VMT THRESHOLD UPDATE: STANDARD RECOMMENDATION AND IMPLEMENTATION

THRESHOLD UPDATE INITIATIVE

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CONTENTS

DRAFT

SUMMARY OF RECOMMENDATIONS

Staff seeks Regional Plan Implementation Committee guidance on the recommended threshold standard.

Recommendation: Establish a new threshold standard category "Transportation and Sustainable Communities", and threshold standard "TSC1 – Reduce Annual Daily Average VMT Per Capita by 6.8% from 12.48, the 2018 baseline, to 11.63 in 2045." The goal of the standard is to reduce dependence on the automobile, support GHG emission reduction, and increase mobility.

BACKGROUND

TRPA operates under the authority of the states of California and Nevada and the federal government through the Bi-State Compact, which was ratified by Congress and signed by the President of the United States. The revised Bi-State Compact, signed nearly forty years ago, wrote "the waters of Lake Tahoe and other resources of the region are threatened with deterioration or degeneration, which endangers the natural beauty and economic productivity of the region(96th Congress 1980)" To ensure the natural beauty and economic productivity of the region would persist for generations to come, the Bi-State Compact directs TRPA to establish "environmental threshold carrying capacities," defined as "an environmental standard necessary to maintain a significant scenic, recreational, educational, scientific or natural value of the region or to maintain public health and safety within the region." These environmental threshold standards establish goals for environmental quality and express the shared aspiration for environmental restoration of the Tahoe Region. The standards shape the goals and policies of the Regional Plan and guide millions of dollars of public and private investment in the basin through the Environmental Improvement Program. The initial threshold standards set the course for the Region 40 years ago but were never intended to be immutable. The multi-disciplinary team that authored the 1981 threshold study report outlined specific triggers for standard review, and set the expectation that the standards would be reassessed at least every five years, and wrote: "environmental thresholds are not static standards that once in place remain forever" (TRPA 1982a).

Most of the current threshold standards were adopted in 1982, and are based on science that is now over 40 years old. Numerous recommendations for modifying the system have been put forward, including over 90 recommendations in the 2011 Threshold Evaluation Report, and the standards have been repeatedly critiqued by partners, members of the threshold evaluation team, and external scientific peer reviewers. Prior attempts to review and revise the threshold standards, including the multi-year Pathway 2007 process, proposed but failed to eventuate significant revisions to the standards.

Following the 2015 Threshold Evaluation, the TRPA Governing Board identified the review and updating of the threshold standards and performance measures as a strategic initiative for the agency. TRPA is currently leading the process and incorporating new scientific information so that the standards that guide millions of dollars of public and private investment in the basin are representative, relevant, and scientifically rigorous. The goals of the initiative are:

- A representative, relevant, and scientifically rigorous set of threshold standards.
- An informative, cost-efficient, and feasible monitoring and evaluation framework to support adaptive management towards threshold standard attainment.
- A robust and repeatable process for review of threshold standards in the future.

BACKGROUND ON THE VMT THRESHOLD STANDARD FOR NITROGEN DEPOSITION

Nitrogen is a nutrient that promotes algal growth and is a pollutant of concern in the Lake Tahoe Basin (Lahontan & NDEP 2010a). In 1982, when the threshold standards were first adopted, a number of standards were adopted to address loading of algal nutrients to the lake. While the motivation for the standards was the clarity of the lake, some of the standards were adopted as air quality standards to reflect the pathway (the air) through which the nutrients reached the lake. Included in that set of standard were two standards adopted to reduce nitrate deposition onto the lake in 1982 (TRPA 1982a).

(AQ13) Reduce the Transport of nitrates into the Basin and reduce oxides of nitrogen (NOx) produced in the Basin consistent with the water quality thresholds.

(AQ14) Reduce vehicle miles of travel in the Basin by 10% of the 1981 base year values.

A third standard was adopted to that established the goal of stabilizing NOx emission in order as a regulate ozone concentrations.

(AQ4) Maintain Oxides of nitrogen (NOx) emissions at or below the 1981 level.

In 1982, the current VMT standard (AQ14) was also adopted as a part of sub-regional visibility standard (TRPA 1982b)[1].

The 10% reduction target from 1981 levels in AQ14 has its basis in the subregional visibility concerns, rather than in science that established a 10% reduction in emissions as target for lake clarity. Page 7-42 of the Threshold Study Report, includes a discussion of how a 10% reduction in VMT could help achieve a 30% reduction in atmospheric soil particles thought necessary to achieve the visibility standard (TRPA 1982a):

> *"The recommended [subregional visibility] standard is based primarily upon the ability to mitigate the sources of the problem [subregional haze]. To develop a recommended visual range for the subregional visibility threshold, reduction in 30 and 15 percent for soil particles in the atmosphere and wood smoke were used, respectively. To attain the 30 percent reduction in suspended soil, a 10 percent decrease in the number of vehicle miles of travel will most likely be required. However, it may be more effective to attain the recommended threshold by mitigating some of the other factors."*

When discussing nitrate deposition, the Study Report provides background on the sources and deposition of nitrate and concludes as follows (at p. 7-44):

> *"Based on what is known about the atmospheric removal and chemical conversions involving nitric acid and particulate nitrate, it is not possible to develop an environmental threshold for these pollutants at this time. However, it is clear that the levels of oxides of nitrogen emissions in the Basin should be reduced. As a result, a 10 percent reduction in the number of vehicle miles of travel from the 1981 base year level is recommended."*

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[1] The VMT standard was removed as a measure of sub-regional visibility as part of the 2012 threshold updates which replaced it with four direct measures of Respirable and Fine Particulate Matter in the air, related to human health and regional visibility values (TRPA 2012a, 2012b).

Thus, the current threshold standard for nitrogen deposition, that establishes a goal of 10 percent reduction in VMT from 1981 was based on calculations to achieve the subregional visibility standards and was thereafter repeated as a recommended policy statement that would also promote attainment of other goals. Where standards were focused on a management practice or policy direction (rather than a desired end state), the initial threshold study often included the recommended standard multiple times. For example, prior to the reorganization of there were three standards adopted to prevent degradation of stream environment zones, the management standard for inorganic nitrogen loading was repeated verbatim as both a pelagic and littoral standard. As part of the threshold update initiative, the Tahoe Science Advisory Council has recommended that this practice be discontinued to avoid confusion.

WHAT IS VMT?

Vehicle miles travelled (VMT) is a measure of the number of miles driven on roadways in a specified area and period of time. Estimates of VMT are generally approximations of actual vehicle miles traveled, based on estimates of trip distance and frequency (Salon et al. 2012). VMT could be precisely measured using car odometers, but rarely is because of the difficulty in obtaining the information (Salon et al. 2012) and the challenge of determining where the vehicle travel occurred. VMT is influenced by a complex set of interconnected factors and synergies between individual factors. For example, higher fuel prices reduce regional VMT, but the response at the household level is influenced by household location and income (Salon et al. 2012, 2013). Nationally, VMT has generally increased as the population has grown, the economy expanded, and car ownership has increased. The Federal Highway Administration (FHWA) forecasts suggest that nationwide VMT will continue to grow by 1.07% annually through 2035. The FHWA forecast is influenced by projections for population growth, economic growth, and disposable income, all of which are positively associated with VMT (FHWA 2017).

VMT is a function of the complex interplay of a variety of factors including: population (both inside and outside the region), gas prices, employment rates, local housing costs, demand for recreational opportunities in the region, access to alternative forms of transportation, and secondary home ownership. Increased congestion, work from home programs, employer carpool programs, concentration of development in centers, presence of travel alternatives, higher unemployment, and higher fuel prices are all linked with reductions in VMT. Population growth, higher household income, higher employment rates, increased fuel economy and greater roadway capacity are all linked to increasing VMT. Increasing access to transit services, access to bicycle and pedestrian facilities, and the relative desirability of alternative modes of transportation in comparison to the use of the personal automobile may reduce VMT.

GOAL FOR THE NEW THRESHOLD STANDARD

The Bi-State Compact instructs TRPA to develop a transportation plan for the Region with two goals: first, to reduce dependency on the automobile, and second, to reduce air pollution from motor vehicles (Public Law 96-551, 96th Congress 1980). As a result of increasingly stringent federal and state tail pipe emissions standards, vehicles today are far cleaner than they were when the Bi-State Compact was amended nearly 40 years ago. Because of those improvements, air quality in Tahoe today is generally good, and nitrogen emissions today are well below the emissions reduction goal established in 1981.

Threshold standards establish the goals for environmental quality and express the shared aspirations for the Tahoe Partnership to work towards. Dating back to 2001, four consecutive threshold evaluation reports have recommended that the basis for the nitrogen based VMT threshold be reviewed (TRPA 2001, 2007, 2012a, 2016). Formal review of the current threshold standard process began nearly four years ago. In February of 2017, the Environmental Improvement Program (EIP) sub-committee of the Governing Board asked the Advisory Planning Commission to convene a Transportation Measures Working Group. Over eight months and six public meetings, the group surveyed the transportation measures landscape and produced a final report that identified and cataloged over 200 measures.

The report itself does not answer which measures best align with TRPA goals, it provides a resource from which to draw from. During the process of developing the report experts in the field provided their perspectives to the Working Group. When considering how to use the report to identify indicators appropriate for the Region's goals, Fehr & Peers Director of Evolving the Status Quo, Ron Milam, suggested considering three things, "What is it you are trying to create? What is it you are trying to protect? And, what is it you are trying to avoid?" Guided by those questions, Staff reviewed the concerns expressed by stakeholders in association with VMT and identified areas where the goals of the partnership were not expressed by the existing threshold standards.

That process led to the identification of three core considerations to drive target setting. First, to support the attainment of the Greenhouse Gas (GHG) reduction goals of California and Nevada. Second, to increase mobility with a regional land use and transportation system comprised of alternative forms of transportation and a complementary development pattern. Third, to implement the Compact's direction to reduce dependence on the private automobile. RPIC formally endorsed updating the current nitrogen based VMT standard to one based on those three goals at its March 2020 meeting.

Two broad types of thresholds standards have been established. The first were standards established to protect existing resources from degradation. These were standards which were in attainment at the time of adoption, and for which the implementation mechanisms were designed to protect the resource from degradation. Examples include the standards for maintenance of the scenic viewsheds and the standard for the prevention of new aquatic invasive species from entering the lake. The second type of threshold standards sought to restore a resource that had been degraded or create something new entirely. Examples of the latter include the stream environment zone restoration standard and the pelagic lake clarity standard. The recommended standard is a standard of the latter type. It sets a goal for the region to work towards. However, it differs from past threshold standards of the type, in that it seeks to create something that never existed, rather than restore something which has been lost.

THRESHOLD STANDARD REVIEW

In addition to reviewing the content of the threshold standards, TRPA also committed to reviewing the structure implementing the standards. Following two years of work with the Tahoe Science Advisory Council, TRPA adopted a new adaptive management structure for managing information related to the threshold standards in April 2019. The adaptive management structure lays out a vision for organizing information to support evidence-based management in the Tahoe Region. The structure is designed to provide the data necessary to improve decision-making, promote accountability, and increase transparency at all levels. The structure also provides a framework to guide the review and updating of threshold standards and performance measures for the Environmental Improvement Program, Regional Plan, and Regional Transportation Plan.

The adaptive management system structure draws from best practice in the field of environmental management and integrates four elements: (1) conceptual models – that ground threshold standards in the scientific understanding of ecosystem function, (2) results chains – that link management actions to desired outcomes (threshold standards), (3) management actions – that are the implementation strategies and actions rooted in results chains, and (4) monitoring, evaluation, and learning – which provides the structure for incorporating new information into the design of policies, programs, and strategies to accelerate threshold attainment. The adopted structure provides specific criteria that new or revised TRPA thresholds standards must meet. The minimum criteria ensure that threshold standards will contain three qualities:

1) Specific - The standard establishes a specific numeric target, and benchmark/baseline values are documented where necessary.

2) Measurable – The standard has clearly defined indicator(s) that links to the standard, and there are practical ways to measure progress objectively and accurately towards attainment.

3) Outcome-based – Standards focus on a desired condition for an environmental end state, not a means to achieve the desired outcome, or an intermediate product.

INDICATOR SELECTION

To identify a new indicator and target, the staff reviewed the appropriateness of indicators for effectively measuring progress of the three policy goals of the standard: support the attainment of the Greenhouse Gas (GHG) reduction goals of California and Nevada, increase mobility, and reduce reliance on the automobile.

VMT can be expressed in absolute terms (total miles traveled) or as a function of another factor (e.g. per worker, or per residents). The latter are collectively referred to as efficiency-based measures. Efficiency based measures express the amount of VMT in a region as a function of a factor thought to be related to that VMT. One of the most common efficiency-based measures is expressing VMT in a region as a function of the region's population. Analyzing VMT as a function of the population (VMT per capita) allows for comparison of trends through time (Circella et al. 2016) or between regions (Clark & Cushing 2004; McMullen & Eckstein 2013) while controlling for differences in population size.

While absolute VMT has historically been of interest because of the relationship between VMT and total vehicle emissions, VMT per capita is a measure of efficiency of a transportation system in moving individuals between the places they need to be. Higher VMT per capita regions are those where individuals are traveling farther distances to get between home, work, shopping, etc. and are generally reliant on the automobile to move between their destinations. Lower VMT per capita regions are those that are characterized by individuals travelling shorter distances between their desired destinations, and where there are options other than the car (e.g. bike paths, transit systems) that are chosen more frequently as a means of taking those trips.

When applied in practice, absolute VMT and per capita VMT provide different information about a Region or regions being compared. For example, the New York metro area has the second highest absolute VMT of the 100 largest metro areas in the United States, but the lowest VMT per capita (Robert Puentes & Adie Tomer 2008). This means that New York is responsible for more transportation-based emissions than all but one other metro area in the country, but also that if all residents lived in metro areas like New York, nationwide emissions would be far lower. Jackson, Mississippi and Rochester, New York have about the same total VMT, but in Jackson the average resident drives more than twice as much as a resident of Rochester (Robert Puentes & Adie Tomer 2008). As illustrated by the examples above, per capita VMT is more reflective of auto dependence than absolute VMT, because of the confounding influence of factors like population.

The combination of the development footprint, the transportation infrastructure, and choices made by travelers in the region influence the VMT per traveler. The total amount of VMT is a function of the three factors listed above, and the choices of individuals that influence the total number of travelers in the region. Total number of travelers (i.e., the service population) in the region is influenced by the number of people that chose to live, work, or visit Tahoe. These decisions are largely independent of local policy setting but exert significant influence over the total VMT in the region.

The current threshold standard establishes a target for the total amount of VMT in the region. As a result, the attainment status of the threshold standard has varied in response to factors that do not meaningfully reflect the changes in regional land-use or transportation system from realization of the Regional Plan and Regional Transportation Plan.

To protect and preserve the national treasure that is Lake Tahoe for future generations, the Regional Plan places strict controls on the pace of and total amount of development allowed in the region (TRPA 2012b). Despite these strict controls on regional development, the attainment status of the VMT threshold standard has fluctuated over the years. Twenty years ago, the current VMT standard was assessed as out of attainment, while in the 2011 and 2015 threshold evaluations it was found to be in attainment (TRPA 2012a, 2016). The California Department of Transportation (CalTrans) estimates for VMT on the California side of the region during this same time period showed the same general pattern, but with even greater fluctuation than estimated in Tahoe[2]. In 2001, estimated daily VMT on the California side of the Region was 1,073,000 (CalTrans 2018a). In 2014, California side VMT was estimated to have dropped to just over half the volume in 2001, at 560,840 daily (CalTrans 2018b). These changes are likely attributable to macro scale factors, including the loss of resident population, decline in gaming visitation, and the great recession.

Macro scale factors, like choice of residency exert significant influence on absolute VMT. If more people choose to live in the Region, total VMT in the Region will likely increase as VMT generally increases as population increases (FHWA 2010, 2017). If people choose to live elsewhere, in-Region VMT will likely decrease. There are currently 47,655 residential units in the Tahoe Region. Occupancy rates published by the U.S. Census Bureau 2018 American Community Survey (ACS), estimate that 45% of residential units are occupied by full-time residents and 55% are not occupied by full-time residents (US Census Bureau 2019). Housing units not occupied by full time residents may be second homes, time-shares, seasonal rentals, or short-term rentals. Population in the region can and does fluctuate for reasons unrelated to the number of residential units in the region. Expanding the geographic range considered, the dynamics of VMT can also change. If current residents of the region are priced out of the market or chose to move outside the region, but continue to work in the region, the longer commute trips can increase total VMT (inside and outside the region) even if there is a reduction in the VMT within the region.

Similar dynamics exist with visitation and visitor generated VMT. While the total number of rooms available to visitors to the region is limited by the Regional Plan, VMT varies considerably in response to the occupancy rate of the hotels, motels, resorts, and casinos in the region. In the “shoulder” season, when fewer visitors choose Tahoe as a destination, both occupancy rates and VMT decline. The same pattern can be seen in response to macro-economic conditions. During the great recession, there was a considerable decline in the number of overnight visitors in the Region (see figure 1). It wasn’t until about 2017 that the number of rooms rented in the region returned to pre-recession levels. The economic recovery is also evident in CalTrans VMT estimates. CalTrans estimates suggest that after declining during the recession, daily VMT in 2018 was 1,032,960, just shy of the 2001 level (CalTrans 2018c). The decline in gaming visitation is well documented, with estimates suggesting that between

[2] Nevada Department of Transportation did not estimate VMT in Nevada portion of the Region until 2016.

1990-2010, the industry declined by two-thirds (Eadington 2011). That the attainment status of an absolute VMT could fluctuate in response to macroeconomic conditions rather than regional programs and policies, is a core area of concern for indicator selection for the updated threshold standard.

Indicator selection considered responsiveness to the plans, as well as how the indicator would likely respond to specific projects or region changes. Looking at the historic record of VMT in the region, the response of absolute VMT to the great recession raised concerns about absolute VMT as metric. The potential response of the metric to Regional Plan priorities like affordable housing also raised concerns. Throughout the threshold update process, stakeholders have commented on the need to build more workforce and affordable housing units in Tahoe. Affordable and workforce housing would likely increase the resident population of the Region, which in turn would likely increase the in Region VMT.

TRPA's unique planning authority allows it to closely coordinate land use (Regional Plan) and transportation (Regional Transportation Plan) planning. The two plans work together to provide visitors and residents with alternatives to personal automobile travel and reduce VMT. For more than twenty years the focus of both has been supporting compact, mixed-use development, and walkable, bikeable, transit-friendly communities. An efficiency based VMT standard better aligns with the identified polices goals. It also affords consistency with California and Nevada state policies with respect to GHG reduction and aligns with and is responsive to meaningful change in the regional land use and the transportation system. At its July 2020 meeting RPIC directed staff to develop an efficiency-based metric for establishment of the VMT threshold standard.

TARGET ESTABLISHMENT

There is no absolute value for per capita VMT that distinguishes efficient from inefficient or a well-designed community from a poorly designed one. Unlike many threshold standards which owe their target to a historic period where conditions were better, there is also no historic precedent that stakeholders' reference as an era when the Region's transportation and land use system worked together to efficiently move people around the Region without relying on the private automobile.

The desire to reimagine Tahoe's transportation system dates back at least to the Bi-State Compact, which established TRPA and directed it to "reduce dependency on the automobile by making more effective use of existing transportation modes and of public transit to move people and goods within the region." To achieve that goal the Regional Plan emphasizes mixed-use and compact development /redevelopment, and the Region's Regional Transportation Plans have prioritized investments in non-auto modes and have not proposed any major expansions of the Region's automobile infrastructure.

Target setting for the standard was divided into three steps; 1) Establish the baseline level of VMT, 2) Establish the baseline population, and 3) Set the target and design the implementation framework. The first two steps establish the amount of per capita VMT of today (or baseline), and the third step sets the vision for reducing per capita VMT in the future. To solicit feedback on each step of the target setting process, staff brought draft proposals to a Transportation Technical Advisory Committee (TTAC). Between August and December of 2020, the TTAC convened three times, once for each of the three steps of the target setting process. The recommended target incorporates much of the feedback received during those sessions. A diverse array of stakeholders provided feedback through the TTAC meetings and subsequent meetings. The guidance and direction received was often conflicting, and the recommended target and implementation framework reflect a compromise. No single stakeholder is likely to see all that they want in the package.

VMT BASELINE

Identifying the baseline amount of VMT for standard establishment required answering three questions identified below. Feedback on each was solicited at the August 2020 meeting of the Transportation Technical Advisory Committee.

WHAT VMT SHOULD BE INCLUDED?

Standard establishment requires clear articulation of which VMT should be included in the standard. Options considered included, limiting VMT by geography, to either only VMT that occurs inside the region, or consideration of the full trip length of any trip that passes through the region. Other alternatives considered included limited VMT consider to specific trip purposes (e.g., recreation, work), or specific traveler types (e.g. day visitors, commuters). Staff recommends that all VMT inside the region by any traveler or for any trip purpose be included the VMT for threshold standard establishment. The inclusion of all VMT in the threshold standard, places emphasis or reducing VMT from any source. The inclusion of all VMT for standard establishment purposes does not preclude more detailed analysis of travel patterns and VMT generation (e.g. identification of commute or resident recreation VMT). Staff further recommends investment in refining methods to estimate trip length outside the region and continued programmatic emphasis to reduce external VMT.

WHICH TRAVELERS SHOULD BE INCLUDED?

Establishment of an efficiency-based threshold standard also requires defining the unit (population) over which that efficiency will be measured. Populations considered for establishment of the threshold standard could include, residents, seasonal residents, workers, all travelers, or any subset or combination of the travelling population. Staff recommends that the standard seek to accurately reflect the overall efficacy and efficiency of the transportation and land use system. To do so, all travelers must be accounted for in the efficiency metric. Accounting for all travelers means the inclusion of visitors, residents, commuters, and anyone else traveling in the Region. Accounting for only a subset of those travelers would provide only a partial picture of the source of VMT and be inconsistent with the recommendation to consider all VMT.

WHAT TIME PERIOD SHOULD BE CONSIDERED?

VMT and the total number of travelers contributing to it can be measured at any time scale for which data is available. This includes on a multi-year, annual, seasonal, monthly, or even daily basis. Smaller time periods of evaluation will likely result in more bias in estimating both VMT and population as a result of uncertainty inherent of estimates of both. Staff recommends standard establishment using annual average VMT. The use of annual average VMT emphasizes the importance of and accounts for the contributions of projects and programs that reduce per capita VMT at any time of year. Staff recommends that 2020 VMT estimates not be considered in the establishment of a VMT baseline because of the impact of Covid-19 and the fact that data for all of 2020 are not available. Use of multiple years and longer time periods as the basis for standard setting and evaluation generally reduces that uncertainty.

VMT DATA SOURCE: HIGHWAY PERFORMANCE MONITORING SYSTEM (HPMS)

The Highway Performance Monitoring System (HPMS) is a U.S. Department of Transportation, Federal Highway Administration (FHWA) national reporting program that provides information on all travel on public roads in the United States. States use standardized reporting and monitoring procedures to produce and submit a suite of travel related data to FHWA each year (FHWA 2016). CalTrans and NDOT both publish VMT estimates for their respective portions of the Tahoe Region as part of their HPMS reporting requirements.

Links to the annual reports for each state are provided below:

- Caltrans: https://dot.ca.gov/programs/research-innovation-system-information/highway-performance-monitoring-system
- NDOT: https://www.nevadadot.com/doing-business/about-ndot/ndot-divisions/planning/roadway-systems/annual-vehicle-miles-of-travel

Caltrans has published estimates of VMT on the California side of the Tahoe Region for each year since 2001. NDOT has published VMT estimates for the Nevada side of the Tahoe Region since 2016. Table 1 summarizes the CalTrans and NDOT estimates for annual average daily VMT for the region. CalTrans HPMS data is still preliminary for 2019.

Table 1: HPMS VMT Estimates for the Tahoe Region (2016-2019)

Year	CA	NV	Total
2016	1,016,891	435,213	1,452,104
2017	1,026,876	525,728	1,552,604
2018	1,032,957	437,612	1,470,569
2019	937,268	488,709	1,425,977

Staff recommends HPMS reporting be the primary source of VMT data for threshold standard establishment and assessment. Staff further recommend that the three-year annual average of HPMS VMT be used as the baseline for establishment of the VMT threshold standard (Table 2). The use of multiple years of data will help reduce the influence of interannual variability (e.g. as a result of weather) in single strange that is not reflective of meaningful change in the land use or transportation systems.

Table 2: Three-year annual average daily VMT (2016-2019)

Period	3-year HPMS average
2016-2018	1,491,759
2017-2019	1,483,050

Staff had initially recommended the use of VMT data from StreetLight Data Inc. (StreetLight) for standard establishment. Numerous stakeholders raised concerns about reliance on a novel VMT estimation technique, and the possibility that the attainment status of the standard could change solely for methodological reasons. In response to those concerns, staff is proposing to use the more mature and established government sources of VMT data for establishing the standard. HPMS reported VMT for the region is more likely to provide a robust and stable estimate at the regional scale. Staff will continue to explore the use of StreetLight and other big data sources, to better understand travel patterns and inform management actions to accelerate threshold attainment.

To establish the baseline for tracking threshold standard progress, staff recommends that the 3-year HPMS average centered on the 2018 base year be used. The VMT baseline for the standard is 1,483,050.

POPULATION DATA SOURCE: TAHOE EFFECTIVE POPULATION MODEL

Tahoe is a tourist destination. Like other tourist destinations, the number of people moving around the Region on any given day far exceeds the number of full-time residents. The full-time residential population of the Region was most recently estimated at just over 50,000 by the US Census American Community Survey (US Census Bureau 2019). The full-time resident population as estimated by the US Census American Community Survey has been relatively stable for the last decade (US Census Bureau 2019).

The total number of people moving around the region, is referred to as the effective, traveling, or service population. Effective population can include residents, visitors, workers, students, and anyone else traveling in the region. Because both Regional Plan and Regional Transportation Plan seek to provide a more efficient travel experience for all travelers within the Region, staff recommends that the service or total traveling population be used for the establishment of the threshold standard. While estimations of Resident population are more readily available than estimates of the effective population, they provide a more limited and potentially biased perspective on the overall travel experience within the Region.

Staff engaged the Tahoe Science Advisory Council to help estimate the total number of travelers or the effective population of the region. The effective population refers to the number of individuals in an area at a specific time (Campanelli et al. 2017; Morrison et al. 2020). While regional and infrastructure planning often relies on the estimates of the resident population of a region, in regions with large variations in seasonal population, the residential population estimates provide only a partial picture of the actual number people that are in or traveling around the region.

Tahoe's regional resident population has never exceeded 65,000 people, according to the U.S. Census, but the number of people in the Tahoe Region on peak days has been estimated to exceed 200,000. Estimating visitation to the Region has always been a challenge. Early estimates suggested that 15 million people visited annually (TRPA 1978). More recent estimates have varied widely, suggesting between 13 and 24 million visitors annually (Svensson 2017; TTD 2017).

The Tahoe Effective Population Model (TEPM) is an approach developed with the Tahoe Science Advisory Council to estimating the annual average daily effective population of the Tahoe Region using a variety of available datasets, in conjunction with information about travel and visitation behavior of residents and visitors derived from surveys and studies. The effective population defined here includes residents, visitors (including day, overnight, second homeowners and their guests), and commuting workers. Formal estimates are available for some of these populations, while others, such as the number of day visitors are more challenging to develop. The approach is implemented in two primary steps, first estimation of the overnight population of the region, and second estimation of the population entering the region during the day.

The TEPM takes an additive approach to estimating the total effective population by first estimating the size of contributing sub-populations. The sub-populations considered include, residents, visitors, and commuters. The size of individual sub-populations is then summed to arrive at the effective population. The TEPM's approach to sub-population estimation is rooted in the conceptual framework of the Tahoe Travel Demand Model. The overnight population is estimated using data on the number of residents of the region, and information on the number of visitors at overnight accommodations in the region (including hotels/motels, campgrounds, and short-term rentals). The population entering the region is estimating by balancing the total entry traffic volumes in the region with the known populations and travel behaviors of the sub-populations.

Application of the TEPM to the 2018 base year produced an estimated annual average effective daily population for the Region of 118,856. Full documentation for the approach and the base year estimate can be found in appendix C.

The conceptual approach can be applied at a variety of time scales ranging from a single day to an annual estimate. Application of the approach should acknowledge the uncertainty in the estimate of the individual parameters of the model increases with narrowing of the time period over which the estimate is produced. That is, annual average estimates are likely to be more accurate than estimates for an individual day.

Staff discussed the possibility of direct estimation of the Region's population based on big-data sources to the TTAC in September 2020. The overwhelming feedback received at the meeting, and in subsequent discussions with stakeholders was that the estimation method should be rooted in data that could be more readily quantified and reviewed by stakeholders, such as traffic counts and hotel occupancy rates. This direction guided Staff's continued investment in TEPM approach to population estimation.

TARGET SETTING

Using the recommended VMT (1,483,050) and effective population (118,856) from the above sections, yields a baseline VMT per capita of

VMT per capita is a function of the interaction between the existing and future land use and transportation systems. The Regional Plan establishes the vision for the future land uses and development pattern of the Region. The Regional Transportation Plan (RTP) establishes the vision for the robust multi-modal transportation system that enables people to navigate the current and future landscape. Numeric target setting was grounded in Regions' shared vision for its future.

To establish a numeric target for per capita VMT threshold standard, Staff considered full implementation of the Regional Transportation Plan and effectiveness of Regional Plan incentives to promote multifamily development and concentrate development in town centers. The forecasts were used to develop the recommended target for the threshold standard and the associated implementation milestones.

At a high level the target reflects the impact of continued investment in the RTP core areas of transit, trails, and technology to improve the traveling experience in the Region. This includes providing 15-minute transit service between town centers and recreation destinations and the region, and 30-to 60-minute transit service between neighborhoods and town centers, and inter-regional service for commuters and visitors from neighboring regions. Waterborne transit connecting the north and south shores and connecting residents and visitors to key destinations around the lake. As result, ridership will increase over fivefold. The plan includes completion the multi-use Tahoe Trail around the lake and improving connectivity within and between communities. It includes closing gaps in the sidewalk and trail system that will increase safety, enhance accessibility for people with a disability, and provide critical community, work, and recreation connections from the neighborhoods. In total this includes construction of an additional 110 miles of bicycle and pedestrian trails. Seventeen mobility hubs and transit centers will provide enhanced access to the augmented network of transit and trails and support parking once within the Region and using alternative modes to travel within the region once here. Technologic advances and investments will provide real-time information to travelers through online interactive maps and will promote informed travel choices. These investments will build awareness and promote utilization of app-based transportation services, such as on-demand microtransit and bike and scooter sharing. Trip planning tools and informational kiosks will also help manage parking at heavily visited recreation sites, relieving congestion at pinch points. The plan will also continue to accelerate the shift to zero emission vehicles, by promoting installation of electric vehicle charging stations around the lake. In short, the vision would completely alter the travel experience in Tahoe. Additional details on the projects included in the forecast can be found the 2020 RTP.

The projects mentioned above and forecasts for future demographics and land use were simulated in the Tahoe activity-based travel demand model and associated analysis framework to estimate VMT in 2045. Those forecasts suggest that implementation of the 2020 RTP would result in a 6.8% reduction in per capita VMT by 2045. Staff recommends this as the threshold standard goal for per capita VMT. The goal is both ambitious and achievable goal for Region. Achieving the goal would significantly advance the three goals for the standards; reduce reliance on the automobile, reduce per capita GHG emissions, and increase mobility.

TABLE 3: TAHOE TRAVEL DEMAND MODEL FORECAST REDUCTION IN PER CAPITA VMT (2018-2045)

	2018	2035	2045
Percent Reduction from 2018 VMT per Capita		5.5%	6.8%

The 2018 baseline used here reflects the base year for the Tahoe travel demand model used to forecast VMT in the Region for the 2020 RTP. The forecasted change in population and VMT from the Tahoe travel demand model, were applied to the TEPM estimated effective population and the HPMS estimated VMT to develop the forecast for The recommended target is currently formulated as a percent reduction from the baseline VMT and Population for 2020.

TABLE 4: TAHOE REGION EFFECTIVE POPULATION AND VMT ESTIMATES (2018-2045)

	2018	2035	2045
Effective Population (TEPM)	118,856	125,236	129,002
Total Average Daily VMT (HPMS)	1,483,050	1,477,014	1,500,293
VMT per Capita	12.48	11.79	11.63
Percent Reduction from 2018 VMT per Capita		5.5%	6.8%

Target setting with a recognition of what is attainable or achievable is also consistent with prior discussions with, and direction from, the Tahoe Science Advisory Council on the updating of the Threshold Standards. The Council has repeatedly emphasized the importance of articulating SMART (Specific, Measurable, Attainable, Relevant, and Timebound) threshold standards. The proposed threshold standard target is consistent with that guidance. Ambitious, but reasonably attainable.

TARGET CONFORMANCE ANALYSIS

The overlapping federal, state, and Bi-state Compact transportation planning authorities that apply to the Tahoe Region form the foundation upon which TRPA prepares transportation plans and performance measures. The Bi-State Compact requires TRPA to prepare a transportation plan as part of the Regional Plan. Federal legislation requires governors to designate metropolitan planning organizations (MPOs) responsible for regional transportation planning and project funding. The TRPA Governing Board, with the addition of a federal government representative, is the designated Tahoe MPO by both the California and Nevada governors.

California's SB375 seeks to reduce GHG emissions from the transportation sector. SB 375 applies to the Tahoe MPO, requires the transportation plan to include a Sustainable Communities Strategy (SCS) to achieve per capita GHG reduction goals for the transportation sector as set by the California Air Resources Board. The SB 375 per capita GHG reduction goal for the Tahoe MPO is a 5% per capita reduction over the 2005 level by 2035. Although the GHG reduction requirements of the RTP/SCS apply only to the California side of the Region, as a practical matter the Tahoe Region is a single airshed. The state of Nevada is now in the process of adopting the California vehicle emission standards and preparing a state climate plan that also includes GHG reduction in the Tahoe Basin. Hence, GHG per capita reduction targets are included as a key component of the new VMT per capita threshold standard.

GHG emissions from the transportation sector is a function of VMT and the engine type and operation of the vehicles that travel those miles. Per capita mobile source GHG and per capita VMT are positively correlated, but the relationship is not exactly one to one. Engine size and the type of vehicles in the fleet (e.g. diesel, hybrid) and driving conditions (e.g. presence of traffic) also influence total emissions per mile traveled. Under SB375, the majority of the per capita reduction in GHG is expected to come from lower per capita VMT, not lower emissions per vehicle. Regions are prevented from taking credit for GHG reduction from state or national programs that require low and zero emissions vehicles.

The recommended threshold standard establishes a goal for per capita VMT reduction through 2045. To assess the relationship with the regioin's SB375 GHG reduction 2035 goal, the expected performance of the per capita VMT reduction goal through first 15 years of program is compared with the 2035 target for SB375. The analysis below differs from the threshold standard analysis above in that only the resident population for the Region is considered in the denominator, and the baseline for the assessment is 2005, not 2018. Thus, even though the "per Resident" estimates in Table 5 are higher than the "per Capita" estimates in Table 4, the percentage reduction is what is relevant for the comparison.

TABLE 5: TAHOE REGION PER CAPITA VMT - RESIDENT ONLY (2005-2045)

	2005	2018	2035	2045
Residents	54,473	51,624	55,776	58,040
Total Daily VMT	1,506,665	1,393,994	1,388,320	1,410,202
Annual Average Daily Total VMT per	27.66	27.00	24.89	24.30
Percent reduction from 2005 VMT per Resident		2.4%	10.0%	12.2%
Percent reduction from 2018 VMT per Resident			7.8%	10.0%

The above analysis indicates that the proposed target for the threshold standard would achieve the per capita GHG reduction goal for the Region and is in conformance with the adopted goal under SB 375 (i.e., Table 4 shows the reduction is projected to be 10.0% when compared to 2005, well over the 5% target). The proposed 6.8% VMT per capita reduction threshold standard would provide GHG reduction benefits above and beyond both the reductions from state and national emissions reductions. The proposed threshold standard is also more ambitious than the 5% per capita GHG reduction target under SB375. The recommended standard establishes a longer planning horizon, and does not include contributions from other regional programs that reduce mobile source GHG.

IMPLEMENTATION

The Regional Plan and the Regional Transportation Plan are designed to achieve threshold standards. TRPA, together with implementing partners, adaptively manage the region so that all threshold standards are achieved and maintained. The agency reviews and updates the goals for the Region (threshold standards). It also reviews and updates the relevant implementation mechanisms (i.e., policies, plans, regulations, and programs) so that in their entirety the new threshold standards will be attained and maintained. The adaptive management approach is a key component of the new generation of threshold standards being created. TRPA is proposing to replace the current VMT standard, designed to reduce nitrogen emissions to improve air and water quality, with a new VMT threshold standard that measures the efficiency of the Region's transportation system operation. As part of the update, TRPA is reviewing the Regional Plan, Regional Transportation Plan, Code of Ordinances, and other implementing programs like the Environmental Improvement Program to determine where these plans and programs can support implementation of an updated VMT efficiency standard.

To reduce reliance on the automobile, promote mobility, and support the GHG initiatives of the two states, RPIC directed staff to establish a target for reducing per capita VMT in the Tahoe region. Based on that direction, Staff develop the recommended target presented above. The per capita VMT standard establishes a goal for the Region to work towards and it will be several decades before the standard is likely to be attained. This also means that like the lake clarity standard, the per capita VMT standard will be out of attainment as soon as it is adopted.

To monitor progress towards standard attainment, two types of interim milestones are recommended. The first are milestones at which progress is evaluated, and where appropriate, modifications to implementation mechanisms (policies, plans, programs, etc.) are recommended to the decision bodies. The second are milestones at which progress is evaluated, and if it is found not to be in line with expectations, a specific, predefined action is taken. Staff recommends that an advisory group be tasked with reviewing progress, developing recommendations for program modification to accelerate attainment, and determining status relative to the established milestones.

The recommended milestones reflect reasonable expectations for progress towards attainment based on the forecasts. Progress towards the standard will be driven by implementation of the 2020 RTP and regional land use change. Both regional land use and transportation infrastructure are expected to change slowly over time. Funding and project delivery take time in both the transportation and land use sectors. Detecting response in per capita VMT as a result of those changes lags further because it requires at least a calendar year of data collection post the start of occupancy/operation for development/redevelopment projects and changes in transportation infrastructure or operation (e.g. transit operation or new bicycle or pedestrian infrastructure).

The VMT per capita milestones were established using the forecasted reductions in per capita VMT. The milestone schedule uses a linear decline in annual per capita VMT between the base year and the target attainment date (Table 3). The schedule utilizes the recommended three-year annual average to assess progress. Because a three-year annual average is used, the assessed per capita VMT in the evaluation year will be slightly higher that the observed per capita VMT in that year. For example, the annual VMT per capita is expected to achieve the target in 2045, but the three-year annual average is not expected to achieve the target until 2047.

TABLE 6: EXPECTED VMT PER CAPITA REDUCTION SCHEDULE

Year	VMT /Per Capita	Annual Reduction	Cumulative Reduction	3 year Average	3 year Average Reduction	3 year Average % to Target
2018	12.48	0.03				
2019	12.45	0.03	0.03			
2020	12.41	0.03	0.06	12.45	0.25%	3.70%
2021	12.38	0.03	0.09	12.41	0.50%	7.41%
2022	12.35	0.03	0.13	12.38	0.75%	11.11%
2023	12.32	0.03	0.16	12.35	1.01%	14.81%
2024	12.29	0.03	0.19	12.32	1.26%	18.52%
2025	12.26	0.03	0.22	12.29	1.51%	22.22%
2026	12.23	0.03	0.25	12.26	1.76%	25.93%
2027	12.20	0.03	0.28	12.23	2.01%	29.63%
2028	12.16	0.03	0.31	12.20	2.26%	33.33%
2029	12.13	0.03	0.35	12.16	2.52%	37.04%
2030	12.10	0.03	0.38	12.13	2.77%	40.74%
2031	12.07	0.03	0.41	12.10	3.02%	44.44%
2032	12.04	0.03	0.44	12.07	3.27%	48.15%
2033	12.01	0.03	0.47	12.04	3.52%	51.85%
2034	11.98	0.03	0.50	12.01	3.77%	55.56%
2035	11.94	0.03	0.53	11.98	4.03%	59.26%
2036	11.91	0.03	0.57	11.94	4.28%	62.96%
2037	11.88	0.03	0.60	11.91	4.53%	66.67%
2038	11.85	0.03	0.63	11.88	4.78%	70.37%
2039	11.82	0.03	0.66	11.85	5.03%	74.07%
2040	11.79	0.03	0.69	11.82	5.28%	77.78%
2041	11.76	0.03	0.72	11.79	5.54%	81.48%
2042	11.72	0.03	0.75	11.76	5.79%	85.19%
2043	11.69	0.03	0.78	11.72	6.04%	88.89%
2044	11.66	0.03	0.82	11.69	6.29%	92.59%
2045	11.63	0.00	0.85	11.66	6.54%	96.30%
2046	11.63	0.00	0.69	11.64	6.71%	98.77%
2047	11.63	0.00	0.69	11.63	6.79%	100.00%

PROPOSED REGIONAL PLAN AMENDMENT

To implement and facilitate management towards attaining and maintaining the per capita VMT threshold standard, an amendment to the Regional Plan Goals and Polices is proposed. The proposed amendment adds a new goal in the Development and Implementation Priorities sub-element and six associated policies. The proposed amendments are included in attachment D of the packet.

WATER QUALITY AND LAKE CLARITY

Lake Tahoe's famed clarity has declined significantly since UC-Davis began regular monitoring in the 1960s (TERC 2020). The declines prompted the concerns of managers and stakeholders alike and led the implementation of numerous development controls and restoration projects designed to restore the lake's famed clarity. Declining lake clarity was also the primary motivation for the adoption of the current nitrogen deposition VMT threshold standard. The threshold update process reviewed the current knowledge of the relationship between VMT and lake clarity to assess the potential for a VMT based water quality standard. That review concluded that a VMT based standard would not meaningfully contribute to attainment of the TMDL identified load reduction targets, but that a VMT based standard would contribute to the goals outlined above.

LAKE TAHOE TMDL

Building upon earlier work to restore lake clarity, the Lake Tahoe Total Maximum Daily Load (TMDL) is a science-based strategy to restore the historic clarity of Lake Tahoe over 65 years (Lahontan & NDEP 2010a). TMDL development began nearly ten years earlier after Lake Tahoe was listed by the U.S. Environmental Protection Agency as a Section 303(d) impaired waterbody in 2002. Section 303(d) of the Clean Water Act requires the identification of waterbodies that do not meet standards (impaired water bodies) and the development of Total Maximum Daily Loads to restore the waterbody. A TMDL identifies the pollutants of concern, and the load of each pollutant a waterbody can tolerate and still achieve the desired standards.

For the 30 years prior to the science that informed the development of the Lake Tahoe TMDL, increased nutrient loading and the resulting algal growth were thought to be primarily responsible for the declining clarity of lake Tahoe (Goldman 1988). The science for the Lake Tahoe TMDL, however, pointed not to nutrients as the primary driver of clarity loss, but to fine sediments (Jassby et al. 1999; Swift et al. 2006; Lahontan & NDEP 2010a; Sahoo et al. 2010). The work found that excess inorganic fine sediments were responsible for two-thirds of clarity loss and algal growth was responsible for the remaining third (Lahontan & NDEP 2010a). The design of the implementation framework for the Lake Tahoe TMDL established a series of load reduction benchmarks to restore the lake over 65 years. Pollutant load targets and expected improvements in lake clarity were formally adopted by the states of California and Nevada, and the federal government as the Lake Tahoe Clarity Challenge (Lahontan 2013).

The TMDL identified three pollutants of concern (fine sediment particles, nitrogen, and phosphorus) that would need to be managed to restore the historic clarity of the Lake. The TMDL also identified the sources and associated loads of those pollutants, and evaluated opportunities to reduce pollutant loading from each source (Lahontan & NDEP 2008, 2010a). The TMDL established load reduction targets necessary for each pollutant of concern (a 65% reduction in fine sediments, a 10% reduction in nitrogen, and 35% reduction in phosphorus) to restore the historic clarity of the lake. The more ambitious load reduction target for fine sediments, reflects both the primary importance of fine sediments as a driver of clarity, and the cost effectiveness of load reduction opportunities.

Prior to the development and subsequent adoption of the TMDL, the threshold standard for deep water clarity was a seasonal standard, focusing on winter clarity. After the adoption of the TMDL, TRPA aligned its threshold standard for pelagic clarity with the annual goal established in the TMDL (TRPA 2012c). While TRPA updated its goal for deep water clarity to align with the TMDL goal it did not update the associated pollutant load reduction targets to align with the TMDL pollutant load reduction targets.

Each year, TMDL program managers at the Nevada Division of Environmental Protection (NDEP) and California Lahontan Regional Water Quality Control Board (Lahontan) prepare a "Performance Report" summarizing implementation progress from the prior year. The 2020 pollutant load reduction report found that the in 2019, implementors were achieving the required load reduction targets. The report estimated that loading from the urban uplands had reduced by 19.7% for FSP, 15.5% for phosphorus, and 11.7% for nitrogen (Lahontan & NDEP 2020).

Following the 2017 water year, the two states asked that the Tahoe Science Advisory Council (Council) complete a comprehensive review of the available data and integrate recent observations within the context of the larger understanding of the drivers of clarity. The Council's report reaffirmed the importance of pollutant loading and the influence of loading on clarity (TSAC 2020a). However, the report also suggested that climate change and ecological change may also be impacting clarity (TSAC 2020a). Subsequent work by the Council to integrate the findings of the report into regional management suggested that revisions be made to the Lake Tahoe Clarity Model. The Lake Tahoe Clarity Model provides the scientific grounding for the load reduction targets of the TMDL. The Council suggested improvements be made to enable the model to better represent physical dynamics influenced by climate change and in lake ecological processes (TSAC 2020b).

VMT AND NITROGEN

Prior to the science conducted to support development of the TMDL, increased algal growth was thought to be the primary driver of declining clarity. Nitrogen and phosphorus are nutrients that promote algal growth and excess nutrient loading was widely believed to the primary reason the clarity of the lake was declining. The Lake Tahoe Total Maximum Daily Load (TMDL) identified atmospheric deposition as the primary source of nitrogen reaching the lake (Lahontan & NDEP 2010a). Atmospheric deposition was estimated to account for 55 percent of the nitrogen reaching the lake (Lahontan & NDEP 2010a). Emissions from on-road mobile sources are estimated to account for between 37-46 percent of nitrogen emissions in the Tahoe Basin (Pollard et al. 2012).

NOX EMISSIONS

NOX is a byproduct of the high-temperature combustion of fossil fuel in engines. NO_X is emitted from automobile and truck engines, as well as off-road vehicles and other sources including power plants, and residential and industrial oil combustion. The relationship between VMT and NO_x emissions has changed significantly over the last 40 years as a result of increasingly stringent tailpipe emissions standards, improvement in the overall fuel economy of the nation's vehicle, and changes fuel mix technology. Nationally, NOx emissions have decreased by 57 percent since 1980 despite a 49 percent increase in VMT since 1990 (TSAC 2018a). In the 1950s the average new car released 3.6 grams of NOx emissions for each mile travelled (EPA 2018).The U.S. Environmental Protection Agency (EPA) established the first NO_x emission standard (3.1 grams per mile of NOx) for cars and light duty trucks in 1975 (EPA 1999). Since that time, NO_x emissions standards per mile have become increasingly strict (Figure 3). EPA tier 3 emission standards began in the 2017 vehicle model year, and grouped NO_x emissions regulation with regulation of non-methane organic gases (NMOG), and established a light duty fleet average of 0.03 g/mile(EPA 2020). Thus relative to the standards in place at the time the original threshold standard was adopted, a modern car would have to drive 103 miles to emit the same amount of NO_x as was emitted by a single mile traveled by a vehicle under the tier one standards. The new fleet average emission standards established an immediate 46 percent reduction from the tier 2 requirements and become increasingly stringent leading to a 81 percent reduction by 2025 (EPA 2014).

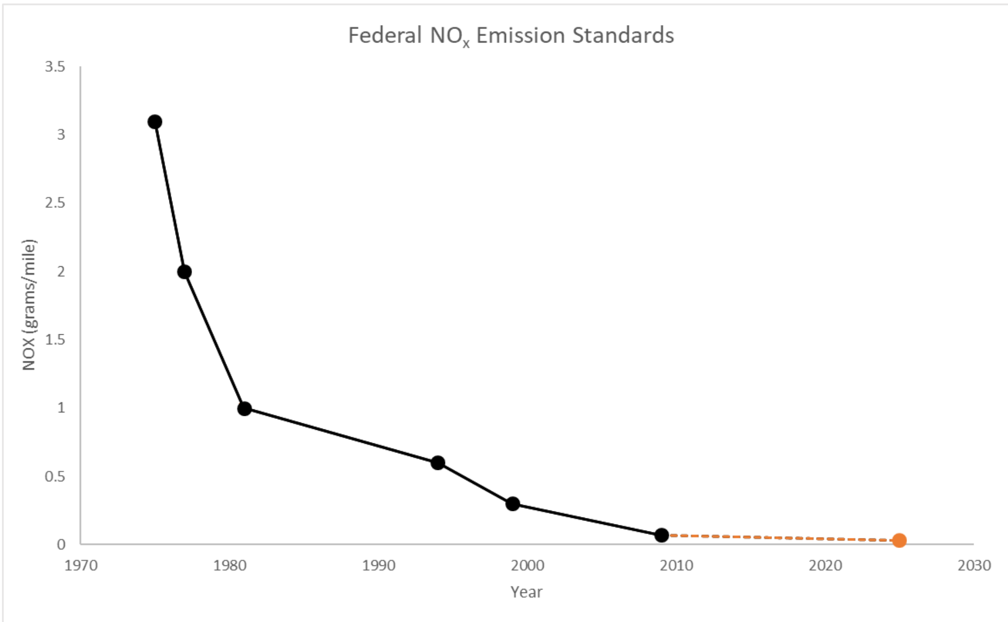

FIGURE 2: NOX EMISSIONS PER MILE EMISSIONS STANDARDS (1975-2025)

As a result of increasingly strict emission standards, the California Air Resources Board estimates that NOx emissions from mobile sources in the California side of the region have decreased from 5.7 tons/day in 2000 to 2 tons/day in 2015. Current forecasts suggest that NOx emissions will decrease further to 0.6 tons/day by 2030 (CARB 2016). The trend suggests that current emissions are approximately 25 percent of emissions in 2000. Current forecasts suggest that NOx emissions will continue to decrease to 0.6 tons per day by 2030 (CARB 2016).

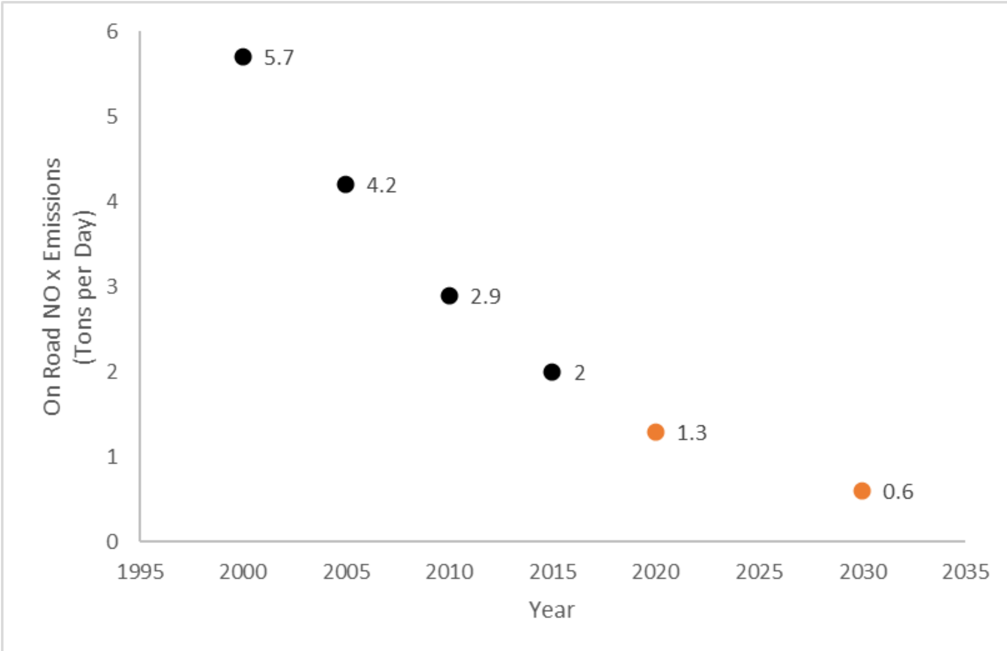

FIGURE 1: ON ROAD DAILY NO_x EMISSIONS IN THE TAHOE BASIN. SOURCE: CARB 2016

The reduction in transportation sector related NO_x emissions is the result of reduced tailpipe emissions from automobiles.

VMT BASED ATMOSPHERIC NITROGEN LOAD REDUCTION TARGET

As part of the threshold update process, TRPA considered establishing a new VMT based nitrogen load reduction target. The simplest version of this would be to recalculate the amount of VMT today that would generate 10% less NOx emission than was emitted in 1981. Because of the aforementioned reductions in emissions per mile, cars in the region could travel 90 times more vehicle miles, and still emit less NOx than a 10% reduction from 1981 emissions level. There is no realistic scenario in which that level of VMT could ever occur in the region.

Staff also considered aligning the standard with the science of the TMDL and current work to restore the clarity of the Lake. The baseline for atmospheric deposition was calculated based on emissions and deposition estimates from 2002-2003 (Lahontan & NDEP 2008; Dolislager et al. 2012). As explained above the TMDL establishes pollutant load reduction goals relative to a 2010 baseline. The TMDL estimated that atmospheric deposition accounted for 63% of annual average nitrogen load to the lake

(Lahontan & NDEP 2010a, 2010b). To restore the lake's historic clarity the TMDL established a target of reducing atmospheric deposition of nitrogen by 2% over 65 years.

At least two considerations inform potential VMT based target setting relative to the nitrogen loading to the lake. The first consideration is what portion of the atmospheric loading target should the regional VMT target be responsible for achieving. Preliminary work by the Tahoe Science Advisory Council estimated that 20% of nitrogen deposition was the result of vehicle travel within the Tahoe region (TSAC 2018b). Treating the target in absolute terms would mean that 20% of the absolute TMDL target should be achieved through in basin vehicle emissions/deposition reductions.

The second consideration is the forecast for the relationship between VMT and NOx emissions over the planning horizon. While VMT in the region has remained relatively constant since 2010, CARB estimates that NO_X emissions from on road mobile sources decreased by nearly a third between 2010 and 2015, from 2.9 tons per day in 2010 to 2.0 tons per day in 2015, and is expected to be 1.9 tons per day in 2020 (Figure 2). CARB forecasts suggest that NOx emissions will continue to decrease to 0.6 tons per day by 2030 (CARB 2016). Tier 3 national fleet average emissions standards gradually increase to full implementation by 2025 at which point NOx emissions per mile will be less than 20% of what it was under the previous requirements (EPA 2014). The TMDL load reduction target extends to 2075, and there is reason to believe that emissions per mile will be even lower at that time. Executive Order N-79-20 establishes a goal that all passenger car and trucks sold in California be zero emissions by 2035 and all trucks be zero emissions by 2045 (Newsom, Gavin 2020). Zero emissions vehicles mean there would no longer be a link between VMT and NOx emissions. Even if the goal attainment took three times longer (achieved in 45 years, not in 15), all passenger vehicles sold would be zero emission 10 years prior to the TMDL established target of 2075.

Applying the precautionary principle for both considerations would result in requiring 100% of load reduction target come from local emissions reductions and that there are no additional reductions in emissions per mile. This approach runs contrary to earlier suggestions from the Tahoe Science Advisory Council which suggested it would be reasonable to assume N emissions would continue to decline in the future (TSAC 2018b). It also runs counter to more recent source analysis work for atmospheric N which suggested that a lower fraction of N was locally generated that was assumed by the TMDL (Lahontan & NDEP 2008; TSAC 2018b).

To establish the allowable level of VMT to still achieve the NOx emissions reduction target, regionally specific estimates for emissions per mile were compared from the 2003 (TMDL base year) and 2020. Emissions estimates were sourced from the 2017 EMFAC database utilizing aggregated emissions across model years and operation speeds (CARB 2020). Fleetwide estimates for emission reduction were developed by weighting emissions per mile emissions rates by the proportion of all vehicle miles traveled in the Region by vehicles of that category and fuel type. VMT estimates by vehicle category were generated by averaging 2003 and 2020 estimates by class, excluding electric vehicle classes not included in the 2003 EMFAC database. The exclusion of electric vehicle classes not included in 2003 EMFAC database likely results in a small underestimate in overall emissions reductions between 2003 and 2020. In 2020, VMT weighted NOx emissions per mile across all vehicle types in the region was 79.5% lower than it was in 2003 (Appendix 1). Based on the 79.5% reduction in emissions per mile, even if no additional emissions reductions were achieved, VMT in the region could increase nearly five-fold (478%) above the levels currently observed and the TMDL target could still be attained. The 478% increase above todays levels in a conservative estimate. Incorporation of the expected reductions from the current emissions standards or executive order would result in an even higher allowable level of VMT.

VMT within the Tahoe region has remained within a relatively narrow band since the 1980s, never varying by more than 15% of VMT in 1980. Given the unlikelihood of ever reaching this level of VMT, establishing a VMT based goal for rooted in concerns about nitrogen impacts on water quality is unlikely to result in meaningful action.

The conclusion that VMT is not suitable for target setting for nitrogen loading is consistent with that of the TMDL. The Lake Tahoe TMDL Pollutant Reduction Opportunity Report analyzed the potential efficacy and costs associated with those alternative pollutant load reduction methods (Lahontan & NDEP 2008). Report suggested that reducing atmospheric loads through “non-mobile” methods was far cheaper than through “mobile” methods, *“Atmospheric non-mobile costs ($35-$88 million) are orders of magnitude less than mobile costs ($2.9 to $7.2 billion) (Lahontan & NDEP 2008).”* The total cost to achieve all load reductions necessary in the first 15 years of TMDL implementation was estimated to be $1.5 billion (Lahontan & NDEP 2010a).

VMT AND FINE SEDIMENT PARTICLES

The TMDL identified excess loading of fine sediment particles (FSP) as the primary cause of clarity loss in Lake Tahoe (Lahontan & NDEP 2010a). Unlike nitrogen, which is a byproduct of combustion, there is no direct relationship between VMT and FSP. VMT is indirectly related to FSP, in that FSP (dust) present on paved roadways can be resuspended by vehicle travel (Lahontan & NDEP 2008; Dolislager et al. 2012). The indirect relationship between vehicle travel and road dust varies based on road surface. CARB and the TMDL estimate loading from paved road surfaces based on the area of roadway surface, while loading from unpaved road surfaces is a function of VMT on the roads (Lahontan & NDEP 2008). The difference is a function of the source of FSP. On unpaved roads the road itself is the source of the FSP, while on paved roads the source is "material previously deposited" on the roadway (Lahontan & NDEP 2008). Paving roads that are currently unpaved was estimated to reduce dust emissions by 99% (Lahontan & NDEP 2008).

FSP from roads are primarily influenced by road operation and management practices and the application of winter traction material (Zhu et al. 2009). FSP and loading from Tahoe's roadways are on average five times higher in the winter than they are in the summer, and can be 10 times higher following the application of winter traction material (Zhu et al. 2009, 2011). VMT patterns in the basin are marked by an inverse seasonality pattern of FSP loading from roads. VMT in the Tahoe region is higher in the summer months, when there are more visitors in Region, and lower in the winter months (Figure 3). The observation is consistent traffic counts from the States of Nevada and California, as well the observations that informed the TMDL (Dolislager et al. 2012).

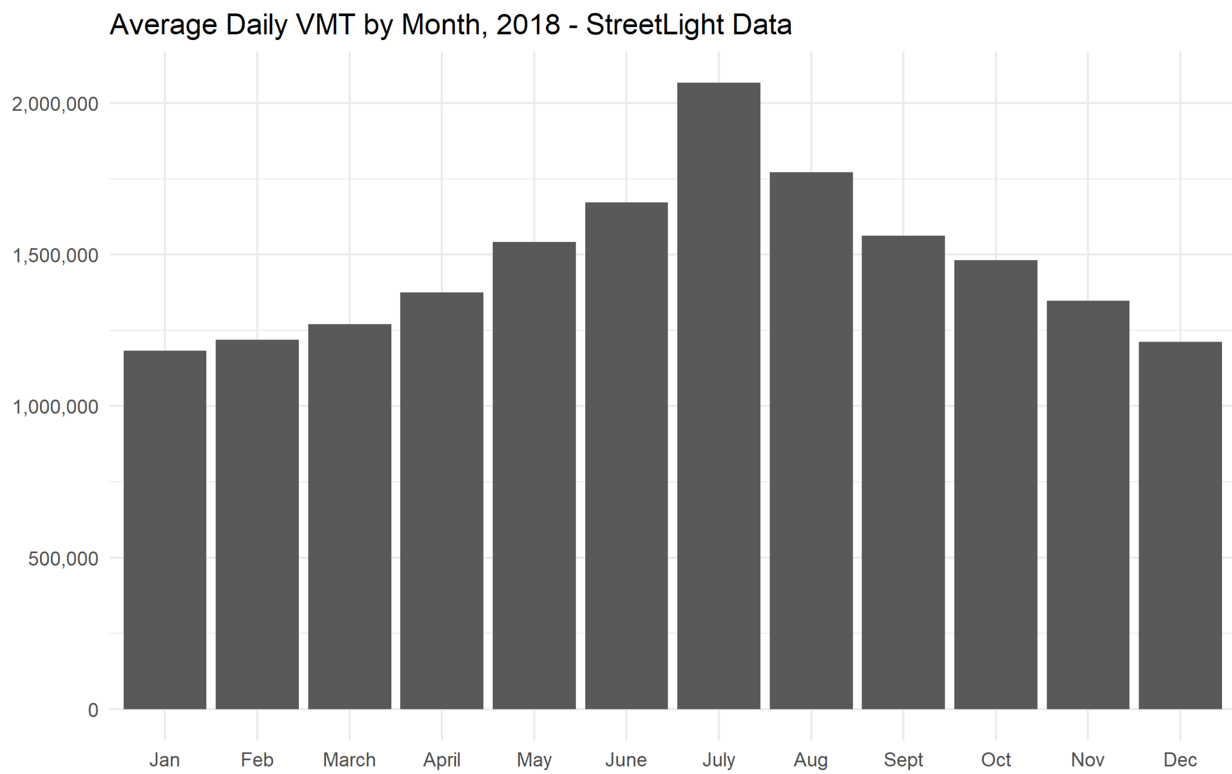

FIGURE 3:TAHOE REGION MONTHLY VMT (2018) SOURCE: STREETLIGHT DATA

After adoption of the TMDL in 2010, managers and scientists continued to leverage Southern Nevada Public Land Management Act (SNPLMA) funds to augment earlier research on control and influence of the FSP from roadways. The additional research suggests that the estimates for FSP deposition to the lake from travel on paved roads may have been overestimated in the Lake Tahoe Atmospheric Deposition Study (LTADS) used in the Lake Tahoe TMDL (Zhu et al. 2011). Zhu et. al. suggest that atmospheric dry deposition may have been overestimated by 95%. "The results support much lower estimates of dry deposition to the lake than calculated by LTADS. We estimate that from paved road travel, the atmospheric dry deposition to the lake is approximately 6% of the total LTADS dry deposition (Zhu et al. 2011)." The refined estimates suggested that atmospheric dry deposition accounts for less than 1% of the TMDL estimated FSP loading to the lake (Zhu et al. 2014). The work suggested that 99% of FSP retrained as a result of vehicle traffic on paved roadways was deposited back on the landscape (Zhu et al. 2014). "Only ~2% of road emissions of PM_{10} (20 Mg/year) and ~1.5% of TSP (35 Mg/year) is estimated to reach the lake. The vast majority of PM_{large} emitted into the air is deposited within minutes, especially in the presence of dense vegetation (Zhu et al. 2011)."

VMT BASED ATMOSPHERIC FINE SEDIMENT PARTICLE LOAD REDUCTION TARGET

The TMDL estimated that atmospheric deposition accounted for 16% of annual average FSP load to the lake (Lahontan & NDEP 2010a, 2010b). To restore the lake's historic clarity the TMDL established a target of reducing atmospheric deposition of FSP by 55% over 65 years. TMDL development considered a number of management strategies for FSP load reduction. Preliminary studies conducted for the TMDL also explored the efficacy of VMT reduction as a strategy to reduce atmospheric fine sediment loading. The preliminary understanding of the system suggested that VMT reduction would likely not be a cost-effective strategy for FSP load reduction (Lahontan & NDEP 2008). This understanding was further support by subsequent work that estimated that, "a 25 percent reduction in VMT would reduce FSP loads by less than half of one percent (Lahontan & NDEP 2008)." Instead of focusing on traffic volumes, the TMDL focused on a) preventive controls – to prevent FSP from being deposited, and mitigative controls – to remove FSP already deposited on roadways (Lahontan & NDEP 2008) for both roadways and parking lots. Because of the indirect nature of the relationship between VMT and FSP loading it is not possible to develop a meaningful VMT target for phosphorus.

VMT AND PHOSPHORUS

TMDL source analysis for atmospheric phosphorus reveals a profile similar to FSP. Phosphorus is not a by-product of combustion, so there is no direct relationship between VMT and phosphorus emissions or deposition. Phosphorus is indirectly related to VMT through road dust (Lahontan & NDEP 2008; Dolislager et al. 2012). The TMDL estimated that atmospheric deposition accounted for 18% of annual average phosphorus load to the lake (Lahontan & NDEP 2010a, 2010b). The TMDL identified three sources of atmospheric phosphorus deposited on the lake; road dust, residential wood combustion and dust from construction activities (Lahontan & NDEP 2008).

VMT BASED ATMOSPHERIC PHOSPHORUS LOAD REDUCTION TARGET

The TMDL estimated that atmospheric deposition accounted for 18% of annual average phosphorus load to the lake (Lahontan & NDEP 2010a, 2010b). To restore the lake's historic clarity the TMDL established a target of reducing atmospheric deposition of phosphorus by 61% over 65 years. Because of the indirect nature of the relationship between VMT and phosphorus loading it is not possible to develop a meaningful VMT target for phosphorus.

DISCUSSION

TRPA has adopted nearly 200 thresholds over the years, all of which fit into one of two categories. Either they seek to protect something from degradation (WQ8-Prevent new AIS, VP1- SEZ non-degradation, VP17-Protect the Freel peak cushion plant community), or they seek to restore something that has been lost (WQ1-Clarity, F1-F3-Restore fish habitat). Perhaps the closest analog to the proposed standards are the two recreation policy statements, which direct the Regional Plan to “preserve and enhance” recreation opportunities and experiences in the region. However, even the recreation standards differ in their motivation, which was rooted a fear of losing something that once was.

The identified goals are not rooted in a fear of what could be lost, but rather hope for what is possible when the Tahoe Partnership works together. The recommended standard seeks to create something that never was. Tahoe has always been reliant on the automobile. The threshold study report for the initial environmental thresholds in 1982, wrote “Another method of providing alternatives to the automobile would be to expand pedestrian and bike facilities. Currently, these facilities are non-existent or inadequate. The most effective way to improve the existing situation would be through redevelopment that would encourage pedestrian orientation and access to transit.” Attainment of the standard will implement that vision, and result in higher quality experience for all travelers in the Tahoe Region.

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APPENDIX 1: NO_X EMISSIONS PER MILE, TAHOE REGION 2003/2020

Region	Vehicle Category	Fuel	NOx Per mile (2003)	NOx Per mile (2020)	% VMT	NOx Reduction Per mile
TMPO	HHDT	GAS	11.90	2.53	0.07%	79%
TMPO	HHDT	DSL	21.77	4.84	1.81%	78%
TMPO	LDA	GAS	0.85	0.12	34.08%	86%
TMPO	LDA	DSL	1.53	0.29	0.33%	81%
TMPO	LDA	ELEC	0.00	0.00	0.24%	0%
TMPO	LDT1	GAS	1.31	0.25	10.46%	81%
TMPO	LDT1	DSL	1.55	1.45	0.02%	7%
TMPO	LDT1	ELEC	0.00	0.00	0.00%	0%
TMPO	LDT2	GAS	1.43	0.23	24.24%	84%
TMPO	LDT2	DSL	1.58	0.11	0.09%	93%
TMPO	LHDT1	GAS	1.33	0.61	3.55%	54%
TMPO	LHDT1	DSL	7.39	4.02	2.63%	46%
TMPO	LHDT2	GAS	1.33	0.45	0.36%	66%
TMPO	LHDT2	DSL	7.41	2.43	0.64%	67%
TMPO	MCY	GAS	1.33	1.29	0.73%	2%
TMPO	MDV	GAS	1.15	0.26	18.42%	78%

TMPO	MDV	DSL	1.49	0.13	0.28%	91%
TMPO	MH	GAS	2.37	1.01	0.23%	58%
TMPO	MH	DSL	10.16	5.88	0.04%	42%
TMPO	MHDT	GAS	3.30	1.82	0.30%	45%
TMPO	MHDT	DSL	13.21	4.19	1.14%	68%
TMPO	OBUS	GAS	3.48	1.13	0.09%	68%
TMPO	OBUS	DSL	19.34	5.32	0.15%	72%
TMPO	SBUS	GAS	2.88	0.42	0.01%	85%
TMPO	SBUS	DSL	13.09	10.66	0.08%	19%

APPENDIX 2: ORIGIN OF TERM "ENVIRONMENTAL THRESHOLD CARRYING CAPACITIES"

Congress amended the Bi-State Compact (Compact) in 1980 (PL 96-551; December 19, 1980) with a directive and a Compact definition (Article II (i)) to adopt standards it termed "environmental threshold carrying capacities." The Compact defined the standards as:

> *"… an environmental standard necessary to maintain a significant scenic, recreational, educational, scientific or natural value of the region or to maintain public health and safety within the region. Such standards shall include but not be limited to standards for air quality, water quality, soil conservation, vegetation preservation and noise".*

The definition included in the Compact bears little resemblance to the notion of "carrying capacity" as it is generally understood. The disconnect between and potential for confusion has been repeatedly identified and was again called out by the peer reviewers of the 2015 threshold evaluation report. One suggested changing the name entirely:

> *"..simply refer to "Threshold Standard" instead. The term "carrying capacity" has very specific meanings depending on context, and could lead to unintended interpretation."*

To avoid this confusion TRPA and partners routinely refer to "threshold standards" in keeping with the Compact definition.

The Compact directed TRPA and partners to identify appropriate environmental standards within 18 months of signing (PL 96-551, Article V(b)), and to develop and implement a Regional Plan to assure attainment or maintenance of those standards (PL 96-551, Article V(b)). TRPA initiated a 10 step process that included public comment and an environmental impact statement with an objective of developing recommendations for adopting the required standards (TRPA 1982c).

In October 1982, TRPA released a report based on the best available science at the time detailing suggested environmental threshold standards (TRPA 1982d). The report, completed within the timeframe mandated in the 1980 Compact, provided a rationale for each proposed threshold standard, summarized relevant scientific information related to the proposed standard, and provided guidance on how attainment would be achieved (TRPA 1982). The TRPA Governing Board unanimously adopted the proposed standards via Resolution 82-11 in December 1982. The resolution established nine threshold categories that have been retained to this day and adopted multiple standards in each: air quality, fisheries, noise, recreation, scenic resources, soil conservation, vegetation preservation, water quality, and wildlife.

Historical Context

The conceptual basis for the threshold standards traces its origin to the agencies involved in the 1970s, and federal and state environmental quality legislation of the time, such as the Porter-Cologne Act in California (1969), Clean Air Act (1970), Clean Water Act (1972), Noise Control Act (1972), Endangered Species Act (1973), and Safe Drinking Water Act (1974). These national regulations along with the 1969 TRPA Compact agreement between Nevada and California (PL 91-147; December 16, 1969) likely framed the approach for standard development in Tahoe. In 1974, the EPA published a report entitled "*The Lake Tahoe Study*" which introduced the "environmental threshold" concept as a means to protect environmental quality in the Tahoe Region. According to that report, environmental thresholds would be represented by a set of parameters that specify the numerical value beyond which undesirable ecological damage occurs. In 1978, the Western Federal Regional Council (WFRC), a coalition of 11 federal agencies, signed a consensus federal policy statement for the Tahoe Region. The statement encouraged federal agencies to promote the establishment of "environmental threshold controls" to guide decision making in the Region. The federal agencies committed to policies to enhance coordination of National Forest land use planning to emphasize outdoor recreation and protection of water quality, threatened and endangered species, cultural resources, scenery, air quality, and the health of natural communities.

In 1979, the WFRC published the "*Lake Tahoe Environmental Assessment*" summarizing existing environmental and socioeconomic conditions at Lake Tahoe and exploring the feasibility of applying the environmental thresholds concept to the Tahoe Region. Chapter 7 of that assessment presented a framework for integrating environmental thresholds ("socially desirable levels of environmental quality") with the carrying capacity concept. The WFRC report proposed application of the carrying capacity concept to human populations and suggested that carrying capacities could be defined based on the environmental impacts of human activities (WFRC 1979a). The WFRC suggested integrating the carrying capacity and environmental thresholds concepts by starting with the desired environmental conditions in the Region (environmental thresholds) and then to achieve those conditions by defining levels of development and human activity (carrying capacities) to ensure the desired environmental conditions are maintained (WFRC 1979a). The inclusion of the term “carrying capacity” in the Bi-State Compact, likely originated out of the work of the WFRC. However, the WFRC treated “Environmental Thresholds” and “Carrying Capacities” as distinct, but related, ideas and never merged the terms together in the way they appear in the Bi-State Compact.

The WFRC report suggested definitions for both “environmental thresholds” and for “carrying capacity.” Environmental thresholds were defined as “end-states” for a resource (e.g., air quality, wildlife), or socially desirable levels of environmental quality. The concept of a carrying capacity emerged from the field of ecology, where it is used to describe limits on a species’ population size imposed by the environment. Carrying capacities for the Tahoe region, the report suggested, should be defined as, “the maximum population and associated urban activity that a region can accommodate without exceeding environmental thresholds and without exceeding the infrastructure and mitigation cost limitations.”

The WFRC suggested the “carrying capacity” and “environmental thresholds” concepts could be integrated to manage the Region by defining both the desired environmental conditions (“environmental thresholds”) and levels of development and human activity (“carrying capacities”) to ensure the desired environmental conditions are maintained (WFRC 1979). This was the approach ultimately made explicit in the Compact, to adopt environmental standards (Compact Article II(I)) and an implementing Regional Plan with levels of development defined as growth caps and management actions designed to achieve the adopted standards (Compact Article V(c)). The Regional Plan regulates human activities and provides a vision for desired changes in those activities (e.g., a different regional development pattern, non-auto mobility, scenic improvements, etc.), while prescribing standards that must be met to ensure that the desired environmental conditions (e.g., water quality, air quality, etc.) are attained and maintained.

Using the example of carbon monoxide, the WFRC report suggests that the desired end-state for carbon monoxide concentration could be achieved by a suite of management and mitigating actions; a) reducing the number of vehicle trips, b) increasing road capacity, c) cleaner burning automobiles, or some combination of all three (WFRC 1979b). Within this framework, the determination of carrying capacities for impacts from human activities in the Region is a function of action to manage and mitigate the environmental impacts of those activities versus an absolute numerical limit on a given human activity. "Carrying capacity" in this context refers to the policies and programs that govern development and human activities to ensure the desired conditions are achieved.

The peer reviewers of the draft 2015 Threshold Evaluation pointed out that since its introduction, when it focused primarily on the number of people, the application of the carrying capacity concept for management of people in ecological systems has evolved substantially. A broad body of scientific study has now developed over the last four decades, generally in the field of recreation management, giving the concept robust and more nuanced meaning. Years of management experience that found that total capacity limits were "seldom the most effective way to deal with most management problems (Cole & Carlson 2010)." Today, capacity limits are no longer viewed as the preeminent management strategy, but rather one of many strategies (Marion 2016). That shift in thinking was summarized in a recent policy guidance document on the use of visitor capacity as a management tool, *"..research and managerial experience have revealed that managing the number of visitors in an area is only one tool within a suite of strategies that can be used to achieve and maintain desired conditions. Effective visitor use management is often more about managing factors such as the types, timing, and location of visitor activities and associated visitor behaviors* (IVUMC 2016a)." Current best practice is consistent with the conceptual approach defined in the Compact that look to varied environmental standards and required management actions to achieve those standards (IVUMC 2016b).

Estimation of the Effective Traveling Population of the Lake Tahoe Region

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CONTENTS

EXECUTIVE SUMMARY

Resident population size is a core building block for transportation and land use planning. In regions with large variations in seasonal population that include high visitation rates, resident population estimates provide only a partial picture of the number of people that are in or traveling around the region

The Lake Tahoe region's resident population has never exceeded 65,000 people, according to U.S. Census estimates, but prior analysis has indicated that the number of people in the Tahoe Region on days of peak visitation may exceed 200,000. For more than 50 years, stakeholders and planners in region have been evaluating ways to mitigate high automobile usage of both residents and visitors, who are reliant on their vehicles due to limited alternative transportation options.

Effective planning efforts that can address this issue require first accounting for the number of travelers in the region at any given point. This accounting effort must necessarily include visitors, short and long-term residents and workers, commuters, and anyone else traveling in the Region, which represents the effective population of interest. Confounding the issue is that visitors can include day and overnight visitors, second homeowners and their guests, all of which travel in different ways. While some regular data collection and estimation efforts provide reasonable estimates of some of these various types of visitors, others such as the number of day visitors or the number of second home owners in the Basin at a given time are more difficult to determine. Using multiple publicly available data sources and estimation procedures, the framework we develop here helps to provide a more detailed estimate of the total effective population of the Tahoe Region that considers these differences in population types and classifications.

This document describes the development and parameterization of the Tahoe Effective Population Model (TEPM). TEPM is a bottom-up approach to estimating the annual average daily effective population of the Tahoe Region based on observed traffic counts, visitation records, data provided by the U.S. Census and American Community Survey (ACS), and information on employment and commuters. Applying the TEPM to the most recent year for which all necessary data was available (2018) the daily average effective population for Tahoe Region is estimated to be 118,856 which is comprised of roughly 52,000 full time residents, 5,000 commuters, 15,000 day visitors, 36,000 overnight visitors, and 10,000 second home owners.

The TEPM, like most mathematical models, provides an estimate of the effective number of traveling individuals to the last individual. The precision should not be confused with confidence that the average number of individuals in the region can actually be estimated to the last person. There is uncertainty in many of the input parameters, and we urge caution in treating the estimate as precise of the number of individuals.

TAHOE EFFECTIVE POPULATION MODEL (TEPM)

The Tahoe Effective Population Model (TEPM) is an approach to estimating the annual average daily effective population of the Tahoe Region using a variety of available datasets, in conjunction with information about travel and visitation behavior of residents and visitors derived from surveys and previous studies. The approach is implemented in two primary steps, first estimation of the overnight population of the region, and second estimation of the population entering the region during the day, which includes three distinct sub-populations (Figure 1).

Total Effective Population of the Tahoe Region:

(1) Effective Population = Residents + Overnight Visitors + Day Visitors + Commuters

The TEPM takes an additive approach to estimating the total effective population by first estimating the size of contributing sub-populations. The sub-populations considered are residents, visitors, and commuters. The size of individual sub-populations is then summed to arrive at the effective population. To estimate each individual sub-population, the TEPM approach is adapted from the conceptual framework used by the Tahoe Travel Demand Model. The overnight population is estimated using data on the number of residents of the region, and information on the number of visitors at overnight accommodations in the region (including hotels/motels, campgrounds, and short-term rentals). The population entering the region is estimating by balancing the total entry traffic volumes in the region with the known populations and travel behaviors of the sub-populations.

The conceptual approach can be applied at a variety of time scales ranging from a daily to an annual estimate. Application of the approach should acknowledge that the uncertainty in the estimate of the

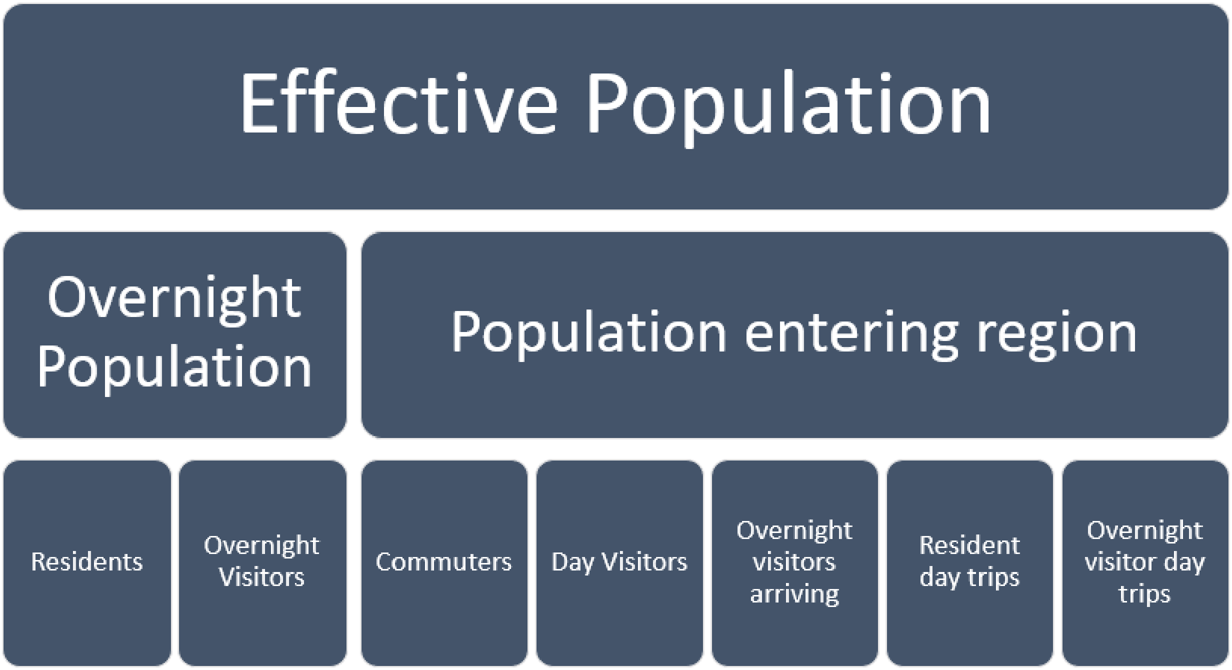

FIGURE 4: SUB-POPULATIONS OF TAHOE'S EFFECTIVE POPULATION

individual parameters of the model increases with narrowing of the estimation window. That is, annual average estimates are likely to be more accurate than estimates for an individual day.

OVERNIGHT POPULATION

Resident Population - The resident population is derived directly from data provided by the US Census. The US Census Bureau provides a complete estimate every 10 years through the decennial census, and annual estimates every year as part of the ACS. The more recent estimates from the ACS are presented here.

Overnight Visitors – The overnight visitor population is comprised of three different sub-populations, 1) visitors staying at accommodations that collect Transient Occupancy Tax (TOT), 2) visitors staying in campgrounds, and 3) visitors staying in residences where TOT is not collected. The size of each is estimated independently as described below.

1) *Overnight Visitors Paying TOT* – The population of overnight visitors staying in accommodations that collect TOT, including casinos, hotels, motels, and resorts, as well as short-term vacation rentals (STRs), can be estimated using information sourced from local jurisdiction's TOT collection reports or data from third party vendors that aggregate the information. TOT reports generally include both the dollar value collected and the number of nights in which accommodations were

occupied. This data reflects the number of hotel/motel/casino/STR units that are rented in the region on an annual basis.

2) *Overnight Visitors at Campgrounds* – Overnight visitors at campgrounds within the region. Campground occupancy is reported separately by individual campground operators and added to produce the total number of occupied "units" in the Region.
3) *Overnight Visitors in Accommodations where TOT is not collected.* The number of residences *where TOT is not collected* is estimated using data on the total number of residences in the region, and data from the US Census American Community Survey (ACS), which identifies the number of "vacant" units and the number of units occupied on a "Seasonal/Recreational/ Occasional" basis. Such visitors may include second homeowners, guests staying with friends, or seasonal renters (i.e., anyone who has a primary residence outside of the region). Because this category ostensibly includes some short-term rentals (STR), which are included in the above overnight visitor estimate, the known STR units are subtracted from the total number of units used to calculate occupancy for the category. With the remaining units, an estimated annual occupancy is assigned to determine the number of second home units that are occupied on an average day. Lastly, similar to the overnight visitor estimate, the approach relies on a suite of parameters related to visitor behavior, including the average number of vehicles per unit, length of stay, and vehicle occupancy to reach the final population estimate.

Overnight Visitors in Accommodations where TOT is not collected:

(1) Number of Seasonal Residential Units = Total residential units – Units occupied by residents – Number of STRs – Vacant Units

(2) Overnight Seasonal Visitors = Number of Seasonal Residential Units * % occupied * Individuals per unit

After estimating the number of occupied units of each type, the number of visitors at each type is calculated by using an estimate of the average party size staying at each accommodation type.

Overnight Visitors in the Region:

(1) Number overnight visitors = Number of Occupied Units * Average Party Size

POPULATION ENTERING THE REGION

The population entering the region during a day consists of six sub-populations: 1) non-resident incoming commuters, 2) resident outgoing commuters who then return at the end of the day, 3) day visitors, 4) overnight visitors arriving, 5) resident day trips and 6) overnight visitors making day trips to destinations outside the region and returning for their overnight stay. Estimation of the total number of cars entering the region on a daily basis is considered the most reliable variable of the equation to estimate the population entering the region on a day, and is used as a limiting factor to balance the individual sub-population sizes. That is, if there are 30,000 trips entering the region on an average day, the total number of trips of the contributing subpopulation trips cannot exceed 30,000. Because sub-population sizes are balanced against observed traffic counts, augmentation of the size of a sub-population reduces the size another sub-population in the traveling into the region. This means that if traffic counts stay constant, and the number of commuters increases, there needs to be an equal size reduction in trips made by the other sub-populations.

(1) **Total Entry Trips =** Day Visitors + Incoming commuters (Non-residents who work inside) + Outgoing commuters (Residents who work outside) + Overnight Visitors Arriving + Overnight Visitor Discretionary trips + Resident Discretionary Trips

The overall approach involves using the best available data on known population sizes and movements. The approach first allocates trips to known parties and the remaining trips are then allocated to day trips into the region, which are considered the least well-known variable.

Overnight Visitors Arriving:

(1) **Overnight Visitor Entering** = (Number Overnight Units Occupied / Length of Stay) * Party Size

(2) **Overnight Visitors Cars** = Overnight Visitors Entering / Visitors Per Car

Overnight Visitors Arriving- The number of occupied units (paying TOT, not paying TOT, and campgrounds) is used in conjunction with assumptions about the average number of individuals per unit.

The total number of occupied units is divided by the average length of stay to arrive at the number of overnight visitor parties arriving or leaving on an average day. The number of visitor parties is then multiplied by the average party size for accommodation units to estimate the total number of individuals entering the Region. Finally, the number of individuals entering is dividing by the average vehicle occupancy for entry trips to estimate the number of overnight visitor entry car trips. StreetLight data are used in a supplemental fashion to help estimate the number of vehicles attributable to overnight visitors.

Commuters – The commuter population can be directly estimated from data provided by several US Census data programs such as Census Transportation Planning Products (CTPP) and Longitudinal Employer-Household Dynamics (LEHD), or through the use of StreetLight data. Two regional reports, one for the north shore and one for the south shore also estimate the number of commuters (TTCF 2016; Sullivan et al. 2019).

Day Visitors – The population of day visitors is estimated using observed entry traffic volumes, in conjunction with assumptions about vehicle occupancy derived from past surveys. The TEPM approach apportions the total entry vehicles to each of these party types using information from several data sources including StreetLight Data, as well as assumptions about the average length of overnight visitor stay. In the end, the number of day visitor vehicle entry trips are estimated, and a vehicle occupancy assumption is applied to conclude the total day visitor population. Trips that enter the region through one external station and exit through a different location (thru trips) are incorporated in the estimation of day visitors. Because TEPM is based upon trips that enter the region, the entry portion of the thru trip is accounted for in the same manner as day visitors.

ENTRY/EXIT STATION TRAFFIC VOLUMES

Traffic volumes for the entry/exit stations are sourced from big data provided StreetLight Data. Streetlight allows users to place "gates" at any point along the roadway network and to assess the volume of cars passing through the identified point. Points were placed along regional boundary at all seven roadways leading into the region. Estimated AADT, for those points is included in the table below.

(1) Day visitation trips = Total Entry Trips – Overnight Entry Trips – Commute Entry Trips – Discretionary Entry Trips

(2) Day visitors = Day visitation trips X vehicle occupancy

Table 7: Streetlight Entry/Exit AADT estimates (2018)

Source	Route	Location	AADT	AADT - Entry
Streetlight	SR431	Mt Rose	6,186	3,093
Streetlight	US50	Spooner	14,044	7,022
Streetlight	SR207	Kingsbury	6,860	3,430
Streetlight	267	Brockway	9,314	4,657
Streetlight	89	Truckee River	9,098	4,549
Streetlight	Hwy 50	Echo	7,632	3,816
Streetlight	89	Luther	1,860	930
	Total		54,994	27,497

Although traffic volume data is collected by the California and Nevada departments of transportation (DOTs), StreetLight Data was used. StreetLight volume estimates are calibrated with DOT data and provide continuous measurement at all entry exits to the region. DOT traffic volume data is currently not collected at all seven of the entry stations. While some DOT count stations are located near entry/exit points, there are several stations where data is collected several miles away from the TRPA boundary (thus potentially including/excluding trips that never enter the region) and other stations where no reliable data is available at all. Moreover, for several of the traffic stations on the California side, the data is not collected on a continuous basis and is less reliable. StreetLight Data's 2018 volumes methodology is the most reliable available data for this time period. Moving forward, as the TEPM inputs are updated over time, it may be necessary to integrate StreetLight Data with DOT counts – or other data sources – to produce comparable volume estimates to 2018. There are known issues with comparing StreetLight Data year to year due to changes to their algorithm methodology. In the future, TRPA will vet new StreetLight volume estimates with DOT data to ensure consistency and accuracy.

RESIDENT POPULATION

The US Census Bureau's American Community Survey (ACS) continuously gathers economic and demographic data to compliment the decennial census. The population data reported in the 2014-2018 ACS 5-year estimate is a total population of 51,577 in the Lake Tahoe Region.

While the ACS is not a complete count, like the decennial census it addresses some of the shortcomings of the decennial census data. The decennial census uses a date of April 1st to establish residency for the purpose of the count. For regions with seasonal fluxes in population this represents a potentially biased estimate of population, and the continuous ACS sampling may provide a more accurate estimate of the population of the region (Van Auken et al. 2006). ACS population estimates for areas with populations under 65,000 use between 3-5 years of monthly sample data (Van Auken et al. 2006). Differences

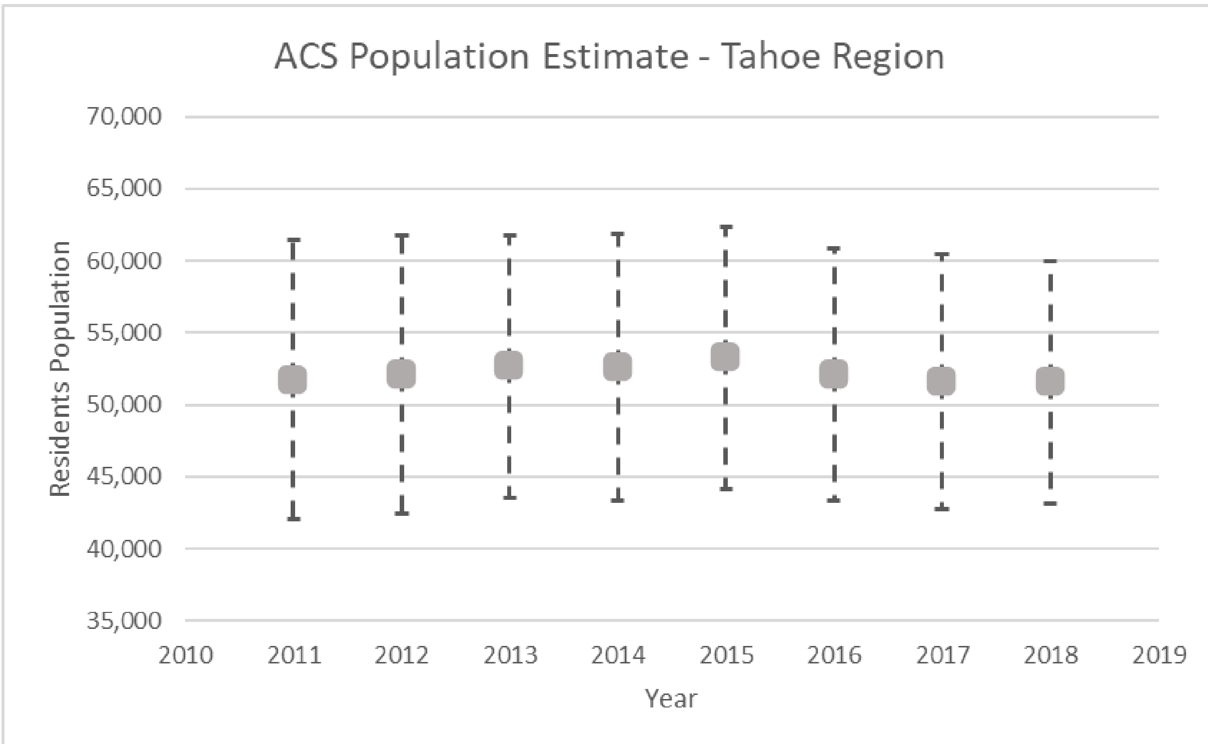

Figure 5: Resident Population of Lake Tahoe Region (American Community Survey 2010-2018)

between ACS and Decennial census estimates have been shown to be larger in communities where larger fractions of the housing stock is seasonal (Van Auken et al. 2006).

The 2014-2018 American Community Survey (ACS) 5-year U.S. census estimate suggests that the population for the Region has been relatively stable, having declined only slightly between 2010 and 2018. We rely on these statistics cautiously because the margin of error is larger than the estimated change. The decline in resident population in the Tahoe Region between 2010 and 2018 was in stark contrast to the growth in the states of California and Nevada (US Census Bureau 2019)

COMMUTERS

Commuters are defined as individuals that live in the region and commute out of the region for work, or individuals that live outside the region and commute into the region for work. Because the attribution of entry trips is a zero-sum exercise, if the number of annual average daily commuters is on the higher end of the expected range, the number of day visitors would be reduced. And, because resident populations are already accounted for, the total effective population is also lower. Estimates of the number of commuters in the region from different sources vary greatly and range from 3,500 a day to nearly 10,000 a day, although very few if any estimates exist detail both incoming and out-going commuters for the Tahoe region (TRPA boundary) only. Individual estimates of the commuting population from various sources are discussed in further detailed below as well as the final estimate that is embedded within TEPM.

2017 Corridor Connection Plan

At the lower end of the spectrum for the number of commuters in the region is the estimate of the 2017 corridor connection plan estimate of just under 2,000 incoming commuter trips a day (Albright 2016; TTD 2017). The estimate was developed by Stantec, who was engaged by the Tahoe Transportation District to analyze travel patterns in the region using anonymous cell phone data from AirSage (Albright 2016; TTD 2017). AirSage Analytics is a firm that specializes in processing anonymous cell phone to better understand movement in the transportation system. Using information about device home location, Stantec estimated that 6% of trips entering the region were commuter trips and that there were a total of 21.8 million vehicles trips into or out of the Region annually (TTD 2017). Using the assumption that half of the vehicle volume flows in each direction, there would be 10.9 million trips into the region annually, 29,863 daily, and 1,792 commuters daily. The estimate was treated with some caution because of the low resident trip attribution rate in the Stantec AirSage analysis. The analysis attributed just over 8.8 million trips to residents in the region annually. With an estimated resident population of 55,000, this works out to less than half a trip per day per resident. The national average is about 4 trips a day per person (USDOT-BTS 2017). If residents of the Tahoe region took trips at a similar rate to the national average, that would result in 80 million resident trips a year, nearly ten times the amount estimated in the AirSage analysis.

2020 Regional Transportation Plan

For the 2018 base year analysis for TRPA's 2020 Regional Transportation Plan, and using travel survey, census data, employment data and the Streetlight data, TRPA and WSP estimated that 13% of basin entry/exit trips were commuter trips (WSP 2020). This estimate includes the entire region and includes individuals residing in the Tahoe Region and commuting to a job outside of the region.

StreetLight Data

The number of commuters can also be estimated directly using Streetlight Data. Streetlight classifies trips in part based on the “home” location of the device that made the trip. One of the classes of trip types StreetLight identifies is “home-based work” trips, which are defined as trips that are taken on a semi-regular basis from the overnight location of the device (home) to daytime location of the device “work.” Streetlight estimates there are 3,000 home based work trips entry the region on an average day. The Streetlight estimate likely underestimates the actual number of home based work trips, because Streetlight’s trip classification identifies a new trip after a five minute stop. Thus if a commuter stopped for gas on the way to a job in the region, and the stop lasted for more than five minutes, the trip would not be identified as a home based work trip.

Housing Needs Assessments

The 2019 South Shore Region Housing Needs and Opportunities assessment estimated that there between 4,480 - 5,555 people commuting into work in the South Tahoe region (Sullivan et al. 2019). The assessment found the average commuter traveled to the region 4.4 times a week; that puts 63% of these trips on any given day (there is a 63% chance that any given commuter is travelling on a particular day; or on average, 63% of commuters are travelling on each day of the week). Taking 63% of 4,480 and 5,500, results in 2,816 and 3,457 commute trips into the south shore area of basin on an average day.

Analyzing a region that included part of the north and west shore of Tahoe, and neighboring areas in Truckee, the Truckee North Tahoe Regional Workforce Housing Needs Assessment (TTCF) estimated that in 2013 that there were 9,271 people living outside the region that commuted into the area for work, and that 5,723 Residents of the region that were commuting out of the region for work (TTCF 2016). Here, we focus on the 9,271 people who were commuting into the area, since we do not have “out commuters” for the south shore area. While the Truckee – North Tahoe study area extends outside the Tahoe region, the estimated percentage of the commuting population may provide insight. The report indicates a total of 15,841 jobs in the study area. TRPA estimates that of these jobs approximately 5,419 are in the Tahoe basin (in Placer County). This means that about 34% of the jobs counted in the TCCP report are within the basin. This amounts to 34% of 9,271, or 3,152 commuters. And, as above, if each commuter makes 4.4 trips per week, and we use a 7-day work week, on average 63% of workers are commuting on any given day. Thus, on an average 1,985 (63% of 3,152) commuters travelling into the North Tahoe portion of the basin each day.

Utilizing a Streetlight to analyze intraregional commuting between the Tahoe portion of TCCF study region and other portions of the Tahoe Region, we found there are approximately 750 home-based-work trips daily between the two areas. These 750 trips account for only 60% of these trips, and thus we remove a total of 1,250 trips, and estimate 735 commuters enter the northern areas of the basin on an average day.

The housing needs assessments described above cover all portions of the Tahoe region except for Washoe county. We also add another 1,270 commuters, travelling into Washoe County, which is not represented in either of the housing needs reports. Applying the average of 4.4 commute days per week or 63% commuting each day to the Washoe County portion, this adds 63% of 1,270 or 800 commute trips each day. With 2,816 trips into the south shore area, and 735 commute trips into the north area, and these 800 trips into the Washoe County portion of the region, there are 4,351 commuter trips coming into the Basin, each day.

To refine the estimate to only those commuters that travel into the Tahoe Region for work, we utilize Streetlight analysis for an average day in 2019 that estimated intraregional commuting between the north and south shore areas at approximately 140 home-based work trips on an average annual day; if we again assume this represents only 60% of the actual work trips, 140 is 60% of 233 trips. From this we infer that around 233 of the commute trips are made by people who commute between the two areas on an average day. So, we remove these trips from the sum of 4,351 and have a final rough estimate of 4,117 commute trips per day into the basin.

We also add the estimate of 1,973, based on the most recent TRPA resident travel survey This results in a total of for a total of 6,090 commuters going in both directions on an average day. This accounts for 21% of the 29,000 daily trips.

The commute trip estimation based on the NHTS data was derived by identifying travelers within the 2017 NHTS data that had any travel within, into or out of the Tahoe Basin. The Basin was defined using the zip codes and cities within the area. Each trip was evaluated to determine if it was a work trip or not and whether it started and ended inside or outside of the Tahoe Basin. All trips that included more than one member of the same household were counted as a single trip (though they were reported by every traveler), so as not to double count any trips. There were a total of 600 trips in this subset. Of these, 108 were trips into or leaving from the Basin (the remaining 492 trips were entirely within or entirely outside of the Basin). Only 20 of the 108 trips, or 18% were work trips made by residents and non-residents. Applying this 18% to the total of 27,497 trips into the basin results in an estimate of 4,949 trips.

TABLE 8: TEPM SUMMARY OF DAILY AVERAGE COMMUTE ENTRY TRIPS ESTIMATES

Total Entry Trips (2018)	Commute Trips	% of Total	Commute direction
25,281	4,949	19.6%	Inbound
25,281	1,800	7.1%	Outbound
25,281	6,749	26.7%	Total (both directions)

OVERNIGHT VISITORS

NUMBER OF ANNUAL HOTEL/MOTEL/STR ROOMS RENTED

For the 2018-2019 fiscal year, we estimate 1,754,130 occupied room nights in hotel and motels room basin-wide. In addition to the estimated 482,940 VHR unit rentals, we estimate a grand total of 2,237,070 annual rentals.

Data sources included TOT reports and data from Douglas County, the City of South Lake Tahoe, El Dorado County, Placer County, and Washoe County's "District B", which includes North Lake Tahoe properties in Incline Village and Crystal Bay. Estimates and procedures used to derive them for each of the four spatial sub-units vary according to reporting practices of each of the five subregions, and are detailed in Appendix A. Table 3 provides the total estimated rentals by type for each geographic subregion throughout the Basin.

Table 3. Estimated Hotel/Motel Rooms and VHR Units Rented, FY 2018-2019, Tahoe Basin.

Geographic Area	Hotel & Motel Rooms	VHR Units	Total
Douglas County (NV)	805,695	37,488	843,183
South Lake Tahoe (CA)	717,336	110,693	828,029
Placer County (CA)	105,880	233,620	339,500
Washoe County (NV)	125,219	70,072	195,291

El Dorado County (CA)[a]	--	31,067	31,067
TOTAL	**1,754,130**	**482,940**	**2,237,070**

[a] Data from the unincorporated area of county within the Basin, but outside of the City of South Lake Tahoe municipal boundary

CAMPGROUNDS

Campsites in the Region are managed by numerous public and private entities including the United States Forest Service (USFS), California State Parks, the City of South Lake Tahoe, and Tahoe City Public Utilities District. Reporting by campground operator varies, as does the reliability of the estimates for the average number of individuals at each site. Campgrounds in the region generally operate from late May through September. The last year for which complete data is available from all operators is 2018, when 99,284 campsite nights were booked within the region (Table 4).

The average number of visitors per campsite is not always captured in reporting. California State Parks currently estimates total visitation based on 4.5 persons per campsite, but suggests it likely represents an underestimate of the total number of visitors served. This is used to generate the estimate for State Parks occupants, based on the reported 32,879 occupied sites. The remaining data on units and estimated occupants were provided by the various reporting agencies. In total, there were 381,857 estimated person nights at campgrounds in the Tahoe Region in 2018, leading to an estimate of 3.8 occupants per site.

Another important element of TEPM is estimating the number vehicles per campsite. This data point was estimated by first estimating the number of vehicles by dividing the number of total occupants by the average vehicle occupancy, which was obtained from the TRPA travel surveys (381,857/3.26in). The number of total vehicles is then divided by the number of campgrounds to estimate the number of vehicles per campsite at 1.8.

Table 4. Campground Unit and Occupancy Estimates, Lake Tahoe Basin (2018)

	USFS	CA State Parks	TCPUD	City of South Lake Tahoe	**TOTAL**
Units	48,004	32,879	1,331	17,070	**99,284**
Occupants	173,551	147,956	2,110	58,240	**381,857**

Occupants/Units	3.6	4.5	1.6	3.4	**3.8**

VISITOR LENGTH OF STAY

The 2018 and 2020 TRPA travel surveys showed an average length of stay of 4.28 for overnight visitors staying in short term rentals and 3.44 days for overnight visitors staying in hotels/motels/casino/resorts. Moreover, the survey showed that second homes are occupied on average for 29% of the year.

The 2004 TRPA summer visitor travel survey found the average overnight visitor spent 6.0 days in Tahoe, with longer stays on the north shore (6.6 days) than on the south shore (5.5 days) (NuStats 2004b). Winter survey results revealed similar north-south patterns, with shorter overall lengths of stay (NuStats 2004a). The winter survey found the average overnight visitor spent 4.9 days in Tahoe, 5.3 days for north shore visitors and 4.7 days for visitors to the south shore.

In 2017, Dean Runyon and Associates (DRA) completed a comprehensive review of the economic impacts of visitation on the California side of North Lake Tahoe region for the North Lake Tahoe Resort Association (NLTRA) (DRA 2017). The study area included Tahoe region from Tahoma north and east within the Tahoe region to the Nevada state line. In 2017, NLTRA estimated there were 1,275,000 visitors to the region (NLTRA 2018). The report estimated that there were 3,233,000 visitor days at overnight accommodations in the region (NLTRA 2018). The visitation estimates of the report utilized estimates of both the number of persons per accommodation type (Table 6) and the average length of stay by accommodation type (Table 7). The average length of stay of all overnight visitors to the Region was estimated by the study to be 4.3 nights (DRA 2017).

TABLE 9: PERSON PER UNIT BY ACCOMMODATION TYPE (DRA 2017)

	Hotel/Motel/B&B	Rented Condo/Home	Private/Vacation Home	Campground
Persons per Unit	2	3	2.5	3

TABLE 10: AVERAGE LENGTH OF STAY BY ACCOMMODATION TYPE (DRA 2017

	Hotel/Motel/B&B	Rented Condo/Home	Private/Vacation Home	Campground

Length of Stay	3.4	3.5	10.4	3.5

NUMBER OF VEHICLES PER UNIT

NUMBER OF VEHICLES PER SECOND HOME

The number of second homes was estimated using a combination of US Census ACS data, in conjunction with observed STR data from local jurisdictions. The ACS estimates the total number of “seasonal/recreation/occasional” housing units. We ca then subtract out the number of known STR units that were reported from local jurisdiction to estimate the number of second homes in the Tahoe region.

We estimate that there are 1.27 vehicles per second home. This estimate is derived using the total estimate of second homes in the basin (20,580), the estimated occupancy rate for the year from recent TRPA surveys (19%), an estimate of 2.5 occupants per occupied second home, and the traveling party size from the most recent TRPA intercept travel survey (1.97). Using the 19% occupancy estimate, that means that 3910 second homes are occupied by 9776 people staying in them. Dividing the occupants per second home estimate by the average occupancy of 1.97 seasonal residents per vehicle (per the travel survey), this translates to 1.27 vehicles per occupied second home.

NUMBER OF VEHICLES PER HOTEL OR MOTEL ROOM RENTED

Throughout the Lake Tahoe Basin, we estimate that an average of 1.08 vehicles accompany visitors for each hotel or motel room rented for FY 2018-2019. Specifically, this is an estimate for the number of vehicles that enter each property where hotel or motel rooms are rented each day throughout the course of a year, attributable to those staying overnight in a rented unit.

There is no existing dataset that reports the number of vehicles attributable to each hotel or motel room rented. While some properties collect this data when a customer reserves a room or checks in at the property, such data are not made available in any centralized way. This should be explored as a future data collection effort in order to better understand vehicle travel attributable to those who come to stay in the Basin's hotels or motels.

To generate our estimate, we relied on a combination of 1) the hotel and motel rooms reported in the section entitled: "Number of Annual Hotel/Motel/STR Rooms Rented", 2) StreetLight data, and 3) an existing dataset of known hotel and motel properties in the basin provided by TRPA, which includes data on total available units at each property. The estimation procedure is described in full detail in Appendix A.

In short, we created polygon datasets in GIS to represent the 183 known hotel and motel properties throughout the basin that encompassed the structures and adjacent parking areas. Using StreetLight's built-in ability to extract the average number of daily vehicle entries into the 183 polygons in GIS, we could get estimates for four unique volumes of interest. The first is an overall total of inbound vehicles per day. Then, three subtotals that comprise the total inbound vehicles are provided. These are as follows: HBW (home-based work), HBO (home-based other), and NHB (non-home based). These breakdowns are essential to providing a more refined estimate attributable to visitors, as not all vehicles that enter a hotel or motel property each day are those driven by people staying there. To more accurately account for external visitors, we specifically identify trips that enter each property that pass through the seven entry points (Tahoe City, Brockway Summit, Echo Summit, Kingsbury Grade, Luther Pass, Mt Rose Highway, Spooner Summit) to the Lake Tahoe Basin that reach the properties.

Full details, explanations, and justifications about assumptions used to assign inbound vehicle entries to overnight visitors within each of the three subcategories are provided in Appendix A. Briefly, we exclude all HBW trips, then include the following: 95% of the HBO trips that pass through the seven entry points, 90% of NHB trips that pass through the seven entry points, and 20% of NHB trips with origins somewhere in the Lake Tahoe Basin.

After summing each of these three trip type volumes for each property (95% external HBO + 90% external NHB + 20% internal NHB), we produce the estimate of vehicles attributable to a room rental as follows:

1) Sum the total estimated daily vehicle entries for all 183 properties, attributable to visitors

2) Multiply the daily vehicle entries by 365, then

3) Divide this total by the 1,754,130 total annual hotel/motel rooms rented

The final estimated values are presented in Table 5.

Table 5. Analysis Vehicle of Entries to Hotel/Motel Properties.

Trip Type	**All Trips**	**All Internal Trips**	**All External Trips**	**Estimated Visitation Trips**
HBO Trips/Day (StreetLight)	10,488	9,202	1,286	1,222
NHB Trips /Day (StreetLight)	14,377	12,839	1,538	3,952
Notes on Inclusion Estimates	--	*20% NHB*	*95% HBO, 90% NHB*	
Vehicle Entry Trips/Day (95% external HBO + 90% external NHB + 20% internal NHB)				5,174
Annual Vehicle Entries (Vehicle Entry Trips/Day * 365)				1,888,510
Annual Vehicle Entries/Rooms Rented (1,754,130 for FY 18-19)				**1.08**
Estimated guests per Room (3.2 visitors/vehicle, per visitation survey)				3.45

NUMBER OF VEHICLES PER STR RENTED

The number of vehicles per STR was estimated using information about the size of STRs and the vehicle occupancy entering the region. Detailed information on the size and frequency individual STRs are is not available for the region. In the absence of that data, information on the STRs available for rent in the region was used to establish the likely number of individuals staying in STRs in the region. To estimate the size of STRs information was source from AirDNA on October 15, 2020. AirDNA provides information and market research on vacation rentals nationally. Within Tahoe information on units is available for 11 areas. The total number of estimated STRs is consistent estimates provided by the local jurisdictions. Information on the number of rentals, and average guest capacity of rentals was complied. The average guest capacity region was 8.3 individuals. Using the conservation assumption that each rental accommodates the full capacity of guests for each visit, and average occupancy of cars entering the basin carrying overnight visitors (3.92), yields a regional estimate of 2.07 (8.13/3.92) cars per STR.

TABLE 11: ESTIMATED SIZE AND OCCUPANCY OF SHORT TERM RENTALS IN THE TAHOE REGION (AIRDNA 2020)

Area	Rentals	Rooms	Guests
Carnelian Bay	355	3.3	8.1
Glenbrook	35	4.1	10.5
Homewood	245	3.4	8.5
Incline Village	681	3.2	7.9
Kings Beach	530	2.7	7.1
South Lake Tahoe	2803	3.1	8.3
Stateline	507	3	8
Tahoe City	903	3.3	8.1
Tahoe Vista	188	2.7	7.7
Tahoma	256	3.1	8.2
Zephyr Cove	303	3.4	8.9
Total	6806	3.13	8.13

VEHICLE OCCUPANCY

Vehicle occupancy is an important TEPM input, as it converts observed vehicle volumes to population and informs several other model estimates. Vehicle occupancy data was sourced from the last two TRPA travel surveys (summer 2018 & winter 2020), which showed an average vehicle occupancy of 2.62 for day visitors, 1.59 for residents, 3.26 for overnight visitors staying in hotel/motel/casino, 3.92 for overnight visitors staying in short-term rentals (STRs) and 1.97 for seasonal residents. The average occupancy of the last two surveys were averaged together to represent both summer and winter time travel behavior. The TRPA travel surveys are intercept surveys where trained field surveyors traveled to popular sites around the Basin and asked people to voluntarily answer a series of survey questions about their travel behavior. The surveys are completed in dozens of different locations throughout the region and includes responses from all party types of interest to this study, such as day visitors, overnight visitors, seasonal residents, and full-time residents. More information on these surveys can be found at monitoring.laketahoeinfo.org/TravelBehavior.

OTHER ENTRY/EXIT TRIPS

NUMBER OF DISCRETIONARY ENTRY TRIPS

Resident

Resident discretionary trips include trips residents make to destinations outside the region for purposes other than work or school. For example, this would include trips to Alpine Meadows or Kirkwood to ski, or trips to Reno or Carson City to shop, dine, or see a show. The National Household Travel Survey (NHTS) indicate that 23% of entry trips are resident discretionary, which equates to roughly 5,750 resident discretionary entry trips.

Visitor

Visitor discretionary trips include trips overnight visitors staying within the basin make to destinations outside the region. The TRPA travel demand model estimates that 7% of overnight visitors make a day trip out of the region. This 7% estimate is then applied to the total TEPM overnight visitor population to conclude the number of overnight visitor discretionary trips.

SHUTTLES

Shuttle services operate daily between Reno and the north and shore shores. Relative to the total number of individuals arriving in the region on a daily basis, the number that arrive on passenger shuttles is relatively small, and the total effective population estimate was not adjusted for shuttle arrivals. If the number of passengers arriving on shuttles substantially increases, they should be accounted for in future estimates.

TABLE 12: SOUTHSHORE PASSENGER SHUTTLE ARRIVALS (2017-2019)

Year	Total Passengers	Arriving Passengers	Daily Passenger Arrivals	Source

2017	62,033	31,017	85	Amador Stage Lines
2018	63,033	31,517	86	Amador Stage Lines
2019	64,477	32,239	88	Amador Stage Lines

FREIGHT

Freight trips account for roughly 3-5% of total entry/exit trips on any given day. Both StreetLight Data and Caltrans Traffic Census data indicate this magnitude of freight trips which equates to roughly 750 freight trips entering the region on an annual average day.

SUMMARY

In summary, the TEPM 2018 estimate is an effective population of 118,856 for the Tahoe region. This estimate is comprised of 52,000 full time residents, 5,000 commuters, 15,000 day visitors, 36,000 overnight visitors, and 10,000 second home owners.

For more information about the quantitative TEPM data inputs and to test out other assumptions, we've developed an interactive, web-based tool. You can visit the tool at trpa.shinyapps.io/effective_population. The tool displays all of the quantitative assumptions of the 2018 TEPM estimate and the final model outputs. Moreover, the tool allows the user to enter different quantitative inputs and observe how those assumptions impact the final population estimate. If stakeholders have additional information related to the TEPM inputs, they are able to enter this information to potentially refine the 2018 population estimate.

UNCERTAINTY

There are a number of elements of uncertainty that should be considered when evaluating these estimates. These can be classified as uncertainties inherent in the data sources, and uncertainty in their representativeness. We discuss these below, including some suggested ways to mitigate uncertainty where applicable.

Data Sources

The data found by or provided to the study team included either comprehensive counts (such as the TOT reports), and those that were themselves samples or estimates (such as the StreetLight data and the NHTS data). The estimates that carry the most uncertainty are: 1) those that attempt to account for the number of vehicles per visitor type, and 2) accounting for those occupying second homes at any given time in a year. Day visitation is estimated by the model, so while the estimate contains uncertainty, that uncertainty is consistent with the overall model uncertainty, not uncertainty associated with a specific data source. Each require compiling a number of different sources. As a general note, it is clear that day use visitation statistics are an area of uncertainty that need more targeted data collection efforts to better improve estimation precisions.

StreetLight data were necessary to generate estimates of vehicles attributable to those renting hotel or motel rooms, and as detailed above, required a number of assumptions to arrive at an estimate. StreetLight data themselves also carry their own elements of uncertainty. First, they represent a sample of travel collected from a subset of mobile devices that had location services enabled while in use in the study area. That means derivative data are reflections of those carrying such devices and may therefore be biased. Second, the way that StreetLight delineates separate trips (through the 5-minute of stationary activity), and the implications that carries for how trips are classified (as HBW, NHB, or HBO) are a real issue for delivering accurate estimates for visitor travel in the Lake Tahoe Region. Ultimately, a more robust value could most be generated by collecting vehicle count data when someone reserves a room at one of these properties. This may require developing and maintaining a central database that could be populated when a visitor reserves a hotel or motel room and indicates the number of vehicles that will accompany them. We do acknowledge, though, that those reserving rooms may not always be forthcoming about the numbers of accompanying vehicles.

The estimate of those in the region's second homes (and the vehicles accompanying them) also will require future attention and data collection efforts. In this report, we use a compilation of ACS data and survey data responses, such as those collected from Placer County second homeowners. It is possible that these are not reflective of second home use throughout the Lake Tahoe Region. There is no question this is a difficult population to collect information about, though we recommend distributing a future survey to second homeowners who have properties that are *not* registered STRs throughout the region that collects information generally on: 1) occupancy length and frequency over the past year, 2) number of occupants that are at the property over those times, and 3) the number of vehicles that accompany them. Alternatively, local officials could drive past identified properties on a given day and record number of vehicles they see at these properties, though such an effort may be problematic for a number of reasons.

Finally, we also recognize that renting out rooms in residents' primary and secondary homes to those seeking shorter-term housing is a common practice, and that no data set reviewed or estimation procedure detailed in this study captures travel from this group. This is also a somewhat trickier topic to ask about, too, but does warrant an acknowledgment and future consideration in developing population estimates.

Representativeness. To generate our estimates, we relied on data collected from both 2018 and 2019. This was done so as not to include data that might reflect changes brought about by the COVID-19 pandemic. In some cases, these 2018-2019 data were the most recent available, but others included 2020 values. Indeed, finding a consistent time period across multiple datasets for efforts like this is not uncommon, though we note that we are fortunate to have consistent data as recent as 2018 for all relevant estimates. In addition, some data were provided at the both the annual and fiscal year levels, so adjustments were required to ensure consistency, as outlined in Appendix A.

However, to what extent visitation in 2018-2019 is representative of that of a "normal" year is also a consideration that should be evaluated in the future. Still, the methods and estimation techniques outlined here could be applied to other years, assuming similar datasets are available. Should formats or availability change in the future, adjustments will need to be made to the procedures developed here.

It should also be noted that the TEPM approach presents a daily annual average estimate, and that daily, weekly, monthly, or seasonal variation certainly is present in these relative volumes throughout the year. A day in July may show markedly different relative volumes than a day in April or October. Special events, particularly good (or bad) ski conditions, wildfires, or other causes of unusually high or low travel to the region can dramatically change the balance of the varying subpopulations considered in the model. Future data collection efforts should consider better ways to consistently collect and report information at finer time scales across these groups to gain a better understanding of these fluctuations.

FUTURE DATA NEEDS

The TEPM approach is predicated around knowledge of the total number of entry trips into the region on each day. As previously mentioned, the current model relies upon StreetLight Data for 2018 volumes. Although StreetLight data is currently the best available source of data, it is still an estimate and not an observed count. This creates uncertainty given potential changes to StreetLight's algorithm over time. In the future, sourcing the data from actual traffic counters at all seven entry/exit points would provide the most reliable data. Out of the seven stations, there are currently 3 which have reliable, continuous data collected by the state DOTs. The four other stations either have non-continuous counter, and counter located near but not at the desired location, or not counter at all. Continuous and reliable counter data at all seven entry/exit stations would ensure the most accurate and precise TEPM estimates in the future.

Route	Location	Continuous counter	Data Quality
SR431	Mt Rose	Needed	NA
US50	Spooner	Existing	Good
SR207	Kingsbury	Needed	NA
267	Brockway	Existing	Good
89	Rampart	Existing	Poor
Hwy 50	Echo	Existing	Poor
89	Luther	Needed	NA

APPENDIX A: VISITATION DATA ESTIMATES AND METHODS

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Introduction.

The research team from the Department of Geography at the University Of Nevada, Reno (UNR) collected and generated estimates for four primary parameters for Tahoe Effective Population Model (https://trpa-shiny-apps.shinyapps.io/effective_population/), all of which were related to various components of visitation. These four are:

1. Number of Annual Hotel/Motel/VHR Rooms Rented
2. Second Home Occupancy
3. Average Number of Vehicles per Lodging Room Rented
4. Number of Occupied Campgrounds and Visitors per Campground

This document provides detailed information about the methods and assumptions used to generate the estimates in the overall document. It also lists relevant data sources, so that these estimates may be reproduced in the future. Each of the four estimates are individually described in their own sections below.

Number of Annual Hotel/Motel/VHR Rooms Rented

Summary

For the 2018-2019 fiscal year, we estimate that there were **1,754,130** occupied room nights in hotel and motel rooms throughout the Tahoe Basin. In addition to the estimated **482,940** VHR unit rentals during the same time period, we estimate a grand total of **2,237,070** nights in paid overnight accommodations (Table 1).

Data sources used to produce these estimates primarily include transient occupancy tax (TOT) reports, and where necessary, supplementary data, from Douglas County, the City of South Lake Tahoe, Placer County, and Washoe County's District B, which includes North Lake Tahoe properties in Incline Village and Crystal Bay. Estimates and procedures used to derive total rentals for each of the subregions that comprise the grand total are described below. Table 1 provides the total estimated rentals by type for each geographic subregion throughout the Basin.

Table 1. Estimated Hotel/Motel Rooms and VHR Units Rented, FY 2018-2019, Tahoe Basin.

Geographic Area	Hotel & Motel Rooms	VHR Units	Total
Douglas County (NV)	805,695	37,488	843,183
South Lake Tahoe (CA)	717,336	110,693	828,029
Placer County (CA)	105,880	233,620	339,500
Washoe County (NV)	125,219	70,072	195,291
El Dorado County (CA)[a]	n/a	31,067	31,067
TOTAL	**1,754,130**	**482,940**	**2,237,070**

[a] Data from the county within the basin but outside of South Lake Tahoe

Douglas County

Douglas County, Nevada, provides room tax revenue data on an annual (fiscal year) basis. The County categorizes these data into two geographic regions ("Lake", and "Valley", the former of which corresponds with properties in the Lake Tahoe Basin), and into three distinct types: 1) Lake Casinos, 2) Vacation Homes, and 3) Other Lake-Not Casinos.

Casino rooms rented in Douglas County's Lake region in FY 18-19 are **558,531**. For non-casino rooms, this total is **284,652** rooms, which includes VHR rentals.

Reporting on Vacation Home room sales, however, did not begin until FY 2019-2020. The challenge to using these data is that the COVID-19 outbreak overlapped with the last four months of the fiscal year in which data were reported, reflecting a precipitous drop in room rentals. Indeed, no rooms of any kind are reported rented in May or June 2020 in Douglas County. Between July 2019 and February 2020, which is the last month before COVID-19 related shutdowns began, **25,117** VHR rooms were reported as rented. To produce an estimate for VHR rentals in the county, we pro-rate data reported for the 8 months preceding the onset of COVID-related lockdowns and travel restrictions to a 12-month estimate of a "normal" year, bringing the total estimated VHR rooms in Douglas County to **37,488**. In absence of data for FY 2018-2019, we use this estimate for the year of interest.

Further complicating estimation is that in reporting years prior to FY 2019-2020, VHR rentals in the Lake Tahoe Basin in Douglas County were categorized as "non-casino rooms." Therefore, reporting the non-casino rooms as-is from the FY 2018-2019 report in addition to the prorated VHR room estimate would double-count totals in the former category, so we remove 37,488 (the VHR estimate) from the 284,652 non-casino rooms estimate for FY 2018-2019. In total, then, we estimate **805,695** hotel and motel room rentals in the Basin (558,531 + 247,164) in FY 2018-2019 and **37,488** VHR rentals.

In total, then, we estimate a total of **843,183** rentals that include the estimated casino and non-casino rooms rented, and VHR units rented within the Lake region of Douglas County, Nevada.

Data Source*: https://www.douglascountynv.gov/cms/one.aspx?portalId=12493103&pageId=13612059*

South Lake Tahoe

The City of South Lake Tahoe provides TOT data and reports on a monthly basis, although they are organized on the city's website on an annual basis that begins in October and runs through the following September. Each monthly report provides a wealth of information, though of most interest to this estimate is Page 2 of each report, which includes 1) room nights rented in hotels and motels, and 2) VHR units rented. Additional information provided includes total room nights, units available, occupancy percentage, average room price, and a comparison of each metric to that of the previous year.

To stay consistent with the Douglas County estimates, we reported totals for each month in FY 2018-2019 (July 2018-June 2019).

In total, **717,336** hotel and motel room nights were reported as rented in South Lake Tahoe. In addition, there were **110,693** VHR unit rentals between July 2018-June 2019. .

In total, then, we estimate a total of **828,029** rooms that include the estimated hotel and motel rooms, and VHR units within South Lake Tahoe, California.

Data Source: *http://www.cityofslt.us/588/TOT-Reports* *(each month July 2018-June 2019)*

Placer County (only within Tahoe Basin)

Placer County TOT data were provided directly to the research team from Placer County employees, and can be accessed on request from the county. The data provided to the team is the "Statistical YTD August 2020 dataset", which includes data collected county-wide from FY 2016-2017 through FY 2020-2021. Data are provided on a quarterly basis for each of these fiscal years. To stay consistent with the other geographic subregions, we isolated data for the FY 18-19 fiscal year by selecting only records with records in the TOTQTR field of either: 18-19Q1, 18-19Q2, 18-19Q3, and 18-19Q4.

Since this was a county-wide dataset, we next had to isolate records for only the Lake Tahoe Basin, using the county-provided geographic designations. These included the following designations: Carnelian Bay, Kings Beach (plus O.P.A.), Tahoe City (plus O.P.A), Tahoe Miscellaneous, and West Shore. "West Shore" seems to be a catch-all for the other cities along the West Shore that do not have specific city-level geographic identifiers.

To estimate hotel and motel room rentals, we isolated records that had one of the following designations: hotel, motel, or bed and breakfast, and tabulated those rooms rented across each of the four quarters in the FY 18-19 period. In total, **105,880** hotel, motel, or bed and breakfast room rentals are recorded in the Lake Tahoe Basin within Placer County during FY 18-19.

To tabulate VHRs, we isolated all records that had the following designations: "Condo", "CondoTel (or Condohotel)", "Duplex", "Home", "Triplex", "Timeshare", or "Other." There were a handful of quarterly records that were unreported for some records with these designations, while three of the other quarters were reported. In these cases, mean imputation for the category using the other three quarters' records in the FY were used. In total, then, we estimate **233,620** VHR unit rentals during FY 18-19 in Placer County.

The estimated combined total of rentals, then, is **339,500** in the Placer County portion of the Lake Tahoe Basin during FY 18-19.

Washoe County

The geographic area of interest for occupancy estimates in the Lake Tahoe Basin in Washoe County, Nevada, includes both Incline Village and Crystal Bay on the North Shore of Lake Tahoe. Washoe County reports room occupancy statistics within various subregions of the county, which encompasses everything from the area adjacent to Lake Tahoe north to the Oregon border. It designates District B as that area within the Tahoe Basin that includes Incline Village and Crystal Bay, and its Monthly Hotel Statistics FY 18-19 document reports all rentals for this "North Lake Tahoe" area together.

However, the way it reports room occupancy differs from the other three counties (there are no tourist accommodations in Carson City portion of the Tahoe basin). A combination of the Monthly Hotel Statistics Document for FY 18-19 from Washoe County, Washoe County District B Occupancy & Revenue History document, and a discussion with Washoe County employees were used to generate the necessary estimates.

First, we used each month's "North Lake Tahoe" hotel occupied records for each month between July 2018 and June 2019. This required recording both cash occupied rooms ("Cash Occ.") and compensated rooms ("Comp Occ"), noted in Table 2, which are fields in the Monthly Hotel Statistics Document for FY 18-19 from Washoe County. Using these records, which only report hotel room rentals, we estimate **121,531** hotel rooms rented during FY 2018-2019 (Table 2). The ("Total Occ") comes from the Washoe County District B Occupancy & Revenue History document, which we use to isolate and estimate non-hotel rentals. Hotel rooms are reported as a separate category of all cash rooms in Washoe District B, in addition to the general term of "Cash Rooms," which can include both motel rooms and VHR rentals.

Table 2. Washoe County, Nevada, Estimation of Occupied Hotel/Motel rooms and VHRs, FY 2018-2019.

Month	Cash Occ.	Comp Occ.	Hotels (Cash + Comp)	All Washoe B Cash Rooms	Non-Hotel Rentals (All - Hotels)	Motels (5% of non-hotel)	VHR (95% of non-hotel)
Jun-19	11,368	287	11,655	18,916	7,261	363	6,898
May-19	7,964	279	8,243	12,902	4,659	233	4,426
Apr-19	6,623	243	6,866	11,182	4,316	216	4,100
Mar-19	8,065	281	8,346	15,507	7,161	358	6,803
Feb-19	9,019	549	9,568	15,131	5,563	278	5,285
Jan-19	8,769	377	9,146	16,484	7,338	367	6,971
Dec-18	8,546	375	8,921	15,711	6,790	340	6,451
Nov-18	8,771	266	9,037	13,652	4,615	231	4,384
Oct-18	9,893	255	10,148	13,886	3,738	187	3,551
Sep-18	11,563	288	11,851	19,593	7,742	387	7,355
Aug-18	13,134	294	13,428	20,116	6,688	334	6,354
Jul-18	13,817	505	14,322	22,211	7,889	394	7,495
TOTALS	117,532	3,999	**121,531**	195,291	73,760	**3,688**	**70,072**

Specifically, we note that cash rooms include any rentals where TOT is paid, including 1) the aforementioned hotel-specific reporting, but also 2) motels, time share rentals, and VHR rentals registered with Washoe County. Hotel rooms, then, are the only ones clearly categorized in the reports. Subtracting the hotel rentals from all cash rooms throughout Washoe B provides a remainder of "non-hotel" rentals that ranged from a minimum of 3,738 in October 2018 to a maximum of 7,889 in July 2018. The exact breakdown of these non-hotel rentals in Washoe B was initially unclear, so a meeting with Washoe County Staff in November 2020 helped to finalize the estimation.

Based on statistics provided during this conversation, we estimate that 5% of the non-hotel rentals are motel room rentals, while the remaining 95% are VHR rentals. Adding these motel room estimates (3,688) to the hotel room rentals (121,531), we estimate a total of **125,219** hotel and motel room rentals in Washoe County in FY 2018-2019. Assuming that 95% of the non-hotel rentals in Washoe B were VHRs, then, we estimate that there were **70,072** VHR rentals in FY 2018-2019. In total, then, we estimate **195,291** total rentals in the Washoe County portion of the Lake Tahoe Basin in FY 2018-2019.

5) El Dorado County

This final geographic subregion to account for is the unincorporated part of El Dorado County that does not include South Lake Tahoe. To estimate rentals for FY 2018-2019, we use TOT data collected by El Dorado County and provided by request to the research team. El Dorado County provided quarterly TOT income for all quarters, beginning from Q3 of 2015. These data did not include the number of units nights rented, but did include a breakdown of permitted units by type. Quarterly revenue figures includes TOT collected by platforms like AirBNB from both permitted and unpermitted units. The vast majority of permitted rentals in El Dorado county are vacation homes (Table 3). Because the majority of the units are VHRs, for the purposes of this estimate procedure, we treat all El Dorado County rentals as VHRs.

Table 3. Permitted Units by Type, Unincorporated El Dorado County in the Lake Tahoe Basin, FY 2018-2019.

Type	Number Permitted	Unit Type Proportion
Homes	895	97%
Rooms	20	2%
Other	2	0%
BNB	1	0%

The El Dorado County TOT rate is 10%, and this has been the case for the entire period of record. AirDNA estimates that the average unit cost in the Lake Tahoe portion of El Dorado County is currently $355/night. To estimate the number of units rented in each quarter, the TOT reported collected was divided by the 10% TOT rate to arrive at the total amount spent on VHRs in the quarter. The total spent on VHRs was then divided by the average cost of a night in an VHR to arrive at the total unit nights rented. In the 2018 calendar year, there were 18,461 unit nights rented, and 43,673 in 2019. Because the vast majority of the units are VHRs, we treat all rentals as VHRs for the purpose of population estimation.

To transform these calendar year estimates into 2018-2019 FY estimates that are used throughout the document, we take half of each individual year total and sum each of these halves, producing a final estimate of **31,067** unit nights rented.

No hotel or motel rooms were reported as rented in the unincorporated part of the county within the Lake Tahoe Basin. Within the effective population estimation framework treating all rentals in El Dorado County as vacation rentals rather than hotel room rentals is likely to produce a slightly higher estimate of the number of overnight visitors in the County because average occupancy of a VHR is higher than a hotel room.

2) Percentage of Occupied Second Homes

This has remained one of the more difficult parameters to estimate and should be a priority of future data collection efforts. To generate an estimate with existing data, first, we identify all homes classified as those for seasonal or recreational use, per American Community Survey (ACS) 2014-2018 5 year estimates at the US Census Block Group level (Table 4), which shows these home comprise a substantial portion of the housing stock in the Lake Tahoe Basin. This classification (seasonal or recreational home) identifies second homes. Table 4 also presents all units classified as vacant (unoccupied for at least 6 months out of the year), and all units in the housing stock in each county's portion within the basin. Most classified vacant units, unsurprisingly, are second homes.

Table 4. Summary Statistics for Vacant and Second Home Units for all geographic subregions of interest in the Lake Tahoe Basin.

County	All Units	Vacant Units	% Vacant (of all units)	Seasonal or Rec Use	% Seasonal or Rec Use (of Vacant)	% Seasonal or Rec Use (of all Units)
Douglas	4,809	2,312	*48.1*	**1,944**	84.1	**40.4**
El Dorado	25,298	13,815	*54.6*	**12,273**	88.8	**48.5**
Placer	12,331	8,903	*72.2*	**8,434**	94.7	**68.4**
Washoe	7,931	4,126	*52.0*	**3,431**	83.2	**43.3**
TOTAL	50,369	29,156	*57.9*	**26,082**	89.5	**51.8**

Source: ACS 5-yr estimates (2014-2018), for all units, vacant units, and units designated for seasonal or recreational use for all US Census Block Groups within Tahoe Basin

Next, we sought to quantify the number of these second homes that were *not* registered as VHRs, as these are likely occupied by a second home owner for a period of time at some point in the year. Additionally, VHR rentals have already been accounted for in the previous section. We acknowledge that the following estimates of non-VHR second homes may be unregistered VHRs and rented out to visitors anyway, but without data on such properties, we can only speculate as to the degree to which this occurs. Therefore, occupancy may in fact be higher than we can estimate.

To identify non-VHR second homes, we compiled data on units registered as VHRs within each county in the Lake Tahoe Basin. Using these totals and the totals of all homes designated for seasonal or recreational use within each county, we could produce an estimate of non-VHR second homes. Data on registered VHR units for each county are as follows:

Placer County (Lake Area): **3,344**
Source: MHC White Paper (https://www.mountainhousingcouncil.org/wp-content/uploads/2019/10/mhcstrwhitepaper_final.pdf)
This represents 39.6% of the 8,434 units designated as those for seasonal or recreational use, according to the ACS 2014-2018 estimates. Therefore, we estimate 5,090 non-VHR second homes (Table 5).

South Lake Tahoe: **1,861**
Source: Table 2.3, Socioeconomic Impacts of Vacation Home Rentals in South Lake Tahoe (https://cityofslt.us/DocumentCenter/View/7908/SLT-Vacation-Home-Rental_Final-Report_6-5-17?bidId=)

However, recent policy enacted by the City of South Lake Tahoe moved the maximum to **1,465**, which we use in this estimate, leaving 10,808 non-VHR second homes.

For both Douglas County and Washoe County, there are no publically-available data on registered VHRs as of this writing, so we assume the same proportion of registered units in each location as there are in Placer County (39.6%). This produces estimates of 771 and 1,360 such units, respectively, for each county. Further data collection efforts should prioritize gathering accurate tabluations of these totals.

Subtracting these registered VHRs units from the total of all designated for seasonal or recreational units produces the estimate of 19.335 non-VHR second homes in the Lake Tahoe Basin (Table 5).

Table 5. Estimates of Non-VHR Second Homes, Lake Tahoe Basin.

County	Seasonal or Rec Use	Registered VHR	Non VHR Second Homes
Douglas	**1944**	771	1,173
El Dorado	**12273**	1465	10,808
Placer	**8434**	3344	5,090
Washoe	**3431**	1167	2,264
			19,335

To estimate occupancy per day across the year, we used data collected from a survey distributed to 555 second home owners in Placer County in Spring 2018 (https://www.flashvote.com/placer-ca/surveys/second-home-rental-program-ideas-04-18). Table 6 shows the frequency that respondents indicated they were at their second home during the course of a given year. Complicating the estimate is that the survey prompted the respondent to choose one of the categorical answers in the survey (<1 month, 1-3 months, 3-6 months, 6 months or more). We convert these categories to days spent in their home across a given year, by using the midpoint of each category. For example, a respondent that answered they were in their home 1-3 months out of the year was treated as being in the 61 days a year (mid point between 1-3 months). Using the midpoint, we find 29.3% of second home owners reported presence in their homes 15 days a year, 33.8% are there 61 days a year, and 20.5% are there 137 days a year (Table 6). Out of the possible 1,095 possible occupancy days (365 days in each of the three categories), this means that 213 out of 1,095 (19.5%) of possible days are estimated to be occupied. We also estimate that this translates to 19.5% of occupied days over the course of a given average year. This is of course imperfect, as stays can overlap, so future research is needed to produce a more robust estimate. However, this value is close to that found in the Lake Tahoe visitation intercept survey effort.

Table 6. Second Home Occupancy Estimates, using Placer County survey responses

How Often are you there?	Survey %	Occupied Days of Year[a]	Occ. % of Year	Homes Occupied by Second Home Owners on an average day (out 19,335)
< 1 month	29.3	15	4.1	232
1-3 months	33.8	61	16.7	1091
3-6 months	20.5	137	37.5	1486
Remainder[b]	16.4	0	--	--
TOTALS		213		2810

%		19.5		15.0

[a] for calculations, midpoint of range is used,
[b] not occupied by non-VHR second home owner. Rented out to others, so would be short or long term rental, not evaluated here, not is considered occupied by non-VHR second home owner.

Our figures do not account for the survey response weights, which show that the highest frequency category is those who are in their second homes 1-3 months out of the year. To weight by survey responses, we first translate occupied days per year to the percentage of the year occupied. We then multiply the yearly occupied percentage by the total number of non-VHR second homes to estimate how many homes are occupied at any given point throughout the year by these home owners. This produces a total of 2810 of second homes occupied at any given point in the year out of 19,335, or a total of about 15%. This is the equivalent of use of the average second home on about 4.5 nights a month or just over two weekends a month.

3) Average Number of Vehicles per Lodging Room Rented

Basin-wide, we estimate that there is an average of **1.08 vehicles** accompany each hotel or motel room rented throughout the year. Specifically, this is an estimate for the number of vehicles that enter each property where hotel or motel rooms are rented each day throughout the course of a year, attributable to those staying overnight in a rented unit.

There is no existing dataset that reports the number of vehicles attributable to each hotel or motel room rented. While some properties collect this data when a customer reserves a room or checks in at the property, such data are not made available in any centralized way. This should be explored as a future data collection effort in order to better understand vehicle travel attributable to those who come to stay in the Basin's hotels or motels.

To generate our estimate, we relied on a combination of 1) the hotel and motel rooms reported in the previous section: "Number of Annual Hotel/Motel/VHR Rooms Rented", 2) StreetLight data, and 3) an existing dataset of known hotel and motel properties in the basin provided by TRPA, which includes data on total available units at each property. The estimation procedure is described below.

Geocoding and GIS work

First, we geocoded the 183 known hotel and motel properties in the Lake Tahoe Basin from the dataset provided by TRPA using ESRI's API, based on the street address record associated with each property. This produced 183 points. Next, we digitized polygons in ArcGIS around each of these 183 points that represented the full hotel property. As a digitizing rule, polygons had to encompass both: 1) the buildings associated with the hotel or motel, 2) and any adjacent parking lots where customers could park. Parking lots were generally obvious in terms of association with certain hotel or motel properties simply by viewing aerial imagery, thus making the heads-up digitizing relatively straight-forward, but in some cases, it was less clear which parking lot was associated with which motel. In these cases, a known parking lot GIS dataset provided by TRPA that included parcel records was used to match against the APN of the hotel/motel and the associated parking lot. As an additional check, all digitized polygons were compared to the parking lot GIS dataset's APN values to ensure they were matched with the correct property. Each of the 183 polygons were mutually exclusive (non-overlapping), and also digitized at such a scale so as not to overlap with busy roads adjacent to hotel properties, which would inflate traffic count estimates.

StreetLight Data Analysis

Next, we used StreetLight's built-in ability to extract the **average number of daily vehicle entries** (for calendar year 2018) into any user-defined zone of interest. We used each of the 183 hotel property polygons that are not used as full time residences as the zones of interest, allowing StreetLight's built-in analysis to produce an estimate of average daily vehicle entries for each polygon (which represented each hotel/motel property and its associated parking lot). The output produced by the StreetLight analysis is a useful starting point, but a number of steps were required to produce a reasonable final estimate of vehicle entries attributable to visitors staying at the property.

StreetLight's analysis provides four (4) different values in its output. First, an overall total of ***inbound*** vehicles per day is provided for any zone of interest: in other words, the zone (the hotel polygon) reports only daily vehicle entries. Then, the total trips are subcategorized as follows: HBW (home-based work), HBO (home-based other), and NHB (non-home based) vehicle entries, which together sum to the total trip entry value. These breakdowns are essential to providing a more refined estimate attributable to visitors, as not all vehicles that enter a hotel or motel property each day are those driven by people staying there.

One technique that helped our estimate was to leverage the limited number of entry points to the Tahoe Basin. There are seven such points along major roads, most of which are mountain passes. These include 1) 89 - Tahoe City, 2) Brockway Summit, 3) Echo Summit, 4) Kingsbury Grade, 5) Luther Pass, 6) Mt Rose Highway, and 7) Spooner Summit. For the Streetlight analysis, we set the "Origin" as each of the seven entry points, which carry a unique volume of traffic to the "Destination", which is each hotel property.

We then ran separate analyses for 1) all entries to hotel properties, which we refer to as "all trips", including all entries regardless of where the vehicle originated, and 2) all vehicle entries that had the seven basin entry points as origins, with the destinations as hotel properties. We refer to this second group of trips as "external" trips, as they travel through one of the passes to reach the property.

This allowed us to produce a balance of trips with greater spatial precision, as subtracting external trips from all trips leaves only those trips with origins inside the Basin (we refer to this group as "internal" trips), which is helpful for producing estimates for each of the trip types. Using the trip type designations (HBW, HBO, and NHB), and the all trips, external trips, and internal trips categorizations, we could produce the estimates summarized in Table 7 below. Each subsection contains an explanation of considerations, and concludes with a concise estimate assumptions statement to help with comprehension of Table 7.

Home-Based Work Trips

HBW trips are those where home is one end of the trip and work is the other. For our analysis, given that the hotel or motel property is one of the anchors, and unless someone lives at the property, is not a home location for anyone, we assume these are employees' trips that reach the property. Therefore, we assume **none** of these trips are attributable to visitors, and therefore not included in potential visitor estimates.

<u>Estimation Assumptions</u>: We do not include any of these trips in our visitor estimates.

Home-Based Other Trips

HBO trips are those where home is one end of the trip and a destination (besides work) is the other. Notably, for this analysis, StreetLight analysis only records vehicle *entries* to the property. Since home is one end of the trip and we know the hotel or motel property is the other, it is reasonable to assume these represent trips where someone begins their trip at home and ends at the hotel or motel property. Additionally, because of how StreetLight records trips, these trips include no intermediary stops between home and the property **that exceeded five minutes**. The only exception would be if someone lives at the property, exits, and re-enters after visiting a destination (that is not work), but this is too infrequent to consider for this analysis.

In total, we estimate there are 10,488 HBO trips to the hotel properties on an average day (all trips). Interestingly, only 1,286 are external trips, which require travel through one of the entry points to the Basin to reach the property. There are no other reasonable entry points into the basin beyond these seven entry points, so we conclude that the remainder must necessarily begin at a home location within the Basin, as the home-based trip did not move through one of the seven entry points. These trips, then, likely include resident vehicle entries to on-site restaurants, shops, resorts, or other on-site amenities shared with the hotel property. It also could be a reflection of locals using some of the larger hotel and resort property parking lots, which are free, as means to reach shopping, dining, or recreation. These could also include trips made to the properties by ride-hailing operators such as Uber or Lyft, where a driver left from a local home location and drove to the property to pick up a customer. These considerations should be further explored in future work in the area.

Estimation Assumptions: For visitor trips, we consider 95% of the 1,286 external HBO trips to be attributable to visitors. Given that these trips began at an external origin classified as a "home" location, went through one of the seven entry points, and reached the hotel property without any intermediary stop, it is reasonable to assume these are all visitors. It is possible that some stopped at this property before proceeding elsewhere, so reducing this total by 5% accounts for this possibility.

Non-Home Based Trips

This category of 14,377 trips (all trips) unquestionably contains the most uncertainty regarding attribution to overnight visitors for our analysis. First, by definition, these trips are those where home is neither the origin nor the destination. From a visitation standpoint, this could include vehicles entering the hotel property on a trip that began at nearby restaurants/bars, shops, recreation areas, etc., or any other of the kinds of locations that tourists would frequent while staying in the Tahoe Basin.

This brings up an additional consideration. StreetLight stops recording a trip when a device has **been stationary for five minutes**. When the device is in motion again after that point, **a new trip is recorded**. This has ramifications for our analysis, particularly for designation as one of three trip type categories (HBO, HBW, NHB). Consider a hypothetical visitor's trip between the San Francisco Bay Area and the Tahoe Basin, where a visitor has a reservation at a hotel or motel. If that trip leaves from home, then they stop along the way for food, fuel, a rest, or some other purpose, and - if that stop is at least five minutes long and the device is stationary - the initial trip from home would thus end at this intermediary stop and be recorded as an HBO trip. When hypothetical travel resumes towards the Tahoe Basin, a new trip (per StreetLight) "begins" at that intermediary stop that is not home, and "ends" when they reach the hotel. This would be recorded as an NHB trip, even though travel ultimately began at the visitors' home. From our standpoint, a scenario like this would reasonably be a trip attributable to a visitor.

These kinds of trips that include an intermediary stop at a non-home location prior to ultimately reaching the hotel property destination in the Tahoe Basin are not uncommon, though no data exist on exactly what distribution of trips meet this criteria, no can the StreetLight data be used to determine this. Assumptions, then, are needed to generate an estimate, but will differ depending on whether the trip is external (intermediary stop was prior to Basin entry) or internal (intermediary stop was somewhere in the Basin after the traveling party went through one of the seven entries). Further data collection efforts are needed to better understand vehicle entries related to visitors.

The external NHB trips (1,538 total) of interest to our study include those that stopped outside of the basin on a trip that left from their home or a non-home location (such as one of the regional airports), or left from an external location without an intermediary stop, and then crossed one of these entry points and ended at the property. It would also include someone who started the day at the hotel, went skiing, hiking, climbing, fishing, etc. outside the basin, then came back that day directly from that location to the property. The former case is a trip type we would want to attribute to a visitor while the latter (while also a visitor trip) would be a case of double-counting someone as reentering the region whom was already staying there.

Estimation Assumptions: We estimate that 90% of the 1,538 external trips are attributable to visitors staying at the properties, assuming that the other 10% are those where a vehicle is returning to and re-entering the property after spending the day recreating outside of the basin, those stopping at the property for some other purpose before eventually continuing to a final destination either elsewhere in the basin or externally, or freight deliveries.

The internal NHB trips (12,839 total) of interest to our study are those entered the basin from an external location, and then stopped at an intermediary location for at least 5 minutes, then went to the property. Those would be classified as an in-basin NHB trip per the StreetLight analysis, and examples would include those who stop at a gas station, restaurant, bar, grocery store, beach, store, etc., in the basin before then going to the property.

Estimation Assumptions: We estimate that 20% of the 12,839 "internal" NHB trips, are those that stopped somewhere in the basin first before going to stay overnight at the property. Again, this is a traveling party in a vehicle that stopped at a gas station, grocery store, bar, restaurant, beach, etc., in the basin, then went on to their hotel for the night. As has been well detailed before, the possibilities of these kinds of trips are endless, though it not at all unreasonable to think this kind of trip is unusual. The remaining 80% include the myriad other possible trip types that could be included in this count of 12,839 trips.

To reach out final estimate, we:

1) Sum the total estimated daily vehicle entries for all 183 properties, attributable to visitors
2) Multiply the daily vehicle entries by 365, then
3) Divide this total by the 1,754,130 total hotel/motel rooms rented

The final estimated values are presented in Table 7.

Table 7. Analysis Vehicle of Entries to Hotel/Motel Properties, Approach 1

Trip Type	All Trips	All Internal Trips	All External Trips	Estimated Visitation Trips
HBO Trips/Day (StreetLight)	10488	9202	1286	1,222
NHB Trips /Day (StreetLight)	14377	12,839	1538	3,952
Notes on Inclusion Estimates	--	*20% NHB*	*95% HBO, 90% NHB*	--
Vehicle Entry Trips/Day (HBO + NHB)				5,174
Annual Vehicle Entries (HBO + NHB) * 365				1,888,510
Annual Vehicle Entries/Rooms Rented (FY 18-19)				**1.08**
Estimated guests per Room (3.2 visitors/vehicle, per visitation survey)				3.45

4) Number of Occupied Campgrounds and Vehicles per Campground

There are four data sources regarding the volume and occupancy of campsites within the Tahoe Basin. Data from the United States Forest Service (USFS) shows there were 48,004 occupied campsites and 173,551 estimated occupants in the 2018 season (May-October). State Parks data indicate there are 32,879 sites and 147,956 estimated occupants. State Parks does not track total number of visitors to campgrounds, but suggests the use a multiplier of 4.5 occupants per site to estimate total occupants. According to the summary from the Tahoe City Public Utility District (TCPUD), in Year 2018, the total number of occupied sites was 1331 and 2,110 occupants. Finally, The City of South Lake Tahoe provided data on the number of campground sites (17,070) and total occupants (58,240) in 2018. In total then, the total number of occupied campground sites was 99,284 and the estimated number of people at campgrounds is 381,857, producing an estimate of people per site of 3.8 basin-wide.

Table 8. Campground Unit and Occupancy Estimates, Lake Tahoe Basin (2018)

	USFS	CA State Parks	TCPUD	City of South Lake Tahoe	**TOTAL**
Units	48,004	32,879	1,331	17,070	**99,284**
Occupants	173,551	147,956	2,110	58,240	**381,857**
Occupants/Units	3.6	4.5	1.6	3.4	**3.8**

APPENDIX B: VISITATION DATA ESTIMATES AND METHODS

Susie Pike, Institute of Transportation Studies, University of California-Davis

A robust estimate of the number of commute trips into and out of the Tahoe basin is an important step in the process of estimating per capita VMT in the basin. This document summarizes a method for estimating the number of daily commute trips for the Tahoe basin. This approach draws on two housing needs assessments for the Tahoe Region. The analyses in these assessments estimate the total number of commuters as a portion of the population in need of housing within their respective areas of the Tahoe Basin.

The estimate presented here is based on two reports detailing housing needs for the North and South areas of Tahoe. These two reports differ in their methodologies and other aspects, but both provide an estimate of commuters into their respective areas, and we use these values as a basis for the estimate of daily commute trips into and out of the Basin. Both reports count those who commute into their respective areas which can include north Tahoe commuters who work in the south shore and vice versa. Neither of which would be considered commuters for the purpose of this analysis, which is focused on commute patterns from inside to outside the Tahoe Region. This is addressed in the final adjustments made to the estimates in the final section of this write-up. In addition, TRPA estimates of the number of employees in each area of the basin are used in some of the estimates presented here.

Table 1 Count of Employees in Tahoe Basin by County

Jurisdiction	Employees
CSLT	9,660
DOUGLAS	6,999
EL DORADO	2,428
PLACER	5,419
WASHOE	4,098
Total	28,604

Source: TRPA Draft Regional Transportation Plan (2020)

Report 1. South Shore Housing Needs Assessment

The South Shore Housing Needs Assessment (Sullivan et al. 2019) covers the southern portion of the Tahoe Basin, and overlaps with the TRPA's area of interest for the estimation of the effective commuter population. Much of the relevant information is from Section 2 of the report: Jobs, Seasonality, and Commuting. The total number of jobs is slightly different from TRPA's internal estimate of 28,604 jobs in the South Shore area. This table from the report (Sullivan et al. 2019 p.31) shows the projected jobs in the South Shore area, out to 2026.

Table 2. Job Estimates and Projections: 2011 to 2026*

				Annual Growth Rate	
	2011	**2019 (est.)**	**2026**	**2011-2019**	**2019-2026**
El Dorado County	70,450	79,820	86,610	1.6%	1.2%
Douglas County	24,780	28,680	30,880	1.8%	1.1%
South Shore Region[7]	23,340	26,880	29,110	1.8%	1.1%

*Reproduced from Sullivan et al. 2019

In the South Shore report, two values are used to estimate the number of commuters. First, an employer survey conducted for the report which found that 25% of employees commute. The second value, 31% is based on an adjustment of the US Census Longitudinal Employer-Household Dynamics to account for proprietors (see Sullivan 2019 p. 39). These two values; 25% and 31% are both used in the analysis in the report, and both are used in the calculations presented here.

Based on these two values, the estimates in the report are 4,480 and 5,500 commuters, accounting for 25% and 31% of employees, respectively. The report does not include information about where these employees commute from, though they do note that their employee survey results found that most of the commuters live outside of the basin in Carson City, and drive single-occupant vehicles an average of 4.4 days per week. This would equate to commuting approximately 229 days per year (52 weeks * 4.4 days a week).

If employees commute 4.4 days per week and are equally spread across the seven days of the week, that puts 63% of these trips on any given day (there is a 63% chance that any given commuter is travelling on a particular day; or on average, 63% of commuters are travelling on each day of the week) We assume that many commuters work in industries that are open on weekends such as ski areas, hotels, and other services.

Taking 63% of 4,480 and 5,500, results in 2,816 and 3,457 commute trips into the south shore area of basin on an average day. This value accounts for only commuters who commute into the south shore area *from other locations*; not those commuters who commute from within the south shore to other places.

Report 2. North Tahoe and Truckee

For the northern area of the Tahoe Basin, we looked at the North Tahoe Truckee MHC Housing Report (2016). This report includes a similar assessment of housing needs, based in part on the number of workers commuting into the area.

Based on table 10 of the report, in 2013 there were 9,271 people living outside the region who were commuting into the area for work, and 5,723 residents of the region were commuting out for work (TTCF 2016). Here, we focus on the 9,271 people who were commuting into the area.

TABLE 10: COMMUTE FLOWS, TRUCKEE NORTH TAHOE STUDY AREA, 2003 AND 2013(A)

	2003		2013		Percent Change
	Count	Share	Count	Share	
Employed in Region	**14,266**	**100%**	**15,825**	**100%**	10.9%
Live Outside Region/In-Commuters	7,875	55.2%	9,271	58.6%	17.7%
Live Wit	6,391	44.8%	6,554	41.4%	2.6%

hinRegion					
LivinginRegion	**10,326**	**100%**	**12,277**	**100%**	18.9%
WorkOutsideRegion/Out-Commuters	3,935	38.1%	5,723	46.6%	45.4%
WorkWithinReg	6,391	61.9%	6,554	53.4%	2.6%

ion						
Net Inflow/Outflow	**3,940**		**3,548**			-9.9%

Note: (a) The Truckee North Tahoe Study Area is defined based on 2010 Census Block Groups, to approximate the area encompassed within the desired study area. For a complete listing of the included Census Block Groups, please refer to Appendix A. Sources: U.S. Census Bureau, LEHD Origin-Destination Employment Statistics, 2015; BAE, 2015.

The area covered in this study overlaps with the basin, but is not contained entirely within the basin, as a large portion of the area is in and around Truckee. We account for this through the following: the report indicates a total of 15,841 jobs in the study area. The TRPA estimates that there are approximately 5,419 jobs in the Placer County portion of the Tahoe basin (the only part of the study area in the Tahoe basin). This means that about 34% of the jobs counted in the TCCP report are within the basin. This amounts to 34% of 9,271 or 3,152 commuters.

And, as above, if each commuter makes 4.4 trips per week, and we use a 7-day work week, on average 63% of workers are commuting on any given day, resulting in 1,985 commuters travelling into the basin each day.

We also adjust for the commuters from other parts of the Tahoe Region into or out of the Tahoe portion of the TTCF study region. Utilizing a Streetlight analysis for an average day in 2019 to estimate intraregional commuting between the Tahoe portion of TCCF study region and other portions of the Tahoe Region, there are approximately 750 home-based-work trips daily between the two areas. The results of the most recent resident travel survey indicated that 60% of commuters travel directly to and from home on a given day, it would be mean that the 750 trips between the north and other parts of Tahoe represent only 60% of the total, and that there were actually 1,250 between region commute trips. This is because the Streetlight analysis identifies only home-based work trips, so we adjust to account for the non-home-based work trips. This would reduce the total number of commuters in the north to 735 commuters on an average day for the northern areas of the basin.

Commuters Leaving the Tahoe Basin

The estimates presented above only account for commute trips coming into the basin, and not those travelling out. In this section we present an estimate of the commute trips leaving the basin each day.

For the North Shore area, there is useful information contained in the housing assessment. Based on table 10 of the report, in 2013 there were 5,723 residents of the region commuting out for work (TTCF 2016). We apply the same methodology as above, for the North Shore area. That is, we take 34% of the 5,723 residents of the region who commute out. So, we have 1,945 commuters who commute out of the North Shore area. And, as above, if each commuter makes 4.4 trips per week, and we use a 7-day work week, on average 63% of workers are commuting on any given day, resulting in 1,226 commuters travelling out of the northern portions of the basin each day.

For the South Shore areas there are no estimates of commuters leaving the region, but we may make reasonable estimates based on what we know about the North Shore area. If we assume the same level of out commuters per job, for the south as we do for the north, we can use a rough factor of the ratio of jobs in the north versus the south. That is there are 16,516 jobs in the northern three counties and 12,088 jobs in the southern two counties. The number of jobs in the south is 73% of the number of jobs in the north. If the rate of out commuters per job is approximately the same in the north and south areas, we calculate 0.73 x 1,226 or about 897 commuters out of the south area of the basin each day. Adding this to the 1,226 commuters out of the north shore area results in approximately 2,123 commuters out of the entire basin each day.

Alternatively, we can look at the ratio of in commuters to out commuters in the north portion of the basin and use the same ratio in the south area. In 2013 there were 9,271 people living outside the region who were commuting into the area for work, and 5,723 residents of the region were commuting out for work (TTCF 2016). That is, for every person commuting in, there were approximately 0.62 persons commuting out. We had between 2,816 and 3,457 commute trips into the south shore area of basin on an average day. We apply the ratio of 0.62 persons commuting out for each person commuting and we have a range of 1,738 and 2,143 commuters out of the South Shore areas. This estimate results in a total of 2,964 commuters out of the entire basin each day.

A third way to estimate the out commuters is to estimate out commuters for the entire region at once, using information about jobs in the region and the results of the recent resident travel survey. As shown in table 1, there are 28,604jobs within the region, and we assume that 63% of commuters travel each day, using the 4.4 days per week for each commuter. That means there are approximately 18,020 commuters per day from within the basin and from outside of the basin; to get to these jobs.

From the analysis presented here, we estimate that there are 3,551 (2,816 + 735) incoming commuters each day, taking that away from the 18,000 total commuters leaves 14,469 Tahoe residents (as opposed to those who are residents elsewhere) each day that commute.

Results of the most recent travel survey found that 88% of the commute trips made by residents are within the basin; assuming that these 14,469 trips represent 88% of the commute trips made by residents there are a total of 16,442 commute trips made overall. The remaining 12% of these trips can be attributed to residents commuting out of the basin; or about 1,973 trips made by commuters leaving the basin.

Putting it Together

Taken together, the estimates based on each of these housing needs reports sum to 7,632 commuters (or 8,652 on the higher end). However, Washoe County in Nevada is not covered within either report, though Washoe County has a total of 4,098 jobs and accounts for approximately 14% of the jobs within the Tahoe Basin. The other counties in the basin have a total of 24,506 jobs and 7,632 commuters (or 8,652 on the higher end). This means there are approximately 2.8 jobs within the area per commuter or that commuters fill between 31%-35% of jobs in the Region. We apply this to the 4,098 jobs in Washoe County, and estimate that there are 1,270 commuters into Washoe County. Adding this to 7,632 gives the new estimated population of commuters as 8,902 (or using the higher percentage and value, 1,434 added to 8,652, results in a commuter population of 10,086).

Applying the average of 4.4 commute days per week or 63% commuting each day to the Washoe County portion, this adds 63% of 1,270 or 800 commute trips each day. With 2,816 trips into the south shore area, and 735 commute trips into the north area, and these 800 trips into the Washoe County portion of the region, there are 4,351 commuter trips coming into the Basin, each day.

The housing needs assessments utilized to derive the above estimates of number of commuters classify North-South in Region travelers as commuters even if the entire trip is inside the Tahoe Region. For example, individuals that live in Incline Village and travel to South Lake Tahoe for work. To refine the estimate to only those commuters that travel into the Tahoe Region for work, we utilize Streetlight analysis for an average day in 2019 that estimated intraregional commuting between the north and south shore areas at approximately 140 home-based work trips on an average annual day; if we again assume this represents only 60% of the actual work trips, 140 is 60% of 233 trips. From this we infer that around 233 of the commute trips are made by people who commute between the two areas on an average day. So, we remove these trips from the sum of 4,351 and have a final rough estimate of 4,117 commute trips per day into the basin.

We also add the estimate of 1,973, based on the most recent TRPA resident travel survey This results in a total of for a total of 6,090 commuters going in both directions on an average day. This accounts for 21% of the 29,000 daily trips.

Alternative Estimates of Commute Trips

StreetLight Data

Other methods have been used to estimate the effective commuter population and the total number of daily commute trips entering and leaving the basin. One estimate, based on analysis of StreetLight data, is approximately 3,000 home-based work trips on an average day. This accounts for about 12-13% of trips included in the data (as opposed to estimates of total trips from other daily trip/vehicle counts). The estimate includes only home-based work trips, and likely underestimates commute trips, since not all work trips start at home. A correction factor could be worked out and applied to the non-home-based trips in the StreetLight data to account for those work trips that do not start at home. This correction factor would also provide a means to attribute some trips originating or ending outside of the basin to and from hotel locations to employees. Currently all of the non-home-based trips that originate or end outside of the basin with travel to/from a hotel are counted as hotel visitors.

2017 National Household Travel Survey (NHTS)

Another estimate of commute trips is based on analysis using the 2017 National Household Travel Survey (NHTS) data in the California Add-on sample. Isolating households that made any trips in the Tahoe area , non-resident commute trips accounted for 18% of total entry and exit trips, which equates to 5,220 one way trips, using the total estimate of 29,000 one way trips. The primary limitation of this analysis is the small, and likely unrepresentative sample. A detailed discussion of this analysis is found in the document NHTS TRPA Analysis.

Next Steps

Based on their own household and employee survey, the south shore area report notes that in-commuters travel an average of 29.3 miles in their commutes; useful information for later estimates of VMT for the different groups in the population.

APPENDIX C: EXPLORING THE NATIONAL HOUSEHOLD TRAVEL SURVEY DATA FOR THE TAHOE BASIN

Susie Pike, Institute of Transportation Studies, University of California-Davis

This is a summary of the trips into, out of and within the basin using data from the National Household Travel Survey (NHTS). The data was collected in 2017, and in addition to the national sample collected for the NHTS, an extra sample of 24,000 households was collected in California. The subset of households used here include all households with a *location* within the Tahoe Basin (basin). For most of the households this means that they had a trip that started or ended within the basin, regardless of where their home is (there a few households with no trips – see below). The goal of this exercise is to help determine the proportion of trips coming into and out of the basin that fall into these categories:

- Commute trips from outside of the basin, ending within the basin – and their return trips
- Visitor trips from outside of the basin, ending within the basin – and whether these trips have a return trip to somewhere outside of the basin or not
- Commute trips from inside of the basin, ending outside – and the returns
- Recreational trips from inside of the basin, ending outside – and the returns
- Trips of all types for households within the Basin
- Vehicle occupancy and other characteristics by trip type

To identify locations within the basin, the data was subset to include any household that had a location associated with the following:

- Seven zip codes: 96150, 96142, 96141, 96145, 96140, 96148, and 96143
- Five cities: Crystal Bay, Stateline, Zephyr Cove, Incline Village, and Lake Tahoe

Using the location data, all households with any location in the basin were identified. Note that a location is any place associated with a household; the household location, work and school locations and any other place household members traveled to. The location and household information were merged with the trip data to produce a final dataset that included all trips for all households with any location within the basin. There are 113 households with locations in the basin. The number of households in the sample used here is reduced to 101 as there are 12 households that do not have trips or were removed from the trip data for another reason. These 101 households made a total of 719 trips, and these are broken down below.

Trips are categorized by their start and end location. A trip that enters the basin originates outside of the basin area delineated above and ends within the area. A trip within the basin starts and ends within the basin and so on. Residents are members of households that are located within the basin.

Table 1: Trips by residents and non-residents (including visitors)

Type of trip	Resident	Non-resident and visitor
Enter basin	20	24
Leave basin	20	24
One way in	4	19

One way out	4	18
Entirely outside of basin	44	190
Entirely within basin	215	137
Total	307	412

Looking at only the trips made by residents, and excluding those that are entirely outside of the basin, there are 263 trips, and 48 of those trips, approximately 18%, are into or out of the basin.

Notably, there are not many trips that go into the basin or leave the basin, and non-residents and visitors travel much more within the basin once they are there, than residents do while outside of the basin. Residents account for approximately 43% of the trips and non-residents and visitors the remaining 57%.

The type of trip is further broken down by type of activity at the trip destination, and in some cases the origin, i.e. all trips that start or end at a work location are considered work trips (details below). Trips are designated as resident or non-resident. For the purposes of this exploration, any trip originating outside of the basin and made by a non-resident, that cannot be classified as a work trip is a visitor trip.

Table 2: Trip types by residents, non-residents and visitors

Trip type	**Definition**	**count**	**percent**
nonresident outside	Home location not in basin; origin and destination outside of basin	190	26.54%
nonresident work enter	Home location outside, activity is work, origin outside, destination inside	2	0.28%
nonresident work out	Home location outside, origin activity is work, origin outside, destination inside	2	0.28%
resident one way in	Home in basin, O outside, D inside; no/not apparent return trip	4	0.56%
resident one way out	Home in basin, O inside, D outside; no/not apparent return trip	4	0.56%
resident other in	Home in basin, non-work activity, O outside, D inside	11	1.54%
resident other out	Home in basin, non-work, O inside, D outside	11	1.54%
resident outside	Home in basin, O and D outside basin	44	6.15%
resident within	Home in basin, O and D in basin	215	30.03%
resident work enter	Home in basin, work activity at O, O outside, D inside	8	1.12%

resident work out	Home in basin, work activity, O inside, D outside	8	1.12%
visitor in	Home outside basin, O outside, D inside	21	2.93%
visitor one way in	Home outside basin, O outside, D inside; no/not apparent return trip	19	2.65%
visitor one way out	Home outside basin, O inside, D outside; no/not apparent return trip	18	2.51%
visitor out	Home outside basin, non-work, O inside, D outside	22	3.07%
visitor within	Home outside basin, O and D inside basin	137	19.13%
Total	**---**	**716***	**---**

* 3 trips remain to be classified; didn't catch them with current coding

Most trips are either within or outside of the basin, however if we examined these trips as tours, this would likely shift. This would also change if the non-resident trips that take place outside of the Tahoe area, or outside of the basin were removed from the data. Resident trips entering and leaving the basin account for approximately 4% of trips overall, while visitors account for approximately 9%, and commuters (residents and non) slightly less than 3%.

Looking only at the trips that enter or leave the basin area, commute trips by residents and non-residents make up about 15% of the trips. Other travel by residents, accounts for 23% of the trips, with visitors making up the remaining 63%.

Table 3: Trips entering and leaving the basin

Trip type	count	percent
nonresident work enter	2	1.5%
nonresident work out	2	1.5%
resident one way in	4	3.1%
resident one way out	4	3.1%
resident other in	11	8.5%
resident other out	11	8.5%
resident work enter	8	6.2%
resident work out	8	6.2%
visitor in	21	16.2%
visitor one way in	19	14.6%
visitor one way out	18	13.8%

visitor out	22	16.9%
Total	**130**	100%

Turning to some of the characteristics of these trips, this table shows the mean vmt, hour of day that the trip was started, and vehicle occupancy according to the type of trip. Unsurprisingly, the number of occupants is greatest for trips made by visitors. The higher VMT for one way trips is likely because these trips involve staying at (or returning from) a destination overnight.

Table 4: Trip characteristics by trip type

trip type	Sample (N = 716)	mean distance	start hour	Occupants
nonresident outside	190	9.65	13.94	1.88
nonresident work enter	2	19.38	7.00	1.00
nonresident work out	2	19.27	16.00	1.00
resident one way in	4	99.09	13.50	1.00
resident one way out	4	36.91	12.50	2.00
resident other in	11	18.27	16.27*	1.60
resident other out	11	12.93	14.55	1.91
resident outside	44	8.76	15.39	1.43
resident within	215	2.45	13.26	1.57
resident work enter	8	10.11	15.88	1.13
resident work out	8	10.15	8.50	1.25
visitor in	21	21.03	13.67	2.29
visitor one way in	19	69.24	13.90	2.53
visitor one way out	18	40.66	15.06	2.89
visitor out	22	24.91	14.41	2.23
visitor within	137	1.61	14.61	3.05

*trip start hour not reported for one resident other in trip; n = 10

For the tables above, trips taken by household members traveling together are in effect, double counted. The next section addresses this issue by collapsing multiple trips made by more than one household member traveling together into single trips. Analyses similar to those above are presented for this reduced set of trips.

Trips with multiple household members were collapsed by aggregating the data by the household, the trip origin and destination and the hour the trip was made. The assumption is that there would not be two trips made by two household members starting and ending at the same locations if they were not traveling together. There are some situations where this could happen – such as meeting up with a family member on the way home from work, and then both driving home in separate vehicles. This can be explored in future steps.

All trips made by bicycle, walk, and transit are counted as unique trips; even if two household members travel together, each person trip is counted, since we care about travelers for these modes, while we care about vehicle trips for personal vehicle travel in cars, vans, SUVs, etc.

Table 5: Proportions of Trips for Unique Set of HH Trips

Trip type	Count	percent	Percent – in/out only
nonresident outside	151	25.2%	---
nonresident work enter	2	0.3%	1.9%
nonresident work out	2	0.3%	1.9%
resident one way in	4	0.7%	3.7%
resident one way out	3	0.5%	2.8%
resident other in	10	1.7%	9.3%
resident other out	9	1.5%	8.3%
resident outside	39	6.5%	---
resident within	194	32.3%	---
resident work enter	8	1.3%	7.4%
resident work out	8	1.3%	7.4%
visitor in	17	2.8%	15.7%
visitor one way in	15	2.5%	13.9%
visitor one way out	12	2.0%	11.1%
visitor out	18	3.0%	16.7%
visitor within	108	18.0%	---
Total	**600***	**100%**	**108 trips ~ 18.5% of total *unique* trips**

*trip start hour not reported for one resident other in trip

Taking this smaller sample of trips, does not result in substantial differences in the proportions of trips of different types. Resident trips (including work trips) make up about one third of the trips that enter and leave the basin; work trips by residents and non-residents account for 18% of these trips.

Table 6: Characteristics of Unique Set of HH Trips

trip type	Sample (n = 600)	mean distance	start hour	Occupants
nonresident outside	151	11.94	14.09	1.69
nonresident work enter	2	19.38	7.00	1.00
nonresident work out	2	19.27	16.00	1.00
resident one way in	4	99.09	13.50	1.00
resident one way out	3	49.54	13.33	2.00

resident other in	10	18.71	15.70	1.56
resident other out	9	13.69	14.89	1.89
resident outside	39	9.53	15.41	1.36
resident within	194	2.28	13.41	1.45
resident work enter	8	10.11	15.88	1.12
resident work out	8	10.15	8.50	1.25
visitor in	17	25.88	13.71	2.35
visitor one way in	15	81.20	13.73	2.53
visitor one way out	12	61.49	15.25	2.75
visitor out	18	30.30	14.44	2.28
visitor within	108	1.53	14.56	2.95

Representativeness of the NHTS sample

The NHTS sample differs from the population in terms of socio-demographics in a number of areas. First, the average household size is smaller for the NHTS sample in the reference year of 2017.

Table 7: Average household size:

Estimate	Margin of Error	Year & Source
2.3212	0.3284	2010 ACS 5-year Estimate
2.3132	0.3352	2011 ACS 5-year Estimate
2.354	0.3268	2012 ACS 5-year Estimate
2.364	0.3304	2013 ACS 5-year Estimate
2.37	0.3148	2014 ACS 5-year Estimate
2.3828	0.3092	2015 ACS 5-year Estimate
2.386	0.2896	2016 ACS 5-year Estimate
2.26375	0.2425	2017 ACS 5-year Estimate
2.0956	SD = 0.748	2017 NHTS Data for the Tahoe area
2.325	0.299286	2018 ACS 5-year Estimate

The distribution of income differs, though not for every income category.

Figure 1: Income for NHTS sample and ACS sample

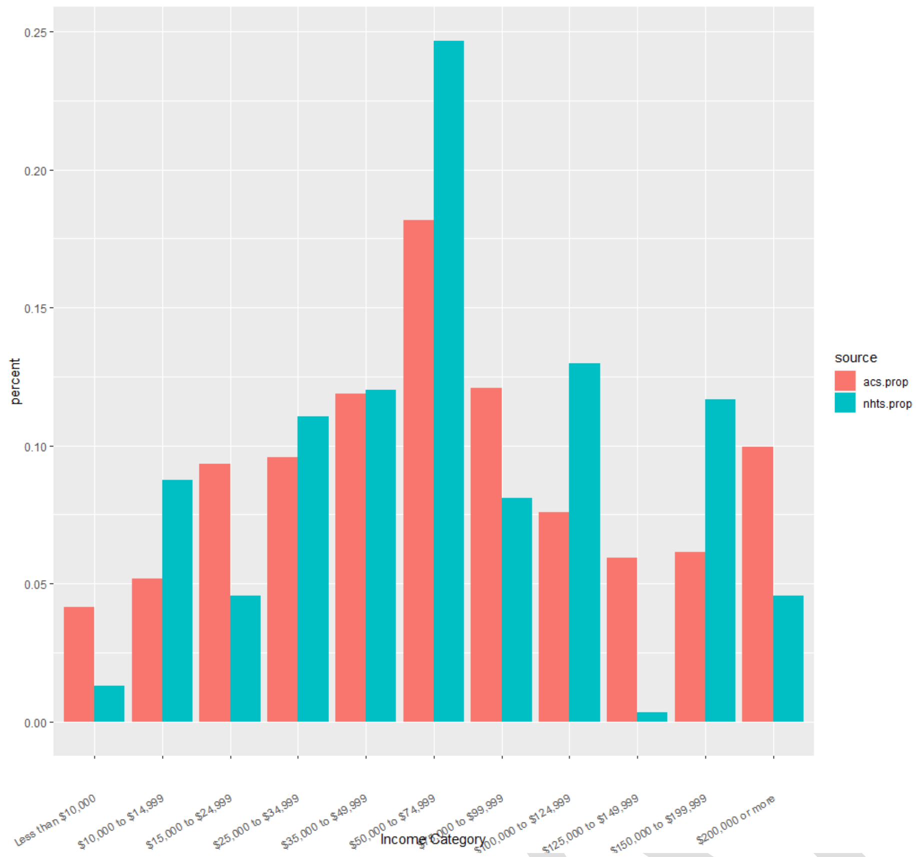

Table 8: Race

Variable Name	Population Count (Source: 2010 Decennial Census) (%)	NHTS data Count (%)
American Indian and Alaska Native alone	389 (0.7%)	---
Asian alone	1,820 (3.3%)	2 (.6%)
Black or African American alone	346 (0.62%)	---
Native Hawaiian and Other Pacific Islander alone	80 (0.14%)	---
Some Other Race alone	4,849 (0.87%)	3 (1.0%)
Two or More Races	1,613 (0.29%)	14 (5.0%)
White alone	46,510 (83.6%)	279 (91.0%)
Regional Population	55,607	307

There are a number of race groups that are not represented in the NHTS data for the Tahoe area. The other proportions are also therefore slightly higher? The total sample for race is 307, so the proportions shown do not add up to 100, since there are some who refused to answer.

Additional variables may be reviewed, and weighting could be applied for some demographic characteristics; probably best to do so for income but we could add age and gender information when available (or when processed).

APPENDIX 4: FORECAST SUMMARY

Introduction

As part of the 2020 TRPA Regional Transportation Plan (RTP), TRPA prepared regional development and transportation forecasts for the years 2035 and 2045. The regional development forecast includes changes in development, population, demographics, and visitation. The transportation forecast includes the RTP project list, as well as the transportation strategies. The regional development forecast and the transportation forecast are implemented in the Tahoe travel demand model and the Trip Reduction Impact Analysis (TRIA) tool to allow planners to assess the efficacy of policies and projects that promote the goals of the Regional Plan and the RTP.

Development Forecast Summary

The 2035 and 2045 forecast years build upon the 2018 model base year, which was developed during the fall of 2019. More information about the 2018 base year can be found on the Tahoe model website. The forecasts include a variety of projections related to land use and the characteristics of the Regions' traveling population in the forecast years; this population includes residents, visitors, and commuters. The forecast years of 2035 and 2045 were selected to meet specific regulatory requirements of the California Sustainable Communities Strategy (SCS) and Federal RTP requirements.

Residents– The forecast projects Lake Tahoe's full-time residential population to increase slightly. The forecasted increase is a deviation from the declines in the Region's population observed over the last 20 years and is influenced by a suite of factors. First, the number of regional housing units will increase as residential allocations are distributed and workforce housing/affordable housing programs are implemented using residential bonus units (which restrict units from being used as second homes or vacation rentals). Similarly, the residential occupancy rate – the proportion of homes occupied by residents – is expected to increase due to the increase in housing supply available for residents from implementation of workforce and affordable housing initiatives as local and regional efforts to increase the housing supply for local residents take effect. The downward trend in regional population in the last 20 years was likely influenced by the declines in gaming and associated job loss. The precipitous declines in gaming revenues observed in the early part of the century following the opening of casinos in northern California have not continued into the second decade as revenues appear to have stabilized. The income distribution of the residential population will remain steady as increased provision of workforce and affordable housing counteract recent upward trends in household income. School enrollment will increase slightly because of overall population growth. Employment will also increase slightly as additional Commercial Floor Area (CFA) and Tourist Accommodation Units (TAU) are constructed throughout the Region.

Visitation – The forecast projects both day and overnight visitation to the Lake Tahoe Region to increase during the forecast years. This forecasted increase is based upon the projected population growth in the mega-region (Bay Area/Sacramento/Reno), forecasted increases in traffic counts in adjacent areas, and the increasing popularity of the outdoor recreation experience. This increase in visitation will result in an increase in the number of occupied overnight lodging units, short-term rentals, and seasonal homes.

Table 1: 2045 Forecast Data Summary

Forecast Data Summary				
	Base Year 2018	Forecast 2045	change (#)	change (%)
Residential Units and Population				
Residential Population	**51,624**	**58,041**	**+ 6,417**	**12.4 %**
Occupied Units	**21,624**	**24,315**	**+ 2,691**	**12.4 %**
Unoccupied Units	**26,031**	**28,056**	**+ 2,025**	**7.8 %**
Total Residential Units	**47,655**	**52,252**	**+ 4,597**	**9.6 %**
Income of Occupied Residential Units				
Low Income Units	**10,463**	**11,886**	**+ 1,423**	**13.6 %**
Medium Income Units	**4,891**	**5,437**	**+ 546**	**11.2 %**
High Income Units	**6,254**	**6,843**	**+ 589**	**9.4 %**
Total Overnight Visitor Units				
Short Term Rentals	**6,005**	**5,931**	**-74**	**-1.2 %**
Seasonal Units	**17,129**	**18,544**	**+ 1,415**	**8.3 %**
Campground Spots	**2,120**	**2,120**	**0**	**0 %**
Total Lodging Units	**11,107**	**12,052**	**+ 945**	**8.5 %**
Occupied Overnight Visitor Units				
Occupied Short Term Rentals	**2,227**	**2,240**	**+ 13**	**0.6 %**
Occupied Seasonal Units	**6,396**	**6,911**	**+ 515**	**8.1 %**
Occupied Camping Spots	**1,278**	**1,278**	**0**	**0 %**
Occupied Lodging Units	**6,190**	**7,086**	**+ 896**	**14.5 %**
Other Key Data Points				
Commercial Floor Area	**6,327,319**	**6,533,869**	**+ 206,550**	**3.3 %**
Employment	**28,604**	**29,462**	**+ 858**	**3 %**
School Enrollment	**8,887**	**9,992**	**+ 1,105**	**12.4 %**

Forecast Methodology

The overall approach to forecast development was to apply the best available information and data. The development rate forecast was informed by a review of historical development rates, and an assessment of the performance of past forecasts. The forecast differs from past forecasts in at least two ways:

1. More rational development rates – Prior forecasts have generally assumed that full build out of the Region would occur by 2035 but historic development rates have not kept pace with those forecasts. This forecast refines past methodologies by placing greater weight on observed development rates.

2. Recent overhaul of development rights system - This is the first forecast since significant changes were made to the development rights system to accelerate attainment of threshold standards and Regional Plan goals and policies. The changes enable easier conversion between types and facilitates the attainment of State housing mandates.

The forecasts contained in this document represent a conservative yet realistic view of the continued build out of the Lake Tahoe Regional Plan. Prior forecasts by TRPA had projected significantly faster growth and a faster consumption of the remaining development rights. The annual rate of consumption for commercial floor area and tourist accommodation units were adjusted to align with observed trends more accurately since the adoption of the 2012 Regional Plan update. Additionally, the forecast assumes that not all the remaining development potential for commercial floor area and tourist accommodation units will be constructed by 2045.

Staff anticipates that by 2045 the unknown but likely time-limited economic impacts from the COVID pandemic will be replaced by more normal economic forces.[3]

RESIDENTIAL UNITS

The number of housing units in the Region is influenced by market conditions as well as TRPA's development rights system, which caps the total development potential for the Region. The residential occupancy rate of the housing stock is influenced by economic factors, the number of residents, second home ownership, and visitors that frequent the Region.

There are currently 47,655 residential units in the Region (based on TRPA records); according to the occupancy rates published by the U.S. Census Bureau 2018 American Community Survey (ACS), an estimated 21,624 residential units (45%) are occupied by full-time residents and 26,031 units (55%) are

[3] Additional detail on the considerations related to COVID-19 are included in an addendum at the end of this document.

not occupied by full-time residents (ACS 2018). Currently, approximately 20% of existing residential units in the Region are multi-family units (approximately 9,530 units) and 80% of existing units (38,125) are single family units. By 2045, an additional 4,597 units are expected to be constructed, bringing the total number of residential units in the Region to 52,252, a 9% increase. This includes the construction of 1,823 additional single-family residential units (40% of additional units) and 2,774 additional multi-family residential units (60% of additional units). Forecasts of residential projects in the three California jurisdictions are sufficient to accommodate the Regional Housing Needs Assessment (RHNA) Cycle 5 (2013-2021) and Cycle 6 (2022-2029). The forecast includes a continuation of the RHNA requirements beyond 2029. These requirements were linearly extrapolated to 2045 based on requirements established to date and are accommodated in the forecasts.

All remaining residential allocations (2,234) are allocated and constructed in the forecast. This includes the award and construction of all residential bonus units (1,609), and all currently banked residential units (204) by 2045. The forecast also includes the conversion of 100,000 square feet of CFA and 130 TAUs to residential units, which will generate an additional 290 multi-family and 260 single-family units. The projected conversions are consistent with conversion trends since the adoption of the conversion programs and observed development rights utilization rates. The observed trends indicate a net conversion from CFA and TAUs and towards Residential.

Several key assumptions informed the spatial distribution of residential development in the forecast. First, new residential units were allocated to projects known to be in the pipeline, including multi-family and affordable-/moderate-income projects on public lands. This included 580 units expected to be built on California Tahoe Conservancy (CTC) asset lands[4] , redevelopment successor agency parcels[5] and other publicly-owned parcels where large multi-family and affordable/moderate-income housing projects are likely to be constructed[6]. For multi-family development on private properties, where the exact number of units to be constructed was not fully known, a computer-generated random selections to distribute units to vacant buildable multi-family and existing underbuilt residential parcels throughout the Region. For these parcels, the number of units allocated was 60% of the maximum allowable buildout based on current zoning, coverage constraints, and density restrictions. This assumption is consistent with

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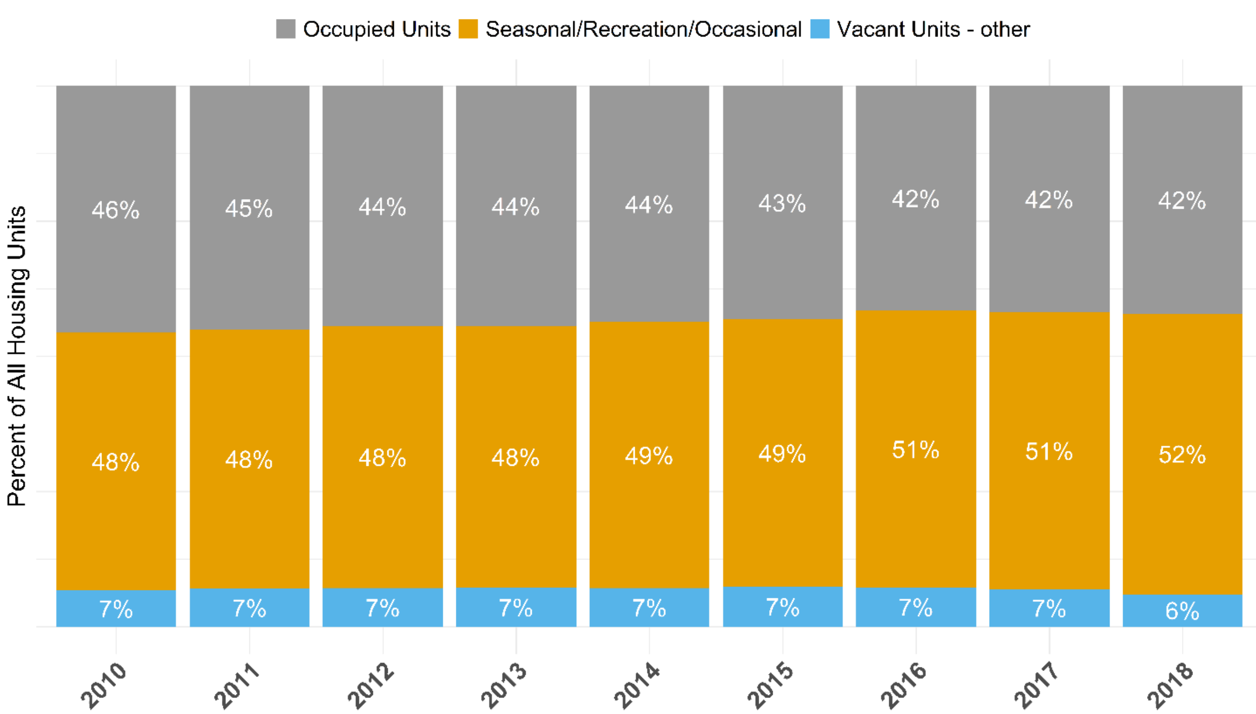
[4] See https://tahoe.ca.gov/programs/tahoe-livable-communities/asset-land-sales/ for more details about potential housing development opportunities that have been identified by the California Tahoe Conservancy.
[5] See https://www.placer.ca.gov/3396/Housing for information about potential housing development project opportunities in Placer County.
[6] Includes housing commitments made by the Tahoe Transportation District as part of the Highway 50 Community Revitalization Project, see https://www.tahoetransportation.org/us50.

observed buildout patterns, and conservative in that it distributes new residential development throughout the Region (rather than modeling the most compact possible pattern). Multi-family units were only assigned to parcels that are currently zoned for multi-family residential, meet density requirements, and that have remaining coverage available to support additional units. Finally, the remaining private residential units were constructed as single-family units through random assignment to vacant buildable properties throughout the Region.

RESIDENTIAL OCCUPANCY RATE

The U.S. Census American Community Survey (ACS) estimates that, since 2010, the proportion of occupied housing units in the Tahoe Region has dropped from 46% to 42% in 2018 (U.S. Census Bureau 2020). The remaining 58% of the regional housing supply not occupied by full time residents is classified by the ACS as vacant (ACS classifies houses as “vacant” if they are permanently unoccupied, periodically occupied by seasonal residents, used as a second homes, or rented by visitors, including short-term rentals). In recent years, the total number of seasonal or short-term housing units increased by 24%, from 21,000 in 2010 to 26,000 units in 2018.

Figure 1: Housing Occupancy (2010-2018)



SOURCE: AMERICAN COMMUNITY SURVEY (ACS)

Despite these trends over the past several years, the forecast includes an increase in the proportion of residential units occupied by full-time residents (owner-occupied and renter-occupied). Three factors are expected to contribute to the shift: 1) Housing Initiatives to promote construction of new workforce, achievable, and affordable housing in the Region, 2) Housing initiatives to promote the transition of the existing stock of residential units from second homes and short term rentals to resident-occupied units, and 3) Measure T in the City of South Lake Tahoe. Additional detail on each factor is provided below.

1. *Housing initiatives to promote new workforce and income-restricted housing*: The development forecast includes construction of all the remaining 1,609 residential units from the TRPA residential bonus unit pool. Residential Bonus Units are awarded as transfer incentives for relocating remote development into town centers, and for the construction of affordable/moderate/achievable housing. New housing constructed with Residential Bonus Units is required by TRPA Code to be deed-restricted to prohibit these housing units from being used for second homes or vacation rentals.
2. *Housing initiatives to transition existing housing stock*: There are several initiatives underway to transition second homes, vacation rentals, and vacant house into residential units for full time residents. The forecast includes significant level of success for these initiatives (and other initiatives unknown at this time) that results in 700 additional units (~1.5% of the 2018 housing stock) occupied by residents in 2035 and 2045. The increase is independent of the forecasted increases described in and 1 and 3.
3. *Measure T in the City of South Lake Tahoe*: Voters passed Measure T in the City of South Lake Tahoe in November 2018 (see https://www.cityofslt.us/453/Vacation-Home-Rentals). The measure includes broad restrictions on short term rentals (STRs) outside select areas in the city. The restrictions go into effect on December 31, 2021. As a result of the measure, approximately 1,372 currently permitted VHRs will not be renewed. The market value of the existing VHR stock skews higher than median values in the Region, so a conservative, but optimistic forecast is that 15% of the units will be transitioned to be occupied by residents (rented or owned); other units are expected to become part of the second home market. A recent study on the economic impact of VHRs in South Lake Tahoe suggested that 10% of existing VHR owners would likely rent to full time if they could no longer use the property as VHR (MBI 2017).

COMMERCIAL FLOOR AREA (CFA)

There are currently 556,796 square feet of un-used commercial floor area in TRPA and local jurisdiction community/area plan pools. Since 2013, a total of 41,928 square feet of CFA has been allocated to projects: an average rate of 6,988 square feet of CFA per year. The forecast includes the construction of an additional of 130,067 square feet of CFA by 2035 and 206,550 square feet by 2045. The forecasted rate of development - 7,650 square feet - is just higher than the observed rate since the 2012 Regional Plan, but lower than rates used in prior regional forecasts. For the forecasts, CFA was allocated to known projects that have been permitted or are in the planning phase, but not constructed; remaining CFA was allocated to town centers and area plans using the observed proportions from recent allocations.

The forecast includes the conversion of 100,000 square feet of CFA to residential units, consistent with conversion trends since the adoption of the conversion program; recent trends indicate the net conversion from CFA and TAUs towards Residential. The converted CFA is forecasted to result in the construction of 400 additional residential units --200 multifamily units, and 200 single family units. At the end of the forecast period, 250,246 square feet of CFA remains unallocated and thus unconstructed.

TOURIST ACCOMMODATION UNITS (TAU)

The forecast includes the construction of an additional 629 TAUs by 2035 and 945 TAUs by 2045. The forecast includes the completed construction of all currently permitted projects using 807 banked TAUs and the use of all 138 awarded TAU bonus units. Not all TAUs allowed in the Regional Plan are forecast to be constructed by 2045; an estimated 230 TAUs will remain undeveloped through 2045 (74 TAU bonus units and 156 banked TAUs). The TAU development rights pool is not exhausted within the forecast horizon, because of the slow rate of TAU right utilization and construction over the past 30 years. No TAUs have been allocated to projects and constructed since adoption of the 2012 Regional Plan, and only 58 TAUs have been allocated since the adoption of the 1987 Regional Plan. TAUs were allocated to projects that are permitted but not yet constructed (Homewood, Boulder Bay, Edgewood Casitas, Tahoe City Lodge, and Chateau/Project 3), and the forecast includes the removal and banking of some existing units. Bonus TAUs were assigned to permitted projects (Homewood, Boulder Bay, Tahoe City Lodge) and no additional allocations other than existing permits were included.

The forecast also includes the conversion of 130 TAUs to residential units, consistent with recent conversion trends since the adoption of the conversion programs; observed trends indicate the net conversion from CFA and TAUs and towards Residential.

Development Rights Forecast Summary

Total development in the Tahoe Region is capped by the Regional Plan. The type and rate of that development is further controlled by a complex system governing development rights in the Region. Development rights are land use units someone must acquire before a property is developed. Development rights include tourist accommodation units (TAUs), single and multi-family residential units of use (RUUs), and commercial floor area (CFA). Residential units of use (RUUs) are formed by combining a potential residential unit of use (PRU) and a residential allocation. The forecast differentiates between when a development right is allocated from TRPA or another jurisdiction’s pool and the final use of that development right. Development rights can be utilized in one of two ways; they can be used to construct a project (e.g. a house) or converted to a different type of development right. The forecast is grounded in projections about the utilization, transfer, conversion, and construction of development rights. Tables 2-4 summarize the fate of development rights in the forecast period.

- Table 2 summarizes new construction which influences land use in the future scenarios. Tables 3 and 4 provide background detail on the underlying accounting that enabled the development.
- Table 3 summarizes the expected utilization of development rights in their current type.
- Table 4 summarizes the expected conversion of development rights between types.

The forecast includes the annual construction of 172 residential units, 7,650 square feet of commercial floor area and 35 tourist accommodation units (Table 2).

Table 2: Construction Forecast Summary

Development Right Construction	Annual Constructi on Rate	2035 Net Change	2045 Net Change
Residential Units			
Total Development of Residential Units	**+172**	**+2,924**	**+4,597**
Commercial Floor Area (in Square Feet)			
Total Utilization of CFA	**+7,650**	**+130,067**	**+206,550**
Tourist Accommodation Units			
Total Development of TAUs	**+35**	**+629**	**+945**

The forecast includes the utilization of allocation pools held by TRPA and local jurisdictions in the area plan, community plan, or plan area statement pools, as well as the use of bonus and incentive pools, special projects pools, and banked development rights (Table 3).

Table 3: Development Rights Utilization Forecast Summary

Development Right Utilization	Annual Utilization Rate	2035 Net Change	2045 Net Change
Residential Units			
Residential Allocations	+83	+1,411	+2,234

Development Right Utilization	Annual Utilization Rate	2035 Net Change	2045 Net Change
Residential Bonus Units	+60	+1,020	+1,609
Banked Residential Development	+8	+136	+204
Total Development of Residential Units	**+151**	**+2,567**	**+4,047**
Commercial Floor Area (in Square Feet)			
Commercial Floor Area Allocations	+6,413	+109,021	+173,142
Commercial Floor Area Allocations (TRPA special projects pool)	+2,963	+50,371	+80,000
Banked Commercial Development	+1,979	+33,643	+53,408
Total Utilization of CFA	**+11,355**	**+130,067**	**+306,550**
Tourist Accommodation Units			
TAU Allocations	+5	+85	+130
TAU Bonus Allocations	+6	+102	+138
Banked TAU Development	+31	+527	+807
Total Development of TAUs	**+42**	**+714**	**+1075**

The forecast includes the conversion of development rights between the various types of development (Table 4). TRPA approved a comprehensive update to Tahoe's development rights system in 2018. This allows conversions between different types of development rights using environmentally neutral exchange rates and makes development rights simpler to transfer around the Basin, keeping limits on Tahoe's total development potential. The changes make it easier for the private sector to invest in redevelopment projects that benefit Tahoe's environment and communities and provide needed workforce housing. The projected conversions are consistent with conversion trends since the adoption of the conversion programs and observed development rights utilization rates. The observed trends indicate a net conversion that reduces CFA by 3,700 square feet and 5 TAUs and creates an additional 21 residential units each year.

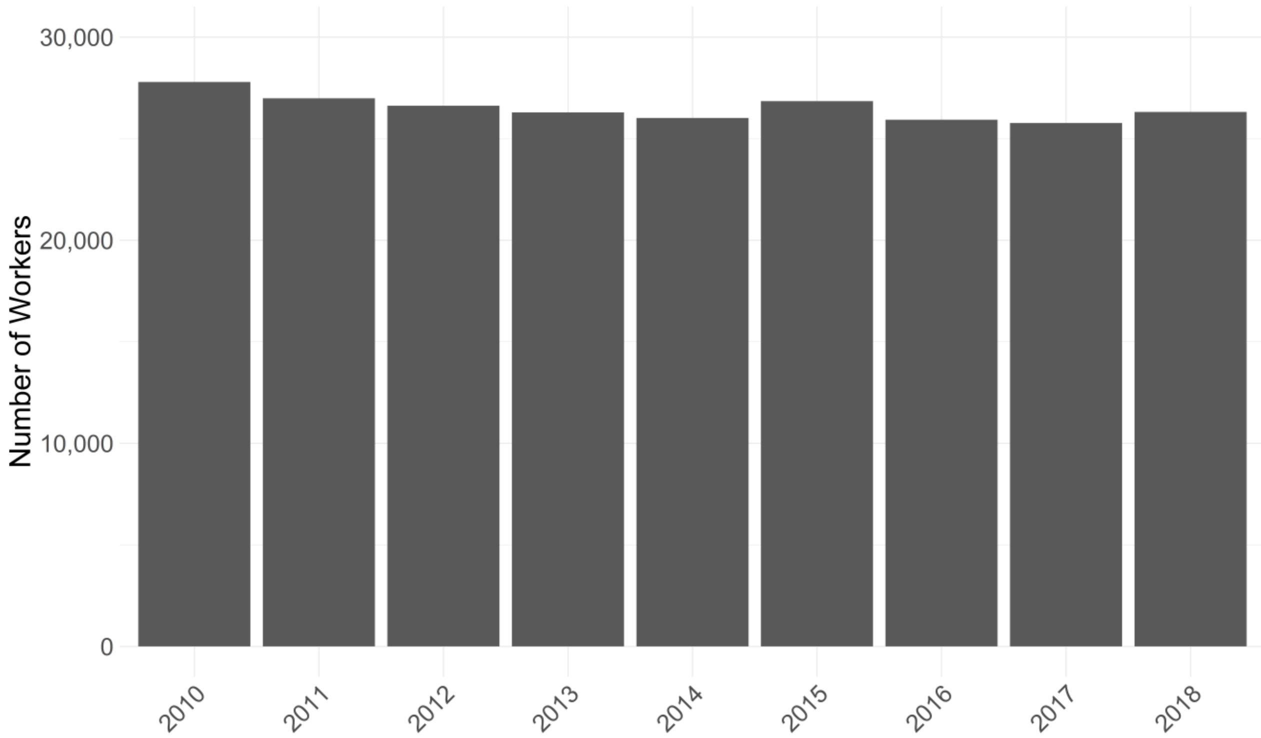
Table 4: Development Rights Conversion Summary

Development Right Conversion	Annual Change as a Result of Conversion	2035 Net Change	2045 Net Change
Residential Units			
Net Development Right Conversions to Residential	+21	+357	+550
Commercial Floor Area (in Square Feet)			
Net Development Right Conversions from CFA to RUU	-3,704	-62,968	-100,000
Tourist Accommodation Units			
Net Development Right Conversions from TAUs to RUU	-5	-85	-130

EMPLOYMENT

The most recent region-wide data estimates that summer-time work opportunities in the Tahoe Region increased by 5% between 2014 and 2018, from 26,637 to 28,053 jobs. While employment increased, the number of workers estimated to be living in the Region decreased by 6%, from 27,785 in 2010 to 26,314 in 2018 (ACS, 2018). This indicates that an increasing number of workers may be commuting into the Region for employment.

Figure 2: Number of Workers (2010-2018)



SOURCE: AMERICAN COMMUNITY SURVEY (ACS)

The forecast projects a small increase in employment in the Region as a result of increased visitation, construction of new CFA and TAUs, and population growth. In the 2018 model base year there are an estimated 28,604 workers in the Tahoe Region (some residents hold jobs outside the Region). The forecast projects continued growth of jobs in the Region, with 572 (+2%) and 858 (+3%) new jobs in the Region by 2035 and 2045, respectively. The number of external workers (those commuting into the Region for work) is not expected to grow because more workers are expected to find housing locally as a result of the regional housing initiatives.

VISITATION

Figure 3: Tahoe Mega-Region

The forecast includes an increase in visitation which is influenced by several factors. The Tahoe Region is located near and draws visitors from several regions that are projected to experience between 20% and 40% growth in the coming decades (Figure 3, Table 5). The Sacramento Council of Governments (SACOG), predicts that population in the greater Sacramento region[7] will grow 26% by 2045. SACOG models traffic volumes on Interstate-80 and US Highway-50 leading into the Tahoe Region, and forecasts between 18% and 22% increases in volume in the next two decades (SACOG 2019). Farther west, but still within the Tahoe Mega-Region, the Association of Bay Area Governments (ABAG)[8] forecasts 27% population increase by 2040 (MTC & ABAG 2017). To the north and east of Tahoe, RTC-Washoe predicts a 27% growth in population in the Reno/Sparks Metropolitan area[9] by 2040 and the Carson Area MPO[10] predicts a 28% growth in

[7] The Sacramento Area Council of Governments (SACOG) includes the counties of El Dorado, Placer, Sacramento, Sutter, Yolo, Yuba and the 22 cities within this six-county region.
[8] The Association of Bay Area Governments (ABAG) region encompasses Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano and Sonoma counties
[9] Regional Transportation Commission (RTC) of Washoe County, Nevada serves the Reno and Sparks areas along with unincorporated areas of Washoe County.
[10] The Carson Area Metropolitan Planning Organization (CAMPO) covers the Carson City urbanized area, which consists of Carson City, northern Douglas County, and western Lyon County.

population (CAMPO 2016; RTC-Washoe 2018). Population growth in the mega-region is likely to create increased demand for the recreation opportunities and the unique experience that Tahoe provides.

Table 5: Mega-Region Growth Forecasts

Location	Metric	Growth	Forecast Year	Source
Sacramento Region	Population	+26%	2045	SACOG 2020 MTP/SCS
Sacramento Region	Employment	+25%	2045	SACOG 2020 MTP/SCS
Interstate-80	Traffic Volumes	+22%	2040	SACOG 2020 MTP/SCS
US Highway-50	Traffic Volumes	+18%	2040	SACOG 2020 MTP/SCS
Reno/Sparks Metro	Population	+27%	2040	RTC-Washoe 2040 RTP, 2018
Reno/Sparks Metro	Employment	+37%	2040	RTC-Washoe 2040 RTP, 2018
Carson City Region	Population	+28%	2040	CAMPO 2040 RTP, 2018
San Francisco Region	Population	+27%	2040	ABAG 2040 RTP, 2017

Table 6: Sacramento and Reno Population Growth

Location	Metric	Growth	Between	Source
Sacramento Region	Population	+32% (+1.4% per year)	2000-2020	SACOG
Reno–Sparks Metro	Population	+36% (1.7% per year)	2000-2018	Nevada Regional Economic Analysis Project

Population growth outside the Region over the last 20 years has not translated to a linear increase in visitation to the Region. Over the past 20 years (Table 6), the population in the SACOG region surrounding Sacramento has increased by 32% overall, or 1.4% per year compounded. The population of the Reno-Sparks Metropolitan region increased by 36%, or 1.7% per year compounded. Therefore, the forecast does not project increases in visitation in proportion to the projected growth in the mega-region. The mega-region is forecast to add another two million people over the next 20 years. The primary challenge in forecasting future visitation is in establishing the relationship between future population growth in the mega-region and visitation to the Tahoe Region. Looking at how historic growth in the mega-region has influenced travel into the Region through, we find that since 1990, the mega-region populations on the

California side have grown by 32%, while AADT at the California entry stations has grown by 15%. Put another way, the populations of San Francisco, Sacramento, and San Jose have grown by over two million people, which translated into 5,500 more trips through the entry or exits on the California side. The mega-region is forecast to add another two million people over the next 20 years. The challenge is further complicated by the impact of macro-economic conditions that affect visitation.

Despite the population growth outside the Region, the number of rooms rented in the Region is lower today than it was at the turn of the century. The recent observed trends in overnight lodging occupancy show generally flat or increasing occupancy in recent years, depending on location. Between 2013 and 2018, the number of hotel/motel rooms rented in the city of South Lake Tahoe increased by 37%. On the other hand, Douglas county casino occupancy (South Shore) has declined over the last two decades (Douglas County Room Tax Reports, 18-19); total rooms sold in the 2018-2019 fiscal year was 80% of the number sold in 2001-2002. The majority of the decline in Casino occupancy occurred between 2000-2010, and more recently occupancy has been relatively stable. Occupancy in Washoe county has varied between years over the last 20 years but overall is generally flat.

It is uncertain why past population growth has not translated in a linear fashion to increased visitation, but working theories include the decline in popularity of the local casinos as the gaming experience has become more widely available, limited tourist accommodation capacity, the limited roadway capacity into the Region and associated willingness to travel to the Region given the longer travel times.

The visitation forecast is comprised of related but independent projections regarding the expected characteristics of both the number and occupancy of overnight lodging accommodations types, and day visitation. The visitation forecast can be broken down into overnight visitors (staying in Hotels/Motels/Casinos/STRs/Private homes*)* and day visitors. The number of occupied overnight visitor units is forecast to grow by 9% by 2045.

Overnight Visitors in Hotels/Motels/Casinos – In the 2018 model base year, 6,190 of the Region's 11,107 TAUs are occupied (56%) during the modeled day. The forecast includes the construction of an additional 945 TAUs by 2045, an 8.5% increase in tourist accommodation units. Forecasted occupancy of TAUs was increased slightly to account for the impact of Measure T in the City of South Lake Tahoe, which is expected to affect where visitors to the city can stay but not the overall demand (MBI 2017). The forecast estimates that 50% of the visitor parties that may have previously stayed overnight in STRs within the City of South Lake Tahoe would now stay in TAUs, because of the expected lower supply of STRs in the City. As a result, the regional overnight lodging occupancy rate (in TAUs) increases from 56% to 59% in the forecast years. As a result of both additional unit availability from new TAU construction and the higher occupancy rate, the actual number of occupied Hotel/Motel/Casino units increases by 14.5% in 2045.

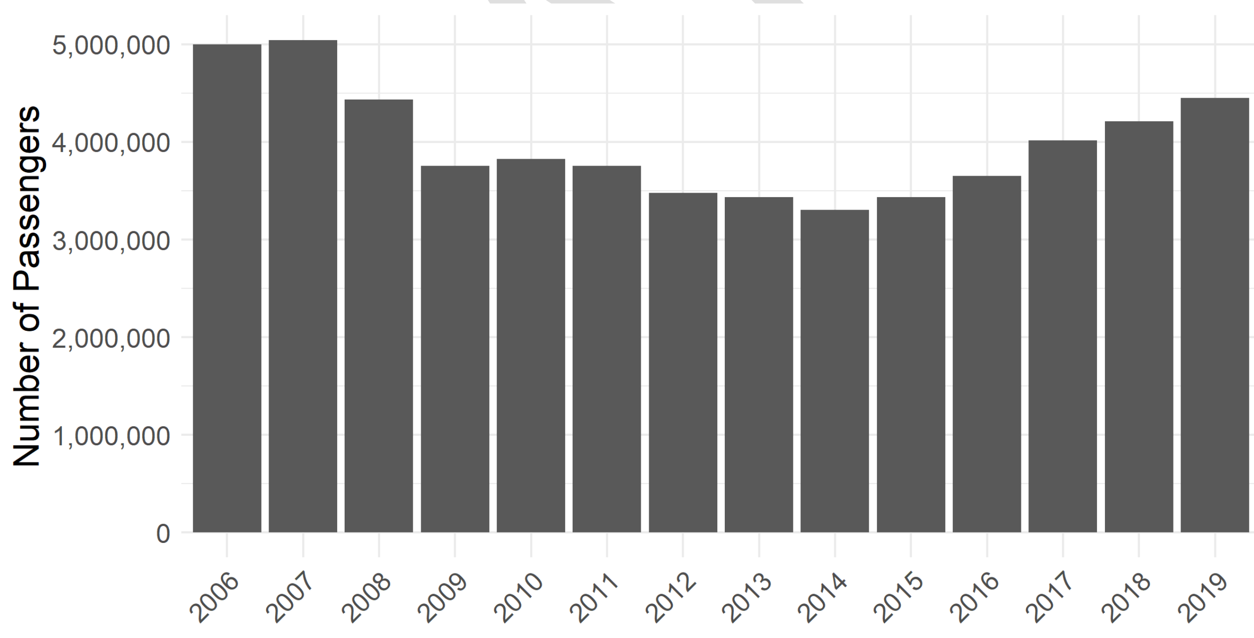
Overnight Visitors in STRs – In 2018, TRPA estimated that there were 6,005 permitted STRs in the Tahoe Region, which comprised approximately 13% of all existing residential units and 23% of the vacant housing units. On the model day, 37% of the units (2,227) are occupied. The forecast projects that both the total number and occupancy of STRs is relatively flat in the forecast years. This projection is highly influenced by the City of South Lake Tahoe's Measure T, which eliminates STRs within most of the City's jurisdiction. Measure T will reduce the number of available STRs in the City of South Lake Tahoe but is unlikely to reduce the overall regional demand for the home-based stay experience in Tahoe. As a result, the forecast includes the displacement of STRs from the city to other jurisdictions in the Region. The result will be more STRs (in absolute and proportional terms) in other jurisdictions in the Region and in areas of the City where STRs are still allowed. As a result of Measure T, approximately 1,372 STRs within the City of South Lake Tahoe but located outside of the Tourist Core area will not have their licenses renewed. During the model analysis period (model day), 508 of those 1,372 STRs were occupied. The forecast assumes that all 508 visitor parties will still visit the Region and find overnight accommodations elsewhere. Of the visitor parties that would have been staying at one of the STRs impacted by Measure T, half are forecasted to find accommodations in STRs in the Tourist Core areas within the City of South Lake Tahoe, where STRs remain allowed, or in STRs in other jurisdictions, and half of visitor parties are forecast to shift to accommodations in the casinos, hotels, motels, and resorts in the Region.

Overnight Visitors in Seasonal Units – Seasonal units are residences within the model that are not claimed as the primary residence for the owner. Within the model they could be occupied by the owner, friends of the owner, time-shares, informally rented, but are not accounted for included in the total of STRs. These units comprise approximately 36% of the total housing market in the Region, of which 37% were estimated to be occupied on modeled day in the 2018 base year. The forecast maintains these percentages into the forecast years. The proportion of seasonal units in the Region has grown in the last 10 years. The proportion of seasonal units is not forecast to continue to increase in the forecast, due to three factors: 1) the construction of additional workforce housing units which cannot be used for second homes, and 2) initiatives focused on making the existing stocking more affordable for workers and residents, and 3) the conversion of some existing vacation rentals in the City of South Lake Tahoe to resident housing because of the Measure T requirements. The forecast projects the occupancy rate of second units will remain the same, maintaining the 37% occupancy of the base year in 2035 and 2045. As a result of the increase in the total number of homes in the Region the number of seasonal units increases by 8% in 2045.

Day Visitors – Day visitation is forecast to increase as a result of population growth in the mega-region, at a similar rate as overnight visitation. Day visitors are one of the more challenging travel parties to forecast. The model assumes the factors that drive overnight visitation are positively correlated with factors driving day visitation. The relationship between these two types of visitors was established as part of the calibration and validation for the 2018 base year and is not expected to change in the forecast years.

Passenger Traffic at Reno Tahoe International Airport - TRPA staff also analyzed the total passenger data from the Reno Tahoe International Airport (Figure 4), which shows that passenger traffic has increased in each of the past 5 years, but remains below the passenger volumes in the mid-2000s. Between 2014 and 2019, annual growth in passengers ranged from +4% to +10%, with the average annual growth from 2014 to 2019 of +6%.

Figure 4: Reno-Tahoe International Airport: Total Passengers 2006-2019



Source: The Reno-Tahoe Airport Authority, Reno-Tahoe International Airport: Passengers and Cargo Statistics Reports 2008 through 2019, Retrieved May 25, 2020 from https://www.renoairport.com/airport-authority/facts-figures/statistics.

Sensitivity of Visitation Forecasts

In meetings with the TRPA Governing Board, Tahoe Model Working Group and other stakeholders, TRPA staff were asked to test and report on the sensitivity and impact of higher or lower than expected changes in visitation and different scenarios that might change the forecast assumptions. In response, staff assessed the sensitivity of VMT forecasts to a range of visitation assumptions. performed additional validation and testing for changes in visitation and the resultant effect on VMT.

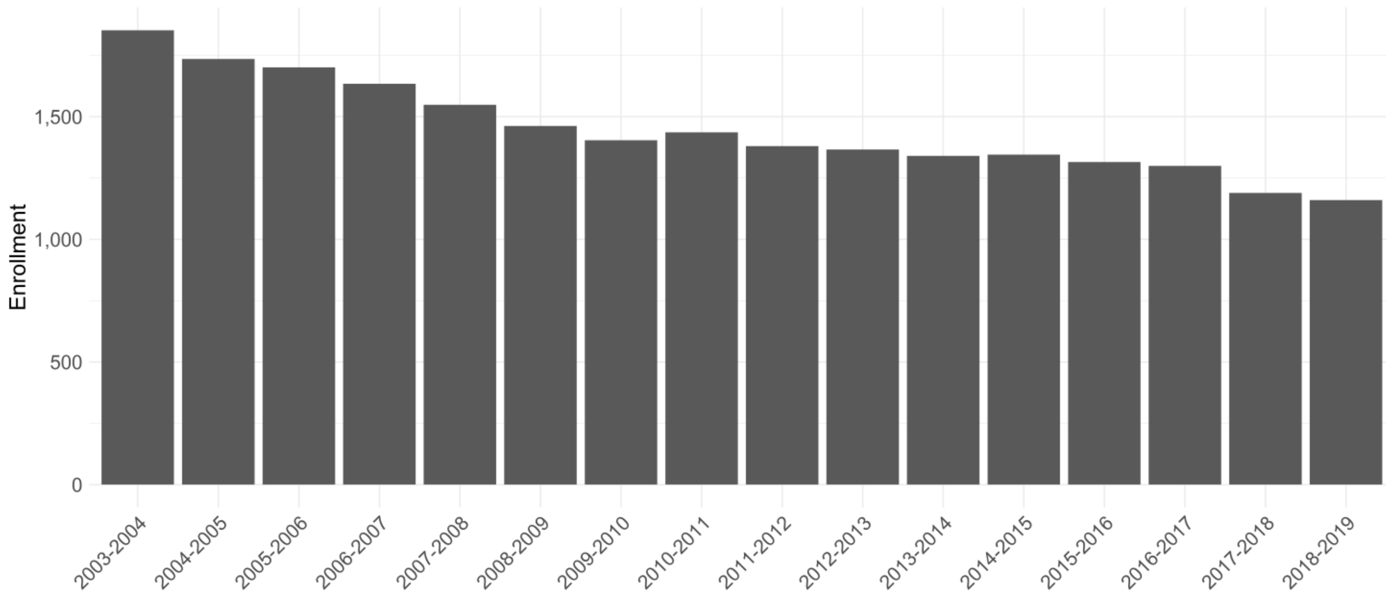
All visitors in the base year model (including day, overnight, second homeowners, and thru-travelers) average 7.9 in-region VMT a day. So, for every 100 additional (or fewer) visitors, Regional VMT would change by 790 VMT. At a high level, Visitors make up 47.3% of the VMT in the model, so if total visitation increased by 10%, regional VMT would increase by approximately 4.7% increase in regional VMT. If each of these visitor types were adjusted independently, the results would be as follows:

- A 10% increase in the number of day visitors would result in a 1.8% increase in regional VMT
- A 10% increase in overnight visitors would result in a 1.8% increase in regional VMT
- A 10% increase in second homeowners would result in a 0.9% increase in regional VMT

School Enrollment

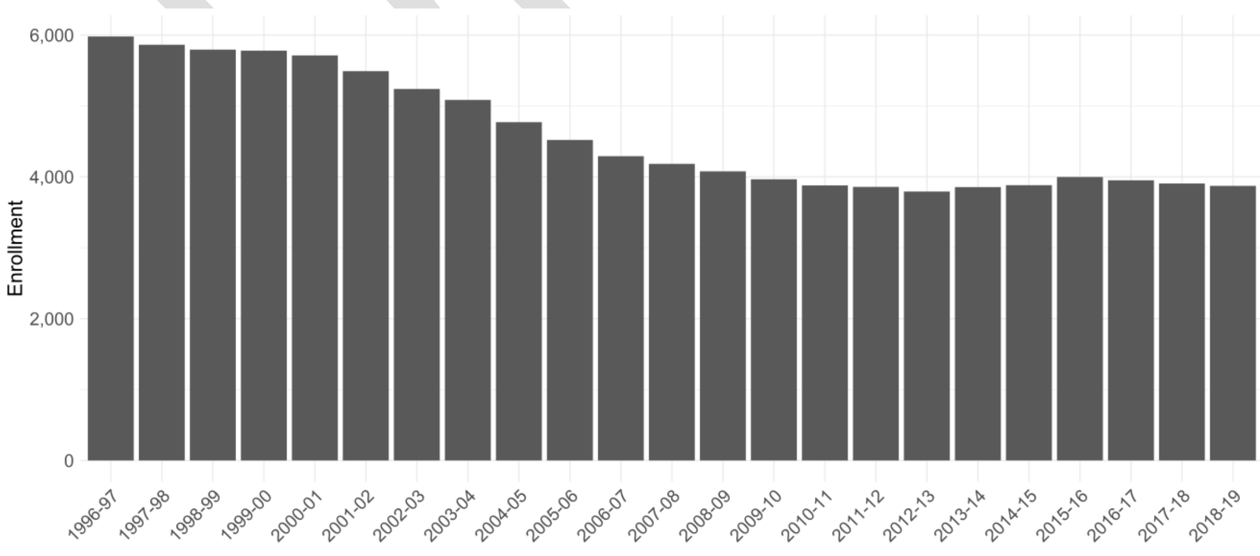
Like the overall population, school enrollment in the Region has decreased in the last two decades, but in most recent years has been relatively steady. Between 1996 and 2018, enrollment in the Lake Tahoe Unified School district in South Lake Tahoe, California decreased by 35%, while enrollment on the Nevada side decreased by 37%, from 1,852 in 2003 to 1,160 in 2019. The forecast projects that school enrollment will increase by 12.4% as new employment (858 additional jobs) and residents (6,417 additional full-time residents) are added to the Region.

Figure 5: Tahoe - Nevada School Enrollment (2003-2019)



SOURCE: HTTP://NEVADAREPORTCARD.NV.GOV/DI/MAIN/DEMOPROF

Figure 6: Lake Tahoe Unified School District Enrollment (1996-2018)

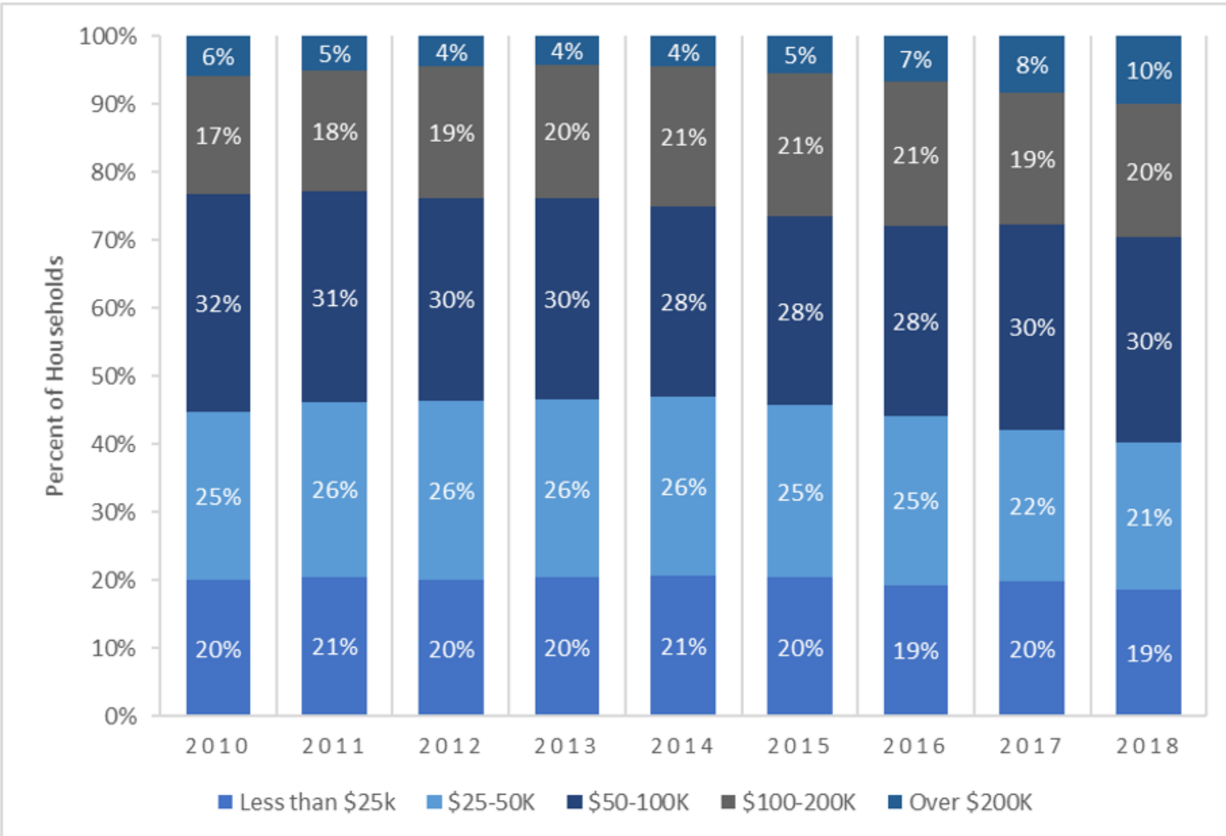


SOURCE: DQ.CDE.CA.GOV

HOUSEHOLD INCOME

Household income is a key characteristic of the residential population, which influences travel behavior. Census data over the last nine years show that household income in the Region is trending upwards towards higher incomes (ACS 2010-2018). Annual median income for households nationally rose to $61,937 in 2018, within California it is $75,277, and in Nevada it is $58,646 (Guzman 2019). Median income in the Tahoe Region has grown over the last five years as the Region emerged from the Recession and is now close the national average. However, the proportion of households earning less than $25,000/year annually has remained at relatively stable, at about 20% of households. Between 2010 and 2018 the number of households earning over $200,000/year grew by 67% and those earning between $100,000 and $200,000 increased by 11%. Despite these gains, households earning less than $100,000/year outnumber households earning more than $100,000/year by two to one. Some have suggested the decline in lower-income households has been driven by workers leaving the Region in search of more affordable housing. The forecast projects that the relative distribution of household incomes will be maintained at the current level. Initiatives to provide workforce and affordable housing are expected to increase the regional housing availability at the lower end of income distribution.

Figure 7: Household Income Categories (% of Households 2010-2018)



SOURCE: AMERICAN COMMUNITY SURVEY (ACS)

Addendum

COVID-19

The research and majority of the forecasts for the 2020 Regional Transportation Plan were developed prior to the impact of COVID-19 on our community and the world. The immediate impact of COVID-19 on our community has been severe. Both states issued stay-at-home orders and the casinos, ski resorts and many other businesses closed in March 2020, furloughing or laying off thousands of employees. The Lakeside Inn and Casino announced that it would not reopen. The hotels, motels, restaurants, bars, and many of the recreation areas, beaches and parks that are the lifeblood of our tourism-based economy were closed for weeks. The impacts on transportation were apparent in the traffic volumes around the Region. In early May, VMT in the counties that make up the Tahoe Region was estimated to be down 30-50% from levels observed in the same period in prior years.

The long-term impacts of COVID-19 on the Region are uncertain. Some believe that the job losses, business closures, and economic hardship will continue. Others think that urban flight will result in a mass movement from cities to rural areas, as remote work continues and people seek to escape crowded cities for open spaces, resulting in massive population shifts and increased housing needs in the Region.

Given this uncertainty, staff recommends maintaining the above assumptions for the forecast scenarios even considering the COVID -19 pandemic and associated economic downturn. The Harvard Business Review (HBR) recommends that in "moments of unprecedented uncertainty", one must "know when not to make a forecast" (Saffo, 2007). HBR suggests that "even in periods of dramatic, rapid transformation, there are vastly more elements that do not change than new things that emerge" (Saffo,2007).

Transportation Projects & Strategies Forecast Summary

TRANSPORTATION PROJECTS & STRATEGIES

The second element of the RTP/SCS forecast was the transportation forecast. The transportation projects and strategies were forecasted using both the Tahoe travel demand model and the Trip Reduction Analysis Tool (TRIA). All fixed-route transit projects were directly incorporated into the travel demand model; the route locations, fares, and headways were directly forecasted within the model network. In terms of roadway capacity, the plan does not include many changes. As a result, the Highway 50 Revitalization project was the only roadway project directly represented in the travel demand model. The rest of projects and strategies were incorporated in the forecast using TRIA; these include microtransit, bike/ped projects, ITS, TDM, parking, and others.

TRIA 2.0

The Tahoe Regional Planning Agency developed and maintains a Trip Reduction Impact Analysis (TRIA) spreadsheet tool to evaluate the trip and VMT reduction impacts of various transportation policies and programs under consideration as part of the Sustainable Communities Strategy (SCS) effort. The TRIA spreadsheet tool captures the strategies that can have a significant effect on travel demand such as parking policies, traveler information systems, new transit operations, or construction of new bike trails and sidewalks but which cannot be accurately captured in the TRPA travel demand model. The purpose of the TRIA is to provide planning-level, order-of-magnitude, comparative estimates of the quantitative vehicle trip reductions in the travel demand modeling process to inform expected total trips, vehicle miles traveled (VMT), and greenhouse gas (GHG) emissions based on the combined impact of the capital improvement projects, operational enhancements, policies, and programs considered in the TRPA 2045 Regional Transportation Plan/Sustainable Communities Strategy (RTP/SCS).

As noted above, the TRIA 2.0 tool provides a way to make comparisons between different policy alternatives and their ultimate effect on vehicle trips, VMT, and GHG emissions. The tool is integrated as a step in the travel demand modeling process in order to allow TRPA to understand the impact of policies, programs, and other investments tailored to the Tahoe area that will help the Region meet the GHG emissions reduction targets set by the California Air Resources Board under California's Senate Bill 375, the VMT reduction targets under California's Senate Bill 743, and trip reduction goals.

As much as possible, the TRIA 2.0 used estimates based on current conditions in the Tahoe Basin, or existing trip reduction estimates developed locally, particularly in the case of new transit services and new active transportation facilities such as bike trails and sidewalks. For policies or projects for which there are no local studies, the trip reduction impacts were estimated based on a review of the current (2020) literature and studies of locations where similar policies, programs, or investments have been implemented. Where research shows that a policy might vary in effectiveness a more conservative approach will be chosen, so as not to overstate the trip and VMT reduction potential.

The TRIA 2.0 is built around the main modes of transportation and analysis of how the land use plan and transportation strategies and policies proposed in the RTP will impact these modes. The main categories previously considered in the model are:

- Active transportation (bicycling and walking)
- Public transit service
- Intelligent Transportation System (ITS) technologies
- Transportation demand management (TDM) measures
- Parking policy changes

As well as updating the existing categories in TRIA, the update also includes the addition of the following categories:

- Shared Micromobility services (i.e., E-scooters)
- Microtransit Services

The model is structured in such a way as to estimate the potential growth for each mode, where relevant (e.g. the potential for new transit riders who were previously vehicle riders), and estimate a vehicle trip reduction as a result of the strategy. See Table for an overview of the strategies analyzed and their individual estimated trip reduction potential in the 2035 and 2045 RTP/SCS scenarios.

ANALYSIS BY MODE

The approach taken in TRIA 2.0 for the strategies considered are summarized below. The table that follows lays out the full details on trip reduction by strategy, sources used and overall reduction.

ACTIVE TRANSPORTATION

The following describes the three active transportation-related trip reduction strategies.

BIKE AND PEDESTRIAN FACILITIES

The vehicle trip reductions for bicycle and pedestrian trips were developed using the bicycle and pedestrian monitoring data collected by TRPA for the past three years (the data used for this analysis and ongoing monitoring data is available at http://www.trpa.org/transportation/monitoring/). The monitoring data was used to develop an understanding of how walking and biking trips vary by different facility types (e.g., sidewalk, bike lanes, and shared-use paths) in different contexts (e.g., town centers, recreation corridors, campgrounds, etc.) to establish a relative classification of usage. New bicycle and pedestrian improvements were then classified into one of the facility and context types to estimate the number of walking and biking trips expected based on the new facility. These usage estimates are then used to estimate a vehicle trip reduction associated with the new walking and biking facilities. The TRIA assumes that the implementation of the bicycle and pedestrian network will happen at a uniform rate across the timeframe of the plan, therefore by 2035 only a portion of the network will have been completed, and therefore the VMT reduction is not as great in 2035 (1.12%) as in 2045, at 1.19% . This trip reduction is applied to all trips in the Region.

ELECTRIC BICYCLES

The prevalence of electric bicycles, or "e-bikes", was introduced in the 2020 TRIA update to calculate trip reductions associated with programs and policies to encourage the safe use of e-bikes. E-bikes are gaining prevalence in many locations around the world through individual ownership, rental programs, and bikeshare services. A literature review was conducted to determine how e-bikes affect travel behavior and patterns. The primary finding of the literature was people are willing to travel nearly twice as far using an e-bike than a regular bicycle. To account for this impact, the TRIA tool estimates increases in the bicycle mode share based on the potential for longer bike trips using e-bikes. The reduction in vehicle trips based on the adoption of e-bikes (0.79%) was applied to all trips in the Tahoe Basin based on an expected bicycle mode share by trip length for both the 2035 and 2045 scenario.

SHARED MICROMOBILITY

Trip reductions associated with shared micromobility services were included in the TRIA 2.0 update. Shared micromobility services include shared e-scooters and e-bikes, that are accessed and paid for via applications and allow trips within a defined service area. Overall trips reduction factors associated with shared mobility services were calculated using 2018 and 2019 trip data and survey data from South Lake Tahoe's implementation of the Lime e-scooter program which showed that 48% of e-scooter trips replaced an automobile trip. The trip reduction is calculated using trips in the areas expected to provide shared micromobility service in the future: Tahoe City, Kings Beach, and South Lake Tahoe areas. The regional trip reduction percentage (0.53%) is calculated by dividing the total trips reduced in micromobility areas by regional trips. The resulting trip reduction factor was corroborated through review of e-scooter trip research from Portland and Chicago and is applied to all trips in the Region.

TRANSIT SERVICES AND FACILITIES

The following four strategies describe the trip reductions calculated in TRIA associated with new or improved transit services not captured by the TRPA travel demand model.

TRANSIT SERVICE AND CAPITAL PROJECTS

The transit portion of the trip and VMT reductions are based on ridership projections for new or improved transit routes included in the RTP's constrained project list for 2035 and 2045. The model currently accounts for transit ridership for all transit trips internal to the TRPA's travel demand model network (e.g., the Tahoe Basin). Therefore, the transit portion of the trip reductions in TRIA is only based on trips that either originate or end external to the Tahoe Basin. Additionally, trip reductions associated with circulator, ferry taxi, and other non-route-based services that cannot be represented in the travel demand model are also estimated in the TRIA 2.0 transit service calculations. The name and description of the new or improved transit routes included in the trip reduction calculations are listed below:

- Year 2035:
    - TTD 20 and 19x (long)- Stateline TC to Carson (interlined)
    - TTD 21x - Stateline TC to Carson via Spooner
    - TART 89 (long) - Tahoe City TC to Truckee Depot
    - TART 267 (long) - Stateline to Truckee Depot
    - Event Center Circulator - Tourist Core to Round Hill
    - South Shore Ferry Taxi - Round Hill Pines to Camp Richardson
    - STS - STS Medical Transportation
- Year 2045:
    - TTD 20 and 19x (long) - Stateline TC to Carson (interlined)
    - TTD 21x - Stateline TC to Carson via Spooner
    - TART 89 (peak) - Tahoe City TC to Truckee Depot
    - TART 89 (off-peak) - Tahoe City TC to Truckee Depot
    - TART 267 - Stateline to Truckee Depot
    - TART 3 - Incline Village to Reno
    - Trans Sierra 1 - Meyers to Stockton
    - Trans Sierra 2 - Meyers to Sacramento
    - Event Center Circulator - Tourist Core to Round Hill
    - South Shore Ferry Taxi - Round Hill Pines to Camp Richardson

- North Shore Ferry Taxi - Sand Harbor to Tahoma
- STS - STS Medical Transportation

Trip reduction calculations associated with these additional transit services results in trip reductions of 0.51% and 1.61% in 2035 and 2045, respectively. This trip reduction is applied to regional trips (including external trips).

INTERCEPT LOTS

Additionally, a strategy implementing intercept parking lots to allow visitors or residents to park in designated lots and transfer to transit services was also evaluated in the updated TRIA calculations. The strategy targets reducing visitor vehicle trips into the Tahoe Basin and the impact was estimated based on a study by the Alameda County Transportation Commission estimating drive-to-transit mode shares. The estimated impact of the intercept lots was adjusted down from 8% to 4% to conservatively estimate the number of visitors that would be willing to use the intercept lots. Based on the percentage of external traffic generated by visitors (70%), the calculated trip reduction for was 2.8%. This trip reduction factor is only applied to external trips entering or leaving the Region.

MICROTRANSIT SERVICE AREAS

Trip reductions associated with microtransit services were also included as a new strategy in the TRIA update. Microtransit services are on-demand transit services that typically provide flexible routes within a defined service area using lower-capacity transit vehicles. Microtransit services can be funded by public agencies, private agencies, or through public-private partnerships. Overall trip reduction factors associated with microtransit were calculated using 2019 and 2020 trip data from the Squaw Valley and Alpine Meadows' Mountaineer microtransit service. User survey data from Aspen's Downtowner microtransit service was used to calculate the percentage of microtransit trips that replace vehicle trips. Vehicle trip reductions associated with microtransit service areas are calculated based on the total number of trips in areas where microtransit services are planned as part of the RTP/SCS: Tahoe City, Kings Beach, and South Lake Tahoe. The reduced vehicle trips are then used to calculate regional trip reduction factors of 0.28% and 0.45% in 2035 and 2045, respectively. The trip reduction factor is then applied to all trips in the Region.

INTELLIGENT TRANSPORTATION SYSTEM (ITS) TECHNOLOGIES

Several strategies to increase the functionality and usability of transit based on ITS technology improvements were included in the TRIA 2.0. These included:

- Improved transit coordination between local and regional providers, through simplified trip planning (e.g. Google Transit). This strategy is associated with trip reduction percentages of 0.68% and 0.66% of trips to or from Town Centers in 2035 and 2045, respectively. For external trips, this strategy is associated with trips reductions of 0.43% and 0.42% in 2035 and 2045, respectively.
- Improved transit coordination between local and regional providers, through the elimination or shortened wait time of transfers, as well as improvements to ticketing structure and agency cooperation to eliminate "transfer anxiety". This strategy is associate with trip reduction percentages of 0.08% and 0.10% of trips to or from Town Centers in 2035 and 2045, respectively.
- Real-time arrival information at transit stops, online, and/or via web-enabled mobile devices. The trip reduction factor for this strategy is 0.04% and is applied to trips to or from Town Centers.
- Dynamic ridesharing for inter-regional trips. This strategy introduces services and/or subsidies to encourage commuters to rideshare. Examples include through carpool matching services and vanpools. The TRIA tool calculates the expected reduction in trips with the introduction of these services as 1.00% and is this reduction is applied to internal-external and external-internal trips only.

TRANSPORTATION DEMAND MANAGEMENT (TDM) MEASURES

The TRIA 2.0 TDM calculations were updated with current employer data. The businesses are categorized by size with 19 small (less than 100 employees), three medium (between 100 and 200 employees) and four large employers (more than 200 employees) included in the data set. TRIA 2.0 compares the effect of improving the participation rate of the existing Employer Trip Reduction ordinance through improved enforcement and/or updating policies and programs. Target participation rates for small, medium, and large employers were established and compared to an assumed 50% existing participation rate. The change in participation is then used to calculate reduced trips based on expected TDM policies impacts based on the current literature and average local employer size data. The TDM measures trip reduction is calculated for new development (1.86%) and existing development (0.82%). New development is estimated to be 3% of all new trips in the Region and is used to weight the potential trip reduction of TDM measures. The TDM measures trip reductions are only applied to trips going to or from a Town Center.

PARKING MANAGEMENT

TRIA 2.0 evaluates the expected reduction in vehicle trips associated with parking pricing and parking management strategies in select parking management zones in the Tahoe Basin. This includes demand-responsive pricing in commercial areas with residential permits to prevent parking spillover into residential areas, changes to parking standards, shared parking arrangements, etc. This trip reduction percentage is calculated relative to regionwide trips based on the trips reduced in areas implementing parking strategies. The trip reduction calculation methodology was updated to simplify the overall calculation method and account for a wider range of parking strategies in an inclusive calculation based on an updated literature review on the latest research into parking impacts on vehicle trip reductions. A parking management trip reduction percentage from the current literature (2.7%) was halved to 1.35% to reflect the lower potential impact of parking management policies based on the high recreational travel demand for the Region. This trip reduction was applied to trips in areas across the Region that were expected to implement parking management strategies to calculate the total number of vehicle trips reduced. These trip reductions were then recalculated as a trip reduction factor that is applied to all regional trips (1.2%).

TRIP REDUCTIONS SUMMARY

Table presents a summary of the trip reductions by individual strategy described above. The summary table provides a brief description of the vehicle trip reduction strategy, the primary source of reduced vehicle trips, the type of vehicle trips impacted, employer type, and the individual 2035 and 2045 percent reductions.

Trip reductions are classified into one of three vehicle trip type groupings:

- **Regional Trips:** This grouping applies the vehicle trip reduction to all trips in the Region.
- **Town Center Trips:** This grouping only applies the vehicle trip reduction to trips that are going to or from a designated Town Center.
- **External Trips:** This grouping only applies the vehicle trip reduction to trips that are entering or exiting the Region.

For the TDM strategy, reductions are calculated for new and existing employers. Given some employers are already participating in employer trip reduction programs, the impact on existing employers is lower than for new employers. This is the only strategy for which the employer type is considered.

Table 7: Trip Reduction Impact Analysis (TRIA) Estimates – 2045 Forecast

Vehicle Trip Reduction Strategy	Primary Source of Reduced Vehicle Trips	Vehicle Trip Types Impacted	Employer Type	2035 Percent Reductions in Vehicle Trips	2045 Percent Reductions in Vehicle Trips
Active Transportation					
Complete regional network of bike and pedestrian facilities (includes expanded bike parking)	Increased bike and pedestrian mode share for trips in the corridor/district served by the project, partially drawn from former vehicle trips of 3 miles or less.	Regional Trips	--	1.12%	1.19%
Shared micromobility service areas	Reduced vehicle trips due to use of shared micromobility devices (e.g., e-scooters or shared e-bikes)	Regional Trips	--	0.53%	0.53%
Promotion of electric bicycle use	Reduced vehicle trips due to the widespread use of electric bicycles	Regional Trips	--	0.79%	0.79%
Public Transit Service					
Intra-regional transit capital projects within the Tahoe Basin; currently this only includes south shore water taxi service)	Increased transit mode share, partially drawn from former vehicle trips.	Regional Trips	--	0.51%	1.64%
Inter-regional transit service that extends outside the Tahoe Basin.	Reduced commuter and recreational trips.	External Trips	--	0.51%	1.64%
Intercept lots at entrances to the Tahoe Basin providing frequent shuttle service into the Region.	Reduced visitor trips.	External Trips	--	2.80%	2.80%
Microtransit service areas	Reduced trips for all types served by Microtransit service areas.	Regional Trips	--	0.28%	0.45%
ITS Technologies					
Improved transit coordination between local and regional providers, through simplified trip planning (for example Google Transit).	Increased transit mode share for trips in the corridor/district served by the project, partially drawn from former vehicle trips.	Town Center Trips	--	0.68%	0.68%
Improved transit coordination between local and regional providers, through the elimination or shortened wait time of transfers, improvements to ticketing structure and agency cooperation to eliminate "transfer anxiety".	Increased transit mode share for trips in the corridor/district served by the project, partially drawn from former vehicle trips.	Town Center Trips	--	0.08%	0.10%
Real-time arrival information at transit stops, online, and/or via web-enabled mobile devices.	Increased transit mode share for trips in the corridor/district served by the project, partially drawn from former vehicle trips.	Town Center Trips	--	0.04%	0.04%
Enhanced transit trip planning (for example Google Transit).	Increased transit mode share for trips in the corridor/district served by the project, partially drawn from former vehicle trips.	External Trips	--	0.43%	0.42%
Regionally implemented dynamic ridesharing (conservative implementation).	Reduced commuter and recreational trips.	External Trips	--	1.00%	1.00%
TDM Measures					
Improve existing employer vehicle trip reduction program (carpool and vanpool matching programs, employee shuttles, on-site secure bicycle storage and shower facilities, flexible work hours, parking, and transit use incentives.)	Reduced peak-hour commuter trips.	Town Center Trips	New Employers	1.86%	1.86%
		Town Center Trips	Existing Employers	0.82%	0.82%
Parking Management					

Parking pricing and parking management strategies including demand-responsive pricing in commercial areas with residential permits to prevent parking spillover into residential areas, changes to parking standards, shared parking arrangements, etc.	Reduced trip generation from managed on- and off-street parking spaces for trips to and from managed areas. Reduced demand due to reduced parking spaces as a result of shared parking requirements or changes to parking standards for new development.	Town Center Trips	--	1.22%	1.22%

Source: TRPA, Kittelson & Associates, Inc., 2020.

CUMULATIVE EFFECT

While the effect of each policy or project type is analyzed individually, the cumulative effect of these strategies was estimated to apply to the TRPA travel demand model. The cumulative effect of each individual strategy is not simply the sum of the individual strategy effects. The impact of some strategies depends on the origin and destination trip type – for example whether they affect trips that start in Tahoe but end outside the Region, or if the entire trip takes place within the Tahoe Basin.

Where there are several reduction measures that are not mutually exclusive, the total cumulative reduction does not equal Measure A + Measure B. Once Measure A has been applied, Measure B will be applied to a base that has already been reduced by Measure A. For example, if two trip reduction measures would each give a 10% trip reduction, the total cumulative reduction is not 20%. Rather, it would be equal to 100% - (90%*90%) = 19%. This process continues for each additional strategy considered for a grouping.

Table 13 summarizes the cumulative impact by trip area type impacted. These cumulative impacts for each of the three trip area types (Town Center, Non-Town Center, and Internal-External) are calculated using the method described above. The strategies applied to trip each area type are combinations of the vehicle trip types noted for each individual strategy in Table . These combinations are summarized below:

- **Town Centers:** all "Regional Trips" and "Town Center Trips" strategies are combined in this trip area type.
- **Non-Town Centers:** only "Regional Trips" strategies are combined for these trip types.
- **Internal-External:** only "External Trips" strategies are combined for this trip area type.

TABLE 13. CUMULATIVE IMPACT BY TRIP AREA TYPE IMPACTED

Trip Area Type	Employer Type	2035 Percent Reduction in Vehicle Trips	2045 Percent Reduction in Vehicle Trips
Town Centers	Existing employers	5.92%	7.21%
	New employers	6.91%	8.18%
	Overall	5.95%	7.28%
Non-Town Centers	--	3.20%	4.53%
Internal-External	--	4.67%	5.75%

Source: TRPA, Kittelson & Associates, Inc., 2020.

For Town Centers, the TDM measures strategy distinguishes between new and existing employers. As a result, a vehicle trip reduction percentage is calculated for each scenario and employer type. These are then combined into overall trip reductions by year using a weighted average based on the assumption that new employer trips represent 3% of all travel consistent with the 2017 RTP/SCS assumptions. The cumulative impacts by trip area type are then applied to the TRPA travel demand model as described below.

TRAVEL DEMAND MODEL INTEGRATION

An additional component of the 2020 TRIA 2.0 update was to integrate the overall trip reductions directly into the TRPA travel demand modeling process rather than relying on off-model reductions using the TRIA tool to post-process vehicle trips. As part of this integration, the TRIA trip reduction factors for each traffic analysis zone (TAZ) in the travel demand model is calculated based on the strategies that are applicable to a trip starting or ending in that zone using the trip area types described above. The trip reduction factors vary based on whether trips are within the Tahoe Basin, travel to a Town Center, or start or end external to the Tahoe Basin. The TRIA 2.0 trip adjustment factor model script is run for each RTP/SCS scenario and the travel demand model's trip table is adjusted to account for the reduction in vehicle trips for each origin-destination pair (e.g., Kings Beach to Tahoe City, or South Lake Tahoe to Carson City). These reduced trips are then reassigned to the travel demand model network to obtain an estimate of trips and vehicle miles traveled for the entire model roadway network. The resulting trip and VMT data can then be used to calculate RTP/SCS performance metrics and impacts based on the expected number of trips after considering the strategies included in the TRIA.

Table 8: Total Proportion of Vehicle Trip Reductions

Parking	TDM	Transit	Rideshare	Ped/Bike	Micromobility
9.8%	22.1%	32.9%	4.3%	24.0%	6.8%

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