APPENDIX A: Smart Mobility Framework Objectives and Methodology

The following sections describe the methodologies employed to evaluate existing and future conditions, as they related to the Smart Mobility Framework objectives.

1.1 Smart Mobility Framework

The Smart Mobility Framework is premised on six key objectives: Location Efficiency; Reliable Mobility; Health and Safety; Environmental Stewardship; Social Equity; and, Robust Economy. These six objectives are informed through the application of seventeen candidate performance measures. The Smart Mobility Framework process is consistent with both the 2018 Comprehensive Multimodal Corridor Plan Guidelines and the SB 1 Solutions for Congested Corridors Program Guidelines from the California Transportation Commission (CTC).

Table 2.1 Smart Mobility Framework Objectives

Location Efficiency	Support for Sustainable Growth
	Transit Mode Share
	Accessibility and Connectivity
Reliable Mobility	Multimodal Travel Mobility
	Multimodal Travel Reliability
	Multimodal Service Quality
Health and Safety	Multimodal Safety
	Design and Speed Suitability
	Pedestrian and Bicycle Mode Share
Environmental Stewardship	Climate and Energy Conservation
	Emissions Reduction
Social Equity	Equitable Distribution of Impacts
	Equitable Distribution of Access and Mobility
Robust Economy	Congestion Effects on Productivity
	Efficient Use of System Resources
	Network Performance Optimization
	Return on Investment

Source: Caltrans' Smart Mobility Framework 2010: A Call to Action for the New Decade

The fundamental premise of the Smart Mobility Framework is to ensure that planning or programming decisions for transportation improvements are performance based, transparent, and address sustainable outcomes and objectives. The performance metrics selected for the Broadway Corridor informed each of the six Smart Mobility Framework objectives to ensure that the resulting improvement recommendations provide a balanced, sustainable, and multimodal assessment of current and forecast corridor conditions.

Requisite rubrics include: planning level cost opinions; vehicular delay and buffer time reduction; level of traffic stress scores; mode shift and vehicle miles traveled (VMT) reduction; collision reduction benefit; health and air quality benefit; societal cost and benefit monetization factors (per Caltrans 2018 Economic Parameters); and return on investment (i.e., benefit-cost). Equal attention will be given to documenting the beneficial outcomes of measures not directly reflected in the benefit-cost assessment. These include: Plan Consistency (with existing plans); Policy Consistency (HCAOG, the City of Eureka, the County of Humboldt, and Caltrans); Environmental/Institutional Sensitivity; Adaptation; Economic Development and, Community Acceptance. Metrics selected for this Broadway Corridor Plan are described on the following section. Results from this analysis were combined with substantial input from the public to inform the selection of the preferred multimodal corridor improvement package.

1.2 Performance Metrics

The performance metrics selected to evaluate this Plan are coordinated with the six objectives outlined in the Smart Mobility Framework to ensure the resulting improvement recommendations provide a balanced, sustainable, and multimodal assessment of current and future corridor conditions.

Many of these performance measures do not have established standards but were analyzed to better understand the existing and future operational characteristics of Broadway Corridor and inform a comparative analysis of improvement concept alternatives. Use of additional metrics other than vehicular Level of Service (LOS) is consistent with the Smart Mobility Framework and with the recent Senate Bill (SB) 743 intended to streamline the California Environmental Quality Act (CEQA) process. Some metrics such as delay, collision reduction, mode shift, and vehicle miles of travel reduction can be monetized and were incorporated into a benefit-cost analysis. Other quantifiable indices, such as suitability scores (i.e. level of traffic stress analysis), adaptation assessments, economic development assessments, and environmental justice impacts, etc. are not conducive to being monetized. Although some of the presented performance metrics cannot be monetized, assessment of the results of these analyses provide value to informing improvement recommendations.

The performance measures by Smarty Mobility Framework objectives and employed methodologies are described in Appendix X.

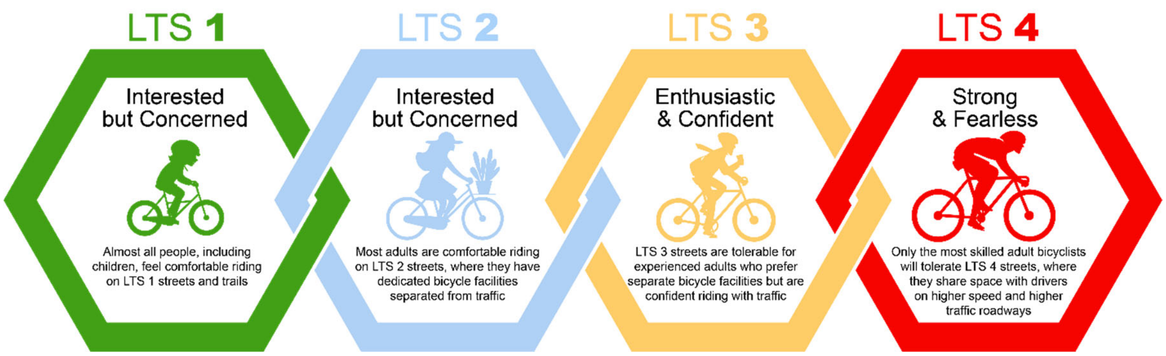
1.2.1 Location Efficiency

1.2.1.1 Accessibility and Connectivity

Bicycle Level of Traffic Stress (Bicycle LTS) measures a bicyclist's perceived sense of risk associated with riding in or adjacent to vehicle traffic. The objective is to provide a connected network of low-stress bicycle facilities within the study corridor.

Level of Traffic Stress (LTS) are calculated for roadway segments and intersections using the methods documented in the paper, *Low Stress Bicycling and Network Connectivity*, Mineta Transportation Institute, Report 11-19, May 2012. Bicycle LTS quantifies the stress level of a given roadway segment by considering a variety of criteria, including street width (number of lanes), speed limit or prevailing speed, presence and width of bike lanes, and the presence and width of parking lanes. Bicycle LTS is a suitability rating system of the safety, comfort, and convenience of transportation facilities from the perspective of the user. Moreover, the methodology allows planning practitioners to assess gaps in connectivity that may discourage active users from traversing roadways.

Bicycle LTS scores roadway facilities into one of four classifications or ratings for measuring the effects of traffic-based stress on bicycle riders, with 1 being the lowest stress or most comfortable, and 4 being the highest stress or least comfortable (see Figure 4.6). Generally, LTS score of 1 indicates the facility provides a traffic stress tolerable by most children and less experienced riders, such as multi-use paths that are separated from motorized traffic. An LTS score of 4 indicates a stress level tolerable by only the most experienced cyclists who are comfortable with high-volume and high-speed, mixed traffic environments. LTS 3 and 4 represent high stress conditions for bicyclists and reflect the need for visibility and safety improvements. The figure below presents the four scoring classifications, subsequent tables show the criteria associated with determining the LTS score.



The Bicycle LTS methodology is comprised of three scoring categories: roadway segments, intersection approaches where right turn lanes exist, and unsignalized intersection crossings. The Bicycle LTS scoring criteria for intersection approaches where right turn lanes exist, for roadway segments with mixed traffic, and for roadway segments where bike lanes exist are provided in the Tables below.

Table 1 LTS Criteria for Intersection Approaches with Right Turn Lanes

Right-turn Lane Configuration	Right-turn lane length (ft)	Bike Lane Approach Alignment[2]	Vehicle Turning Speed (mph)[3]	LTS Score
With Pocket Bike Lane				
Single	≤ 150	Straight	≤ 15	LTS 2
Single	>150	Straight	≤ 20	LTS 3
Single	Any	Left	≤ 15	LTS 3
Single[1] or Dual Exclusive/ Shared	Any	Any	Any	LTS 4
Without a Pocket Bike Lane				
Single	≤ 75		≤ 15	(no effect on LTS)
Single	75-150		≤ 15	LTS 3
Otherwise				LTS 4

[1] Any other single right turn lane configuration not shown above.

[2] The right turn criteria are based on whether the bike lane stays straight or shifts to the left.

[3] This is vehicle speed at the corner, not the speed crossing the bike lane. Corner radius can also be used as a proxy for turning speeds.

[4] There is no effect on LTS if the bikeway is physically separated from traffic, as on a shared-use path.

Table 2 LTS Criteria for Mixed Traffic

	Street Width		
Speed Limit	2-3 lanes	4-5 lanes	6+ lanes
Up to 25 mph	LTS 1 or 2[1]	LTS 3	LTS 4
30 mph	LTS 2 or 3[1]	LTS 4	LTS 4
35+ mph	LTS 4	LTS 4	LTS 4

[1]Use lower value for streets without marked centerlines or classified as residential and with fewer than 3 lanes; use higher value otherwise.

Table 3 LTS Criteria for Bike Lanes

Lane Factor	LTS Score			
	LTS 1	LTS 2	LTS 3	LTS 4
Alongside a Parking Lane				
Street width (through lanes per direction)	1	(no effect)	2 or more	(no effect)
Sum of bike lane and parking lane width (includes marked buffer and paved gutter)	15 ft. or more	14 or 14.5 ft.[2]	13.5 ft. or less	(no effect)
Speed limit or prevailing speed	25 mph or less	30 mph	35 mph	40 mph or more
Bike lane blockage (typically applies in commercial areas)	rare	(no effect)	frequent	(no effect)
Not Alongside a Parking Lane				
Street width (through lanes per direction)	1	2, if directions are separated by a raised median	more than 2, or 2 without a separating median	(no effect)
Bike Lane Width (includes marked buffer and paved gutter)	6 ft. or more	5.5 ft. or less	(no effect)	(no effect)
Speed limit or prevailing speed	30 mph or less	(no effect)	35 mph	40 mph or more
Bike lane blockage (typically applies in commercial areas)	rare	(no effect)	frequent	(no effect)

Note: [1] (no effect) = factor does not trigger an increase to this level of traffic stress.

[2] If speed limit < 25 mph or Class = residential, then any width is acceptable for LTS 2.

1.2.1.1 Bicycle Mode Share

To estimate the induced demand associated with the bicycle improvements proposed in the study corridor, the National Cooperative Highway Research Program (NCHRP) 552 methodology provided in the Guidelines for Analysis of Investment in Bicycle Facilities was utilized. The analysis quantifies the induced demand mode shift (induced demand) associated with the proposed improvements, and monetizes the annualized mobility, health, recreation and decreased auto use benefits provided by the projected mode shift at high, moderate and low estimates. Bicyclists are more likely to use a facility if they live within a 1.5 mile buffer than if they live outside of this distance. Moreover, the highest likelihood of a member of the population to use the facility exists if they live within a 0.5 mile buffer around the facility. The NCHRP 552 methodology suggests that bicycle commute mode share can be utilized to estimate the number of existing and future bicycle ridership based on the population, and low, moderate, and high likelihood multipliers at 1.5 mile, 1 mile, and 0.5 mile buffers that surround a facility. Each buffer area—at 0.5, 1 and 1.5 mile buffers from the proposed improvements was created using a network-based analysis in a GIS environment. Benefit values are based on the following assumptions:

- Existing cyclists near a new facility will shift from a nearby facility to a new facility
- The new facility will induce new cyclists as a function of the number of existing cyclists relative to the attractiveness of the proposed facilities

To estimate future bicycle ridership, the population near the improvements was calculated using block level population data from the 2018 American Community Survey (ACS) 5-Year estimates, and distance buffers of 0.5 miles, 1 mile and 1.5 miles based on the NCHRP Report 552 methodology. 2018 population estimates were utilized as baseline population estimates. Population growth rates were calculated using the land use data by TAZ found in the 2015 and 2045 Greater Eureka Area Travel Model (GEATM) travel demand models and applied to the baseline to estimate future population. The total population within each buffer distance range near the proposed improvements was estimated by multiplying the proportion of area of each buffer to the area of the whole block by the estimated block population.

Using the estimated population and the sketch planning method presented in Appendix A of NCHRP Report 552, existing bicycle rates and the mobility, health, recreation, and decreased auto use benefits at high, moderate and low levels were estimated.

1.2.1.2 Transit Mode Share

Transit mode share measures the degree that system and service improvements in transit service induce more ridership. The methodologies described in TCRP-118 the Bus Rapid Transit Practitioner's Guide were used to determine the degree of mode shift to transit resulting from proposed service and system transit improvements.

1.2.1.3 Vehicle Miles Traveled VMT

Vehicle Miles Traveled (VMT) is calculated by multiplying the number of trip and the average segment lengths of a given trip. Per California's Senate Bill (SB) 743, VMT is now the operative metric used to assess transportation impacts under the California Environmental Quality Act (CEQA). VMT is a measure of both transportation and land use efficiency given that shorter trips or trips not requiring an automobile will result is less VMT.

1.2.2 Reliable Mobility

Forecasted corridor conditions produced results for vehicle miles of travel and travel time, travel time index (TTI), and delay.

1.2.2.1 Multimodal Service Quality

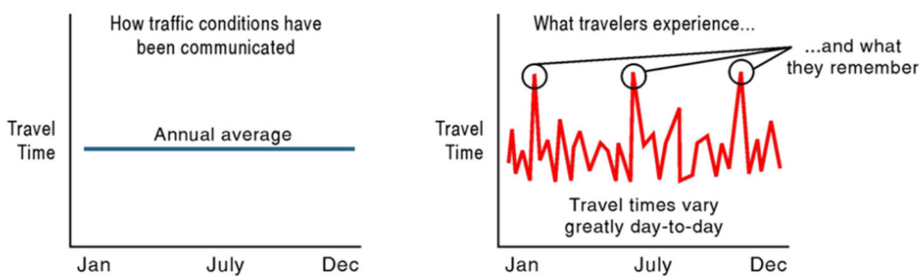
Baseline and forecasted service quality in the Broadway Corridor was empirically based using INRIX and the National Performance Monitoring Research Data Set (NPMRDS) travel time data sets. The Federal National Performance Rule Congestion Threshold performance measure was used to determine the performance of roadway segments within the study corridor: Uncongested (>= 60 % of free-flow) vs. Congested (< 60% of free-flow). Under the federal definition, a roadway is considered congested if peak period travel speeds fall below 60% of free flow speeds. This includes delays experienced at intersections. The analysis is based on NPMRDS speed data collected over a two-year period and reflects the AM/PM peak hours. Given that free flow speed is a key variable for calculating this performance measure, free flow speed was empirically estimated for each roadway segment using NPMRDS data between the hours of midnight and 3 AM.

1.2.2.2 Intersection Operations

Intersection operations were quantified using Synchro software through the determination of Level of Service (LOS) at key intersections. LOS is a qualitative metric that describes the experience of motorists. Intersections and approaches are assigned scores from “A” through “F” with A being free-flowing traffic with little to no congestion and F being highly congested. LOS criteria are established to determine whether a given roadway facility is providing the desired quality of service. The methodologies used to determine LOS (i.e. delay, speed, density) were based on the Highway Capacity Manual (HCM) 6th Edition. Caltrans operating standards have been applied that identify the cusp between LOS C and D as the acceptable threshold for Broadway Corridor.

1.2.2.3 Multimodal Service Reliability

Travel time reliability is defined as the variation in travel time for the same trip from day to day (“same trip” implies a trip made with the same purpose, from the same origin, to the same destination, at the same time of the day, using the same mode, and by the same route). If variability is large, the travel time is considered to be unreliable, because it is difficult to generate consistent and accurate estimates for it. If there is little or no variation in the travel time for the same trip, the travel time is considered to be reliable.



Future buffer times are proportional to correlation between Travel Time Index (TTI) between existing condition and future conditions. Average travel time in calculation of TTI (which is a ratio of average travel time and free flow travel time) was generated by adjusting National Performance Management Research Data Set (NPMRDS) observed travel times by results from Synchro traffic analysis while the free flow travel time was calculated based on an average speed of 45 miles per hour throughout the corridor. The following performance metrics for passenger vehicles were generated:

- Buffer time
- Buffer time index

Both the national rule’s definition of reliability (based on 80th percentile speed) and the HCM definition of reliability (based on 95th percentile speed) were applied.

Federal definitions from the National Performance Management Measures Rule were used to define reliability. Both the national rule's definition of reliability (based on 80th percentile speed) and the HCM definition of reliability (based on 95th percentile speed) were applied. Buffer Time represents the additional time a motorist needs to budget for to ensure they arrive at their destination at the expected time 95% of the time. Buffer Time Index (BTI) simply normalizes Buffer Time for distance and is expressed as a ratio or percentage (added percent of time required). A higher BTI indicates more time drivers need to budget for to drive the corridor as a typical drive time becomes less reliable. BTI equal to or greater than 0.5 indicates that a motorist will need to budget 50+ percent more time over the normal travel window (i.e., departing earlier) to ensure an on-time arrival 95 percent of the time (i.e., equates to allowing for one late arrival for every 30 trips). Table 4.3 displays the Buffer Time Index thresholds as they relate to reliability.

Table 4 Buffer Time Index Thresholds

Reliable	Moderately Reliable	Unreliable
BTI[A] < 0.25	BTI[A] 0.25 – < 0.5	BTI[A] > = 0.5

[A] Buffer Time Index – A measure of reliability, measures percentage of travel time devoted to being on time above average travel time.

To estimate the change in reliability (buffer time only) as a result of the Broadway Corridor improvement concepts, the change of travel time reliability was holistically projected for each Broadway Corridor alternative under future year conditions. The relative change in the Travel Time Index (TTI) between baseline and future was applied to adjust the empirically based NPMRDS baseline estimate of buffer time. This assumes that the effect of construction, weather, and incidents reflected in the most recent 12-24 months of NPMRDS data is reasonably reflective of the frequency of like events in the future.

1.2.3 Health and Safety

1.2.3.1 Design and Speed Suitability (i.e., Crash Reduction Potential of Infrastructure Improvements)

Based on the contributing factors from the baseline crash hot-spot assessment, Parts B and D of the Highway Safety Manual (HSM) 2010 were applied to identify location-specific and corridor-wide countermeasures. At intersections, Part C of the HSM was applied to estimate the potential safety performance and crash reduction potential of identified infrastructure design treatments. Vehicular and bicycle/pedestrian related crashes and countermeasures identified to improve safety were summarized for input into the Highway Safety Improvement Program (HSIP) analyzer to compute anticipated crash reduction. Estimated crash reductions are then monetized using societal cost estimates from the Caltrans 2018 Economic Parameters.

1.2.4 Environmental Stewardship

1.2.4.1 Vehicle Emissions (Criteria Health-Based Pollutants and Climate Change Pollutants)

Corridor and intersection-specific on-road mobile sources of health-based criteria pollutants (including VOC, NOx, and PM_{10}) and climate change pollutants (greenhouse gases) were estimated using the SB 1 Emissions Calculator (or Cal-B/C) tool developed by the California

Transportation Commission (CTC). All requisite on-road activity inputs (i.e. study corridor VMT) for this analysis were generated by the Greater Eureka Area Travel Model (GEATM), the NCHRP 552 bicycle mode shift analysis, and TCRP-118 transit mode shift analysis.

1.2.4.2 Adaptation

A qualitative assessment of the degree of vulnerability and sustainability of future transportation investments in the Broadway Corridor as well as potential benefits associated with evacuation responses to climate change related events such as flood and wildfire was determined using the Caltrans Vulnerability Mapping web-based resources.

1.2.5 Social Equity

1.2.5.1 Equitable Distribution of Benefits and Impacts

A qualitative assessment of the distribution of benefits (i.e., access to and utilization of) and impacts (construction, environmental, and right-of-way impacts) of the proposed future transportation investments in the Broadway Corridor relative to advantaged and disadvantaged communities was determined using disadvantaged and/or low-income communities web-based mapping resources, per SB 535.

1.2.6 Robust Economy

1.2.6.1 Return on Investment

To provide an indication of the projected return on investment of the proposed investment in the Broadway Corridor, a holistic 20-year life cycle benefit-cost (B/C) metric is computed based on the net present value (i.e. life cycle duration using a discount rate of four percent) incorporating the following five measures of effectiveness:

- Safety Benefit (predicted crash reduction)
- Health Benefit (mode shift to active transportation)
- Reduced Vehicle Operating Cost Benefit (VMT reductions)
- Delay and Buffer Time Reduction Benefit (delay and buffer time savings)
- Vehicle Emission Reduction Benefit (VMT and vehicular operations i.e., delay reductions)
- Operations and Maintenance Costs
- Initial Capital Costs

Monetized benefits were based on the 2018 societal cost parameters developed by Caltrans. Improvement costs (capital and operations and maintenance) used a format based on Caltrans preparation guidelines for developing project planning cost options.

The following assessments, though qualitative, relate to the robust economy objective given the importance of ensuring and protecting the integrity and sustainability of the proposed Broadway Corridor investment.

1.2.6.2 Economic Development

An economic assessment using IMPLAN economic multipliers of the short- and long-term economic impacts of the proposed investments in the Broadway Corridor on Gross Regional Product, job creation and income.

1.2.6.3 Plan/Policy Consistency

A qualitative assessment of the degree that the proposed investments in the Broadway Corridor are politically and institutionally feasible and implementable.

1.3 Data Collection/Retrieval

Performance measures require data. The following data sources were tapped to collect/retrieve data needed to operationalize the performance measures used for the Broadway Corridor.

1.3.1 Longitudinal Employment-Housing Dynamic (LEHD) Origin-Destination Data

Longitudinal Employer–Household Dynamics (LEHD) data is primarily based on Unemployment Insurance (UI) earnings data and the Quarterly Census of Employment and Wages (QCEW), and censuses and surveys. Firm and worker information are combined to create job level quarterly earnings history data, data on where workers live and work, and data on firm characteristics, such as industry**.** The most recent available LEHD data (2017) was utilized**.**

1.3.2 National Performance Monitoring Research Data Set (Speed Data)

Per the National Performance Management Measures Final Rule, the preferred data for complying with the National Highway Performance Program is the National Performance Management Research Data Set (NPMRDS) from FHWA. The NPMRDS provides average speed data (five-minute averaging time) for federally defined roadway segments designated as part of the National Highway System (NHS).

NPMRDS data for August 2018 through July 2019 (12-months) was downloaded for analysis[1]. Given the desire to reflect annual average weekday conditions, the data was filtered to isolate average weekday conditions - Tues-Thurs AM/PM peak periods for passenger vehicles and heavy-duty truck vehicles separately. The AM/PM peak hours between 8:00 AM to 9:00 AM and 4:30 PM and 5:30 PM were analyzed for both passenger vehicles and truck.

A total of 163,504 individual data records were processed, and after filtering the data to isolate average peak hour conditions, 34,317 AM and 30,649 PM peak hour records were analyzed to yield 144 averaged observations for 18 segments (reflecting both directions of travel) for both passenger vehicles and heavy duty trucks respectively. The only data “cleansing” applied was to filter/remove extreme high speed outliers (e.g., 90+ mph) from the free flow speed, congestion and reliability calculations. All data was processed and summarized based on the NPMRDS segmentation.

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[1] The National Performance Measurement Rule recommends using 12 months of data to reflect a “true” annual average.

1.3.3 Traffic Counts

Turn movement counts were collected for 24 key intersections in the Broadway Corridor study area. Count data was collected for peak hour periods in the AM (7:00 to 9:00 AM) and PM (4:00 to 6:00 PM), and includes information on heavy vehicle percentages, pedestrian and bicycle counts, and right turn on red volumes. To supplement this new traffic count data, 2018 count data from five (5) additional intersections used in the 2616 Broadway Street Redevelopment Transportation Impact Study was utilized in the analysis. In addition, roadway segment count were collected by Caltrans in September 2019 for average daily traffic (ADT) volumes at nine segment locations along the Broadway Corridor.

1.3.4 Transit Ridership Data

Transit ridership data was obtained from the *Humboldt County Transit Development Plan*[2] for years 2017-2022. Service quantities and performance measures information for the City of Eureka Transit Service (ETS) came from transit monthly reports and/or Draft Triennial Performance Audits.

1.3.5 SWITRS and TIMS Crash Data

Crash data was obtained from the Statewide Integrated Traffic Records System (SWITRS) for the years between 2014 and 2018. Transportation Injury Mapping System (TIMS) data was also accessed for the same period to cross reference the injury and fatality crash data in SWITRS.

1.3.6 Infrastructure Costs

Planning-level costs for infrastructure recommendations were obtained from existing planning studies and regional transportation planning documents. Where costs were unavailable through these sources, costs were estimated based on industry standard planning level procedures.

1.3.7 Societal Costs

Societal cost data were sourced from the 2018 Economic Parameters published by Caltrans. These societal costs are consistent with parameters resident in the Caltrans benefit-cost analysis tool Cal-BC.

1.3.8 On-line Mapping Resources

On-line mapping tools such as Climate Change Vulnerability Assessment Map (Caltrans District 1), and LEHD were utilized to inform examinations for adaptation, travel pattern and environmental justice respectively.

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[2] *Humboldt County Transit Development Plan,* Fiscal Years 2017-18 to 2021-22, LSC Transportation Consultants, 2017

1.4 Analysis Tool Development

1.4.1 Travel Demand Model

The Greater Eureka Area Travel Model (GEATM) is a travel demand model (TDM) that has been developed and maintained by Caltrans. TDMs are typically validated on an overall basis rather than on a microscopic level (i.e. street by street basis).

Caltrans' existing conditions network for Humboldt County encompasses the (US 101) Broadway corridor. The GEATM has been calibrated to daily traffic patterns within the area.

TDMs are a regional based model that link attractions to destinations with a specific regional. The GEATM is calibrated based on a regional basis when a project is conducting a focused study, the TDM should be checked to ensure proper calibration within the study area. If the study area of the TDM does not accurately represent current count and field conditions, a subarea model should be developed, calibrated, and validated. Subarea calibration will allow for a better representation of the specific study area as a regional model may not accurately represent individual areas but the regional as a whole. This is important as US 101 currently experiences annual average daily traffic (AADT) between 20,000 and 40,000 trips per day within the study area.