time

Using Average of Neighboring Tracts

Problematic tracts were dealt with in one of two ways: using the average of neighboring tracts and imputing a measure based on GC distances. The first involved estimating a network travel time/distance for the tract by using the average of the tract's neighbors. Neighboring tracts were identified using ArcGIS to select all those sharing a border with the problematic tract. This was done once for problematic origins and separately for problematic destinations. For simplicity and to avoid confusion, the methods will be described here with reference to problematic origin tracts. The operations and methods, however, are the same for both sets of problematic tracts.

Imputing from GC Distances

The OD dataset is large, which can slow down data processing and calculation. To trim the dataset down, we implement the following general restrictions:

A. Include only OD pairs where the GC distance is less than or equal to 150 miles; and
B. Include only OD pairs where the travel time along the street network is less than or equal to 120 minutes.

An estimated network impedance measure, for tracts missing a network time, is estimated using the GC distance associated with the tract.

Completing Network Dataset

The process of estimating, imputing, and assigning network impedance measures to tracts with missing values is summarized in five steps on the following text.

Step 1: Identify Origin (or Destination) Tracts Missing HERE Time

First, OD pairs that failed to route are isolated to identify the problematic origin (or destination) tract.

Step 2: Identify Tract Neighbors in ArcGIS

The dataset of problematic tracts, generated in Step 1, is added to ArcGIS for mapping. From here, neighboring tracts for each problematic tract are identified using Arc's spatial selection tools. The resulting dataset is one where each "neighbor" has an identifier indicating the problem tract ("seed" tract) with which it is associated.

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[27] See Los Angeles Prototype Monitoring System Report for more detailed discussion.

Step 3: Take Average of Neighboring Tracts' Travel Times and Distance

After identifying the problematic tracts and finding their neighbors, we are then able to begin estimating the network travel times and distances of the problem tracts. This step is accomplished in the Statistical Analysis Systems (SAS) program. The dataset includes the network travel times and distances for all neighbor tracts. Each observation also includes a variable indicating the problem tract it is associated with. Using the problem tract identifier, we use the "PROC SUMMARY"[28] operation to calculate the means for all network travel times and distance by problem tract.

Step 4: Assessing Estimated Time/Distance

After completing Step 3, all problem tracts should have an estimated travel time and distance associated with them. Each observation in the dataset should now contain the OD pair ID, an estimated network time, an estimated network distance, and a GC distance (generated by SAS). Before assigning this value to the tract, we first assess whether the estimate is "reasonable" by comparing the estimated travel distance to its GC distance. If the estimate measure is between 60 percent and 110 percent of the pair's GC distance, then the neighbor-estimated number is taken as the travel time/distance for the pair. If not, and the difference between the estimated numbers and the GC distance is significant, then a "network" time estimated using a distance imputed using GC distances (method described in the following text).

Step 5: Assign Missing Values to Tracts

This step occurs after estimated values are assessed. The type of estimated/imputed values is assigned based on the assessment conducted in Step 4.

Upscaling Housing Density

This subsection documents the construction and evaluation of the housing density indicator. SCSs plans include a long-range vision for how a region's housing and transportation developments will be structured to meet GHG reduction targets. As such, construction of the baseline begins with an examination of housing density. Residences operate as a starting point for many trips, so it is fitting to begin with an examination of where people live. In addition to analyzing housing unit density, a few alternative measures, including population density, the density of larger (10+ unit and 20+ unit) buildings, and vehicle density were assessed during Phase I's Los Angeles prototype efforts. See the Phase I report on the Los Angeles Prototype Monitoring System for full discussion of these.

The 2010 Decennial Census is the primary data source used for this indicator. One of the recommendations upon completing Phase I was for the use of occupied housing units, rather than simple housing units for this measure. That recommendation is adopted, here, in Phase II for the Statewide Monitoring System. The methods for calculating density remain unchanged, however.

Occupied housing unit density is calculated by taking occupied housing units and dividing by the tract's land area (square miles).

<u>Occupied Housing Unit Density Results</u>

Census tracts are the basic unit of analysis. Tracts in California were assigned to a quintile category based on their relative density. The highest-density census tracts in California are concentrated in the major

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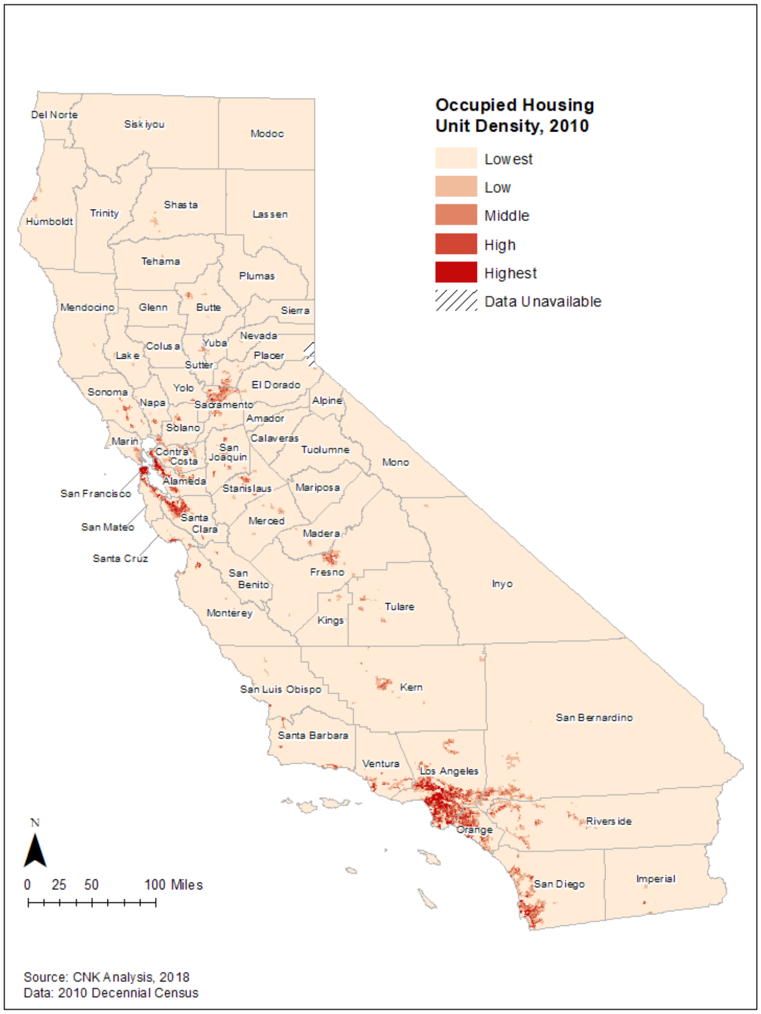
[28] This procedure summarizes numeric variables by specified characteristics. In this example, the operation takes the sum of all travel times/distances for observations sharing the same tract identifier.

metropolitan areas of Southern California (Los Angeles, Orange, and San Diego counties) and the San Francisco Bay Area (Figure 5-2).

Figure 5-2: Occupied Housing Density across California



The map displays the data by census tract. California census tracts are divided into five quintiles based on the tract's occupied housing unit density estimate. Each quintile contains roughly 20 percent of all census tracts in the State.

Jobs-Housing Fit

The jobs-housing fit baseline analyzes the nexus between affordable housing and job commutes for workers at the lower end of the labor market. It was adopted in Phase II and was not included in Phase I's Los Angeles Prototype Monitoring System. Monitoring changes along this dimension provides insights into whether recent developments are potentially consistent with the equity elements of SB 375.

Where there is a better spatial match of jobs and housing, we expect a higher likelihood for reduced travel and congestion (also fewer GHG and pollutant emissions, and lower travel costs for commuters). Where there is an imbalance, we can expect increased commutes, congestion, and emissions because a shortage of nearby jobs will mean more residents having to find work farther away and, similarly, a shortage of nearby housing at job centers will mean fewer residents have the option of living near their place of work.

This measure of the degree of mismatch between earnings and affordability focuses specifically on low-wage earners. Low-earners, on average, drive older, less fuel-efficient vehicles. The environmental benefits come from decreasing the VMT of these less fuel-efficient vehicles. On top of this, the focus on low-earners allows for consideration of equity issues in transportation and housing, as higher transportation costs affect impose the greatest burden on low-earners.

To the best of our knowledge, no jobs-housing fit measure has been constructed for the state. Existing and related works have focused largely on a specific region. CNK's jobs-housing fit measure fills this gap by constructing a statewide jobs-housing fit measure with regional adjustments to account for differences in the cost of living throughout the state.

Assembling Data to Calculate Jobs-Housing Fit Baseline

We relied on two publicly available datasets to construct the jobs-housing fit measure for the Statewide Monitoring System. Data on jobs by earnings level were derived from the 2006–2010 five-year Census Transportation Planning Products (CTPP), which is based on the ACS 2006–2010 five-year estimates. Data on housing units by rent levels come from ACS 2008–2012 five-year estimates. Because these two datasets represent five-year averages, the jobs-housing fit baseline is not 2010 per se, as is the case with most other baseline indicators in the monitoring system. Nonetheless, the counts of these come close as possible to the desired 2010 baseline year.[29]

CTPP was chosen over LEHD, another widely used data source for job counts, because CTPP has more detailed information on earnings levels. For example, CTPP covers nine different earnings level while LEHD only covers three levels of earnings. The lowest monthly earning category reported in LEHD is $1,250 or less, which is equivalent to $15,000 per year. Recent studies (Benner and Karner, 2016) on the jobs-housing balance have used this earnings category to define low-earners. Unfortunately, using this earnings cutoff throughout the state creates inconsistencies across counties. The proportion of workers that make less than $1,250 per month varies from a low 13.5 percent (San Francisco) to a high 40 percent (Mono) across counties in California. This wide variation means that we are not looking at equivalent bottom segments of the labor force.

Calculating Jobs-Housing Fit Baseline

Multiple steps were taken to construct the jobs-housing fit baseline. They are described as follows.

1. **Identify analytical regions for regional adjustments.** Due to differences in housing costs and distribution of low-wage workers throughout the state, the jobs-housing fit baseline required constructing specific regional adjustments to account for these differences. Combined statistical areas (CSAs) were used as the core to determine the different regions into which to assign counties. The Census Bureau defines *CSAs* as "consisting of two or more adjacent metropolitan and micropolitan statistical areas that have substantial employment interchange,"[30] in other words, CSA can be considered an integrated regional economy. Counties that do not fall in a CSA were either assigned into the region that was geographically nearby or shares similar characteristics. It is important to note that the regions selected for the jobs-housing fit baseline, which is only for analytical purposes, are different from the regions discussed in this report for reporting purposes. Figure 5-3 displays the six analytical regions used to construct the jobs-housing fit baseline.

[29] Census tract–level data from the ACS are only reported through its five-year estimates due to sample size. The 2006–2010 CTPP, based on the 2006–2010 five-year ACS, is currently the only available CTPP dataset that comes close to 2010. The 2008–2012 ACS data on rent levels was selected because 2010 represents the midpoint of the five-year estimates.

[30] https://www.census.gov/geo/reference/webatlas/csa.html. Date accessed: September 12, 2018

Figure 5-3: Analytical Regions for Calculating Jobs-Housing Fit Index

2. **Determine the earnings cutoffs that represent the bottom quintile of the labor force for each region.** We define *low-earnings jobs* as jobs with earnings that fall within the bottom fifth of the labor force within each analytical region. For our purpose, they are equivalent to low-earners. The earnings cutoff that defines the bottom fifth of the labor force varies across regions due to variations in the cost of living. For example, the earnings level that corresponds roughly to the bottom fifth of the labor force in the Bay Area is $18,000 and $11,000 for Northern California. For the state as a whole, jobs with earnings of no more than $15,000 constitute the bottom fifth. The earnings cutoffs for each region were determined using by interpolating and each earnings level is rounded to the nearest thousand.

3. **Determine maximum rent level for each region.** For each region, we determine the equivalent maximum rent that a low-earner can pay given their earnings level. We focus on rental units because workers with low earnings are more likely to be renters than homeowners. We adopt Benner and Karner's approach of calculating the maximum rent levels that can be afforded by those with low earnings. Benner and Karner use a combination of a standard definition of housing affordability and some multiple of the monthly low-earnings category to derive an affordable monthly rent cutoff for low-earners. The authors adopt the 30-percent rule to define *affordability*—that is, an affordable rental home is one in which the household pays no more than

30 percent of its income on housing and utility costs. This definition of *affordability* is the most widely adopted standard and is used by many government agencies. For example, the Department of Housing and Urban Development (HUD) and local public housing agencies use this standard in their administration of rental assistance programs including Section 8 HCVs. Along with this definition of *affordability*, Benner and Karner also adopt the approach where rent does not exceed two times the monthly threshold of the low-earnings category.[31] Table 5-1 lists the earnings cutoff that constitutes low-earners in each region (roughly the bottom quintile of the labor force for each region) and their equivalent maximum monthly rent. Using a modified version of Benner and Karner's approach, an affordable monthly rent for a low-earner in Southern California with annual earnings of $15,000 or less would be $750. All rental units with rents levels at or below the maximum monthly rent are designated affordable rental units. As such, total affordable rental units is the sum of all rental units with rents level at or below the maximum rent determined for the region.

Table 5-1: Cutoffs for Low-Earners and Maximum Monthly Rent by California Regions

	Annual Earnings	Maximum Monthly Rent	Maximum Monthly Rent Calculation
California	15,000	750	(30% × 15,000/12) × 2
Northern CA +	11,000	550	(30% × 11,000/12) × 2
Sacramento	15,000	750	(30% × 15,000/12) × 2
Bay Area	18,000	900	(30% × 18,000/12) × 2
Central Valley	12,000	600	(30% × 12,000/12) × 2
Coastal	13,000	650	(30% × 13,000/12) × 2
SoCal	15,000	750	(30% × 15,000/12) × 2

Low-earnings jobs-housing fit: For each tract, we use a catchment area defined as a 2.5-mile buffer around the tract's centroid. The metric is the ratio of the total number of low-earnings jobs within a 2.5-mile buffer[32] of a census tract to the total number of affordable rental units. The indicator should be interpreted as the characteristics of the larger geography that surrounds that tract, including the tract's own characteristics. It has similarity to a spatial moving average.

Results: Jobs-Housing Fit

Using the methods described in the preceding text, jobs-housing fit was calculated for all census tracts in California. California's major metropolitan areas show the highest affordable housing deficit, while more rural areas show a jobs deficit relative to the amount of affordable rental housing.

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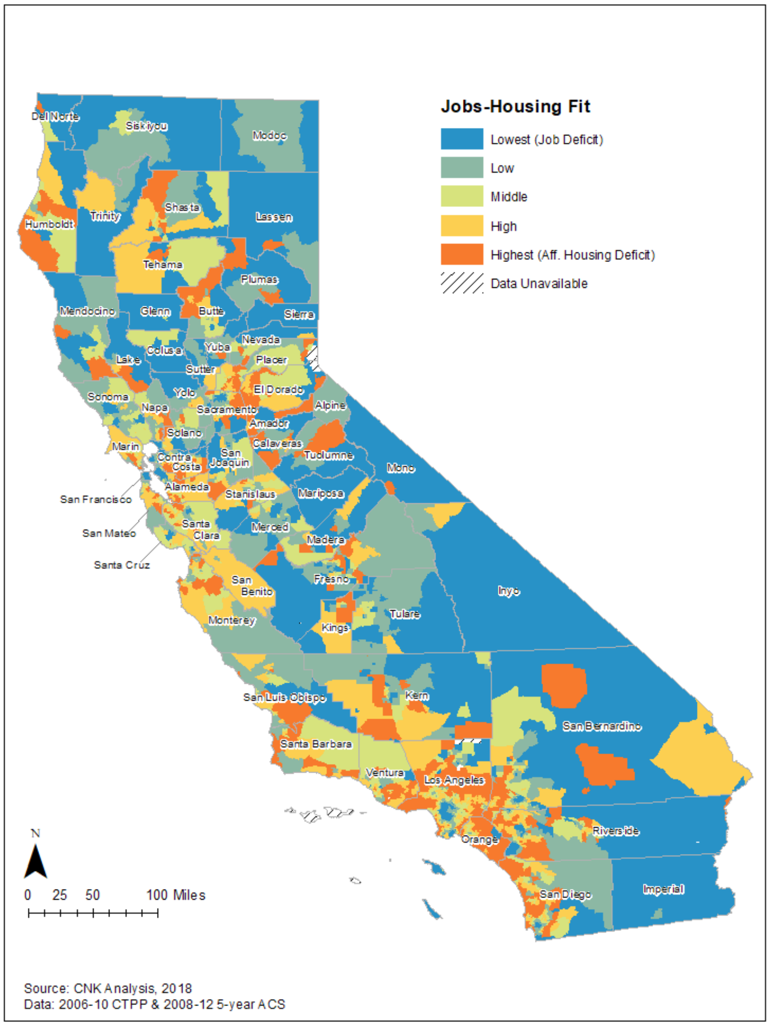
[31] Karner and Benner use LEHD data which uses a $1,250/month wage threshold (equivalent to an annual income of $15,000). Taking into account the characteristics of the San Francisco Bay Area's jobs to housing ratio and the composition of jobs per household, the authors experimented with using a threshold that is 1.2 times and 1.5 times LEHD's $1,250/month. These produced annual incomes well below what is defined by the area's affordable housing developers as low-income. Given this, the authors set their low-wage threshold at two times $1,250/month, defining low-income with an annual income threshold of $30,000.

[32] The 2.5-mile straight-line distance of the population-weighted centroid of a census tract.

Figure 5-4: Jobs-Housing Fit across California



The map displays the data by census tract. California census tracts are divided into five quintiles based on the tract's jobs-housing fit estimate. Each quintile contains roughly 20 percent of all census tracts in the State.

<u>Verifying/Evaluating Results for Jobs-Housing Fit</u>

An important part of constructing any indicator is an assessment and evaluation of the indicator to external sources. This process allows us to test the robustness of our indicator and to make refinements and modifications to the methodology where needed. One external source that was suggested by the Advisory Committee is the jobs-housing fit index that was constructed by Benner and Karner's method for the Bay Area. We originally adopted Benner and Karner's method of calculating jobs-housing fit but found that the method could not be applied to the whole state. CNK's jobs-housing fit index for the Statewide Monitoring System is a modified version of Benner and Karner's method as well as earlier works on jobs-housing fit/balance including the work done by Cervero (1989, 2006).[33]

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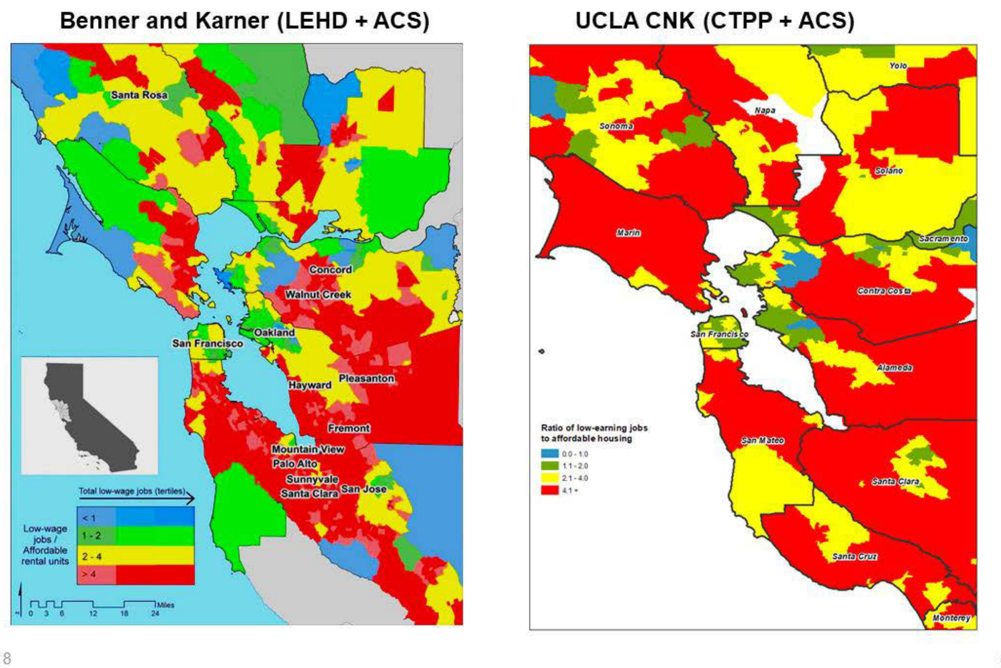
[33] Cervero, Robert. "Jobs-housing balancing and regional mobility." *Journal of the American Planning Association* 55.2 (1989): 136–150. Cervero, Robert, and Michael Duncan. "Which Reduces Vehicle Travel More:

This section evaluates CNK's jobs-housing fit measure against Benner and Karner. Figure 5-5 compares CNK's jobs-housing fit measure against Benner and Karner's index for the Bay Area. The two measures are fairly consistent, particularly within the major urban areas including the East Bay and San Francisco. The differences between the two, mainly in the less urban areas, may be related to the differences in job counts between the two different datasets being used. Benner and Karner's method uses 2011 LEHD/Origin-Destination Employment Statistics (LODES) for jobs while our metric relies on 2006–2010 five-year CTPP. CTPP includes workers not in the unemployment insurance (UI)/disability insurance (DI) system, such as many agriculture workers. This could contribute to a higher jobs-housing fit index in less urban areas. CTPP also includes self-employed, thus a possible job-housing ratio in areas with relatively more self-employed workers such as in the Silicon Valley. LEHD only reports job counts that receive UI/DI and does not include the self-employed.

Figure 5-5: Comparing CNK's Jobs-Housing Fit Index to Benner and Karner's (2016) Index of the Bay Area



The differences may also be due to differences in housing data used. Housing unit data for Benner and Karner's jobs-housing fit metric comes from the 2007–2011 five-year ACS. CNK's also uses the ACS data but a different vintage—the 2008–2012 five-year ACS.

Differences in the definitions for what constitute low-earners and affordable rental units are also some possible reasons that may explain the differences between the two measures. Benner and Karner define *low-wage jobs* as jobs with monthly earnings of $1,250 or less which is equivalent to $15,000 per year. Rather than using one earnings cutoff and applying it for the whole state to define *low-earners*, CNK's defines *low-earners* with earnings that fall roughly within the bottom one-fifth of the labor force. Benner and Karner use a cutoff of $750 per month as the cutoff for affordable housing. Any rental units with rent levels at or less than $750 would be considered "affordable" in the Bay Area. As with defining low-earners, CNK uses a different rent-level cutoff for each region to determine what constitutes affordable

Jobs-Housing Balance or Retail-Housing Mixing?" *Journal of the American Planning Association* 72.4 (2006): 475–490.

rental units. CNK uses a cutoff of $950 per month as the maximum monthly rent low-earners in the Bay Area, although the *Bay Area* is defined differently than the definition used by Benner and Karner.

Upscaling Access to Jobs

This subsection documents the construction of the access to jobs indicator for the Statewide Monitoring System.

The primary data source for jobs data is the 2010 LEHD/LODES database.

Development of the Los Angeles prototype demonstrated that the construction of an access to jobs measure would require us to estimate a customized parameter for California. For Los Angeles, the power decay form with customized parameter was best suited to Los Angeles County. In upscaling efforts, tests showed that the exponential decay form with customized parameter was better suited for the State of California. The main tasks in the construction of the Access to Jobs measure includes the following: (1) data assembly, (2) estimating the decay parameters, (3) calculating accessibility, and (4) verifying results.

<u>Assembling Data to Calculate Access to Jobs Baseline</u>

Data was downloaded for all census tracts in California from the LEHD/LODES database. A full assessment of this and alternative datasets considered is available in Phase I's report on the Los Angeles Prototype Monitoring System.

<u>Estimating Decay Parameters for California</u>

Parameters were estimated for the power decay and exponential decay functional forms. These were then used to calculate job accessibility for California. Results for each calculation method (i.e. the simple gravity calculated measures, power decay with customized parameter, and exponential decay with customized parameter) were tested against commute patterns to determine the best-suited form for commute travel in California.

In evaluating the indicators relative to travel behavior (average commute time and average commute distance), the results showed the strongest relationship between the exponential decay form with author-calculated parameter and commute travel in California.

The functional form used to calculate the final access to jobs measure is:

Exponential decay with author estimated parameter: $e^{-b(t-11)} where\ b =$ 0.0395 and $t = time$

After testing formulas and parameters for the state, the exponential decay was slightly better fit for the State of California than the power decay form (used in the Los Angeles prototype). For more detailed discussion of the formulas tested and the methods used to estimate decay parameters, please see Phase I's Los Angeles Prototype Monitoring System report.

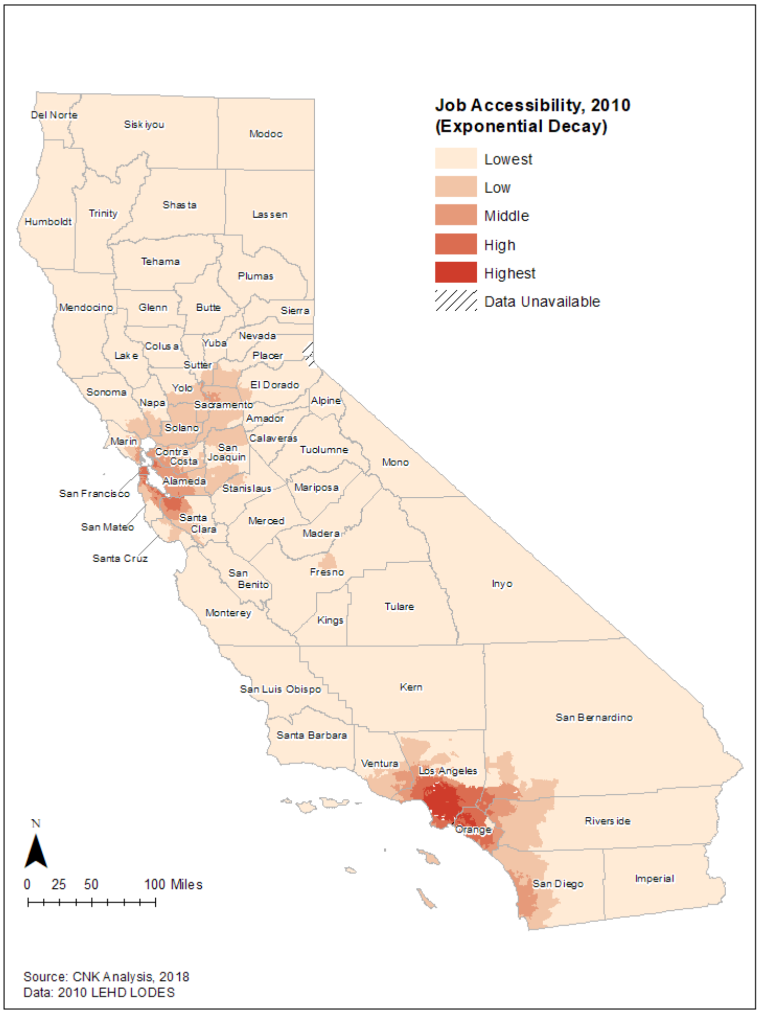
<u>Calculating Accessibility to Jobs Baseline</u>

The final jobs-accessibility indicator is an index score that captures all the job opportunities accessible by a tract, within a two-hour or 100-mile commute. We calculated the jobs accessibility indicator by, first, assembling 2010 job counts for each tract, using the LEHD dataset. The steps to calculating the indicator include assembling the data and attaching these to the OD network. Each OD pair has an associated travel time between them. The job counts, the time measure, and a modifying parameter (to simulate the relative likelihood/attractiveness of driving to jobs at increasing distances) are the three numbers input into each of the functional forms to calculate accessibility. This calculation is conducted for each OD pair for every California tract. The accessibility indicator for each tract is a sum of all these calculations, by origin tract (i.e., all values for pairs with the same origin are added together). Excluded from the final indicator measure are all OD pairs with no jobs, and all pairs where travel between them was greater than two hours or 100 miles.[34]

Results: Access to Jobs across California

Jobs accessibility is calculated using the methods described in the preceding text for census tracts in California. Areas with the highest job accessibility are concentrated in and adjacent to California's major metropolitan areas (Figure 5-6).

Figure 5-6: Jobs Accessibility across California



The map displays the data by census tract. California census tracts are divided into five quintiles based on the tract's access to jobs estimate. Each quintile contains roughly 20 percent of all census tracts in the State.

[34] Commutes of 100 miles or so and greater have been defined by many as an "extreme commute." These are excluded from calculations.

Upscaling Access to High Quality Transit Locations (HQTL)

This subsection documents the construction and evaluation of the access to the HQTLs baseline. The HQTL baseline indicator includes access to bus, rail, and ferry terminals. Construction of the measure includes two key dimensions: a quarter-mile geographic catchment area and level of service (for bus only). *Level of service* is defined as the number of buses that go through the bus stop during the morning peak commute hours on a given weekday. Rail and ferry terminals that are within a quarter mile are automatically designated as a HQTL.

The access to HQTLs baseline was constructed using transit data from agencies that publish their transportation schedules in GTFS format. GTFS consists of a series of text files, all compressed into a .zip folder, that provide information on transit stop locations, scheduled arrivals and departures, routes, and other relevant information such as transit fare. The main purpose behind agencies converting their transit data to GTFS format is to make available their schedules to users of Google Maps, BingMaps, and other trip-planning applications. For additional details on GTFS and an assessment of the dataset, see the Phase I report.

GTFS data was gathered for California from multiple sources. The two primary sources are open data sources, Transitland and TransitFeeds, which collect and archive GTFS feeds and make available GTFS for download. These two sites do not always include the same agencies, thus requiring the use of both. GTFS was also acquired from a transit agency by directly contacting the agency (for those agencies that have GTFS but where the data is not available online). Overall, GTFS feeds were gathered for 127 transit agencies, covering 52 of the 58 counties in California and include both bus and rail (see list of transit agencies in Appendix A).

Our best estimate indicates that 54 percent of the agencies in California have open GTFS data. Of the agencies included in the Federal Transit Administration's (FTA) National Transit Database (NTD) (which does not include many small agencies), the 127 transit agencies included the compiled GTFS dataset and represent approximately 97 percent of the unlinked passenger trips traveled statewide.

The tasks involved in compiling a statewide GTFS database are complex and challenging, requiring a significant amount of time and resources to address. There are a number of major problems with GTFS that were identified for this project.

1. **Not all agencies produce GTFS**, particularly small agencies in both rural and urban areas.
2. **Not all GTFS feeds are on a single common data site** (as indicated, GTFS feeds were gathered from multiple sources).
3. **Because of differences in archiving, consistency in the vintage of data** (e.g., schedules do not cover the same dates across all transit feeds) depended on when data was uploaded and downloaded.
4. **Some existing GTFS feeds do not have complete subfiles** (e.g., the calendar file that is one of the required subfiles and that also helps indicate weekday and weekend schedules was missing for some of the GTFS feeds).
5. **Coding practices for GTFS vary among agencies.** While GTFS standard defines a common format for transit agencies to publish their transit data including what information is required and what is optional, how agencies input this information differs from agency to agency. For example, the "stop_id" field, which is an ID that uniquely identifies a stop, station, or station entrance, is a required field, but agencies differ in how the information is input, with some using numeric values and some using character. The "stop_id" field is a unique ID that is used to merge across the various files in the GTFS including the "schedule" file; some agencies may have it in numeric format in one file but character in another file, causing the files to not merge because the variable "stop_id" is being read as both character and numeric.
6. **Poor documentation.** Other than the generic GTFS documentation provided by Google, which helps explain the types of files that comprise a GTFS transit feed and define the fields used in all

those files, there is no publicly available documentation from individual transit agencies explaining the meaning behind some of their coding.

7. **Multiple schedules.** For many agencies, multiple schedules are included in the feeds, but no documentation is provided explaining the differences between these schedules and how to handle them. For the purpose of this project, one schedule should be selected to avoid double counting the frequency at a given transit location.
    a. Some agencies provide multiple schedules, one for weekday and one for weekend. In this scenario, where there are only two types of schedules, the weekday schedule is selected over the weekend schedule.
    b. There are occurrences where agencies include more than one weekday and weekend schedule. While the weekend schedule can easily be eliminated, identifying which weekday schedules to use from the GTFS feed oftentimes required more time to determine, especially without proper documentation. In some cases, the weekday schedules are duplicate records, with the same arrival and departure time and the same routes but with different service start and end dates. When these types of scenarios occur, the schedule with the most current start date of the two is selected.
    c. Some agencies include separate schedules for services that operate year-round, seasonal schedules (e.g., summer and winter) and school days–only schedules. When these types of schedules are easily distinguishable, the year-round schedule is selected because it is the most consistent schedule throughout the year.
    d. Oftentimes, it is difficult to determine what each schedule represents. The start and end service dates, for example, do not differ from one another and none of the files in the GTFS feed give any indication of how the schedules differ. In these cases, additional analysis was done to determine the differences across schedules. For example, each schedule was assessed against the routes file to see if there were any patterns that would give any clues on how the multiple schedules differ. At times, this process did provide some insights into how the schedules differ. For example, some schedules overlapped in the routes they cover but one might cover more routes than the other. Additional investigation included going directly to agency's website to compare the GTFS to published schedules. In the end, the schedules selected for the access to transit measure is the best that the researchers can do given the resources, time, and limited documentation.

Definitions and Calculations

HQTLs. We define *HQTL* as the quarter-mile buffer around any one or more of the following locations:

1. Any existing transit rail station; or
2. A terminal served by a ferry system in major metropolitan areas; or
3. A location with bus service maintaining average headways of 15 minutes or less during morning peak commute; here defined as 6:30 to 8:30 AM on a given weekday.

Transportation planners generally accept the quarter-mile distance, equivalent to about a five minute walk, as the standard distance one is willing to walk to local transit service.

High-Quality Bus Location. A *bus location* is defined as the sum of all bus stops that are in close proximity to each other. Examples of this are the three unique stops displayed in Table 5-2. Each bus stop has slightly different longitude and latitude but is considered as the same location by street intersection (Hollywood and Western). Together, the location is a high-frequency transit location with total frequency of 36 during the 6:30 to 8:30 AM peak period. To overcome the problem of agencies identifying stops differently (e.g., some agencies identify separate stops that are in close proximity to each other, such as being on opposite corners of an intersection, or different endpoints at a what most would consider a common stop), we merge all nearby stops when their locations are similar, that is, when their longitude and latitude rounded to three digits are identical (a difference of .001 is less than a fifteenth of a mile).

Table 5-2: Determining High-Quality Bus Location

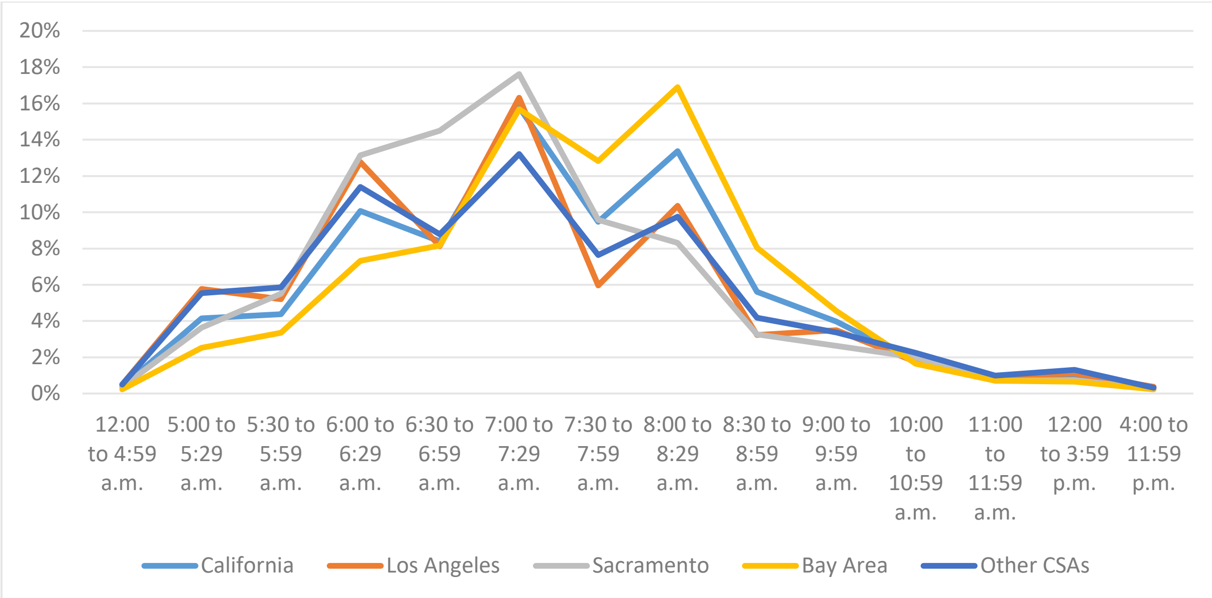
stop_id	stop_name	Latitude	Longitude	Latitude Rounded	Longitude Rounded	Freq. 6:30–8:30 AM
1206	Hollywood/Western	34.10187	-118.30877	34.102	-118.309	0
2493	Hollywood/Western	34.10161	-118.30893	34.102	-118.309	19
11028	Hollywood/Western	34.10186	-118.30902	34.102	-118.309	17
ALL STOPS	**Hollywood/Western HQTL**			**34.102**	**-118.309**	**36**

This concept of high-quality transit is related to terminologies defined in the California Public Resources Code relating to “major transit stops” and “high-quality transit” and that are consistent with SB 375:

- 21064.3. “Major transit stop” means a site containing an existing rail transit station, a ferry terminal served by either a bus or rail transit service, or the intersection of two or more major bus routes with a frequency of service interval of 15 minutes or less during the morning and afternoon peak commute periods.
- 21155. “High-quality transit corridor” means a corridor with fixed route bus service with service intervals no longer than 15 minutes during peak commute hours.

The state’s definitions do not explicitly define what period falls under morning and afternoon peak hours. These decisions are often left to MPOs or a regional-planning authority to decide. A statewide peak period is hard to nail down considering all the regional variability that exists in terms of commute time. For example, peak periods in the Los Angeles and Bay Area CSAs are much different from the peak periods in Sacramento and even more so than the rural areas. Figure 5-7, showing the time workers leave for work by public transportation, illustrates these regional variations across California.

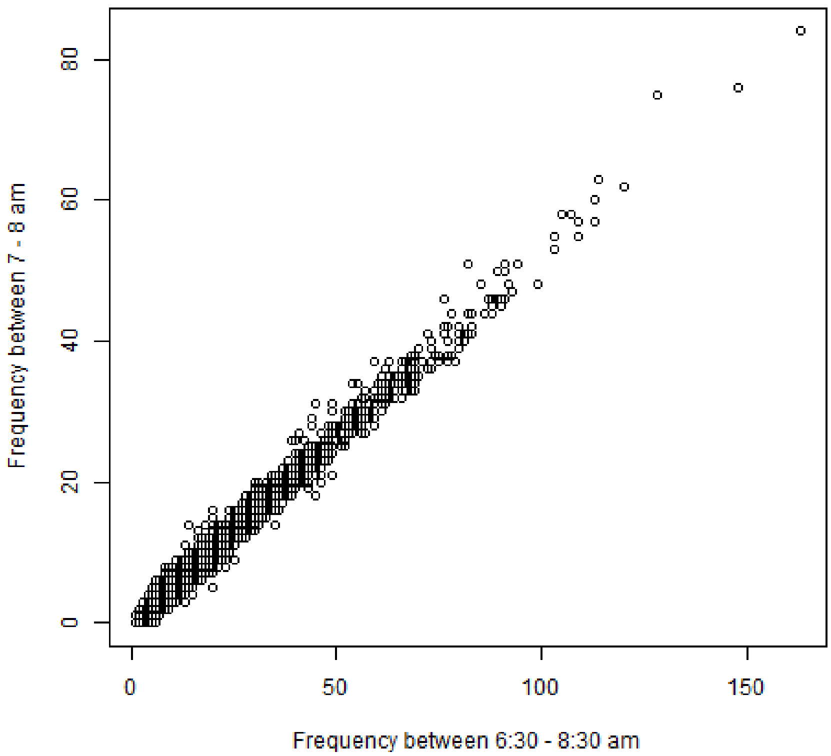
Figure 5-7: Time Leaving Home to Go to Work by Public Transportation by CSAs (2012 to 2016)



Source: 2012–2016 five-year ACS

Despite the regional variation in commute hours, a consistent definition for the state of what period constitutes peak hours is needed for a statewide measure. Figure 5-7 was presented to the Advisory Committee for their input on some possible definitions of morning peak hours. Two periods for morning peaking hours were suggested: 6:30–8:30 AM and 7:00–8:00 AM. An assessment of the two periods indicate that they are highly correlated (r = 0.995), which would suggest that choosing one over the other would not make that much of a difference. Figure 5-8 displays the scatter plot comparing the frequencies in stops during 6:30–8:30 AM and 7:00–8:00 AM periods for California as whole. The 6:30–8:30 AM time slot was selected over the 7:00–8:00 AM time slot because this period captures most of the region's morning peak hours. Although the state's definition includes both morning and afternoon peak hours, this research only focuses on morning peak hours due to limited time and resources. There is also the challenge of defining afternoon peak hours, as there are even further regional variations than morning peak hours.

Figure 5-8: Comparing Transit Frequencies by Locations between 6:30–8:30 AM and 7:00–8:00 AM



Identifying High-Quality Transit Stops for Counties with no GTFS

We used GTFS data to identify HQTLs, but there were counties with no GTFS data coverage. For these, a different method was adopted by using printed bus schedules online. This section describes the methodology to identify high-quality bus stops for those agencies with no GTFS data for the following six counties that do not have GTFS coverage: Alpine, Colusa, Glenn, Imperial, Sierra, and Mono.

For each of these counties, we identified the largest transit agency that serves the county. Due to limited resources and time, we only looked at the largest agency in the county but acknowledge that a county may be served by more than one transit agency. Published schedules, often made available on the agency's website, were collected and downloaded. Many of these schedules are in .pdf format, which required us to convert the paper schedules into an Excel format or similar formats to be readable in ArcGIS and SAS, the two primary analytical software programs used for this project. This process required a considerable amount of time to ensure that each schedule was converted correctly. Agencies were directly contacted to ask if they had their schedules in an Excel format, but many directed us to the online .pdf schedules.

It is important to note that not all bus stops are reported in the printed schedules. Bus stops on major streets or intersection are generally the ones that are reported. Stops located on non-major streets or intersections with fewer routes serving the stop are often omitted from the printed schedules. For each stop, we first determine whether the stop is considered "high quality" based on the definition used for this project.

For each stop, we first identify all routes that serve the bus stop and extracted their schedules. Some bus stops are served by more than one route. From this, a matrix is created with the stop names. Only morning schedules, between 6:30 to 8:30 AM, were extracted because this is the time frame used in CNK's HQTL definition. Table 5-3 provides an example of this.

Table 5-3: Stop Time Table for High-Quality Stops in Imperial County

7th Street and State		Imperial Valley College		3rd Street and Paulin	
Arrival Time	*Route*	*Arrival Time*	*Route*	*Arrival Time*	*Route*
6:58	Green Line	7:00	21 IVC Express	6:30	21 IVC Express
6:58	Blue Line	7:15	21 IVC Express	6:30	32 Direct AM
7:00	45 West	7:26	3 West	6:45	21 IVC Express
7:00	1 North	7:30	22 IVC Express	6:55	1 North
7:10	41 South	7:35	2 South	7:20	31 Direct AM
7:10	Blue Line	8:00	4 East	7:40	21 IVC Express
7:10	1 South	8:10	21 IVC Express	7:45	1 North
7:10	Green Line	8:25	21 IVC Express	7:50	32 Direct AM
7:40	4 East	8:30	2 North	7:55	21 IVC Express
7:45	1 South			8:20	1 North
7:55	1 North			8:30	31 Direct AM
7:55	2 South			8:30	21 IVC Express
8:00	4 East				
8:00	3 West				
8:08	Green Line				
8:08	Blue Line				
8:10	3 East				
8:10	2 North				
8:20	1 South				
8:20	Green Line				
8:20	Blue Line				
Frequency = 21		Frequency = 4		Frequency = 7	
High Quality		**Not High Quality**		**Not High Quality**	

Notes: Imperial Valley College (IVC) Express operates on school days only.
Imperial Valley College and 3rd Street and Paulin bus stops do not qualify as high quality because the frequency of stops does not meet nine or more stops during the morning peak hours. Because IVC Express only operates on school days, its schedule is excluded. Only services operating year-round are included in CNK's HQTL.

For each bus stop, the number of stop schedules during the 6:30 to 8:30 AM time frame was summed up. If the sum of stops exceeded nine, then the stop is designated as high quality. It is important to note that this process only identifies high-quality bus stops and not locations. For this project, we look at high quality transit locations. As noted before, a location includes all nearby bus stops where both the longitude and latitude when rounded to three digits are identical. If their sum of stops exceeds nine then the location is designated as high quality.

Unlike GTFS data, where information on a stop's geographic location by latitude and longitude is given, the printed schedules do not include this information. Only the names of the bus stop, which are oftentimes the street name or intersection that the stop is located on, are listed in the printed schedules. As such, it is difficult to apply the locations method of rounding latitude and longitude, when this is information is not provided.

Table 5-4 reports the total number of high-quality bus stops for the six counties that have no GTFS data. The transit agency used for this analysis is listed in the table. Of all six counties, only Imperial County had bus stops that qualified as being high quality.

Table 5-4: High-Quality Stops Number and Transit Agency for Counties without GTFS

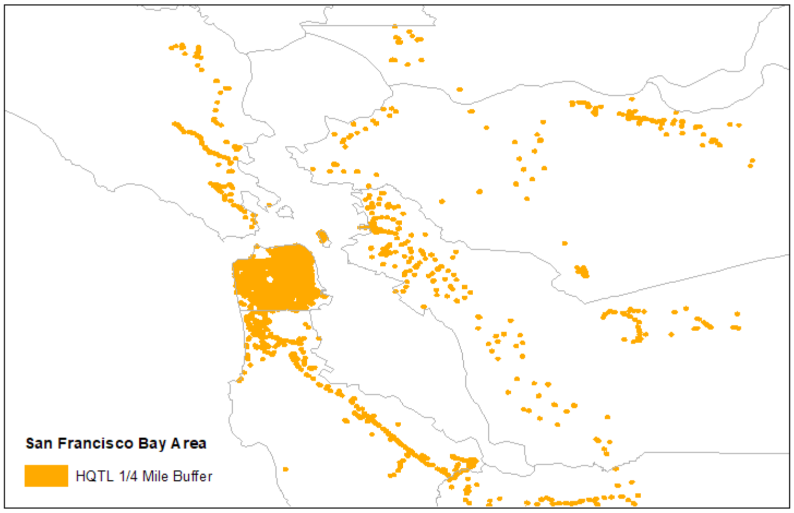
	Number of High-Quality Stops
Alpine	
Alpine County Dial-a-Ride	0
Colusa	
Colusa County Transit (dial-a-ride)	0
Glenn	
Glenn Transit Service	0
Imperial	
Imperial Valley Transit	1
Sierra	
Sierra County Transportation Commission	0
Mono	
Eastern Sierra Transit	0

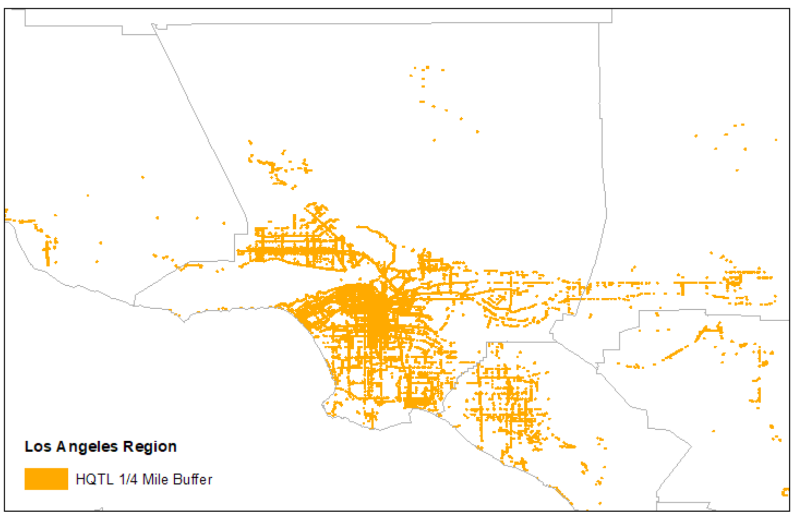
Again, this process only identifies high-quality stops and not locations. It may be the case that some of the agencies listed in the following text might have HQTL when all nearby bus stops are added together, but this is difficult to determine without all the necessary information, including the schedules for stops not listed in the printed schedules.

Figure 5-9: HQTLs

The map displays a quarter mile buffer around high-quality transit locations.

Figure 5-10: HQTLs for Bay Area and Los Angeles Region





Verifying/Evaluating Results for Access to HQTLs

An important part of constructing any indicator is an assessment and evaluation of the indicator to external sources. This process allows us to test the robustness of our indicator and to make refinements and modifications to the methodology where needed. One approach to assessing and evaluating the HQTL indicator is to compare it to similar indicators constructed by MPOs, particularly those that have been done by the two largest MPOs in the state: Metropolitan Transportation Commission (MTC) and Southern California Association of Governments (SCAG). MTC, for example, makes available two shapefiles related to our high-quality transit measure: (1) major transit stops and (2) high-quality transit corridors. Only the major transit stops' shapefile was assessed against our measure. SCAG provides a shapefile for high-quality transit areas.

What we find is that our high-quality transit indicator covers a large proportion both MTC's and SCAG's transit measures and that our measure captures more area. We find differences, but these differences are understandable. For example, some of the discrepancies are due to differences in transit data sources, agencies covered, methods and calculations, and definitions. MTC, for example, uses transit data from 511 Regional Transit Database while we use GTFS. SCAG uses GTFS but only covers a small number of transit agencies compared to our high-quality indicator. MTC also did not cover as many agencies as we did.[35] There are also differences in methods and calculations. For example, there are differences in the concept of locations. MTC uses individual stops while location in our approach can include multiple transit stops. Differences in definitions, such as what hours constitute peak hours, also have a major impact on consistency between agencies. SCAG, for example, uses both morning and afternoon peak hours, while our measure only includes the morning commute.[36] SCAG also defines morning peak hours differently than the definition used for this project. SCAG defines morning peak hours as 6:00 to 9:00 AM and MTC defines morning peak as 6:00 to 10:00 AM. Our measure includes 6:30 to 8:30 AM. Additional details on the external verification process are further discussed in Appendix A.

Despite these differences and limitations described earlier, the access to HQTLs indicator constructed for this project, to the best of our knowledge, is perhaps the most comprehensive access to transit measure available for the state. In particular, we do not know of any access to high-quality transit measure that has been created for the state. Some MPOs have created their own measures but each vary in their data source, methods, and have slightly different definitions of what is considered high quality. Additionally, CNK's HQTL measure covers more transit agencies even more so then for those constructed by some of the MPOs. Although not perfect, the HQTL measure includes a consistent method and definition that is important for a statewide monitoring system.

Average (Mean) PMT at Job Site

Measuring average PMT at the job site is a refinement adopted from recommendations made in Phase I's prototyping efforts. Mean PMT to job site is a measure of the typical commute of a worker at that place of work. If a worksite typically generates very long commutes, the desired change would be for fewer new jobs at this site and, instead, for more newer jobs to go into work areas where the typical required commute is shorter.

<u>Assembling Average PMT at Job-Site Data to Calculate Baseline</u>

The average PMT baseline is constructed using LEHD data for jobs and combining this with HERE OD network times. For a full description of these two datasets and their construction see relevant sections of this report or refer to Phase I's Los Angeles Prototype Monitoring System report.

<u>Calculating Average PMT at Job-Site Baseline</u>

The total number of jobs at a job site is counted using the LEHD flows dataset, which provides data on both where workers are coming from and where they are going for work (leaving from residential tract and ending at job-site tract). The average commute for these jobs is calculated by multiplying the network distance between residential tract and job-site tract and dividing it by the number of workers in the job-site tract.

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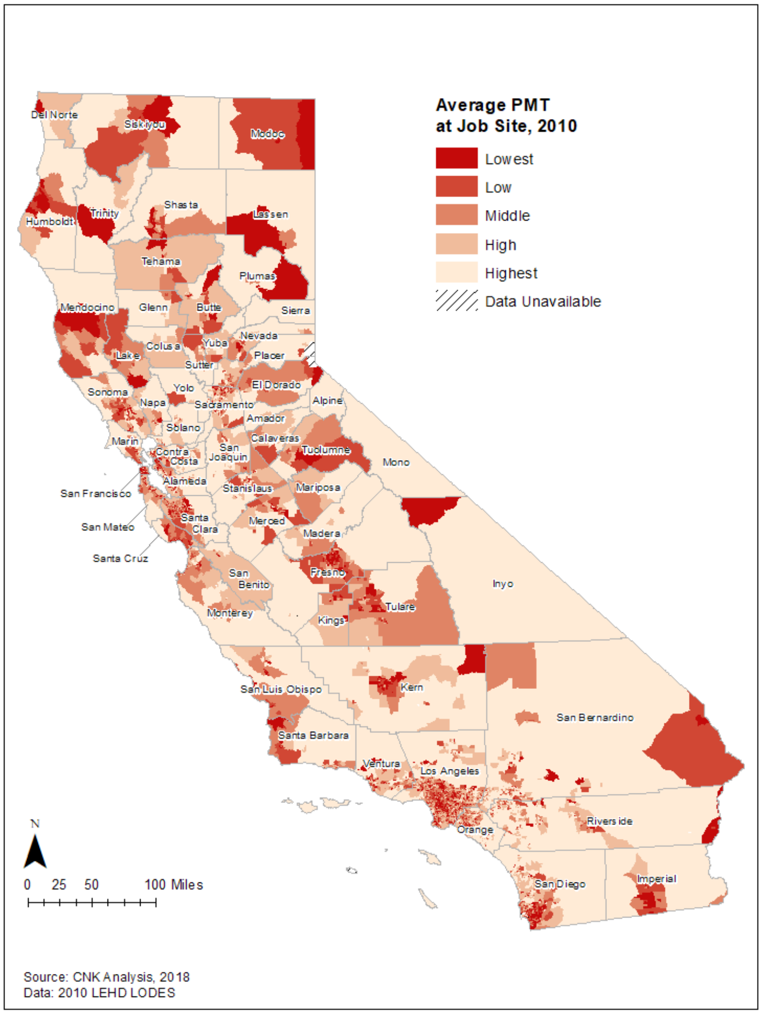
[35] This discrepancy may be due to MTC's more narrow definition of high quality transit. While all Bay Area operators may be represented, some may not provide frequent enough service to qualify as "high quality" by this project's definition.

[36] Note: There are some limitations to focusing only on peak hours (e.g. capturing transit stops that serve only commuters and may exclude members of the general public who rely on transit during off-peak times; capturing commuter bus service as high quality during commute hours which can differ from all-day frequent service). However, since the focus of this project is work-related travel, we focus on morning peaks to best capture these commute trips.

Results: Average PMT at Job Site across California

Unlike with other measures, where highs and lows are clustered around a few regions, the results for average PMT are a patchwork across the state. On the whole, more peripheral areas show the highest commutes while commutes are generally shorter near major job concentrations.

Figure 5-11: Average PMT



The map displays the data by census tract. California census tracts are divided into five quintiles based on the tract's average PMT at job-site estimate. Each quintile contains roughly 20 percent of all census tracts in the State.

Chapter 6 SHORT-TERM CHANGE MEASURES

This chapter describes the process of constructing the short-term measures for the monitoring system and key datasets used. They include parcel data for new housing developments; LIHTCs and HCVs for changes in subsidized affordable housing; and LEHD/LODES for net changes in jobs.

The Statewide Monitoring System measures changes four years out from the baseline. Four-year changes do not constitute consistent base years for all short-term measures. For new housing units (2011–2014) and net changes in jobs (2010–2014) changes represent four years from the baseline (up to 2014). Changes in subsidized affordable rental units represent four-year changes but cover different periods. New LIHTC units cover units built in 2011 to 2014, but net changes in HCVs represent changes between 2012 and 2016.

New Housing Units

About the State Parcel Dataset

Counts for new housing units, defined as units built between 2011 and 2014, are collected from parcel data. The 2016 parcel data, provided by CARB, comes from Digital Map Products (DMP), a third-party vendor that specializes in location data. DMP acquires parcel data from counties and repackages the data for sale. Parcel information is generally collected by each county's Office of the Assessor and typically includes property tax assessment information such as ownership, status, and value of properties. For this measure, we focus on information pertaining to parcel location (e.g., latitude-longitude, census tract identifier) and building characteristics (e.g., use type, number of units).

Alternative data sources for new housing developments were considered for this project, such as data from building permits and counts of housing units from the ACS, but were not selected because of their limitations for the monitoring system. Further discussion of these datasets and their limitations can be found in the Los Angeles Prototype Monitoring System report.

The parcel dataset includes data for all 58 counties in California. However, there was wide variation in the quality of data between counties. One of the biggest problem we encountered with the statewide parcel data from DMP was missing unit counts for parcels that were identified as being "new" (housing units built between 2011 and 2014). For new parcels (2011 to 2014) original unit counts were listed as 0 for nearly 68 percent of all recorded parcels. This amounts to more than 87,000 parcels in that state showing 0 residential units in the building. An assessment of this data revealed a clear discrepancy/error in recording. For example, 74 percent of parcels listed with the use code for a single-family residence showed 0 units listed; nearly 60 percent of condos showed 0 when each of these should technically have 1 unit listed; 28 percent of duplexes, triplexes, quadruplexes listed 0, when they should be 2, 3, or 4; and so on.

We address this issue by imputing unit counts where data was missing or where it appeared problematic. We estimate the number of new units by imputing a value from their use code or through a combination of use codes and living square footage.

After multiple iterations and rounds of testing, we were able to construct a dataset for new parcels that includes unit counts for 99.13 percent of parcels. This closes the gap of coverage in the original dataset (where only 32 percent of parcels had unit counts listed). The following details the steps to constructing the final dataset on new unit counts from the parcel data.

1. Filter dataset for parcels where year built = 2011, 2012, 2013, 2014;
2. Filter dataset for residential parcels, using use code;
3. Impute units for single-family residential, duplexes, triplexes, and quadruplexes;
4. Identify multifamily parcels with missing units; and

5. Impute units for multifamily parcels.

1. Filter dataset for parcels where year built = 2011, 2012, 2013, 2014

The statewide parcel dataset is very large. We begin by filtering the dataset down so that it is more manageable to process and with which to work.

2. Filter dataset for residential parcels, using use code

Because this analysis focuses on new residential units, this next step involves paring the dataset down to only residential parcels. We limit the dataset to residential parcels by including only those with use codes falling within the 1000 (Residential Single) and 1100 (Residential Multi-Family) range.

3. Impute units for single-family residential, duplexes, triplexes, and quadruplexes

For those parcels with use codes that imply an exact number of units, the number of units was imputed based on the number implied in the use code (e.g., estimated unit = 1 for single-family dwellings; units = 2 for duplexes; units = 3 for triplexes).

4. Identify multifamily parcels with missing units

Missing data on multifamily parcels required the most amount of work to rectify. To impute, we began by ascertaining what information for apartment/multifamily parcels was available and what information was not available. These records were assigned one of four designations: (1) full info (available), (2) units only, (3) square footage only, and (4) no information (for units or square footage).

5. Impute units for multifamily parcels

For those with full information and for those where the number of units was available, the given unit counts were taken. This covers about 61 percent of multifamily parcels.

For those with no unit counts but that did contain information on living square footage, unit counts were estimated by taking the living square footage and dividing this by 1,000 square feet (average unit size for the California). This produces an estimated unit count for an additional 38 percent of parcels, amounting to 99 percent coverage of estimated unit counts for multifamily buildings.

The remaining 0.87 percent includes about 18 unaccounted for parcels. These were excluded from analysis. Given available time and resources, the 99 percent of all other parcels that now have estimated unit counts is a significant improvement over the dataset in its original form and sufficiently complete enough for analysis.

For an extended discussion of our methodology to address these gaps in the data as well as the process of verifying our results, see Appendix A.

Changes in Subsidized Affordable Housing (LIHTC and HCV)

Two additional short-term measures were added to the Statewide Monitoring System that was originally not included in the Los Angeles Prototype (Phase I): LIHTC and available HCV units. Information from both sources is used to monitor changes in affordable rental units relative to the jobs-housing fit baseline to evaluate whether changes are occurring in areas with the most need. Changes in subsidized affordable rental units include both new construction of site-based projects (LIHTC units) and net changes in subsidized market-based units (HCV units). At this time, we are unable to construct reasonable measures of changes in affordable market rate units. This is largely due to the nature of available data on rental units by rent levels. It is difficult to estimate affordable market rate units (so called "naturally affordable" rental units) due to census rent brackets that are not adjusted for inflation, the difficulties of separating subsidized from unsubsidized units, and reporting errors related to rent in subsidized units.

Additionally, we acknowledge that there are other housing programs that may assist low-income families with housing, but LIHTC and HCV are the two major programs that can be tracked for use in the monitoring system.

About the LIHTC Database (from HUD's LIHTC Database)

The LIHTC program provides tax incentives to encourage developers to create affordable housing. Administered by the Internal Revenue Service, tax credits are provided to each state's designated tax allocating agency—in California, this agency is the California Tax Credit Allocation Committee which in turn allocates *tax* credits to the developers of affordable rental housing. Developers agree to build housing and rent the housing at an affordable rent and below market rate. Developers are required to set aside at least 20 percent of the units for renters earning 50 percent or less of the area's median income (AMI) or 40 percent of the units for renters earning 50 percent or less of the AMI.[37] Federal law requires developers to maintain these affordability provisions for at least 30 years.[38]

Assembling LIHTC Data for the Monitoring System

The following are some key points that are to be noted in terms of assembling the LIHTC data for the Statewide Monitoring System:

- New LIHTC units are defined as housing units built for low-income families from 2011 to 2014 (four-year time frame).
- New LIHTC units designated strictly for populations other than family, such as for the elderly, disabled, and homeless, were excluded from the final counts of new LIHTC units. We acknowledge that there are elderly or disabled people who work, but these populations make up a lower percentage of the labor force. As such, housing construction designated for low-income families best matches the labor force.
- Only LIHTC housing units classified in the dataset as "new construction" are included. Housing units falling under the categories of "acquisition and rehabilitation (A/R)" or "both new construction and A/R" were excluded as it is difficult to determine whether these housing types add to the stock of affordable housing. For example, some housing units that were acquired and rehabilitated may have already been affordable but nevertheless rehabilitated through LIHTC assistance.
- The variable "year place in service" was used to determine when the housing units were constructed.

About the HCV (Section 8) Database (HUD's Picture of Subsidized Households)

The Housing Choice Voucher Program (formerly known as Section 8) provides rental assistance to very low-income families, the elderly, and the disabled for any privately-owned *housing* that participates in the program.[39] As such, the availability of units is contingent on the willingness of landlords to participate. The program is federally funded by HUD, and administered by local public housing authorities (PHA). Eligibility is determined by the PHA and is based on total annual gross income and household size. Voucher recipients typically pay 30 percent of their income toward their rent, with the rest of their rent covered by

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[37] https://www.hud.gov/sites/documents/DOC_14942.PDF. Date accessed: September 12, 2018
[38] https://www.huduser.gov/portal/pdredge/pdr_edge_research_081712.html. Date accessed: September 12, 2018
[39] https://www.hud.gov/topics/housing_choice_voucher_program_section_8. Date accessed: September 12, 2018

the voucher. Each recipient is responsible for locating and securing an affordable unit of their choosing, contingent that it meets HUD's Housing Quality Standards.[40] Based on HUD's Moving to Opportunity experiment, HUD is examining with the potential of expanding geographic choice to move voucher holders away from high-poverty neighborhoods.

<u>Assembling HCV Data for the Monitoring System</u>

The following are some key points that are to be noted in terms of assembling the HCV data for the Statewide Monitoring System:

- Two years of files were used to calculate the four-year change in available HCV units: 2012 and 2016. Although the preference for the Statewide Monitoring System is to monitor four-year changes from the 2010 baseline, the 2012 to 2016 data files were chosen because the reported census tract information for these files use 2010 geographic boundaries and doing so would eliminate the need to impute and re-allocate counts between changing boundaries. All other baseline and change measures in the monitoring system are in the 2010 vintage boundary. Using HUD's HCV data for the year 2010, which are reported in the 2000 vintage boundary, would require the transformation or reallocation of the data from 2000 census tract boundaries to the 2010 boundaries. This may potentially lead to incorrect allocation of HCV counts into 2010 census tracts.

Changes in Subsidized Affordable Rental Units

The change in affordable rental units for the monitoring system includes both LIHTC and HCV unit and is calculated as:

$$\Delta \text{ subsidized affordable rental units} =$$

$$\text{New LIHTC Units}_{\text{(Built in 2011 to 2014)}} + \text{Net Changes in Available HCV Units}_{\text{(2016–2012)}}$$

Net Changes in Jobs

<u>About the Longitudinal Employer-Household Dynamics OD Employment Statistics</u>

Data for jobs comes from data provided by the US Census Bureau through the LEHD/LODES database. Two years of datasets were selected: 2010 and 2014. The Workplace Area Characteristics file, which shows where jobs are physically located, was the primary source for datasets used. This data is available down to the census tract and census block level. The LEHD/LODES dataset was also one of the primary datasets used in the construction of the Los Angeles Prototype Monitoring System. A more extensive description and assessment of this data source can be found in that report.

Short-Term Measures and Geographic Units

All short-term measures are calculated at the census tract level, with the exception when monitoring changes relative to the HQTL baseline, which is constructed at the block group. A different approach was taken when calculating changes in short-term measures relative to the HQTL baseline. The process is described in the following text.

The quarter-mile HQTL buffer area was overlaid on top of census block group polygons to determine the proportion each block group is covered by HQTL. Census block groups are the second-smallest geographic

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[40] https://www.hud.gov/program_offices/public_indian_housing/programs/hcv/hqs. Date accessed: September 12, 2018

unit (between census blocks and census tracts) for which the Census Bureau collects and tabulates census information. The proportion of the block group covered by HQTL buffer area is calculated using the intersect tool in ArcGIS. The tool essentially cuts the census block group polygon with the buffer ring boundary. A new area is calculated for each census block group polygon and compared to the block group's original area to generate a ratio representing the proportion that the block group falls within the HQTL buffer area. The ratio ranges from 0 to 1 with 0 indicating no coverage (outside of the buffer) and 1 representing full coverage (completely within the buffer area). This ratio is used to factor information from various datasets, including the number of housing units and jobs, which fall in and out of the HQTL buffer area.

Chapter 7 ANALYSIS AND EVALUATION

This chapter focuses on comparing four-year changes in new housing units, new/changes in subsidized affordable housing, and net change in jobs to baseline indicators known to be correlated with VMT and GHG: occupied housing unit density, jobs-housing fit, access to jobs, access to HQTLs, and average PMT at the job site. Benchmarking provides insights into whether short-term changes in new housing units, changes in subsidized affordable housing, and net change in jobs are moving in the direction of promoting SB 375 goals.

The first analysis looks at the construction of new housing units, followed by an evaluation of changes in subsidized affordable housing and net changes in jobs. Recent developments in housing are measured as newly constructed housing units, capturing recent additions to the built environment. These developments can have long-term implications because new housing units are durable capital investments. Changes in subsidized affordable housing are meant to capture housing needs as they relate to low-earners. Lastly, looking at net changes in jobs at worksites provides insight into how economic development in the labor market can affect commute trip distances.

This chapter is divided into three sections. The first section includes a discussion of how all adopted short-term measures can be benchmarked against the baseline indicators. The results and findings from the benchmarking analysis are presented in the second section. A summary of the benchmarking analysis is included in the third section, including the findings for the five regions.

General Framework for Benchmarking Changes in California

This subsection describes the methods for benchmarking recent developments and changes against the baseline indicators. The benchmarking approach is meant to provide insights into whether short-term changes during the analysis period were consistent with SB 375 goals. Table 7-1 illustrates our approach to benchmarking new developments and changes to the baseline.

We use two methods to benchmark and evaluate changes against the baseline: (1) looking at the shift in distribution across quintile categories, and (2) comparing the averages (mean and median) of the baseline distribution to the new/change distribution for select baselines.

For the first method, the relative distribution of these changes across ranked quintile categories is compared to baseline distribution. California census tracts are assigned into five quintile groups by each of the baseline indicators. For example, census tracts are grouped into five categories ranging from least housing dense (lowest quintile) to most housing dense (highest quintile). They are ranked from the least desirable to the most desirable in terms of being consistent with SB 375. Each baseline quintile includes roughly 20 percent of California tracts.

The short-term measures being monitored—new housing units, changes in subsidized affordable housing, and net changes in jobs—are distributed into relevant baseline quintiles. This enables us to determine whether recent developments and changes are over- or underrepresented in each of the quintile categories and how the distribution has changed since the baseline. Ideally, we would like to see a disproportionate concentration of new development and changes in the quintile closely associated with promoting SB 375 goals. For example, if the distribution of new housing units is heavily located in high- and highest-density tracts, this could be characterized as a positive trend toward achieving SB 375 goals.

For the second method, averages for the baseline and new developments/changes are compared against each other for select indicator (i.e. occupied housing unit density, access to jobs, and average PMT at job site). The direction and degree of this difference are evaluated for its consistency with SB 375 goals. For example, if the average density for new housing units is higher than that for the baseline, this could be interpreted as a positive trend toward achieving SB 375 goals. We did not use the average approach for the analysis of monitoring changes against the jobs-housing fit baseline due to the following reasons. One, the analysis compares two types of data. The baseline captures all affordable rental units in the housing market using data from CTPP, whereas changes are monitored for subsidized rental units (housing choice vouchers and Section 8). As discussed earlier, there are many challenges to estimating affordable market rate units, including the difficulties of separating subsidized from unsubsidized units, and reporting errors related to rent in subsidized units. Two, the jobs-housing fit represents a ratio. At one extreme, it tends to produce huge numbers including infinity, particularly when there is few or relatively no affordable housing compared to the number of low-earning jobs in the tract. And third, there are a significant number of tracts with negative value due to losses in subsidized rental units (primarily housing choice voucher units).

Table 7-1: Approach to Benchmarking Short-Term Measures to Baseline Indicators

Baseline Indicator	Distribution of Baseline Indicators	Distribution of New Development/ Changes	Difference
(1) Occupied housing unit density, (2) jobs-housing fit, (3) access to jobs, (4) average PMT at job site	**Share of** housing units, subsidized affordable housing, net change in jobs in each ranked quintile	**Four-year change**, distribution across quintiles	Difference between baseline distriubtion and distribution of new developments/changes
Lowest Quintile	**% →**	**←%**	**+/-**
Low Quintile	**% →**	**←%**	**+/-**
Middle Quintile	**% →**	**←%**	**+/-**
High Quintile	**% →**	**←%**	**+/-**
Highest Quintile	**% →**	**←%**	**+/-**
Mean	→	←	
Median	→	←	

Most consistent w/ SB 375 goals

Notes: Each quintile contains roughly 20 percent of all census tracts in California. Compare distribution of new development/changes to the baseline distribution in each quintile; measure progress relative to promoting SB 375 goals. The horizontal arrow indicates how the measures should be compared; four-year changes should be compared to the baseline measure in the same quintile group and vice versa.

The benchmarking approach of grouping census tracts into quintiles only applies to the baseline indicators of occupied housing unit density, access to jobs, jobs-housing fit, and average PMT at job site. For HQTL, new development and changes are compared to whether they are in HQTL and how the distribution compares to the baseline.

Table 7-2 summarizes the desired relationships between short-term measures and baseline indicators for promoting SB 375. The matrix is based on our interpretation of the literature and our assessments of how the indicators are related to actual travel behavior. It is not meant to be comprehensive but should be useful in providing insights into whether short-term changes are consistent with SB 375 goals. The columns in the table represent either new development or net changes, and the rows are the baseline indicators.

Table 7-2: Relationship between Baseline Indicators and Short-Term Measures for Promoting SB 375

Ideal outcomes (indicated by a positive symbol) would include growth in areas with high density, better jobs-housing fit, and greater access to jobs, as well as in HQTLs and in workplace locations where average commutes are lowest

Baseline Indicators	New Development/Changes		
	New Housing Units	Changes in Subsidized Affordable Housing	Net Change in Jobs
Occupied Housing Unit Density	+		
Jobs-Housing Fit		+	
High Access to Jobs	+		
In HQTLs	+		+
Average PMT at Job Site			+

In general, the addition of new housing units in areas with high residential density[41], high accessibility, and near high-quality transit would have positive SB 375 effects. The literature suggests that, on average, higher residential density tends to lower the need to travel longer distances. Examining changes in subsidized affordable housing allows us to focus on the residential-employment challenges faced by more vulnerable workers. Low-earning jobs are relatively dispersed while affordable housing, generally, is not. Low-earners are, relative to other workers, more likely to locate near their places of work when possible.[42] This measure of change looks at whether those opportunities have been increasing or decreasing across California. In the area of net change in jobs, it is most desirable for new jobs to go into areas where work commutes tend to be lower and into HQTLs to encourage public transit commuting. In the following section, new housing units, changes in subsidized affordable housing, and net changes in jobs are benchmarked against the relevant baseline indicators. The comparisons are meant to provide insights into whether short-term changes in land-use patterns are consistent with promoting SB 375 goals.

Benchmarking Results and Findings

This section presents the results of this analysis and evaluation exercise for California.

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[41] The Housing and Community Development Department has pointed out possible conflicting goals. The State Housing Element law includes avoiding over concentration of lower income households within the region, requiring higher densities accommodating lower income housing of their RHNAs (Regional Housing Needs Assessments), and requiring local governments to zone for a mix of housing types, including multifamily housing. SB 375 does not change the objective of promoting fair housing access to increase better access to educational, economic opportunities and services, including low-density suburban areas. Moreover, the suburbanization of poverty over the last decade or two means that there are increasing need for affordable housing in many low density areas. We agree that these are desirable outcomes. Balancing the different goals is something that the state should address through inter-agency collaboration.

[42] Longer commutes on the average require more out of the pocket expenses. Given their limited financial resources, these expenses pose a heavier burden on low-wage workers. Therefore having shorter commutes is economically beneficial to this segment of the workforce.

Monitoring New Housing Development[43]

Table 7-3: Benchmarking New Housing Development against Occupied Housing Unit Density Baseline

Share of new housing units built four years from the baseline (2010) in census tracts grouped by highest to lowest housing unit density

Baseline Indicator	Baseline 2010	Change Measure	Difference
Occupied Housing Unit Density	**Share of Occupied Housing Units**	**New Housing Units (2011–2014)**	**%-point difference from Baseline**
Lowest Density	**19%**	**42%**	**23%**
Low	**21%**	**21%**	**1%**
Middle	**20%**	**12%**	**-7%**
High	**20%**	**11%**	**-9%**
Highest Density	**21%**	**13%**	**-7%**
Mean	**3,043**	**2,024**	
Median	**2,072**	**895**	

Most consistent w/ SB 375 goals

Interpretation of Table 7-3, new housing relative to occupied housing unit density baseline:

To reduce VMT while maintaining high accessibility, new housing units should be going into higher density areas.

- Compared to the baseline, new housing units are relatively **less concentrated** in the higher-density tracts.
- We observe that a greater proportion (more than 60 percent) of new housing units is going into lowest- and low-density areas. Less than a quarter of new housing units are going into high- and highest-density tracts.
- The average (mean and median) density for new housing is lower than that for the baseline.

[43] The cost, and land availability of building new housing units should also be considered when evaluating where new housing is going relative to the baseline. Unfortunately, examining these items are beyond the scope and resources available for this project but should be noted and considered for future research.

Table 7-4: Benchmarking New Housing against Access to Jobs Baseline

Share of new housing built four years from the baseline (2010) in census tracts grouped by most to least accessible to jobs

Baseline Indicator	Baseline 2010	Change Measure	Difference
Access to Jobs	**Share of Occupied Housing Units**	**New Housing Units (2011–2014)**	**%-point difference from Baseline**
Lowest Access	**21%**	**21%**	**1%**
Low	**21%**	**25%**	**5%**
Middle	**21%**	**19%**	**-2%**
High	**20%**	**23%**	**4%**
Highest Access	**18%**	**11%**	**-7%**
Mean	**1.02 million**	**0.97 million**	
Median	**0.87 million**	**0.76 million**	

Most consistent w/ SB 375 goals

Interpretation of Table 7-4, new housing relative to baseline job access:

Ideally, new housing units should be going into neighborhoods with greater job accessibility.

- Compared to the baseline, new housing units are relatively **less concentrated** in high job access tracts.
- Nearly half of new units are going into areas with lower access to jobs (46 percent in lowest/low), while roughly a third are going into areas with higher access to jobs.
- As with the distributional analysis, the analysis of averages (mean and median) indicates that the average job access for new housing is lower than that for the baseline.

Table 7-5: Benchmarking New Housing against HQTLs Baseline

Share of new housing units located within and outside of HQTLs

Baseline Indicator	Baseline	Change Measure
HQTL	**Share of Occupied Housing Units in HQTL**	**New Units in HQTL (2011–2014)**
Outside HQTL	72%	77%
Inside HQTL	28%	23%

Most consistent w/ SB 375 goals

Interpretation of Table 7-5, new housing relative to access to HQTL baseline:

Promoting new housing in HQTLs is highly desirable for SB 375.

- Compared to the baseline, new housing units are relatively **less concentrated** in HQTL areas.

- Less than a quarter of new housing units have gone into areas with high-quality transit access, with the remaining occurring outside of HQTL areas.

Summary of Key Findings: New Housing Development Benchmarking

Using the available data, the results of monitoring new housing development against the baseline measures of occupied housing unit density, access to jobs, and HQTLs all indicate that the state as a whole is generally not siting more new housing into neighborhoods with higher density, greater access to jobs, and greater access to HQTLs.

Monitoring New/Changes in Subsidized Affordable Housing

Table 7-6 reports the changes in subsidized affordable housing (changes in LIHTC and HCVs) against the jobs-housing fit baseline.

Table 7-6: Benchmarking Changes in Subsidized Affordable Housing against Jobs-Housing Fit Baseline
Share of new/changes in subsidized housing in census tracts grouped by jobs-housing fit index

Baseline Indicator	Baseline 2008 12	Change Measure	Difference
Jobs-Housing Fit	**Share of Affordable Rentals**	**New/Change Subsidized Affordable Rentals (2011-16)**[44]	**%-point difference from Baseline**
Lowest jobs-housing fit (job deficit)	**43%**	**39%**	**-4%**
Low	**25%**	**29%**	**+4%**
Middle	**17%**	**17%**	**0%**
High	**11%**	**10%**	**-1%**
Highest jobs-housing fit (affordable housing deficit)	**4%**	**5%**	**+1%**

Most consistent w/ SB 375 goals

Interpretation of Table 7-6, new housing relative to jobs-housing fit index:

Ideally, more affordable housing should go into areas with the greatest imbalance of low-earning jobs and affordable housing; in other words, into areas with the greatest need for affordable housing relative to the share of low-earning jobs in the area.

- Compared to the baseline, the distribution of new/change in subsidized affordable housing is similar to the baseline, thus reproducing preexisting imbalance of low-earning jobs and affordable housing.
- A greater proportion of subsidized affordable housing (68 percent) is going into areas where there is not a deficit in affordable housing (areas with the least need).

[44] LIHTC units built between 2011 and 2014 and changes in HCV units between 2012 and 2016

Summary of Key Findings: New/Changes in Subsidized Affordable Housing

The results of monitoring changes in subsidized affordable housing against the jobs-housing fit baseline indicates that, on average, the state is generally not siting more subsidized affordable housing in areas with the greatest need. A greater proportion of subsidized affordable housing continues to occur in areas that already have a high share of affordable housing.[45]

Monitoring Net Changes in Jobs

Table 7-7: Benchmarking Changes in Jobs against Average PMT at Job-Site Baseline
Share of net changes in jobs grouped by census tracts ranked by the average PMT at job-site

Baseline Indicator	Baseline 2010	Change Measure	Difference
Average PMT at Place of Work	**Share of All Jobs (2010)**	**Net Increases in Jobs (2010–2014)**	**%-point difference from Baseline**
Highest PMT	**26%**	**27%**	**1%**
High	**31%**	**37%**	**7%**
Middle	**21%**	**19%**	**-2%**
Low	**14%**	**11%**	**-3%**
Lowest PMT	**8%**	**6%**	**-3%**
Mean	**5.2**	**6.6**	
Median	**15.5**	**16.2**	

Most consistent w/ SB 375 goals

Interpretation of Table 7-7, net changes in jobs relative to baseline job access:

In terms of promoting SB 375 goals, it is more desirable (on average) to add jobs into tracts with existing lower commute PMT.

- Compared to the baseline, net jobs are less concentrated in job sites with lower average PMT.
- Nearly two-thirds of net increases in jobs have gone into workplace areas that generate the highest commute distances by workers. Less than 20 percent of increases in jobs are going into workplace areas that generate lower commutes.
- Similar to the distributional analysis, the analysis of averages (mean and median) indicates that the average PMT for new housing is higher than that for the baseline.

Table 7-8 reports the baseline distribution of jobs and net changes in jobs at HQTLs.

[45] It is important that to try to understand how some of these development patterns vary across groups defined by demographic and socioeconomic characteristics. One reality is that there are class and ethnoracial segregation in the housing market that should be analyze fully and for future research.

Table 7-8: Benchmarking Changes in Jobs against HQTLs Baseline

Share of net increases in jobs located within and outside of HQTLs

Baseline Indicator	Baseline	Change Measure
HQTLs	**Share of Jobs in HQTL**	**Net Increases in Jobs in HQTL (2010–2014)**
Outside HQTL	56%	64%
Inside HQTL	44%	36%

Most consistent w/ SB 375 goals

Interpretation of Table 7-8, new housing relative to access to HQTL baseline:

- Compared to the baseline, net jobs are relatively less concentrated in HQTL areas.
- Just more than a third of net increases in jobs have gone into HQTLs compared to 64 percent that have gone outside of HQTLs.

Summary of Key Findings: Net Changes in Jobs Benchmarking

To be consistent with SB 375 goals, changes should trend toward net increases in jobs occurring in locations with lower PMT and also in HQTL areas. The benchmarking analysis indicates that neither of these were the case for the state during the analytical period. Relative to the baseline, increases in jobs occurred in neighborhoods with higher average PMT and into neighborhoods outside of HQTLs.

<u>Summary of Benchmarking</u>

Two methods were utilized to assess whether changes are consistent with promoting the goals of SB 375. The first approach is based on the distributional quintile analysis and the second approach compares the averages (mean/median) between the baseline and short-term measures. For each approach, we examine whether analysis shows an **increasing** trend (consistent with SB 375 goals), **minimal change** (status quo or where the baseline distribution or change distribution are both roughly similar), and **decreasing** trend (inconsistent with SB 375 goal). If both methods yield the same result, then that outcome is reported. For example, if both the quintile and average analysis indicate the baseline-change comparison as decreasing then "decreasing" is reported for that comparison. However, if each of these two methods come up with different conclusion, for example one is "decreasing" and another is "increasing," then the outcome is designated as "mixed results." These notations, and those in table 7-9, are abbreviated and intended to state whether changes in the measured indicators represent land use patterns that were consistent with the stated goals of SB 375. Further, the analysis period of 2010 to 2014 does not capture all strategies enacted by all MPOs during the first wave of Regional Transportation Plans following the enactment of SB 375 in 2010. Instead, this baseline trajectory provides a backdrop against which the first-wave of SCSs can be measured in future analysis. In no way does a "decreasing" or "inconsistent with SB 375 goals" designation imply that a particular region or MPO has not complied with the law.

Table 7-9 summarizes the final outcome of the two analyses for each of the five regions. A separate summary of each approach can be found in Appendix C. Most of the baseline-change comparison indicates a relationship inconsistent with promoting the goals of SB 375. However, there are occurrences where some regions were moving in the direction consistent with the goals of SB 375, as the case with the Bay Area Megaregion in promoting new housing in higher job-access tracts, and the Rural State region in adding more jobs in higher-quality transit locations.

Table 7-9: Summary of Benchmarking Analysis

Desirable SB 375 Outcomes	Statewide	Southern CA	Bay Area Megaregion	San Joaquin Valley	Rural State	Central Coast
New Housing in Higher Density Tracts	Decreasing	Decreasing	Decreasing	Decreasing	Minimal Change	Decreasing
New Housing in Higher Job-Access Tracts	Decreasing	Decreasing	Increasing	Decreasing	Mixed Results	Mixed Results
Net Increases in Jobs in Lower PMT (at Job- Site) Tracts	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing
More Affordable Housing in Tracts with the Greatest Need (based on JHF measure)	Decreasing	Decreasing	Decreasing	Decreasing	Increasing	Increasing
New Housing in High-Quality Transit Locations	Decreasing	Decreasing	Minimal Change	Decreasing	Minimal Change	Decreasing
Net Increases in Jobs in High-Quality Transit Locations	Decreasing	Decreasing	Minimal Change	Decreasing	Increasing	Decreasing

In terms of promoting more affordable housing in areas with the greatest need, both Rural and Coastal regions were experiencing a pattern that is most consistent with the goals of SB 375 as measured by the jobs-housing fit index. One potential reason for this could be due to the unique geographies of these two regions. For example, it may be possible that subsidized housing is being located in towns and (small) cities in the rural and coastal areas, which is where jobs are disproportionately also located. These regions are also more compact; thus, jobs and housing tend to be less spatially separated. The benchmarking analysis only examines how subsidized housing is relatively distributed within a region, not how it is distributed across regions. The latter indicates that both Rural and Coastal regions have disproportionate fewer subsidized housing when compared across all five regions. For example, of all of the new/changes in subsidized housing that occurred in the state during the 4-year period, two percent were in the rural region, and six percent occurred in the Central Coast Region; over half (57 percent) occurred in Southern California, 23 percent in the Bay Area Megaregion, and 12 percent in the San Joaquin Valley.

Table 7-9 also indicates some "mixed results," for both the Rural State and Central Coast regions in comparing job access and new housing units. Using the quintile distributional method, the analysis indicates that the Rural State region saw minimal change in siting new housing in higher job access tracts, but the analysis of averages indicates an "increasing" relationship. Similar outcomes are found for the Central Coast region, with the distributional analysis indicating "minimal change" and the analysis of averages showing results that are "decreasing."

Chapter 8 CONCLUSION AND RECOMMENDATIONS

The purpose of this project is to develop a statewide monitoring system for tracking key changes in land-use and the built environment that reflect progress in meeting the GHG reduction goals of SB 375. The monitoring system is designed to provide a broad overview for California as a whole on selected indicators that complement indicators used in other monitoring efforts. It is not a tool for assessing site- or neighborhood-specific planning and projects, although the information potentially could be useful as a preliminary step in studying small geographies.

This is Phase 2 of a two-phase effort that began with the construction of a prototype monitoring system for Los Angeles County. These efforts are documented in our previous Los Angeles Prototype Monitoring System report.

The system measures changes during the first half of this decade in new housing units, changes in subsidized affordable housing, and net changes in jobs, and assesses the distribution of these indicators against a baseline of relevant indicators. The final product, the Statewide Monitoring System, is not meant to be comprehensive as there are elements and changes in development that cannot be easily measured. Instead, the system is meant to guide the evaluation of a subset of key SCS targets related to land-use, built environment, transportation patterns and changes.

Assessing the Data, Indicators, and Measures

Before presenting the results of the analysis, it is important to note the limitations in some of the data and methods. First, the monitoring system is not comprehensive but is based on what is feasible given available time and resources. The system is most useful in providing a broad overview of the most important statewide SCS relevant trends, as prioritized by stakeholders. It is not a site or neighborhood planning tool as the data are not precise or fine-grained enough for the assessment of small geographies. It is possible to apply the system to cities and regions with further enhancements and refinements. Even at the state level, one needs to be cautious, because the monitoring system only covers a limited number of land-use dimensions. The monitoring system complements other efforts to monitor progress towards SB 375 and its results are best understood and most valuable when considered in tandem with other indicators identified by public agencies. Nonetheless, the monitoring system has produced some important findings useful for understanding statewide trends and refining policies.

There are many alternative ways of transforming data into indicators and measures, and there are tradeoffs associated with selecting one over others. In the process of developing the monitoring system and indicator construction, we found wide variations in the quality of data (e.g., timing in reporting, errors, inconsistencies) which can then impact the quality of constructed indicators and measures (i.e., errors in data that filter down into erroneous results). We also observed issues with potentially uncritical use of preexisting formulas and parameters. This is especially problematic given the complications of scaling up to the state level as there are wide regional variations. Parameters and methods should be customized to the geography and trip characteristics of focus.

This project is not free of the preceding issues in data and indicator construction. To minimize any flaws in data and shortcomings in methods, the process included making corrections when possible, testing alternative methods of indicator construction, and estimating state-specific parameters. At the same time, there are limits to what can be done. Nonetheless, although perhaps imperfect, the system is useful and yields important findings.

For most indicators, data coverage, accuracy, and consistency are such that the research team is fairly confident in the validity of final results. For others, where assessments revealed shortcomings in the data, results should be viewed with caution. In particular, the results of the access to transit measure are complicated by inconsistent data collection and reporting practices among agencies such as the incomplete coverage of stops and schedules in GTFS. These data challenges make the access to transit measures the lowest quality and most problematic set of results in the monitoring system. Additionally, jobs data and results are subject to business-cycle effects that relate to the state of the economy of the time and not necessarily on land-use development patterns. Contrastingly, as they relied on the relatively robust and complete Decennial Census enumeration, occupied housing unit density measures are the highest-quality measures in the monitoring system. There are also limitations to monitoring changes in affordable rental housing units. The current affordable housing change measure in the monitoring system only covers subsidized/deed restricted (HCV and LIHTC) units and not market-based affordable rental units. It is difficult to estimate the latter with available data due to census rent brackets that are not adjusted for inflation, the difficulties of separating subsidized from unsubsidized units, and reporting errors related to rent in subsidized units. Some possible solutions to overcome these challengers are further discussed below in the recommendation section.

Despite any shortcomings, however, the Statewide Monitoring System does accomplish a number of key objectives. As a result of the assessment and evaluation processes, and then with the application of solutions for dealing with the identified gaps in data, the assembly, construction, and analysis for some of those problematic indicators represents the most complete information available, based on current knowledge of the field and review of related studies. Some of these accomplishments are listed below.

- **Transit Coverage:** To the best of our knowledge, the access to HQTLs indicator constructed for this project is perhaps the most comprehensive access to transit measure available for California. Although we identified some significant gaps in coverage, GTFS remains the most complete data source for statewide transit data. It covers 127 out of California's more than 200 agencies. We did not identify any other access to high-quality transit location measure that has been created at the state level, particularly one that uses a consistent data source, definition and method.
- **Jobs-Housing Fit:** This indicator was assessed and refined to adjust for regional variations in earnings and rental costs across California. Other studies have conducted similar analyses, but most focus only on a single region. To the best of our knowledge, no jobs-housing fit measure exist for the State, particularly one that accounts for regional differences in earnings and rental costs.
- **Addressing Missing Data in Statewide Parcel Dataset:** Our assessment of this data shows that if used without adjustment, thousands of units would be left unaccounted for. We found wide variations in the quality of data and the methods of reporting among counties. These include the underreporting of unit numbers, the reporting of zero units where units should exist, and parcels where the number of units was left blank. We developed a method for imputing the number of housing units to address these major gaps.
- **Customized Accessibility Indicators for California:** Unlike many other analysts who often use parameters from the literature, which may or may not be appropriate for California or for the current time period, we investigated numerous alternative methods, selecting the one that best fits the State.

Results and Findings

Despite previously mentioned data and methodological limitations, the final Statewide Monitoring System yields useful insights. The system measures three indicators of change (new housing units, changes in subsidized affordable housing units, and net change in jobs) against relevant baseline indicators (occupied housing unit density, jobs-housing fit, access to jobs by residential location, access to HQTLs, and average PMT at job site). Examining the results of these trends in relation to outcomes that would support progress under SB 375 shows that there is still much that can be done.

Overall, recent land-use development and land-use activities are largely inconsistent with SCS goals and the results show the State is at risk of failing to meet SB 375 goals.

For the state as a whole, the direction (positive progress, negative, or neutral) are summarized in Table 8-1. The results indicate that the changes in land use patterns and its implications for travel during the first cycle of SCS planning were not entirely consistent with SB 375 goals. However, we are not able to measure the counterfactual, that is, although results are not entirely positive, they could have been worse without SCS interventions.

Table 8-1: Summary of Observed Outcomes in Relation to SB 375 Goals

	Short Term Changes		
Baseline	**New Housing Units**	**Changes in Subsidized Affordable Housing (LIHTC and HCVs)**	**Net Change in Jobs**
Occupied Housing Unit Density	New housing units are relatively less concentrated in the higher density tracts, which is inconsistent with SB 375 goals		
Jobs-Housing Fit		The distribution of new/change in subsidized affordable housing is similar to the baseline, thus reproducing the preexisting imbalance of low-earning jobs and affordable housing	
Access to Jobs from Residential Location	New housing units are relatively less concentrated in high job access tracts, which is inconsistent with SB 375 goals		
Access to HQTL	New housing units are relatively less concentrated in HQTL areas, which is inconsistent with SB 375 goals		Net increases in jobs are relatively less concentrated in HQTL areas, which is inconsistent with SB 375 goals
Average (Mean) PMT at Job Site			Net increases in jobs are less concentrated in job sites with lower average PMT, which is inconsistent with SB 375 goals

Recommendations

Given the results of the analysis, our recommendations include the following:

<u>On data and methods:</u>

1. **Update and refine the monitoring system.**
   - Evaluate the monitoring system to identify possible enhancements;
   - Update the monitoring system for the next SCS planning cycle (with a new 2014 baseline and changes between 2014 and 2018)[46]; and
   - Refine the system to address data construction issues documented in this report, particularly relating to data on transit.

<u>On findings:</u>

2. **Use the findings as a part of a larger efforts to refine and revise SCS plans.**

At this time, RTP/SCS plans are evaluated primarily to determine the reasonableness of long-term forecast models and their application to alternative policies, plans, and projects. These activities should be complemented with the short-term monitoring system to add a better understanding of on-the-ground changes over recent years. The added analysis from short-term monitoring should help in revising and refining policies, plans, and projects to meet SB 375 goals.

<u>On future/expanded efforts:</u>

The preceding should be conducted at both the state and regional/MPO levels. Much of the efforts relating to SCSs involve planning and projects at the regional and local levels, as such we recommend:

3. **Adopt monitoring system (by MPOs and local jurisdictions); encourage agencies to consider the monitoring system developed in this report as part of their ongoing monitoring efforts of their own.**[47]

   - As stated, results suggest that baseline land-use development falls short of SCS-desired outcomes. One reason for these may be that there may be changes occurring that are not captured by the system. By adopting this monitoring system and adapting it to local/regional geographies, MPOs may be able to better observe changes not captured in missed in more macro-level analyses.
   - Each MPO, agency, and local jurisdiction has its own priorities and needs. By also conducting their own monitoring, these entities can measure progress in their own specific planning efforts.
   - At the same time, the state can support and encourage these efforts by focusing resources on indicators that cut across all regions and levels.
     - Example: Some housing, employment, and socioeconomic variables/indicators are useful and relevant across policy areas, entities, and jurisdictions and can be used

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[46] Short-term changes in data indicators, beginning with 2010 – 2014, for the most part reflect development entitled prior to or roughly during the adoption of the first RTPs/SCS,' the first of which were adopted in late 2011 (SANDAG) and April 2012 (SCAG and SACOG). Housing constructed as of 2014 would therefore not have been guided by the development pattern of an SCS.

[47] We recognize that it may be difficult for MPOs and local jurisdictions to engage in this type of analyses due to limited resources and staff capacity. Nonetheless, to the degree possible, MPOs and local jurisdictions should partner with the State to conduct to incorporate the Statewide Monitoring System.

to support various reporting and monitoring requirements. The state can focus resources on developing datasets/databases around these indicators, maximizing the utility returns of such efforts, and at the same time setting a standard for other agencies and efforts.

4. **Require extensive evaluation of data and methods when developing a monitoring system or any other evaluative systems.**
    - In the process, the team has encountered and become familiar with many of the dangers and pitfalls that can arise from issues with data and issues with methods of counting/calculation. We include some observations and examples here:
        - Errors in data: Some projects utilize data products without conducting an evaluation or assessment of coverage, reliability, and validity. In instances where this has been done, we have observed that errors and inconsistencies filter down into the indicators that utilize these data products.
        - Flaws in methods: Ideally, methods should be customized for a particular geography. This is especially critical while for decay parameters measuring accessibility. It is imperative that parameters are calibrated for specific geography, time, and potentially other commute/trip characteristics, rather than taking parameters used in other efforts and applying it them. In our experience, it is often the case that studies do not extensively document the methods by which their own parameters are estimated. Given this reality, it is recommended that parameters be customized for each effort and be not taken from other studies. Customizing methods will ensure that these best reflect the commute period, type, and so forth, of interest.
5. **Selection of baselines and indicators should be based on technical recommendations of researchers and on priority areas identified by stakeholders.**
    - It is difficult to be completely comprehensive, so it is important to be deliberately focused. To ensure that results are robust and accurately illustrative, and to ensure that the monitoring system and its findings are directly relevant to policies, plans, and programs, the initial selection of baselines and indicators must be based on input from both parties. Researchers and stakeholders each have unique knowledge and insights to share.
        - Based on their technical expertise, through experience and from knowledge of the literature, researchers should be prepared and able to advise on what can be measured, possible limitations in data and methods, associated costs to consider, and possible insights that could be produced from a selected path, and so forth.
        - Stakeholders should identify the baselines and measures most important and relevant to maximize the use and potential applicability of the system and its findings.
6. **The state should take the lead on setting standards of good practice for data collection/management around a monitoring system and should continue the detailed assessment of data and construction of indicators that were an integral part of this project.**
    - Issues with incomplete or missing data and wide variations in data collection and reporting created challenges in constructing the Statewide Monitoring System. Future efforts would benefit greatly from greater availability and standardization of data and from the collection and management of archived data. The state should actively be collecting and archiving

currently available data. For example, the collecting and archiving of GTFS from transit agencies throughout the state.[48]

- In addition to modeling good data practices, it is equally important that the State adopt the practice of critically assessing data sources for their coverage and consistency and require transparency and documentation of methods in indicator construction. Given the wide variations in the quality of data and in the methods employed to develop indicators, the state should continue the practice represented in this project.
- It would be beneficial for the State to work on improving and making available the key data indicators identified in this report to facilitate subsequent updates of RTP/SCS.

7. **Include more direct and deeper measures for addressing the equity elements of SB 375.[49]**
    - The current system does not focus enough on issues of equity in accessibility, commutes, and housing. Future efforts should include a greater focus on these. The following are some possible items to consider:
        - To better understand affordable housing, its location and changes that may contribute to promoting equity, we recommend developing a method of tracking the stock of rental units by affordability for small geographies (census tracts). This requires overcoming the problem of census rent brackets that are not adjusted for inflation in cross sectional data. There are two possible solutions to over this problem: 1) develop a method to interpolate existing statistics to account for inflation; and 2) request special tabulations from census bureau that uses inflation adjusted brackets. This will complement the current job-housing fit measure.
        - To promote equitable access to housing and desirable locations, we recommend tracking the enforcement of fair housing. This can be done by coordinating state and local efforts to assess HUD's Affirmatively Furthering Fair Housing.
        - To assess equitable access to energy efficient, low emission vehicles, we need to track the degree of "downward filtering" of these vehicles to economically disadvantaged communities. Residents in disadvantaged neighborhoods have less financial resources to purchase new Partial Zero Emissions Vehicles and Zero Emission Vehicles but may be able to buy used one. The goal is to make these vehicles more assessable but we also need to monitor/assess how much of this filtering is occurring.
        - We also recommend developing better measures of neighborhood characteristics that are related to promoting active transport (e.g. safety, network characteristics, and diversity of activities).
        - Generate estimates of total VMT by census tracts. This is important because it gives us a better sense of transportation accessibility. Currently, we are only able to look at PMT for job commutes. Although this is the single largest purpose, it accounts for less than half of total VMT. We recommend exploring the possible use of DMV and BAR records to develop estimates for small geographies (census tracts).

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[48] According to the California Department of Housing and Community Development, the State, including HCD and Strategic Growth Council have attempted to include assessor parcel data in the State Open Data portal, but this data is not publicly available and therefore not conducive to consistent inter-agency monitoring of changes in housing stock. The lack of a consistent public source of statewide transit data, has for example, been a challenge for State agencies such as HCD in trying to better coordinate transit oriented development.

[49] Pursuant to SB 375, RTP plans should include "Measures of equity and accessibility, including, but not limited to, percentage of the population served by frequent and reliable public transit, with a breakdown by income bracket, and percentage of all jobs accessible by frequent and reliable public transit service, with a breakdown by income bracket."

- Future monitoring system should include multidimensions of accessibility to opportunities. This report focuses on jobs but future monitoring system should be expanded to include accessibility to healthy foods, recreational opportunities, high quality education and health services.

8. **Tie information in the Statewide Monitoring System into other existing evaluative systems.**
    - Find a way to create synergy between the data in the Statewide Monitoring System with others (e.g., CalEnviroScreen) to provide agencies and other stakeholders with a more comprehensive, powerful tool for policy, planning, and program evaluation.
    - The monitoring system and its contents should be integrated in other existing evaluative systems and monitoring efforts such as CARB's ongoing monitoring efforts under SB 150, MAP-21 monitoring requirements, and Statewide Performance Monitoring Indicators for Transportation Planning developed by SANDAG in 2013.

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Appendices

Appendix A: Baseline Measures

External Verification of CNK's High-Quality Transit Measure

We conducted external verification and assessment of our HQTL measure by comparing it to similar measures constructed for the Bay Area and for Los Angeles County. Specifically, we compared CNK's HQTL indicator to MTC's "Major Transit Stops" for the Bay Area and SCAG's "High Quality Transit Areas". For the latter, we focus only on Los Angeles County instead of all six counties in the region.

Evaluating CNK's HQTL and MTC's Major Transit Stops

For external verification, we compare CNK's HQTL shapefile to MTC's Major Transit Stops (2017) for the Bay Area. The assessment and evaluation process involved multiple steps. The first step was to simply overlay CNK's HQTL shapefile on top of the MTC's shapefile to determine how much of the MTC's shapefile we were capturing and vice versa. A quarter mile buffer was added to MTC's shapefile of major transit stops since CNK's definition of HQTL includes a quarter-mile buffer area.

The second step was to identify and examine areas that the MTC identified as being high-quality or major stops but where CNK's HQTL measure did not pick up. We do this by identifying on the map where we see the biggest discrepancy between the two. We then identify the name of the transit stop and agencies serving that stop (some stops can be served by more than one transit agency). Once the stops and agencies were identified, we manually check the printed schedules online to see if they fall under our definition of high-quality (having a frequency of 9 or more during 6:30-8:30 AM morning peak hours).

For example, we looked at three transit stops that MTC identified as "major stops" but did not show up in our measure of HQT. They are:

1) A St & Meekland Av Access Rd Rail Station
2) Bonaventura Light Rail Station
3) Larkspur Ferry Terminal

An evaluation of these transit stops and other transit stops that MTC designated as "major stops" but were not being captured by our HQT measure revealed a pattern. And that is, many of them were rail stations or ferry terminals. Although we initially include all types of rail in our measure of HQT, they needed to meet the criteria of high-quality of maintaining average headways of 15 minutes or less during morning peak commute (6:30 to 8:30 AM). Some rail stations did not meet these criteria and therefore was not captured in our HQT measure. Ferries terminals was also not included in our definition of HQT.

After careful reading of MTC's definition for major transit stops, which was adopted from the State's definitions for what constitutes "Major Stops" we determined that MTC defined all rail stations and ferry terminals as "major stops" and that criteria of maintaining average headways of 15 minutes or less during morning peak commute only applied to bus stops. This led us to refine our method for HQT by designating all rail stations and ferry terminals as high-quality.

Our initial assessment indicated that CNK's HQTL (without all rail stations and ferry terminals) measure captured 73% of MTC's major transit stops. By refining our definition to designate all rail stations and ferry terminals as high-quality, this proportion went up to 91%.

Additional assessment also revealed that our HQT measure covered two times the area that MTC's major stops covered. One possible reason for this is that we are using location (which can include multiple stops that share the same latitude and longitude rounded to three decimal points) while MTC is only using individual stops.

We also did additional investigation to see why this might be the case. As with the previous approach, we select three stops that is captured in our HQT metric but not identified as a major transit stop by MTC.

These three stops are (all of which are located in Marin County):

1. Golden Gate Bridge Toll Plaza-Hwy 101
2. Manzanita Park & Ride
3. Sir Francis Drake Blvd & Madrone Ave

Our evaluation of the printed schedules for these stops confirm that all three stops have frequency exceeding nine counts during the morning peak hours of 6:30 to 8:30, which would make them both high-quality under the HQT definition used for this project. Golden Gate Bridge Toll Plaza/Hwy 101 and Sir Francis Drake Blvd/Madrone Ave bus stops are both served by Golden Gate Transit agency. This agency is not included in MTC's shapefile which is most likely why CNK's HQTL measure captures these stops and MTC does not.[50]

There are a number of other reasons that help to explain the differences between CNK's HQTL measure and MTC's Major Transit Stops. One is the data sources being used. MTC's uses several data sources including: Planned Transit Systems identified in the Plan Bay Area 2040 Regional Transportation Plan, Existing Transit locations extracted from the 511 Regional Transit Database[51], and manual editing conducted by the Spatial Modeling team at MTC. We relied on GTFS data.

Another very potential reason is the difference in methodology. We use high-quality location instead of high-quality stops, while MTC counted individual stops. As indicated before, we considered stops with identical latitude and longitude down to three decimals as same locations. Hence, our methodology captured more high-quality locations.

There are also differences in the number of transit agencies being covered. CNK's HQTL covers more agencies then those listed in MTC's major transit stop database (27 for CNK and 16 for MTC).[52]

Another reason for the discrepancy is the difference in definitions. For example, MTC included both morning and afternoon peak hours while our metric only focuses on morning peak hours. What constitute morning peak hours is also be defined differently. MTC defines AM peak hours as 6am to 10am while CNK's measure define morning peak hours as 6:30 am to 8:30 am. Evaluating CNK's HQTL to SCAG's High Quality Transit Areas

We did an additional external verification by comparing our high-quality transit location measure to SCAG's 2012 High Quality Transit Areas (HQTA) and did so only for Los Angeles County instead for all six counties in the region. We follow the same evaluation approach described earlier with MTC's "major transit stops". We find that CNK's HQTL measures captures only 69% of SCAG's HQTA for Los Angeles County. The difference is largely due to differences in methods being used. For example, SCAG uses a slightly larger buffer size - ½ mile - while we use the quarter mile buffer. Additionally, SCAG's includes

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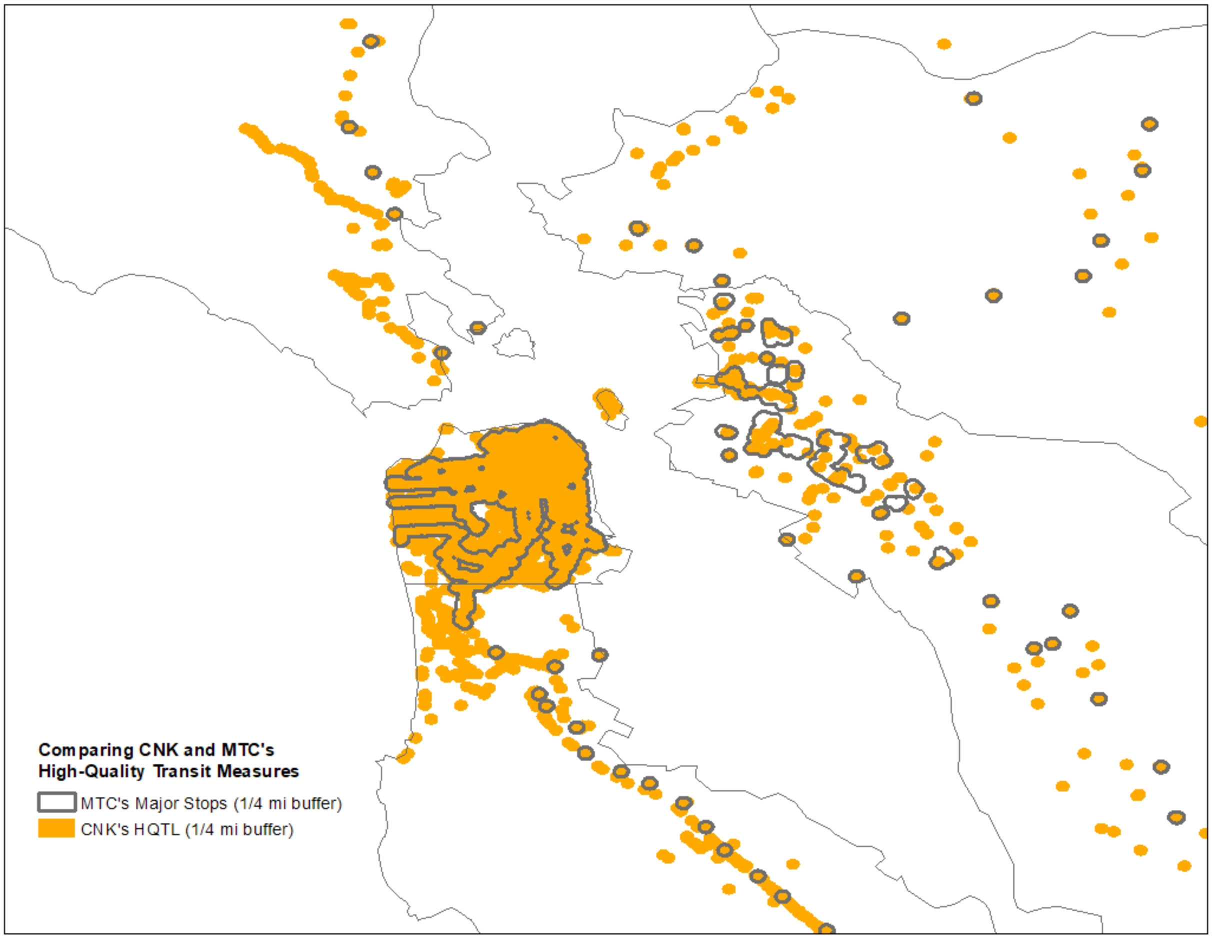
[50] MTC has indicated that Golden Gate Transit is not included in the shapefile as the agency's service does not meet MTC's definition of high quality transit. Golden Gate Transit primarily operates express bus service targeted at commuters working in San Francisco. Service headways during the morning peak period as defined based on local conditions (6-10am) exceed 15 minutes for individual stops.

[51] GTFS is a source used in constructing the RTD

[52] MTC has indicated that some operators were excluded because they do not provide service that meets MTC's criteria for high quality transit

transit corridors in its definition of HQTA while we focus on high-quality transit stops and locations. SCAG is currently in the process of updating its methodology for the 2020 Regional Transportation Plan (RTP) and anticipate finalizing this methodology by the end of the year.

Figure A-1: Comparing CNK's HQTL and MTC's Major Stops



Notes: A quarter-mile buffer was applied to MTC's major transit stops in order to compare to CNK's HQTL shapefile

Although SCAG's uses GTFS for its transit data, it covers fewer agencies than our HQTL measure. Twenty-six agencies are represented in SCAG's HQTA measure (for all six counties), while our HQTL measure includes 38 transit agencies for the region.

Figure A-2: Comparing CNK's HQTL to SCAG's HQTA

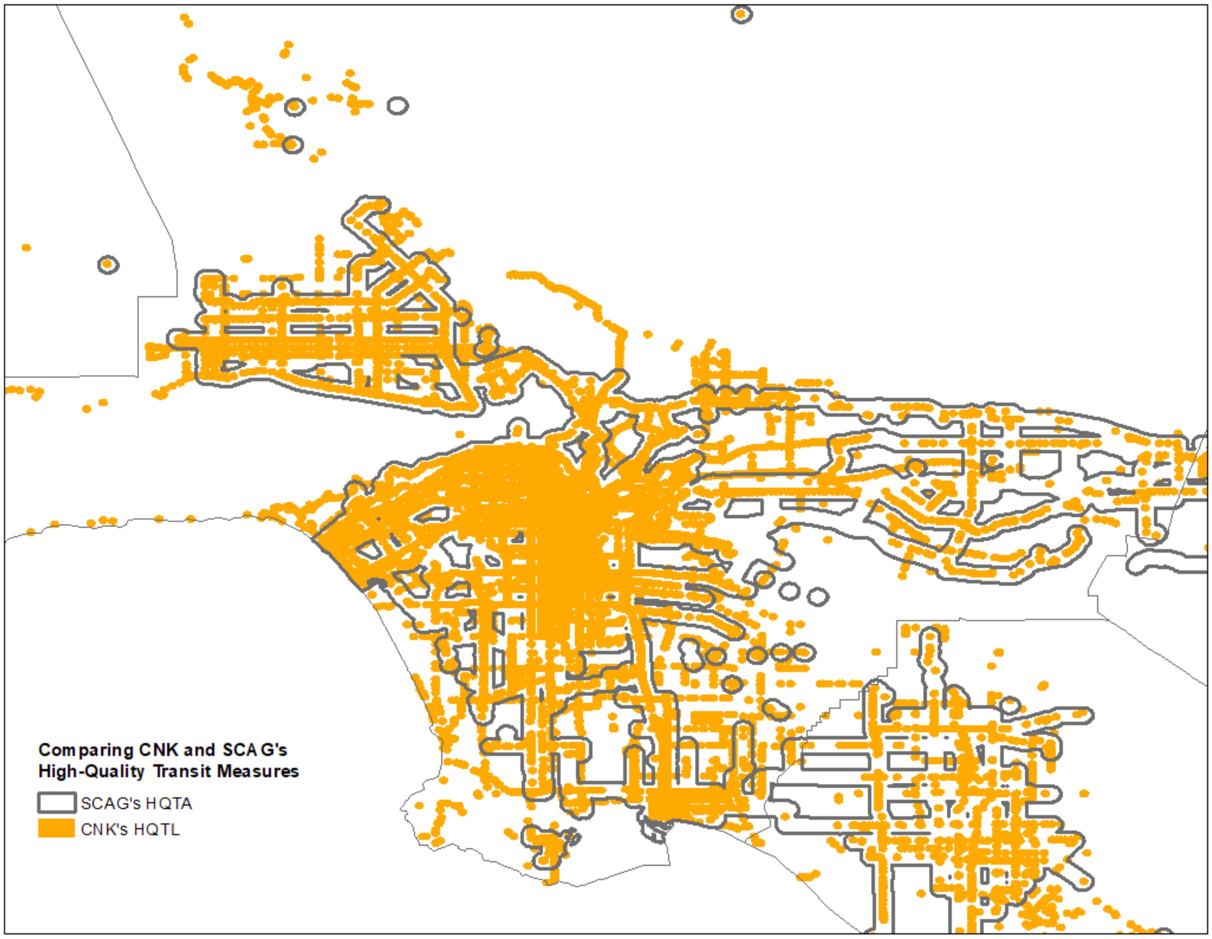


Table A-1: Transit Agencies Represented in CNK's HQTL Baseline (127 agencies)

Alameda-Contra Costa Transit District (AC Transit)	North County Transit District (NCTD)
Altamont Corridor Express (ACE)	Norwalk Transit
Amador Transit	Omnitrans
Anaheim Resort Transportation	Orange County Transportation Authority (OCTA)
Amtrak	Palo Alto Shuttle
Antelope Valley Transit Authority	Palo Verde Valley Transit Agency
Arcata & Mad River Transit System	Palos Verdes Peninsula Transit Authority
Avila Trolley	Pasadena Transit
Bay Area Rapid Transit (BART)	Paso Robles Express
Beaumont Pass Transit	Petaluma Transit
Burbank Bus	Placer County Transit (PCT)
Butte Regional Transit (B-Line)	Plumas Transit
Calaveras Transit	Porterville Transit
Caltrain	Redding Area Bus Authority
Capitol Corridor	Redondo Beach Cities
Central Contra Costa Transit Authority, CCCTA	Rio Vista Delta Breeze
Ceres Area Transit	Riverside Transit Agency
Cerritos on Wheels	Roseville Transit
City of Commerce Municipal Bus Lines	Sacramento Regional Transit District (SacRT)
City of Gardena's Gtrans	Sage Stage (Modoc County)
City of Lodi's Transit (Grapeline)	San Benito County Express
City of San Luis Obispo	San Diego Metropolitan Transit System (MTS)
City of Santa Clarita Transit	San Francisco Municipal Transportation Agency
Corona Cruiser	San Joaquin Regional Transit District
Culver City Bus	San Luis Obispo Regional Transit Authority
Duarte Transit	San Mateo County Transit District (Samtrans)
Dumbarton Express	Santa Barbara MTD
Eastern Sierra Transit Authority	Santa Clara Valley Transportation Authority (VTA)
El Dorado Transit	Santa Cruz Metropolitan Transit District
El Monte Transit	Santa Maria Area Transit
Emery Go-Round	Santa Monica Blue Bus
Eureka Transit Service	Santa Rosa CityBus
Fairfield and Suisun Transit (FAST)	Santa Ynez Valley Transit
Folsom Stage Line	Simi Valley Transit
Foothill Transit	Siskiyou Transit and General Express
Fresno Area Express (FAX)	SoCo Transit

Fresno County Rural Transit Agency (FCRTA)	Solano County Transit (Soltrans)
Glendale Beeline	Sonoma County Transit
Gold Coast Transit	Sonoma-Marin Area Rail Transit (SMART)
Golden Empire Transit (GET Bus)	South Shore BlueGo
Golden Gate Bridge Transit	Stanislaus Regional Transit
Guadalupe Flyer	Susanville Indian Rancheria Public Transportation Program
Humboldt Transit Authority	Tahoe Regional Transit
Kern Transit	Tahoe Truckee Area Regional Transit
Kings Area Rural Transit (KART)	Tehama Rural Area Express
Laguna Beach Transit	Thousand Oaks Transit
Lake Transit	Torrance Transit
Lassen Rural Bus	Tri Delta Transit
Livermore-Amador Valley Transit (LAVTA)	Trinity Transit
Long Beach Transit	Tuolumne County Transit
Los Angeles County Metropolitan Transportation Authority	Turlock Transit
Los Angeles Department of Transportation (LADOT)	Union City Transit Division
Madera Area Express	Unitrans
Madera County Connection	Vacaville Public Transportation (City Coach)
Marin County Transit District	Ventura County Transit Commission
Mendocino Transit Authority	Victor Valley Transit Authority (VVTA)
Merced The Bus	Vine Transit
Metrolink	Visalia Transit
Modesto Express	Western Contra Costa Transit Authority
Monterey Park Spirit Bus	Yolo County Transportation District - Yolobus
Monterey-Salinas Transit	Yosemite Area Regional Transportation System
Morro Bay Transit	Yosemite Valley Shuttle System
Mountain Area Regional Transit Authority	Yuba-Sutter Transit Authority
Nevada County Gold Country Stage	

Appendix B: Short-term measures

Investigating Discrepancies:

The primary issue of missing unit counts was identified and corrected using the method discussed in Chapter 6. In conducting this assessment, we also found parcel records with unusual entries (e.g. very high unit counts, very low total square footage). These issues appear to be isolated among a few cases. In searches for online information about the buildings or through phone calls, many of the apparent outliers were confirmed to be large complexes and their unusually high counts were reasonable. For those parcels with low square footage, unit counts were taken where given, where unit counts were missing, the above described method was used to estimate the number of units.

External Verification:

We conducted an external verification of these counts against housing unit and population counts from the American Community Survey (ACS), and found the distribution of new parcels was largely consistent with trends recorded in ACS.

Table A-2: Parcel Data New Units (2010 to 2014)

New Units (from parcels; 2010 2014)						
Tracts Ranked by Density Catg	**State**	**So Cal**	**Bay Area**	**San Joaquin**	**Rural**	**Central Coast**
Lowest Density	42%	36.4%	40.9%	59.8%	76.1%	57.6%
Lower	21%	21.3%	18.3%	29.0%	21.3%	19.4%
Middle	12%	12.7%	13.7%	10.6%	2.4%	8.2%
Higher	11%	11.8%	13.5%	0.5%	0.1%	12.4%
Highest Density	13%	17.8%	13.7%	0.0%	0.0%	2.3%
Total New Units	177,601	88,520	56,509	24,325	3,783	4,464
% of CA New Units		50%	32%	14%	2.1%	2.5%

Table A-3: American Community Survey New Units (2010 to 2014)

New Housing Units (from ACS; 2010 2014)						
Tracts Ranked by Density Catg	**State**	**So Cal**	**Bay Area**	**San Joaquin**	**Rural**	**Central Coast**
Lowest Density	35%	26.7%	35.6%	52.7%	79.5%	51.1%
Lower	23%	24.2%	17.3%	30.9%	16.8%	12.4%
Middle	14%	15.2%	14.0%	12.9%	3.3%	12.8%
Higher	13%	14.4%	15.8%	3.3%	0.4%	19.2%
Highest Density	15%	19.5%	17.4%	0.2%	0.0%	4.5%
Total New Units	205,874	108,478	57,307	26,788	7,022	6,279
% of CA New Housing Units	-	53%	28%	13%	3.4%	3.0%

Table A-4: American Community Survey Net Housing Units (2010 to 2016)

Net Housing Units (from ACS; 2010 2016)						
Tracts Ranked by Density Catg	**State**	**So Cal**	**Bay Area**	**San Joaquin**	**Rural**	**Central Coast**
Lowest Density	19%	14.6%	23.6%	41.6%	-85.2%	24.6%
Lower	23%	20.7%	16.7%	37.8%	-10.7%	31.3%
Middle	18%	15.9%	17.9%	16.7%	-2.6%	21.2%
Higher	17%	19.1%	17.7%	3.5%	-1.3%	14.3%
Highest Density	24%	29.8%	24.2%	0.3%	0.0%	8.6%
Net Housing Units	229,889	106,987	94,738	36,938	(13,371)	4,597
% of CA Net Housing Units	-	47%	41%	16%	-5.8%	2.0%

Table A-5: American Community Survey Net Population (2010 to 2016)

Net Population (from ACS; 2010 2016)						
Tracts Ranked by Density Catg	**State**	**So Cal**	**Bay Area**	**San Joaquin**	**Rural**	**Central Coast**
Lowest Density	20%	18.2%	18.6%	40.5%	-153.8%	37.8%
Lower	23%	22.9%	17.3%	35.4%	34.7%	26.8%
Middle	20%	20.4%	18.7%	18.7%	10.9%	11.3%
Higher	19%	19.5%	21.5%	5.4%	8.2%	19.9%
Highest Density	18%	18.9%	23.9%	0.0%	0.0%	4.2%
Net Population	1,400,250	748,438	475,868	132,656	(7,730)	51,018
% of CA Net Population		53%	34%	9%	-0.6%	3.6%

In this external verification, counts are not expected to match exactly. The purpose of the check is to assess the consistency in the distribution of units across regions and the state of California and in the direction of trends. In checking the counts of new units from parcel data with new units, net housing units, and net population calculated by the Census Bureau, we find our counts to be generally consistent, and so are confident in our results.

Appendix C: Results of Benchmarking

Table A-6: Benchmarking New Housing Units against Housing Unit Density Baseline

Statewide

Tracts Ranked by Occupied Housing Unit Density	% OHU, Baseline 2010	% New Housing Units 2011-14
Lowest Density	19%	42%
Low	21%	21%
Middle	20%	12%
High	20%	11%
Highest Density	21%	13%
Mean	3,043	2,024
Median	2,072	895

Southern CA

Tracts Ranked by Occupied Housing Unit Density	% OHU, Baseline 2010	% New Housing Units 2011-14
Lowest Density	12%	36%
Low	20%	21%
Middle	20%	13%
High	22%	12%
Highest Density	26%	18%
Mean	3,319	2,305
Median	2,405	1,164

Bay Area Megaregion

Tracts Ranked by Occupied Housing Unit Density	% OHU, Baseline 2010	% New Housing Units 2011-14
Lowest Density	16%	41%
Low	19%	18%
Middle	21%	14%
High	21%	13%
Highest Density	23%	14%
Mean	3,715	2,374
Median	2,267	1,125

San Joaquin Valley

Tracts Ranked by Occupied Housing Unit Density	% OHU, Baseline 2010	% New Housing Units 2011-14
Lowest Density	34%	60%
Low	28%	29%
Middle	28%	11%
High	10%	0%
Highest Density	0%	0%
Mean	1,239	642
Median	1,176	441

Rural State

Tracts Ranked by Occupied Housing Unit Density	% OHU, Baseline 2010	% New Housing Units 2011-14
Lowest Density	76%	76%
Low	20%	21%
Middle	3%	2%
High	1%	0%
Highest Density	-	-
Mean	389	373
Median	67	102

Central Coast

Tracts Ranked by Occupied Housing Unit Density	% OHU, Baseline 2010	% New Housing Units 2011-14
Lowest Density	38%	58%
Low	21%	19%
Middle	15%	8%
High	20%	12%
Highest Density	6%	2%
Mean	1,535	969
Median	1,151	464

Table A-7: Benchmarking New Housing Units against Access to Jobs Baseline

Statewide

Tracts Ranked by Access to Jobs	% OHU, Baseline 2010	% New Housing Units 2011-14
Lowest Access	21%	21%
Low	21%	25%
Middle	21%	19%
High	20%	23%
Highest Access	18%	11%
Mean	1,022,013	906,547
Median	867,930	761,394

Southern CA

Tracts Ranked by Access to Jobs	% OHU, Baseline 2010	% New Housing Units 2011-14
Lowest Access	7%	7%
Low	16%	24%
Middle	19%	24%
High	26%	24%
Highest Access	33%	22%
Mean	1,401,831	1,220,143
Median	1,456,973	1,018,170

Bay Area Megaregion

Tracts Ranked by Access to Jobs	% OHU, Baseline 2010	% New Housing Units 2011-14
Lowest Access	10%	9%
Low	31%	32%
Middle	39%	24%
High	21%	36%
Highest Access	-	-
Mean	785,671	811,728
Median	791,932	828,774

San Joaquin

Tracts Ranked by Access to Jobs	% OHU, Baseline 2010	% New Housing Units 2011-14
Lowest Access	70%	79%
Low	30%	21%
Middle	-	-
High	-	-
Highest Access	-	-
Mean	253,297	250,400
Median	237,042	221,709

Rural State

Tracts Ranked by Access to Jobs	% OHU, Baseline 2010	% New Housing Units 2011-14
Lowest Access	100%	100%
Low	-	-
Middle	-	-
High	-	-
Highest Access	-	-
Mean	63,919	85,518
Median	59,094	75,123

Central Coast

Tracts Ranked by Access to Jobs	% OHU, Baseline 2010	% New Housing Units 2011-14
Lowest Access	90%	87%
Low	10%	13%
Middle	-	-
High	-	-
Highest Access	-	-
Mean	170,295	159,480
Median	167,485	106,988

Table A-8: Benchmarking New Housing Units against High-Quality Transit Locations

Statewide	% OHU, Baseline 2010	New Housing Units, 2011-14
Out HQTL	72%	77%
In HQTL	28%	23%

Southern CA	% OHU, Baseline 2010	New Housing Units, 2011-14
Out HQTL	63%	68%
In HQTL	37%	32%

Bay Area Megaregion	% OHU, Baseline 2010	New Housing Units, 2011-14
Out HQTL	77%	78%
In HQTL	23%	22%

San Joaquin Valley	% OHU, Baseline 2010	New Housing Units, 2011-14
Out HQTL	92%	98%
In HQTL	8%	2%

Rural State	% OHU, Baseline 2010	New Housing Units, 2011-14
Out HQTL	98%	99%
In HQTL	2%	1%

Central Coast	% OHU, Baseline 2010	New Housing Units, 2011-14
Out HQTL	85%	92%
In HQTL	15%	8%

Table A-9: Benchmarking Changes in Subsidized Affordable Rental Units against Jobs-Housing Fit Index

Statewide

Tracts Ranked by Jobs-Housing Fit Index	% Aff. Rentals, Baseline 2008-12	New/Chg. Subsidized Aff. Rentals
Lowest (job deficit)	43%	39%
Low	25%	29%
Middle	17%	17%
High	11%	10%
Highest (aff. housing deficit)	4%	5%

Southern CA

Tracts Ranked by Jobs-Housing Fit Index	% Aff. Rentals, Baseline 2008-12	New/Chg. Subsidized Aff. Rentals
Lowest (job deficit)	39%	41%
Low	21%	23%
Middle	19%	20%
High	14%	11%
Highest (aff. housing deficit)	7%	6%

Bay Area Megaregion

Tracts Ranked by Jobs-Housing Fit Index	% Aff. Rentals, Baseline 2008-12	New/Chg. Subsidized Aff. Rentals
Lowest (job deficit)	49%	50%
Low	27%	30%
Middle	13%	13%
High	9%	3%
Highest (aff. housing deficit)	2%	4%

San Joaquin Valley

Tracts Ranked by Jobs-Housing Fit Index	% Aff. Rentals, Baseline 2008-12	New/Chg. Subsidized Aff. Rentals
Lowest (job deficit)	46%	33%
Low	37%	61%
Middle	12%	7%
High	4%	-1%
Highest (aff. housing deficit)	1%	1%

Rural State

Tracts Ranked by Jobs-Housing Fit Index	% Aff. Rentals, Baseline 2008-12	New/Chg. Subsidized Aff. Rentals
Lowest (job deficit)	44%	-7%
Low	18%	19%
Middle	20%	38%
High	14%	36%
Highest (aff. housing deficit)	3%	14%

Central Coast

Tracts Ranked by Jobs-Housing Fit Index	% Aff. Rentals, Baseline 2008-12	New/Chg. Subsidized Aff. Rentals
Lowest (job deficit)	2%	6%
Low	35%	30%
Middle	32%	14%
High	24%	44%
Highest (aff. housing deficit)	8%	6%

Table A-10: Benchmarking Net Changes in Jobs against Person Miles Traveled at Job-Site Baseline

Statewide

Tracts Ranked by Avg. PMT at Job Site	% All Jobs, Baseline 2010	% Net Changes in Jobs, 2010-14
Highest PMT	26%	27%
High	31%	37%
Middle	21%	19%
Low	14%	11%
Lowest PMT	8%	6%
Mean	5.2	6.6
Median	15.5	16.2

Southern CA

Tracts Ranked by Avg. PMT at Job Site	% All Jobs, Baseline 2010	% Net Changes in Jobs, 2010-14
Highest PMT	28%	31%
High	31%	35%
Middle	21%	11%
Low	14%	17%
Lowest PMT	6%	5%
Mean	4.8	5.7
Median	15.5	15.9

Bay Area Megaregion

Tracts Ranked by Avg. PMT at Job Site	% All Jobs, Baseline 2010	% Net Changes in Jobs, 2010-14
Highest PMT	25%	24%
High	37%	47%
Middle	21%	23%
Low	10%	1%
Lowest PMT	7%	6%
Mean	6.7	8.7
Median	17.2	17.6

San Joaquin Valley

Tracts Ranked by Avg. PMT at Job Site	% All Jobs, Baseline 2010	% Net Changes in Jobs, 2010-14
Highest PMT	23%	13%
High	14%	23%
Middle	19%	28%
Low	21%	33%
Lowest PMT	23%	4%
Mean	4.2	6.0
Median	13.0	14.2

Rural State

Tracts Ranked by Avg. PMT at Job Site	% All Jobs, Baseline 2010	% Net Changes in Jobs, 2010-14
Highest PMT	15%	6%
High	22%	21%
Middle	16%	40%
Low	24%	24%
Lowest PMT	24%	9%
Mean	1.5	1.7
Median	10.6	11.9

Central Coast

Tracts Ranked by Avg. PMT at Job Site	% All Jobs, Baseline 2010	% Net Changes in Jobs, 2010-14
Highest PMT	12%	33%
High	24%	4%
Middle	24%	48%
Low	26%	7%
Lowest PMT	15%	9%
Mean	5.8	6.0
Median	14.1	14.5

Table A-11: Benchmarking Net Changes in Jobs against High-Quality Transit Location Baseline

Statewide	% All Jobs, Baseline 2010	% Net Changes in Jobs, 2010-14
Out HQTL	56%	64%
In HQTL	44%	36%

Southern CA	% All Jobs, Baseline 2010	% Net Changes in Jobs, 2010-14
Out HQTL	48%	54%
In HQTL	52%	46%

Bay Area Megaregion	% All Jobs, Baseline 2010	% Net Changes in Jobs, 2010-14
Out HQTL	60%	62%
In HQTL	40%	38%

San Joaquin Valley	% All Jobs, Baseline 2010	% Net Changes in Jobs, 2010-14
Out HQTL	80%	98%
In HQTL	20%	2%

Rural State	% All Jobs, Baseline 2010	% Net Changes in Jobs, 2010-14
Out HQTL	90%	78%
In HQTL	10%	22%

Central Coast	% All Jobs, Baseline 2010	% Net Changes in Jobs, 2010-14
Out HQTL	71%	119%
In HQTL	29%	-19%

Table A-12: Summary of Benchmarking Results by Analysis Type

Analysis of Quintile Distribution

Desirable SB 375 Outcomes	**Statewide**	**Southern CA**	**Bay Area Megaregion**	**San Joaquin Valley**	**Rural State**	**Central Coast**
New Housing in Higher Density Tracts	Decreasing	Decreasing	Decreasing	Decreasing	Minimal Change	Decreasing
New Housing in Higher Job-Access Tracts	Decreasing	Decreasing	Increasing	Decreasing	Minimal Change	Minimal Change
Net Increases in Jobs in Lower PMT (at Job- Site) Tracts	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing
More Affordable Housing in Tracts with the Greatest Need (based on JHF measure)	Minimal Change	Decreasing	Decreasing	Decreasing	Increasing	Increasing
New Housing in High-Quality Transit Locations	Analysis of quintile distribution does not apply					
Net Increases in Jobs in High-Quality Transit Locations						

Analysis of averages (Mean/Median)

Desirable SB 375 Outcomes	**Statewide**	**Southern CA**	**Bay Area Megaregion**	**San Joaquin Valley**	**Rural State**	**Central Coast**
New Housing in Higher Density Tracts	Decreasing	Decreasing	Decreasing	Decreasing	Minimal Change	Decreasing
New Housing in Higher Job-Access Tracts	Decreasing	Decreasing	Increasing	Decreasing	Increasing	Decreasing
Net Increases in Jobs in Lower PMT (at Job- Site) Tracts	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing
More Affordable Housing in Tracts with the Greatest Need (based on JHF measure)	Analysis of averages does not apply					
New Housing in High-Quality Transit Locations						
Net Increases in Jobs in High-Quality Transit Locations						

Final Outcome

Desirable SB 375 Outcomes	**Statewide**	**Southern CA**	**Bay Area Megaregion**	**San Joaquin Valley**	**Rural State**	**Central Coast**
New Housing in Higher Density Tracts	Decreasing	Decreasing	Decreasing	Decreasing	Minimal Change	Decreasing
New Housing in Higher Job-Access Tracts	Decreasing	Decreasing	Increasing	Decreasing	Mixed Results	Mixed Results
Net Increases in Jobs in Lower PMT (at Job- Site) Tracts	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing
More Affordable Housing in Tracts with the Greatest Need (based on JHF measure)	Decreasing	Decreasing	Decreasing	Decreasing	Increasing	Increasing
New Housing in High-Quality Transit Locations	Decreasing	Decreasing	Minimal Change	Decreasing	Minimal Change	Decreasing
Net Increases in Jobs in High-Quality Transit Locations	Decreasing	Decreasing	Minimal Change	Decreasing	Increasing	Decreasing

Table A-13: Quintile Ranges by Baseline Indicator

	Access to Jobs	Mean PMT at Job-Site	Jobs-Housing Fit
Lowest Quintile	1,500 - 315,900	2.3 - 13	0 - 2.2
Low	316,300 - 702,900	13 - 15.5	2.2 - 4
Middle	702,900 - 1,099,200	15.5 - 18.3	4 - 6.2
High	1,099,200 - 1,879,600	18.3 - 22.1	6.2 - 11.3
Highest Quintile	1,879,700+	22.1+	11.3+

Appendix D: Date of SCS Adoption

Table A-14: Date of First SB 375 Compliant Transportation Plan by MPO

MPO	Date of first adopted SCS
SANDAG	10/2011
SACOG	4/2012
SCAG	4/2012
Butte GAG	12/2012
Tahoe MPO	12/2012
MTC	7/2013
Santa Barbara CAG	8/2013
AMBAG	6/2014
Stanislaus COG	6/2014
Kern COG	6/2014
Fresno COG	6/2014
San Joaquin COG	6/2014
Tulare COG	6/2014
Madera COG	6/2014
Kings CAG	6/2014
Merced CAG	6/2014
San Luis Obispo COG	4/2015
Shasta RTA	6/2015