APPENDIX C: PERFORMANCE METRIC DESCRIPTIONS AND METHODOLOGIES

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ABBREVIATIONS/ACRONYMS

ACS ....American Community Survey
ARTIC.............Anaheim Regional Transportation Intermodal Center
BRT ....Bus Rapid Transit
BRTPG............Bus Rapid Transit Practitioner's Guide
CEQA ....California Environmental Quality Act
FAST Act ....Fixing America's Surface Transportation Act
FTA ....Federal Transit Administration
FTC..................Fullerton Transportation Center
GHG ....Greenhouse Gas
GIS ....Geographic Information Systems
GTFS ....General Transit Feed Specification
HWY................Highway
LA....................Los Angeles County Metropolitan Transportation Authority
LOS ....Level of Service
Mtrlnk.............Metrolink
NEPA...............National Environmental Policy Act
NTD.................National Transit Database
OCP.................Orange County Projections
O&M...............Operations & Maintenance
OCTA ....Orange County Transportation Authority
OCTAM ....Orange County Traffic Analysis Model
ROW ....Right of Way
SARTC ....Santa Ana Regional Transportation Center
SCAG...............Southern California Association of Governments
STOPS ....Simplified Trips-on-Project software
SURF ....Pacific Surfliner (Amtrak)
SWITRS ....Statewide Integrated Traffic Records System
TCQSM ....Transit Capacity and Quality of Service Manual
TDM................Travel Demand Model
TR ....Transit (network speed)
TRB ....Transportation Research Board
VHT.................Vehicle Hours Traveled
VMT................Vehicle Miles Traveled
YoE..................Year of Expenditure

1. TRANSIT PERFORMANCE

Mobility Problem: Traffic conditions limit the speed and reliability of transit service.

Goal: Improve the speed and reliability of transit service by removing bottlenecks and minimizing interactions with auto traffic.

Table 1.1. Objectives and Performance Measures – Transit Performance

GOAL	OBJECTIVE	PERFORMANCE MEASURE	METHOD	SOURCE	FTA
ENHANCE TRANSIT PERFORMANCE	1A: Increase average overall transit operating speed	Improvement in average transit operating speed (Greater than 20% is target)	Quantitative	TDM	
	1B: Improve transit service by reducing conflicts with auto traffic	Increase person throughput	Quantitative	TDM (with post-processing)	
	1C: Improve travel time reliability/On-time performance by ensuring better on-time performance	Measure the travel time reliability for each alternative (and per alternative segment as needed). The following factors may be considered to measure variability: • Minimize connections or transfer times • Provide accurate real-time arrival information • Improve bottlenecks • Dedicated lane miles • Traffic Signal Priority	Quantitative/ Qualitative	TDM; Alternative Description/ Information	
	1D: Congestion relief – New linked project trips	Number of new weekday linked trips resulting from implementation of the project	Quantitative	TDM; STOPS	X

FTA = Federal Transit Administration; STOPS = Simplified Trips-on-Project (Software)*; TDM= Travel Demand Model*

1.1. Objective 1A: Average Operating Speeds

1.1.1. Introduction

Objective 1A measured the projected average operating speeds for Routes 43, 47, 543, and the future OC Streetcar under each proposed alternative. Scores per alternative were based on the percent change in speed compared to a future year (2035) No-Build alternative, and weighted by overall ridership per mile.

1.1.2. Methodology

The following measures were used to evaluate this objective:

a) *Average Speeds:* Average speed calculations were based on bi-directional, weekday morning peak service on the following route segments:

   i. Route 43: Fullerton Transportation Center (FTC) to Harbor Boulevard/MacArthur Boulevard.
   ii. Route 47: FTC to Fairview Street/Westminster Avenue.
   iii. Bravo! 543: FTC to Harbor Boulevard/MacArthur Boulevard.
   iv. OC Streetcar: Santa Ana Regional Transportation Center (SARTC) to the northern termini under each alternative.

b) *Ridership per Mile:* Total projected ridership per mile was calculated and weighted against the projected operating speeds for each alternative. See Objective 1B: *Corridor Mobility* for a more detailed description on the methodology and assumptions used to calculate ridership.

c) *Modeled versus Interpolated Alternatives:* Transit and total person trips on Alternatives H-3, L-3, K-1, K-2, and the No-Build Alternative were directly modeled while the remaining alternatives were interpolated from the projected ridership on the modeled alternatives (see Memoranda A and B at the end of this appendix for a discussion on ridership modeling and elasticities).

Alternatives were assigned scores based on their projected speed improvement and per-mile ridership under each alternative.

1.1.3. Key Assumptions

The modeled alternative scenarios along Harbor Boulevard corresponded closely with OCTA travel speed estimates, however, alternative scenarios using the Anaheim/Lemon and Katella corridors were approximately 15 percent faster in the model estimate compared to OCTA estimates. The difference was applied to the interpolated scenarios for each bus alternative along those corridors.

The additional operating assumptions were applied to calculate operating speeds:

Routes 43, 47

Operating speeds under these local routes improved under all bus rapid transit (BRT) or rapid streetcar alternatives because of the addition of a dedicated transit lane. The following list provides an overview of the assumptions used to calculate speeds for Routes 43 and 47 under each alternative:

a) 9% decrease in speed compared to existing (based on 2035 projections).
b) 4% increase in dwell time for No-Build and all alternatives.
c) 15% running improvement for rapid streetcar alternatives.
d) 37% running improvement for BRT alternatives.
e) 7% dwell time improvement for all alternatives.

Bravo! 543

Operating speeds and dwell times were projected to increase under alternatives that propose to keep existing or modified Bravo! 543 service.[1] The following list provides an overview of the assumptions used to calculate speeds for Bravo! 543 under each alternative:

a) 8% decrease in average miles per hour compared to existing (based on 2035 projections).
b) 4% increase in dwell time for No-Build and all alternatives.
c) 15% running improvement for rapid streetcar alternatives.
d) 30% running improvement for BRT alternatives.
e) 20% dwell time improvement for enhance bus and BRT alternatives.

OC Streetcar

Despite an increase in dwell time, OC Streetcar speeds improved under all streetcar alternatives:

a) 4% increase in dwell time for No-Build and all streetcar alternatives.
b) 15% running improvement for rapid streetcar alternatives.

[1] Bravo! 543 would be discontinued under operational scenarios for all alternatives, with the exception of Alternative H-1: *Harbor Short Streetcar* and Alternative K-1: *Harbor-Katella Streetcar*. However, several proposed alternatives would operate in place of Bravo! 543 along identical alignments, thus obviating the need for a standalone service.

1.2. OBJECTIVE 1B: CORRIDOR MOBILITY

1.2.1. Introduction

Objective 1B measured the effect of each alternative on the total number of persons traveling on key segments of Harbor Boulevard, Anaheim Boulevard/Lemon Street, and Katella Avenue onboard transit and/or personal automobiles.

1.2.2. Methodology

Two measures were considered during the evaluation of this objective:

a) *Transit Passengers*: Projected daily boardings on Routes 43, 47, Bravo! 543, the OC Streetcar, and each alternative, under each alternative's operational scenario.

b) *Automobile Passengers*: Projected average daily number of persons traveling in private vehicles under each alternative's operational scenario.

Alternatives were assigned scores based on their projected change in total person throughput.

1.2.3. Key Assumptions

a) Boardings for the non-modeled alternatives were estimated using the elasticities established as part of the alternatives development process (see Memorandum A and B at the end of this appendix for details on elasticities).

b) Local bus service was estimated using the ratio of change between modeled assumptions (values expressed as daily boardings).

c) Streetcar alternatives could not be represented directly with the mode choice options available in the OCTA travel demand model (*Orange County Traffic Analysis Model*; OCTAM), so they were modeled as 'urban rail,' and then modified using elasticities derived from the *Transit Capacity and Quality of Service Manual*.[2]

d) Overall throughput values were measured as the sum of transit and auto passengers.

e) Bicycle and pedestrian volumes remained consistent between alternatives and were therefore not included in the comparison between transit and automobile passengers.

f) Bravo! 543 was discontinued under each scenario, except under Alternatives H-1 and K-1.

g) Route 43 absorbed Bravo! 543 ridership and contributed riders to alternatives based on modeled ratios.

[2] The *Transit Capacity and Quality of Service Manual,* prepared by the Transportation Research Board (TRB), provides guidance on transit capacity, quality of service issues, and includes quantitative techniques for calculating the capacity and other operational characteristics of bus, rail, demand-responsive, and ferry transit services, as well as transit stops, stations, and terminals. Full document available at: www.trb.org/Main/Blurbs/169437.aspx

h) Route 47 contributed riders to alternatives based on modeled ratios.

i) OC Streetcar ridership increases were assumed as connectivity to destinations north of the current western terminus would improve under alternative.

1.3. Objective 1C: Reliability and On-Time Performance

1.3.1. Introduction

Objective 1C measured travel time reliability and on-time performance for each proposed alternative through a qualitative review of traffic conditions and transit priority design features.

1.3.2. Methodology

The following measures were considered during the evaluation of this objective:

a) *Level-of-Service (LOS)*: This measure evaluated potential on-time performance impacts resulting from existing traffic conditions on Harbor Boulevard, Anaheim Boulevard/Lemon Street, and Katella Avenue.

b) *Dedicated Lanes*: This measure acknowledged the presence of transit-only lanes under each alternative.

Alternatives were assigned scores based on the presence of dedicated lanes and existing LOS ratings. Alternatives with proposed dedicated lanes and higher LOS ratings scored higher than alternatives in shared traffic lanes and lower LOS ratings.

1.3.3. Key Assumptions

a) Roadways in the study area currently experience an LOS of C and D. Corridors with LOS C were rated as more conducive to greater travel time reliability and on-time performance than corridors currently operating under LOS D.[3]

b) Alternatives with dedicated transit lanes would provide greater travel time reliability and on-time performance than alternatives operating in shared traffic lanes.

[3] LOS C represents stable traffic flow with minimal impacts in speed and traffic volume while LOS D represents corridors approaching unstable traffic flow, with a slight decrease in speed as traffic volume is increased. See section 2.2 in the Final Report for full definitions of LOS classifications.

1.4. OBJECTIVE 1D: NEW LINKED TRIPS

1.4.1. Introduction

Objective 1D evaluated new, per-mile projected weekday linked trips per alternative.

1.4.2. Methodology

New weekday linked trips were estimated by the Federal Transit Administration's (FTA) Simplified Trips-on-Project Software[4] (STOPS) model. The analysis assumed 1.43 linked trips per unlinked trip (per STOPS model outputs). Linked trip estimates from the STOPS model showed higher ridership increases associated from streetcar alternatives than OCTAM. As a result, some new linked trip estimates were not directly comparable to estimated ridership numbers.

Scores were based on the number of new daily linked trips, adjusted by the length of each proposed alternative. Scores were assigned according to the number of weekday linked trips under each alternative, with the alternatives with the highest number of linked trips receiving the highest score.

1.4.3. Key Assumptions

This measure used the STOPS model to project future transit boardings in the study area with and without an alternative. The values presented represent the number of new daily boardings associated with each alternative.

[4] STOPS is a software package that the FTA released in September 2013 as an optional ridership-forecasting method for sponsors of New Starts and Small Starts projects.

2. LAND USE

Mobility Problem: There are some land uses within the study area that are not easily or efficiently served by transit.

Goal: Allow cities to leverage improved transit service in the study area to support transit-compatible land uses and minimize secondary effects to surrounding communities.

Table 2.1. Objectives and Performance Measures – Land Use

GOAL	OBJECTIVE	PERFORMANCE MEASURE	METHOD	SOURCE	FTA
ENCOURAGE TRANSIT COMPATIBLE LAND USE	2A: Encourage transit-compatible land uses by locating transit improvements in areas with either supportive uses currently or good potential for future transit-supportive uses.	• Station/stop area population densities ("station area" is defined as the area within a 0.5-mile radius of a station) • Total employment and employment density served by the Project. (e.g., estimate employees throughout project area per standards) • Quality of pedestrian facilities including access for persons with disabilities • Existing corridor and station/stop area parking supply	Quantitative / Qualitative	Corridor Cities Zoning and Land Use data, Site Visits	X
	2B: Economic Development	Examination of existing transit supportive plans and policies; the demonstrated performance of those policies and tools in place to preserve or increase the amount of affordable housing in the project corridor	Qualitative	City zoning; Land use data	X
	2C: Reduce VMT-related impacts to environment	Rate primary (type of mode alternative) and secondary (e.g., VMT) offset and impact on congestion, air quality, GHG) emissions from various mode alternatives and through different alignment alternatives	Quantitative	TDM, STOPS	X

GOAL	OBJECTIVE	PERFORMANCE MEASURE	METHOD	SOURCE	FTA
ENCOURAGE TRANSIT COMPATIBLE LAND USE	2D: Reduce/minimize environmental impacts	These are computed based on the change in VMT resulting from the project: • Noise and Vibration • Historic and Cultural Resources • Parks and Open Space • Traffic/Transportation • Community Disruption/Displacement • Title VI/Environmental Justice • Utilities • CalEnviroScreen score	Quantitative / Qualitative	TDM; Alternative Description/ Information; GIS Analysis; STOPS	

FTA = Federal Transit Administration; GHG = Greenhouse Gas Emissions; GIS = Geographic Information Systems; STOPS = Simplified Trips-on-Project TDM= Travel Demand Model; VMT = Vehicle Miles Traveled

2.1. OBJECTIVE 2A: TRANSIT-COMPATIBLE LAND USES

2.1.1. Introduction

Objective 2A measured the "transit-compatibility" of existing land uses within a half-mile of proposed stops[5] for each alternative. Additionally, this objective also measured pedestrian facilities immediately adjacent to proposed stops.

2.1.2. Methodology

Five measures were considered during the evaluation of this objective:

a) *Land Use*: Proportion of existing transit-supportive land uses along an alternative.
b) *Population*: Projected future population density within a half-mile of each proposed stop.
c) *Employment*: Projected future employment density within a half-mile of each proposed stop.
d) *Parking*: Proportion of frontage along an alternative that consists of parking.
e) *Pedestrian Facilities*: Presence/magnitude of enhanced pedestrian amenities such as tactile paving, sidewalks/sidewalk width, pavers, enhanced crosswalks, and curb extensions/returns.

Alternatives were assigned scores based on a combination of their rankings in land use, population and employment, parking conditions, and pedestrian facilities, as described above.

2.1.3. Key Assumptions:

a) Land uses such as medium/high-density residential, mixed-use housing, and commercial, were deemed "transit-supportive" due to their respective intensity of activities and potential for accommodating transit-oriented development.

b) Alternatives were evaluated against projected 2035 population and employment densities classified according to FTA guidance[6] with the assumption that higher population/employment densities around a stop would lead to greater transit ridership.
c) The presence of street-facing parking (including auto body shops and parking lots serving "big-box" retailers) was classified as a negative contributor to walkability and

[5] See Section 3.4 of the *Central Harbor Boulevard Transit Corridor Study* for a full list of proposed stops per alternative.
[6] See FTA's "Final Capital Investment Grant Program Interim Policy Guidance" (June 2016): www.transit.dot.gov/sites/fta.dot.gov/files/docs/FAST_Updated_Interim_Policy_Guidance_June%20_2016.pdf

transit usage.

d) Intersections around stops with enhanced pedestrian amenities were deemed safer and were assumed to have greater potential for accommodating greater volumes of pedestrians and transit riders.

e) Only the conditions of the intersection immediately next to a proposed stop were considered during the evaluation of this objective.

2.2. Objective 2B: Economic Development

2.2.1. Introduction

Objective 2B measured the economic development potential of a proposed alternative through a qualitative review of each corridor cities' existing and proposed plans, policies, and on-the-ground conditions.

2.2.2. Methodology

Four measures were considered during the evaluation of this objective:

a) *Opportunity sites*: Like parking in Objective 2A: *Transit-Compatible Land Uses*, this measure considered the proportion of street frontage along an alternative that is currently used for parking as potential opportunity site for future development. Thus, alternatives traveling through corridors with greater amounts of street-facing parking received a higher score.

b) *Transit-Supportive Plans:* This measure considered specific plans and other types of policies and tools throughout the study area that may support greater transit usage and, potentially, economic activity, through increased density and walkability. With some exceptions, these plans and policies were mainly developed with a focus on the following nodes: Downtown Fullerton, CtrCity Anaheim (Anaheim's downtown district), The Anaheim Resort, Anaheim's Platinum Triangle District, and the area around Harbor Boulevard/Westminster Avenue. Each alternative was then evaluated against the total number of nodes each alternative travels through. These nodes generally aligned with development patterns, existing/proposed specific plans, or other land use policies and regulations generally considered "transit-supportive."

f) *Transit-Supportive Land Uses*: Like Objective 2A: *Transit Compatible Land Uses*, this measure considered the proportion of existing land uses deemed "transit-supportive" due to their respective intensity of activity and potential for accommodating transit-oriented development.

c) *Affordable Housing*: Per FTA guidelines,[7] projects seeking FTA New Starts funding must evaluate tools to implement transit-supportive plans and policies along a project corridor. Alternatives were evaluated by the proportion of a city's total housing stock that is currently considered affordable by the Orange County Community Services Department.

Alternatives were assigned a score according to a combination of their rankings under opportunity sites, transit-supportive land uses plans, transit-supportive land uses, and proportion of affordable housing, as described above.

[7] See FTA's "Final Capital Investment Grant Program Interim Policy Guidance" (June 2016): www.transit.dot.gov/sites/fta.dot.gov/files/docs/FAST_Updated_Interim_Policy_Guidance_June%20_2016.pdf

2.2.3. Key Assumptions

a) This objective considered land occupied by surface parking as a potential opportunity site for development that may also lead to greater economic activity with the introduction of enhanced transit service. This measure did not consider existing land use regulations or city policies that may restrict the conversion of surface parking or the types of development that may occur along an alternative and the economic impacts typically associated with such developments.

b) When designating specific areas within the study area as "transit-supportive" nodes, the following plans and policies were considered:

   i. *The Anaheim Resort Specific Plan* (City of Anaheim, 1994).
   ii. *The Disneyland Resort Specific Plan* (City of Anaheim, 1993).
   iii. *Fullerton Transportation Center Specific Plan* (City of Fullerton, 2010).
   iv. *Harbor Mixed Use Transit Corridor Specific Plan* (City of Santa Ana, 2014).
   v. *Harbor Walk Specific Plan* (City of Fullerton, 2014).
   vi. *Hotel Circle Specific Plan* (City of Anaheim, 1994).
   vii. *Orangefair Specific Plan* (City of Fullerton, 2013).
   viii. *The Platinum Triangle Master Land Use Plan* (City of Anaheim, 2016).
   ix. *Soco Walk/Fullerton Transit Village Specific Plan* (City of Fullerton, 2004).

   In addition to the plans listed above, CtrCity Anaheim is also considered a node of transit-supportive plans due to existing land uses and planned development. For the purposes of analysis, some plans and policies were combined due to proximity and each plan was considered equally supportive of transit and walkability.

c) Land uses such as medium/high-density residential, mixed-use housing, and commercial, were deemed "transit-supportive" due to their respective intensity of activities and potential for accommodating transit-oriented development.

d) The evaluation of alternatives by the proportion of affordable housing within city limits does not account for proximity to a proposed alternative nor does it consider other plans or policies that promote housing affordability. Moreover, this objective did not evaluate existing city affordable housing policies or initiatives and their impacts on overall housing affordability.

2.3. Objective 2C: Vehicle Miles Traveled

2.3.1. Introduction

Objective 2C measured the impact of an alternative on countywide vehicle miles traveled (VMT). This measure considered VMT offset, which is a commonly used metric under the California Environmental Quality Act (CEQA), to evaluate the transportation impact of a project.

2.3.2. Methodology

The change in VMT for each alternative was estimated by comparing projected total daily VMT in Orange County, from both private vehicles and transit, with a No-Build alternative VMT estimate for each alternative.

Daily private automobile VMT in Orange County was calculated by multiplying the total private vehicle person trips in each alternative (established in Objective 5B: *Transit Mode Shift*) by the OCTAM-provided average trip length. Daily transit VMT was calculated using daily transit vehicle hours traveled (VHT) in the study area and adding each alternative's VHT to the countywide transit VHT. Using existing ratios of established countywide transit VMT and VHT, daily transit VMT was calculated for each alternative.

This, combined with daily private VMT, provided a daily total VMT in Orange County, with net changes calculated and scored based off this countywide change.

2.3.3. Key Assumptions

Change in VMT for each alternative was estimated using average vehicle occupancy for each corridor compared with the private automobile passengers estimated in Objective 1B: *Corridor Mobility* to determine corridor VMT for each scenario.

2.4. Objective 2D: Environmental Impacts

2.4.1. Introduction

Objective 2D measured potential environmental impacts during construction and operation of an alternative based on a review of measures commonly used during environmental reviews under CEQA and the National Environmental Policy Act (NEPA). Identification of potential impacts allows the public to make informed decisions on projects in their community during the CEQA and/or NEPA process and help minimize or avoid impacts altogether if possible.

2.4.2. Methodology

Four measures were considered during the evaluation of this objective. The first three measures were aggregated and considered jointly under "Operating Impacts" while the fourth measure (d) was considered separately.

a) Potential "sensitive receptors," i.e., facilities/land uses where the occupants are more susceptible to the adverse effects of exposure to respiratory pollutants. This study considered schools, parks, hospitals, and nursing/convalescent homes directly adjacent to alternatives as potential sensitive receptors.
b) Potential historic resources listed in the California Register of Historical Resources.
c) The overall percentage of housing along each alternative.
d) Potential magnitude of temporary impacts during project construction.

Alternatives were assigned scores according to their potential overall impact. Alternatives with the least number of potential impacts received the highest scores.

2.4.3. Key Assumptions

a) This study only considered facilities immediately adjacent to an alternative's proposed alignment. Thus, while a potential sensitive receptor located off a study corridor or on a perpendicular street may be impacted by construction or operation of an alternative, this study only considered those resources immediately adjacent to an alternative's proposed alignment. Moreover, this study only considered potential sensitive receptors that were identified during a visual survey of the study area and does not control for size or location of existing sources of pollutants such as freeways. Streetcar alternatives were deemed twice as impactful as bus alternatives under this objective. The actual environmental impact of a mode may vary during construction and implementation, however.
b) Similarly, this study only considered potential historic resources immediately adjacent to an alternative's proposed alignment. Moreover, this study only considered resources listed in the California Register of Historical Resources and did not consider unlisted

resources or resources in local or other registers. Streetcar alternatives were also deemed twice as impactful as bus alternatives under this measure. The actual impact of a mode may vary during construction and implementation.

c) The evaluation of the housing measure of this objective considered the proportion of all housing types within a quarter-mile of an alternative's proposed alignment. This study did not distinguish between housing types (i.e., detached single family homes and multi-family apartment units), density, or a housing unit's orientation with respect to an alternative's proposed alignment.

d) Scores for temporary construction impacts were assigned to each alternative based on mode and length, with longer streetcar alternatives deemed most impactful and shorter enhanced bus alternatives deemed least impactful.

3. CONNECTIVITY

Mobility Problem: Connections to/from major activity centers are difficult for many transit users.

Goal: Ensure that major destinations for core transit ridership are reachable via one-seat transit rides or easy transfers.

Table 3.1. Objectives and Performance Measures – Connectivity

GOAL	OBJECTIVE	PERFORMANCE MEASURE	METHOD	SOURCE	FTA
IMPROVE LOCAL & REGIONAL CONNECTIVITY	3A: Ensure major activity centers in the region can be reached within a reasonable amount of time	Determine the percentage of activity centers that can be reached within fifteen minutes, thirty minutes, forty-five minutes, one hour, greater than one hour, per alternative using isochrone mapping. Transfer times will be adjusted based on improvements in transfer areas.	Quantitative	TDM; GIS Analysis	
	3B: Ensure zero and one-transfer rides to all major regional activity centers	Identify all major activity centers in study area and adjacent region and determine number that can be reached with a one-seat ride per alternative and determine which mode alternative is better for select connections. Level of Stress measures similar to what is used for Active Transportation/Bike commutes will be analyzed to support this objective.	Quantitative/ Qualitative	TDM; GIS Analysis	
	3C: Compliance with Long Range Regional Mobility Goals	Ensure project complies and helps agency meet long-term regional goals.	Qualitative	2016 Southern California Association of Governments (SCAG) Draft Regional Transportation Plan (RTP)	X
	3D: Improve first/last mile connections to major hubs and seek opportunities to link to bike and pedestrian amenities	Evaluate existing connections to major transit hubs (FTC, SARTC, ARTIC) and activity centers (Downtown Fullerton, CtrCity Anaheim, The Anaheim Resort, Grove District) and compare travel time with alternatives. This measure will mainly focus on walk and bike sheds, although other first/last mile connections will be considered as applicable.	Quantitative	TDM, Bicycle and Pedestrian Plans	X

ARTIC = Anaheim Regional Transportation Intermodal Center; FTA = Federal Transit Administration; FTC = Fullerton Transportation Center
GIS = Geographic Information Systems; SARTC = Santa Ana Regional Transportation Intermodal Center; TDM = Travel Demand Model

OBJECTIVE 3A: CONNECTIVITY

3.1.1. Introduction

Objective 3A measured travel time savings under each alternative compared to conditions under a future year No-Build alternative scenario. Travel time savings were based on major activity centers during weekday morning peak hours.

3.1.2. Methodology

Six connections were used to measure travel time savings under each alternative:

a) California State University, Fullerton to Harbor Boulevard/Lampson Avenue.
b) Knott's Berry Farm Amusement Park to Harbor Boulevard/Westminster Avenue.
c) Downtown Santa Ana to the Anaheim Resort.
d) Orange Station to CtrCity Anaheim.
e) "Little Saigon" (in the city of Westminster) to the FTC.
f) FTC to Harbor Boulevard/Westminster Avenue.

These activity centers were selected according to three criteria:

a) Areas with large concentrations of transit trips.
b) Areas with large concentrations of carless (zero-car) households.
c) Areas recognized as distinct activity nodes.

Alternatives were assigned scores based on their average projected travel time savings between the six connections listed above.

3.1.3. Key Assumptions

a) This criteria used the travel times calculated in Objective 1A: *Average Operating Speeds* to measure travel time savings compared to conditions under a future year No-Build alternative scenario. Travel times included total run times, dwell times, and turn times under each alternative for Routes 43, 47, Bravo! 543, and the OC Streetcar.

b) Transfer time were factored into total travel time. These were based on an average walking speed of three feet per second, as defined in the *Manual on Uniform Traffic Control Devices*.[8]

c) In addition to transfer times, wait times were included in overall travel times and were

[8] The *Manual on Uniform Traffic Control Devices* contains the national standards governing all traffic control devices in the U.S. The manual is issued by the Federal Highway Administration of the U.S. Department of Transportation and updated periodically. The most recent edition (2009) is available at: https://mutcd.fhwa.dot.gov/pdfs/2009r1r2/mutcd2009r1r2edition.pdf

based on 50 percent of headways.

d) If a connection required a transfer to another OCTA line, the average weekday run time during the hours of 6:00 AM to 9:00 AM was added to the overall total travel time.

3.2. Objective 3B: Zero-Transfer Rides

3.2.1. Introduction

Objective 3B identified key regional activity centers and determined the number that could be reached within a zero or one-transfer ride with each alternative.

3.2.2. Methodology

The following twelve activity centers, introduced in section in Objective 3A: *Connectivity,* were considered:

a) *California State University, Fullerton*: As the largest university in Orange County, Cal State Fullerton is considered a key activity center and distinct node. The university is also a major trip generator due to its large number of students and employees.

b) *Fullerton Transportation Center*: The FTC is recognized as a key activity center, offering connections to OCTA, Amtrak, and Metrolink service.

c) *Knott's Berry Farm*: The amusement park is recognized as a distinct node and landmark in central Orange County. Additionally, although this key activity center is located the further outside (>3 miles) of the study area than other activity centers in the city of Buena Park, it is near census tracts representing a high percentage of zero car households.

d) *CtrCity Anaheim*: Anaheim's downtown district is recognized as a key activity and jobs center. It is also located near census tracts with a high percentage of carless households.

e) *The Anaheim Resort*: The Anaheim Resort, with its proximity to the Disneyland Resort, is a key jobs and activity center. It attracts a large number of transit riders and connects passengers with nearby commercial activities and numerous OCTA bus lines.

f) *Anaheim Regional Transportation Intermodal Center* (ARTIC): ARTIC is recognized as landmark and key activity center. The station also offers connections to OCTA, Amtrak, and Metrolink service. ARTIC also provides connections with other regional and long-distance bus providers, such as Greyhound and Megabus.

g) *Orange Station*: The station is recognized as a key activity center, offering connections to OCTA and Metrolink service. Orange Station is also within walking distance to other nearby activity centers, such as downtown Orange and Chapman University.

h) *MainPlace Mall*: The mall is recognized as key activity center and attracts a significant number of transit riders.

i) *Harbor Boulevard and Lampson Avenue*: The intersection of Harbor Boulevard and Lampson Avenue is in an area with a high proportion of carless households. This intersection also offers connections with nearby large-scale commercial land uses, such as the Great Wolf Lodge.

j) *Harbor Boulevard and Westminster Avenue*: The intersection of Harbor Boulevard and Westminster Avenue is near census tracts with a high proportion of carless households and offers connections to multiple OCTA lines, including the future OC Streetcar.

k) *Downtown Santa Ana*: Like Harbor Boulevard and Westminster Avenue, downtown Santa Ana is a key activity and jobs center. Large concentrations of carless households are located within or nearby Downtown Santa Ana.

l) *Little Saigon*: Centered east of the study area in the city of Westminster, this famous Orange County neighborhood, is a distinctive node and attracts a large numbers of transit riders.

Alternatives were assigned scores based on the number of additional destinations that could be reached without a transfer.

3.2.3. Key Assumptions

a) Zero and one-transfer rides to activity centers include all possible origin and destination points measured by proposed stop per alternative.

b) Alternatives scored higher if they provided additional zero or one-transfer compared to existing conditions.

3.3. OBJECTIVE 3C: REGIONAL GOALS

3.3.1. Introduction

Objective 3C ensures that OCTA contributes to meeting long-term transportation and sustainability goals. The goals used in this objective were developed by the Southern California Association of Governments (SCAG), and reflect a broad spectrum of improvements in economic development, mobility, and land use patterns.

3.3.2. Methodology

Alternatives were evaluated according to nine long-term regional goals identified in the SCAG *2016-2040 Regional Transportation Plan/Sustainable Communities Strategy* Final Report:[9]

1) Improve regional economic development and competitiveness.
2) Maximize mobility and accessibility for all people and goods in the region.
3) Ensure travel and reliability for all people and goods in the region.
4) Preserve and ensure a sustainable regional transportation system.
5) Maximize the productivity of our transportation system.
6) Protect the environment and health of our residents by improving air quality and encouraging active transportation (e.g., bicycling and walking).
7) Encourage land use and growth patterns that facilitate transit and active transportation.
8) Maximize the security of the regional transportation system through improved system monitoring, rapid recovery planning, and coordination with other security agencies.

Alternatives were assigned scores based on the total number of goals they supported, and the degree to which they contributed to their fulfillment.

3.3.3. Key Assumptions

1) Support for goal 1 above was measured through the scores and assumptions from Objective 2B: *Economic Development*.
2) Support for goal 2 above was measured through the scores and assumptions from Objective 1B: *Corridor Mobility*.
3) Support for goal 3 above was measured through the scores and assumptions from Objective 4B: *Safety*.
4) Support for goal 4 above was measured through the scores and assumptions from

[9] "2016 RTP/SCS Goals," p. 64: http://scagrtpscs.net/Documents/2016/final/f2016RTPSCS.pdf

section Objective 6B: *Operations Costs*.

5) Support for goal 5 above was measured through the scores and assumptions from Objective 5A: *Attract New Riders*.
6) Support for goal 6 above was measured through the scores and assumptions from Objective 2C: *VMT Impacts*
7) Support for goal 7 above was measured through the scores and assumptions from Objective 2A: *Transit Compatible Land Uses*
8) Support for goal 8 above was assumed equal across all alternatives as each will conform to OCTA's adopted security policies.

3.4. Objective 3D: First/Last Mile Connections

3.4.1. Introduction

Objective 3D measured first/last mile connections within one-mile of select stops for all alternatives.[10]

3.4.2. Methodology

Two measures were considered during the evaluation of this objective:

a) *Sidewalks:* This measure identified all existing sidewalks within one-mile around each proposed stop.

b) *Bikeways*: This measure identified all existing and proposed Class I, II, or III bikeways within one-mile around each proposed stop.

Five proposed stops were selected for evaluating these measures:

a) Fullerton Transportation Center
b) Santa Ana Regional Transportation Center
c) CtrCity Anaheim (intersection of Anaheim Boulevard and Santa Ana Street)
d) Anaheim Regional Transportation Intermodal Center
e) Harbor Boulevard/Westminster Avenue

Alternatives with more sidewalk and bikeway connections at proposed stops received higher scores than those without.

3.4.3. Key Assumptions

a) The proposed stops listed above were selected because they are major transit hubs and/or key activity centers.

b) High scoring alternatives were considered as having greater potential for facilitating first/last mile connections.

[10] See Section 3.4 of the *Central Harbor Boulevard Transit Corridor Study* for a full list of proposed stops per alternative.

4. CONSTRAINTS

Mobility Problem: Constrained corridor infrastructure is mainly allocated to personal automobiles.

Goal: Ensure roadway space is allocated equitably for travel modes to allow residents, workers and visitors to travel freely and safely through a variety of mode choices within the study area.

Table 4.1. Objectives and Performance Measures – Infrastructure Constraints

GOAL	OBJECTIVE	PERFORMANCE MEASURE	METHOD	SOURCE	FTA
OPTIMALLY ALLOCATE INFRASTRUCTURE WITHIN CORRIDOR CONSTRAINTS	**Optimally allocate roadway infrastructure** between auto movement, parking, and transit, bicycle, and pedestrian uses	Measure proposed roadway right-of-way (ROW) allocation by mode and compare to projected volumes by mode. Consider improvements as needed such as: • Queue jumpers • Lane reconfiguration • Lane restriping • Bus bays • Bulb-outs • Peak-hour travel lanes • Bicycle and pedestrian improvements	Quantitative/ Qualitative	TDM; Alternative Description/ Information	
	Improve overall safety in corridor for all modes and identify collision hot spots	Identify hotspots for vehicle and pedestrian collisions and recommended improvements (e.g., crosswalks, striping, and signage) in areas of concern. The following are safety factors to be considered: • Decrease in modal conflict • Pedestrian safety elements (striping, crossing beacons, etc.) • Decrease in fatal and/or severe injury crashes	Qualitative/ Quantitative	TDM; Statewide Integrated Traffic Records System (SWITRS), Alternative Description/ Information	
	Optimize traffic operations	Measure vehicular travel time impact on auto and other roadway modes	Quantitative	TDM	
	Develop a project that compliments local neighborhoods and communities and minimizes constraints with physical corridor constraints	Assess project impact to physical environment—does project divide or segregate neighborhoods or communities? Does project require enhanced coordination with regional, state, and federal agencies?	Qualitative	Orange County, State of California, U.S. Federal Agencies	

FTA = Federal Transit Administration; TDM = Travel Demand Model

4.1. Objective 4A: Roadway Allocation

4.1.1. Introduction

Objective 4A measured the allocation of roadway space by mode and its effects on person throughput on each alternative. Vehicle throughput, ridership projections, and presence of dedicated lanes all contributed to a final score.

4.1.2. Methodology and Assumptions

One key measure was considered during the evaluation of this objective:

> *Difference between auto and transit lane throughput*: If alternatives included dedicated lanes, the projected ridership of that alternative was subtracted from estimated person throughput per lane to identify the difference.

Scores for each alternative under Objective 4A were based on the difference between person throughput per lane in shared traffic lanes compared to person throughput in dedicated transit lanes. Alternatives with no or small differences scored highest, while alternatives with the greatest differences scored lowest.

4.1.3. Key Assumptions:

a) The average number of general travel lanes along a corridor was used to represent the entire corridor. In some cases, the actual number of lanes along certain segments of a road varied.

b) Alternatives with dedicated lanes removed one shared traffic lane from private vehicle use.

c) In alternatives with dedicated transit lanes, projected private vehicle traffic in the corridor was reassigned to the remaining shared traffic lanes.

d) Projected ridership for each alternative served as the person throughput for a dedicated transit lane (in alternatives with dedicated transit lanes).

e) Alternatives with no dedicated transit lanes showed no difference between person throughput per lane.

f) Results reflected corridor averages.

4.2. Objective 4B: Roadway Incidents and Collisions

4.2.1. Introduction

Objective 4B measured the safety performance of each alternative through an evaluation of potential modal conflicts and current levels of collision rates.

4.2.2. Methodology

Three measures were considered during the evaluation of this objective:

1) *Turns*: the number of turns from one street to another in each alternative.
2) *Dedicated Lanes*: the presence of dedicated lanes in each alternative.
3) *Incidents and Collisions*: Accidents per mile in each alternative were based on 2015 *Statewide Integrated Traffic Records System* (SWITRS) data. Accidents were identified using geospatial analysis within a 200-foot radius of each alternative alignment to avoid double-counting collisions across corridors.

Scores for each alternative under Objective 4B were based on a composite score of the three measures listed above.

4.2.3. Key Assumptions

a) The greater number of turns per alternative, the greater the risk of multi-modal collisions. Thus, alternatives with a lower number of turns received a higher score.
b) Dedicated lanes reduce modal conflict and thus the risk of collisions, particularly with vehicles. Thus, alternatives with dedicated lanes received a higher score.
c) Alternatives with high levels of accidents per mile indicate a potentially higher incident/collision risk and greater need for mitigation. Thus, alternatives traveling along corridors with a greater number of accidents per mile received a lower score.

4.3. OBJECTIVE 4C: OPTIMIZING TRAFFIC OPERATIONS

4.3.1. Introduction

Objective 4C measured the impact of each alternative on average peak congested speed (in miles per hour) of shared traffic lanes in each alternative corridor.

4.3.2. Methodology

Objective 4C used model outputs to create a ratio comparing the peak congested speed of general traffic lanes in each alternative with existing conditions. Alternatives that increased average peak congested speed scored highest, and alternatives with no impact on peak congested speed scored next highest. Alternatives received lower scores if they lowered the average peak congested speed.

4.3.3. Key Assumptions

Corridor average speed was estimated using model outputs to determine a speed ratio for each mode on a given corridor. Thar ratio was applied to non-modeled alternatives.

4.4. OBJECTIVE 4D: PHYSICAL CONSTRAINTS

4.4.1. Introduction

Objective 4D measured potential conflicts with structures along each alternative. These conflicts may impact engineering/design, require enhanced coordination during permitting, and present other jurisdictional challenges.

4.4.2. Methodology

Potential conflicts such culverts, railway crossings, overpasses, underpasses, and other structures were counted along each corridor.

Scores for each alternative under Objective 4D were based on a sum of the potential conflicts along each alternative corridor. Alternatives with fewer potential conflicts scored higher, while alternatives with more potential conflicts scored lower.

4.4.3. Key Assumptions:

a) Conflicts with structures and roadways applied to streetcar alternatives only.
b) Conflicts exclusively on or within roadways applied to BRT alternatives.
c) Because enhanced bus alternatives would operate like existing OCTA buses, only existing at-grade railway crossings were considered conflicts.
d) All potential conflicts were weighted equally.

5. MODE CHOICES/USER EXPERIENCE

Mobility Problem: Inconsistent user experience at transit stops can be confusing; for many study area trips, mode choices are limited.

Goal: Enable transit-dependent riders, choice riders, and tourists to easily access transit options and improve perceptions of transit service.

Table 5.1. Objectives and Performance Measures – User Experience

GOAL	OBJECTIVE	PERFORMANCE MEASURE	METHOD	SOURCE	FTA
ENHANCED USER EXPERIENCE/MODE CHOICES	**5A: Attract new riders**	Increase ridership and ensure annual system-wide new riders exceed baseline average hourly boardings	Quantitative	TDM; ACS	
	5B: Reduce auto dependence/ auto trips and promote mode shift to transit (primarily focus on choice riders)	Measure before and after mode share for each alternative. Alternatives with larger non-auto mode shares will score better.	Quantitative	TDM; National Household Travel Survey (NHTS)	
	5C: Improve mobility for all households (primarily focus on zero-car households)	Increased ridership/capacity, including: • Annual study area transit ridership • Annual study area VMT Mobility Improvement: Estimated number of linked trips on the project by non-transit dependent persons + (Estimated number of linked trips taken by transit dependent)*2	Quantitative	TDM; ACS; STOPS	X
	5D: Improve user experience by evaluating level of amenities per stop	Evaluate stops by amenity level (e.g., informational materials, seating, shade, sidewalk conditions) and offer recommendations for improvements to suit ridership needs. Criteria will consider the following stop amenities and the quality/level of amenity: • Defined stops • Bench (basic, premium, ad) • Shelter (ad shelter, barrel vaulted roof shelter, high capacity, etc.) • Bus Service Information • Off-Board ticketing • Adequate lighting (hard-wired shelters, pole mounted) • Trash Cans	Qualitative	Alternative Description/ Information	

ACS = American Community Survey; FTA = Federal Transit Administration; STOPS = Simplified-Trips-on-Project; TDM = Travel Demand Model

5.1. Objective 5A: New Riders

5.1.1. Introduction

Objective 5A measured the increase in net ridership as a direct result of the implementation of each alternative.

5.1.2. Methodology

Net ridership projections per proposed alternative were calculated as the difference between existing systemwide ridership and estimates of systemwide ridership per alternative. The result was then adjusted by proposed alternative length to yield the specific ridership contribution from an alternative.

Alternatives with high ridership per mile received the highest scores.

5.1.3. Key Assumptions

a) See Objective 1B: *Corridor Mobility* and Objective 1D: *New Linked Trips* for more information on ridership modeling.
b) Systemwide ridership impacts account for diversion from Bravo! 543 to local routes and new riders on proposed alternatives.

5.2. OBJECTIVE 5B: TRANSIT MODE SHIFT

5.2.1. Introduction

Objective 5B measured the proportion of increased transit mode share per alternative compared to a future year (2035) No-Build alternative scenario.

5.2.2. Methodology

This objective measured increases in transit ridership as a measure of overall transit mode share within Orange County. Private vehicle person throughput and transit riders, calculated for Objective 1B: *Corridor Mobility*, were used to establish total person throughput as a basis for comparison. Comparing these two numbers resulted in countywide transit mode share per alternative, and allowed for comparison between each alternative's impacts on mode share.

Alternatives that contributed to a greater countywide transit mode share received a higher score.

5.2.3. Key Assumptions

As described in Objective 1A: *Average Operating Speeds*, Transit and total person trips on Alternatives H-3, L-3, K-1, K-2, and the No-Build Alternative were directly modeled while the remaining results were interpolated by comparing existing corridor ridership to projected ridership.

5.3. Objective 5C: Improved Mobility

5.3.1. Introduction

Objective 5C measured the improvements in mobility for all households in the study, with a particular focus on zero-car households.

5.3.2. Methodology

This objective evaluated weighted linked trips per mile per alternative. Weighted linked trips were calculated as zero-car household trips multiplied by two, plus all other trips, then divided by alternative route length.

Alternatives with a larger number of weighted linked trips received a higher score.

5.3.3. Key Assumptions

This measure used the STOPS model to evaluate the number of linked transit trips per alternative. This measure also evaluated the relative proportion of transit-dependent riders (i.e., zero-car households) that are likely to use the service. In higher ridership alternatives, non-transit dependent riders made up larger proportions of the total ridership, but transit dependent ridership also increased with overall ridership.

Results from the STOPS model estimated a lower proportion of zero car households as riders for streetcar alternatives, but more zero car riders overall due to larger ridership totals.

5.4. OBJECTIVE 5D: USER EXPERIENCE

5.4.1. Introduction

Objective 5D measured the potential of each alternative to improve overall user experience at proposed stops along each alternative.

5.4.2. Methodology

Existing bus stops at proposed stop locations were evaluated according to their existing level of amenities. Existing conditions for each existing stop were collected through extensive field and visual surveys. Stops were assigned scores based on existing conditions ('high' amenity stop = 3, 'medium' amenity stop = 2, 'low' amenity stop = 1) and a static high score (4) assigned to all stops along a proposed alternative. Existing condition scores (ranging from 1-3) were then subtracted from improved transit stop scores (4).

Alternatives with a large number of low amenity stops saw a greater improvement and higher score, while alternatives with a large number of existing high amenity stops saw smaller improvements and lower scores.

5.4.3. Key Assumptions

Scores for each alternative under Objective 5D were based on the difference in level of amenities between existing and proposed stop designs. The greater the difference in scores, the greater the assumed improvement in user amenities and user experience. As a result, a longer alternative with a lower level of existing stop conditions would score higher because each stop along an alternative received a "4," while shorter alternatives with better existing conditions would score lower because the net improvement was lower overall. Alternatives were not adjusted for route length or number of stops as this objective was intended to rate improvements holistically.

Other assumptions include:

a) Introduction of an alternative would improve existing stops beyond their current level of amenities.
    i. Each stop along a proposed alternative would include amenities and provide a user experience beyond existing stops.
b) Stops with a high level of existing user amenities would require fewer upgrades than stops with a lower level of existing user amenities.

6. COST

Mobility Problem: Limited availability of transportation funding imposes a significant constraint on the design and extent of the final project.

Goal: Pursue cost-effective and financially feasible projects to balance mobility benefits and best use of public funds.

Table 6.1. Objectives and Performance Measures – Cost Effectiveness

GOAL	OBJECTIVE	PERFORMANCE MEASURE	METHOD	SOURCE	FTA
PURSUE PROJECTS THAT ARE COST EFFECTIVE	**6A: Design a cost-effective project while minimizing Capital and required Operations and Maintenance (O&M) costs**	Annualized capital cost plus annual O&M cost of the project divided by the annual number of forecasted trips on the project (Trips on the Project are the number of linked trips using the project, with no extra weight given to trips taken by transit dependent persons. Trips can be calculated using STOPS or the local travel model)	Quantitative/ Qualitative	Capital & O&M Cost Estimates; TDM	X
	6B: Operate the Project while minimizing O&M Costs	Incremental cost per new transit trip	Quantitative/ Qualitative	O&M Cost Estimate	
	6C: Build and operate a cost effective Project that balances costs and benefits	Farebox recovery—exceed systemwide average farebox recovery within three years of opening	Quantitative	TDM	
	6D: Financial Feasibility	Assess overall project cost and competitiveness for outside funding	Quantitative/ Qualitative	Capital and O&M Cost Estimates	

FTA = Federal Transit Administration; TDM = Travel Demand Model

6.1. Objective 6A: Cost-Effectiveness

6.1.1. Introduction

Objective 6A measured each alternative based on the FTA's definition of cost-effectiveness, which measures the net cost of an alternative per new rider.

6.1.2. Methodology

The evaluation of this objective required four inputs:

a) *Capital cost estimates per alternative:* Estimates were developed according to FTA Standard Cost Categories. This method includes the approach used for each category of project components (items that are to be constructed), purchase of new transit vehicles, purchase of property for use by the project, and allowances for 'soft costs,' including administration, project management, construction management, community relations, insurance and legal requirements, and start-up testing and training. These costs were annualized according to projected useful life (in years) and annualization factors provided by the FTA.

b) *Annual Operations and Maintenance cost estimates per alternative:* See Objective 6B: *Operations Costs* for a description of the methodology on developing these costs.

c) *Current and Future Year Annual Linked Trips:* Future year (2035) weekday boardings per alternative from Objective 1B: *Corridor Mobility* were converted to total annual linked trips after adjusting for weekends and holidays (which typically receive fewer boardings). Total annual boardings were then converted to linked trips after being normalized by a factor derived from the STOPS model.

   Current year linked trips were developed by scaling down the future year estimates by 13.3 percent. This factor was derived from boardings under a future year No-Build alternative scenario, which increased by 13.3 percent over existing year. Thus, it was estimated that 2015 annual linked trips on project would be approximately 13.3 percent less than in 2035.

d) *Annual Cost per Rider:* Annual alternative cost per rider was calculated as the weighted average of current and future year (2035) costs per linked trips (see above for methodology), using current year annual cost figures, per FTA guidance.

Ratings were based on total annual cost per rider. Alternatives with the lowest annual cost per rider received the highest score.

6.1.3. Key Assumptions

a) Current year estimates were escalated annually by three percent from the current year to an assumed future base year of expenditure (YoE). This escalation factor accounts for inflation and increases in the cost of construction, materials, and labor over time.

b) The YoE is the year in which the mid-point of construction is anticipated. The YoE is assumed to be 2025 for all streetcar, rapid streetcar, and hybrid (streetcar and BRT) estimates and 2023 for bus and BRT alternatives. It is a reasonable estimate of the possible inflation that could be expected given constants fluctuations in the economy and the cost of materials, fuel, and labor. Actual inflation and cost escalations over the next several years will vary.

c) For the purposes of annualization, each project component was given a "useful life" factor from the FTA:

   i. Guideway and Track Elements: 30 years
   ii. Stations, Stops, Terminals, Intermodal Facilities: 70 years
   iii. Support Facilities: Yards, Shops, and Administrative Buildings: 50 years
   iv. Sitework and Special Conditions: 125 years
   v. Systems: 30 years
   vi. ROW and Existing Improvements: 125 years
   vii. Vehicles: 25 years (streetcar); 12 years (bus)

   Detailed cost estimate sheets are located in Appendix B.

d) Capital costs developed as part of the evaluation of alternatives are conceptual in nature and based on limited engineering data. These estimates were developed for comparative purposes and to establish an order of magnitude budget as the project moves forward into a more detailed alternatives analysis process. As more detailed design and analysis occur during the alternatives analysis and preliminary engineering phases, the estimates produced will be reviewed and refined. The project costs estimated with limited engineering and investigation may be higher or lower than actual costs, depending on changes to the project definition.

6.2. Objective 6B: Operations Costs

6.2.1. Introduction

Objective 6B measured the impact of each alternative on current annual OCTA operations and maintenance (O&M) costs.

6.2.2. Methodology

The evaluation of this objective required three inputs:

a) Annual O&M costs
b) Annual capital costs
c) Net annual trips

The marginal cost per net annual trip was calculated as the sum of marginal annual O&M costs and net annual capital costs (from 6A: *Cost-Effectiveness),* divided by annual net ridership (adjusted for ridership).

Scores were based on total annual cost per rider. Alternatives with the lowest annual cost per rider received the highest score.

6.2.3. Key Assumptions

a) Annual O&M costs were calculated by multiplying annual projected VHT per alternative by a standard cost factor provided by the FTA through the National Transit Database (NTD) in 2014,[11] and adjusted to current year figures with an assumed 2.5 percent annual inflation rate:

   i. Bus: $142.64/Vehicle Revenue Hour
   ii. BRT: $158.26/Vehicle Revenue Hour
   iii. Streetcar Rail: $186.03/Vehicle Revenue Hour

b) Annual VHT was determined by assuming 23 daily hours of travel, multiplied by weekly and annual factors.

[11] The *Transit Profiles: 2014 Report Year Summary* is one of five profiles provided in the National Transit Database Annual Report. It consists of aggregate profiles for (1) all transit agencies and (2) full reporting agencies filing an NTD Annual Report for 2014. Profiles contain general, financial, and modal data, as well as performance and trend indicators. The full report is available at: https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/Transit%20Profiles%202014%20Report%20Year%20Summary.pdf

6.3. Objective 6C: Balance Project costs/Benefits

6.3.1. Introduction

Objective 6C measured how well an alternative balances costs and benefits during operations.

6.3.2. Methodology

This objective measured the annual impact of each alternative to OCTA's systemwide farebox recovery ratio.

This objective evaluated the following:

a) Annual O&M Costs
b) Annual Fare Revenue

Annual fare revenue was derived from ridership inputs provided in Objective 1B: *Corridor Mobility* and multiplied by an assumed base fare. Annual fare revenue was then divided by annual O&M costs (from Objective 6B: *Operations Costs*).

Ratings were based on the percentage improvement in farebox recovery among all affected routes per alternative. Alternatives with the lowest annual cost per rider received the highest score.

6.3.3. Key Assumptions

The evaluation of this objective measured the change in annual fare revenue across OCTA lines Bravo! 543, 43, 47, and OC Streetcar with added additional ridership from an alternative. In some cases, Bravo! 543 was discontinued and replaced with an alternative or enhanced service on another existing OCTA line. Other assumptions include:

a) Annual ridership was adjusted for weekend and holiday service.
b) Base fare was assumed to be $1.10 for all trips regardless of mode.
c) No free transfers were assumed.

6.4. OBJECTIVE 6D: FINANCIAL FEASIBILITY

6.4.1. Introduction

Objective 6D assessed each alternative's financial feasibility by measuring competitiveness for outside funding through a combination of overall costs and project features that strengthen each alternative's chances of receiving local, state, and federal funds.

6.4.2. Methodology

The evaluation of this objective considered the following inputs:

a) Annual combined Capital and O&M costs
b) Presence of dedicated lanes
c) Connections to a Metrolink station

Scored were assigned based on the presence of dedicated lanes and connections to Metrolink. Alternatives with both scored highest while alternatives without both scored the lowest.

6.4.3. Key Assumptions:

a) Alternatives with dedicated lanes scored higher due funding requirements under the FTA's New Starts funding program. Under the *FAST* Act of 2015, proposed projects seeking New Starts funding must be extensions to existing fixed guideway systems or new fixed guideway projects operating on a separated ROW along the majority of the route (i.e., greater than 50 percent of the total route length).

b) Alternatives that directly enhance connections to Metrolink stations in the study area (i.e., the FTC and ARTIC) are eligible for funding under Measure M2—a countywide half-cent sales tax to fund transportation projects.[12] Specifically, projects connecting to a Metrolink station are eligible for funding under Measure M2 Project S: *Transit Extensions to Metrolink*. Thus, an alternative with a direct connection to the FTC or ARTIC scored higher than alternatives without a direct connection.

[12] Measure M was originally approved by Orange County voters in 1990. In 2006, it was extended for a period of 30 beginning in 2011. Funds are administered by OCTA.

7. COMMUNITY SUPPORT

Industry best practices suggest that OCTA pursue projects with broad support from stakeholders. To achieve this, OCTA considered input received during outreach activities and throughout project development. An overview of outreach activities is provided in section 5 of the Final Report. Sample outreach materials used throughout the course of the study are included in Appendix D. Comments received, and key themes developed through outreach activities helped inform the project throughout the life of the study.

Table 7.1. Objectives and Performance Measures – Community Support

OBJECTIVE	PERFORMANCE MEASURE	SOURCE
Define a project with widespread support from Corridor Cities, Stakeholders, and Public	Measured support for alignment and mode alternatives from corridor cities (they can define how they want to provide this measure, such as staff or Council preferences), key stakeholders, and public	Project Development Team meetings; Key Stakeholder Workshops; Public Open Houses; Project website

8. TECHNICAL MEMORANDA

8.1. MEMORANDUM A: RIDERSHIP FORECASTING ASSUMPTIONS AND METHODOLOGY

8.1.1. Background

The purpose of this technical memorandum is to describe the methodologies and assumptions used in quantitatively estimating ridership of transit alternatives near Harbor Boulevard in Orange County. To effectively evaluate these alternatives, not all alternatives were coded in the OCTAM regional travel demand model; only alternatives with highest and lowest potential ridership were integrated into the model for ridership forecasting. Ridership of other alternatives was interpolated based on previous studies.

8.1.2. Assumptions and Methodologies

To create a comprehensive forecast of the transit ridership and secondary factors associated with each of the proposed alignments, two models were used for this study. One was the latest version of the Orange County Traffic Analysis Model (OCTAM), and the other was the FTA's STOPS model. Details of each model are provided below.

8.1.2.1. OCTAM

The OCTAM 4.0 regional model and 2014 Orange County Projections (OCP) Modified demographic data served as the starting points for estimating the ridership of different transit modes by corridor. Based on previous studies, transit services with higher speeds should have the highest ridership, as transit routes and services with lower speeds are less likely to be chosen by travelers. Table 8.1 shows the route conditions for Alternatives H-3: *Harbor Rapid Streetcar*, L-3: *Anaheim-Lemon Enhanced Bus* and K-2: *Katella + Anaheim-Lemon Enhanced Bus* (the modeled alternatives). Details and assumptions of these scenarios are provided in Table 8.1 and in the section below.

Table 8.1. Route Conditions for Modeled Alternative Scenario

Scenario	543	43	OC Streetcar	Alternative	Notes
No-Build	-	-	Delete and recode to light rail	-	
Alternative H-3	Discontinued	Increased headway south of Westminster Ave	Delete and recode	Streetcar, Santa Ana to FTC – Dedicated lane	Extend OC Streetcar north along Harbor Blvd to FTC a dedicated lane – add overlay Route 43 south of Westminster Ave to offset loss of Bravo! 543
Alternative L-3	Discontinued	-	Delete and recode	Enhanced bus from MacArthur Blvd to FTC via Anaheim Blvd/Lemon St	
Alternative K-2	Discontinued	Increased headway south of Westminster Ave	Delete and recode	Enhanced bus Westminster to ARTIC to FTC	Runs alternate between FTC direct and FTC via ARTIC

a) *2040 No-Build Scenario*

i. The OCTAM 2040 constrained scenario and OC streetcar were coded as rail in the No-Build scenario for this study.

ii. Facility type of roads that loaded OC Streetcar has been changed to 52.

iii. Facility type of roads that loaded OC Streetcar has been changed to 52.

b) Alternative H-3: *Harbor Rapid Streetcar* travels north to south along Harbor Boulevard between the FTC in Fullerton and Westminster Avenue in Garden Grove Boulevard.

i. Alternative H-3: *Harbor Rapid Streetcar* is coded as light rail and linked with OC streetcar.

ii. One lane is removed from Harbor Boulevard existing conditions from FTC to Westminster Avenue, and a dedicated lane for rapid streetcar is created parallel to the general-purpose lanes. The speed and travel time of the streetcar mode in a dedicated lane is manually adjusted based on OCTA operational speed.

iii. Bravo! 543 is discontinued.

iv. Peak hour headways of Alternative H-3 are set to be 10 minutes during peak hours and 15 minutes during off-peak hours.

v. To represent the enhanced service of Route 43 south of Westminster Avenue, it is coded as two separate transit routes. One runs the regular route length with a headway of 20 minutes during peak and off-peak hours, and the other runs from Westminster Avenue to 18th Street with a headway of 60 minutes.

vi. Base fare assumed to be $1.06 in 2010 dollars.

c) Alternative L-3: *Anaheim-Lemon Enhanced Bus* travels north to south along Lemon Street-Anaheim Boulevard (transitioning between Lemon Street and Anaheim Boulevard via La Palma Avenue) and Harbor Boulevard (transitioning between Anaheim Boulevard and Harbor Boulevard via Disney Way); between the FTC in Fullerton and Westminster Avenue in Garden Grove; and continues south into Santa Ana to MacArthur Boulevard

i. Alternative L-3 is coded as two separate OCTA express bus routes. One represents the regular routes as described above, and the other represents the enhanced service between Westminster Avenue.

ii. Stop locations from Westminster Avenue to MacArthur Boulevard are consistent with Bravo! 543.

iii. Bravo! 543 is discontinued.

iv. Alternative L-3 headways are set to 10 minutes during peak hours and 15 minutes during off-peak hours

v. Base fare is assumed to be $1.06 in 2010 dollars.

d) Alternative K-2: Katella + Anaheim-Lemon Enhanced Bus travels primarily north to south along Lemon Street-Anaheim Boulevard (transitioning between Lemon Street and Anaheim Boulevard via La Palma Avenue) and Harbor Boulevard (transitioning between Anaheim Boulevard and Harbor Boulevard via Disney Way) between the FTC in Fullerton and Westminster Avenue in Garden Grove. Additionally, every other run of Alternative K-2 will travel along Katella Avenue (via Disney Way-Manchester Avenue or Anaheim Way) and terminate at ARTIC.

i. Alternative K-2 is coded as two separate OCTA express bus routes. One represents the regular run, and the other represents every other run that travels along Katella Avenue and ends at ARTIC.

ii. Bravo! 543 still exists but is discontinued south of Westminster Avenue.

iii. Route 43 headway is set to be 15 minutes during peak hours and off-peak hours.

iv. Base fare is assumed to be $1.06 in 2010 dollars.

Attributes of the roadways considered in this study are provided below in Table 8.2 while Table 8.3 shows the attributes of the proposed enhanced bus and rapid streetcar. The speed curve table (Table 8.4) is included for reference.[13]

Table 8.2. Study Corridor Roadway Attributes

Corridor	Facility Type	Area Type
Harbor Blvd	3 (Primary: Four Lane Divided Arterial Highway) 2 (Major: Six Lane Divided Arterial Highway)	3 (Suburban)
Anaheim Blvd	3 (Primary: Four Lane Divided Arterial Highway)	3 (Suburban)
Parallel Transit-Only Lane	54 (Transit Only-BRT)	3 (Suburban)
Katella Ave	7 (Smart street: Six+ lanes divided, includes operational enhancements)	3 (Suburban)

Table 8.3. Proposed Mode Attributes

Attribute	Enhanced Bus	Streetcar
Peak Headway	15	15
Off-Peak Headway	15	15
Mode	16 (OCTA express routes)	18 (rail transit) in Alternative 2 16 (OCTA express routes) in Alternative 4
Fare	$1.06 in 2010 dollars	$1.06 in 2010 dollars
Mode Type	4 (OCTA Express)	2 (Fixed Guideway)
Speed	Speed curve 7	12.79 MPH on Harbor Blvd* 10.82 MPH on Katella Ave*

*From the OCTA Harbor Study Operating Speed Analysis

[13] Speed curve represents the proportional relationship between transit line speed and highway network speed. OCTAM uses speed curve to assign speed to each transit line based on speed of highway network it runs on accordingly.

Table 8.4. Speed Curve Table

CURVE	PER	LOW_HWY	HIGH_HWY	LOW_TR	HIGH_TR
1	OP	0.0	70.0	3.0	3.0
2	OP	45.0	65.0	45.0	65.0
3	OP	25.0	50.0	12.0	27.0
4	OP	20.0	40.0	9.0	21.0
5	OP	20.0	35.0	6.0	12.0
6	OP	15.0	30.0	4.0	10.0
7	OP	25.0	50.0	13.0	29.3
8	OP	20.0	40.0	9.8	22.8
9	OP	25.0	50.0	10.0	22.5
10	OP	20.0	40.0	7.5	17.5
11	OP	1.0	100.0	1.0	100.0
1	PK	0.0	70.0	3.0	3.0
2	PK	40.0	65.0	40.0	65.0
3	PK	20.0	45.0	12.0	27.0
4	PK	15.0	35.0	9.0	21.0
5	PK	15.0	30.0	6.0	12.0
6	PK	10.0	25.0	4.0	10.0
7	PK	20.0	45.0	13.0	29.3
8	PK	15.0	35.0	9.8	22.8
9	PK	20.0	45.0	10.0	22.5
10	PK	15.0	35.0	7.5	17.5
11	PK	1.0	100.0	1.0	100.0

Per = Period
OP = Off-Peak
PK = Peak
Low_HWY = Lower limit of transit network speed
High_HWY = Upper limit of transit network speed
Low_TR = Lower limit of highway network speed
High_TR = Upper limit of highway network speed

8.1.2.2. STOPS

The STOPS model developed for the OC Streetcar was used as a starting point to build the Central Harbor Boulevard Transit Corridor Study STOPS model. The following scenarios are assumed for this preliminary level of transit planning.

a) 2015 Existing

   i. "OCTA Jun 2017" (OCTA service), "LA" (Los Angeles County Metropolitan Transportation Authority), "Mtrlnk" (Metrolink), and "SURF" (Amtrak's Pacific Surfliner) General Transit Feed Specification (GTFS) files were used in existing year scenario.
   ii. District was redefined along Harbor Boulevard, Anaheim Boulevard, and Katella Boulevard. Figure 8.1 shows both the study area and district boundaries

b) 2035 No-Build

   i. "OCTA Jun 2017," "LA," "Mtrlnk," "SURF," "SAGG6," and "BRI" General Transit Feed Specification (GTFS) files were used in No-Build year scenario.

c) Alternative H-2: *Harbor Long Streetcar*

   i. Alternative H-2 was coded in a new GTFS file and linked to the OC streetcar.
   ii. Alternative H-2 was coded as a streetcar. Visibility[14] was set to 0.75 to remain consistent with the OC streetcar model run.
   iii. Assumed operational speed of Alternative H-2 was set to 13.15 mph.
   iv. Headway on Route 43 was set to 20 minutes between the FTC and Westminster Avenue; 15 minutes between Katella Avenue and Oceanfront/Palm Street.
   v. Bravo! 543 was excluded.

d) Alternative H-3: *Harbor Rapid Streetcar*

   i. Alternative L-2: *Anaheim/Lemon Rapid Streetcar* was coded in a new GTFS file and linked to the OC streetcar.
   ii. Alternative L-2 was coded as a streetcar. Visibility was set to 0.75 to remain

[14] According to the Florida Department of Transportation's *Guidebook for Florida STOPS Applications*, the visibility factor is a "setting that approximates the differentiation of fixed-guideway alternatives and regular bus service within a corridor. The visibility factor ranges from 0.0-1.0, where a number close to 0.0 would reflect a BRT project indistinguishable from local bus and 1.0 would reflect a light-rail alternative that operates along exclusive right-of-way. There is a direct correlation between the selected visibility factor and ridership: higher project ridership can be expected with higher visibility factors." Full document available at www.fsutmsonline.net/images/uploads/Task_1_Guidebook_for_Florida_STOPS_Application.pdf (p.16)

consistent with the OC streetcar model run.

iii. Assumed operation speed of Alternative H-3 was set 14.03 mph.

iv. Headway on Alternative H-3 is set to 10 minutes during peak hours, and 15 minutes during off-peak hour.

v. Headway on Route 43 was set to 20 minutes between the FTC and Westminster Avenue, 15 minutes between Katella and Oceanfront/Palm Street.

vi. Bravo! 543 was excluded.

e) Alternative H-4: *Harbor Enhanced Bus*

i. Alternative H-4 was coded as a bus. Visibility was set to 0.25.

ii. Assumed operational speed of Alternative H-4 was set to 15.45 mph.

iii. Headway on Alternative H-3 was set to 10 minutes during peak hours and 15 minutes during off-peak hours.

f) Alternative K-1: *Harbor-Katella Streetcar*

i. Alternative K-1 was coded in a new GTFS file and linked to the OC streetcar.

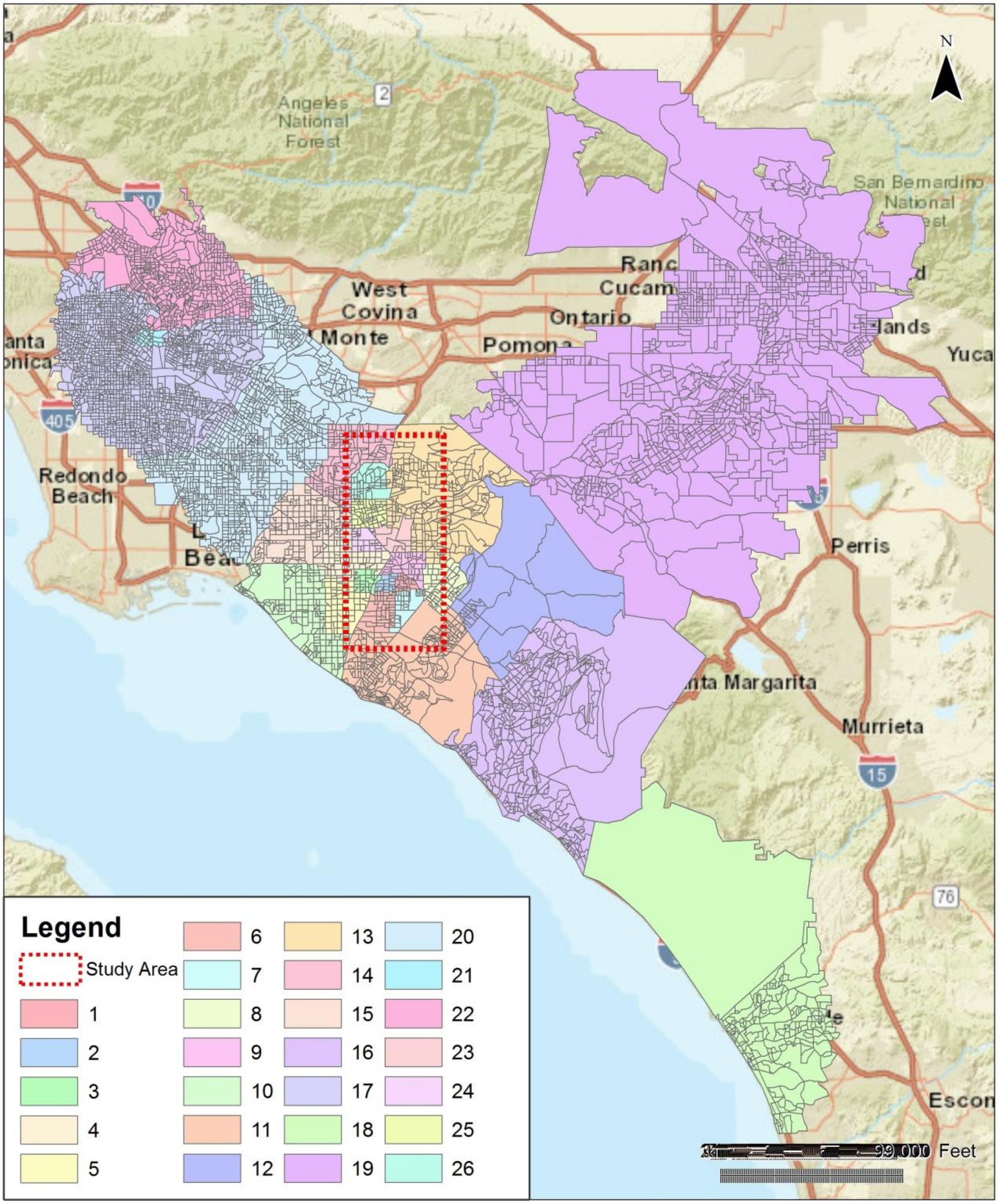
ii. Alternative K-1 was coded as a streetcar. Visibility was set to 0.75 to remain consistent with the OC streetcar model run.

iii. Assumed operational speed of Alternative K-1 was set to 11.6 mph.

iv. Headway on Alternative K-1 was set to 10 minutes during peak hours and 15 minutes during off-peak hour.

Inputs of the alternatives and scenarios are listed in Table 8.5.

Figure 8.1. Study Location and District Boundary



Source: Kittelson & Associates, 2017

Table 8.5. Inputs of STOPS scenarios

	Existing	No-Build	H-2	H-3	H-4	K-1
Input GTFS	• OCTA Jun 2017 • LA • Mtrlnk • SURF	• OCTA Jun 2017 • LA • Mtrlnk • SURF • SAG G6 • BRI	• OCTA Jun 2017 • LA • Mtrlnk • SURF • BRI • 43H-47H • H2	• OCTA Jun 2017 • LA • Mtrlnk • SURF • BRI • 43H-47H • H3	• OCTA Jun 2017 • LA • Mtrlnk • SURF • SAGG6 • BRI • H4	• OCTA Jun 2017 • LA • Mtrlnk • SURF • BRI • K1
Exclusions		From 'OCTA Jun 2017' exclude: 43,47,53,55,59,83,54 3,560,462 From BRI exclude: 0feffac (150), 109ab78 (206), 3642f5b (64S), 3d468ac (463P), 40f6ba4 (60WDS), 45bfb39 (60L), 4b462cb (57S), 4e30258 (60WES), a6e4c02 (64L), dfda1ae (801), e4da562 (463A), ee5175b (57L).	From 'OCTA Jun 2017' exclude: 43,47,53,55,59,83,54 3,560,462,53X From BRI exclude: 0feffac (150), 109ab78 (206), 3642f5b (64S), 3d468ac (463P), 40f6ba4 (60WDS), 45bfb39 (60L), 4b462cb (57S), 4e30258 (60WES), 6odfc84 (43), a6e4c02 (64L), dfda1ae (801), e4da562 (463A), ee5175b (57L), f7641c0 (543).	From 'OCTA Jun 2017' exclude: 43,47,53,55,59,83,54 3,560, 462,53X From BRI exclude: 0feffac (150), 109ab78 (206), 3642f5b (64S), 3d468ac (463P), 40f6ba4 (60WDS), 45bfb39 (60L), 4b462cb (57S), 4e30258 (60WES), 6odfc84 (43), a6e4c02 (64L), dfda1ae (801), e4da562 (463A), ee5175b (57L), f7641c0 (543).	From 'OCTA Jun 2017' exclude: 43,47,53,55,59,83,54 3,560,462,,53X From BRI exclude: 0feffac (150), 109ab78 (206), 3642f5b (64S), 3d468ac (463P), 40f6ba4 (60WDS), 45bfb39 (60L), 4b462cb (57S), 4e30258 (60WES), a6e4c02 (64L), dfda1ae (801), e4da562 (463A), ee5175b (57L).	From 'OCTA Jun 2017' exclude: 43,47,53,55,59,83,54 3,560,462,,53X From BRI exclude: 0feffac (150), 109ab78 (206), 3642f5b (64S), 3d468ac (463P), 40f6ba4 (60WDS), 45bfb39 (60L), 4b462cb (57S), 4e30258 (60WES), a6e4c02 (64L), dfda1ae (801), e4da562 (463A), ee5175b (57L).

GTFS = General Transit Speed Specification; LA = Transit lines operated by Los Angeles County Metropolitan Transportation Authority; Mtrlnk = Transit lines operated by Metrolink; OCTA Jun 2017 = Transit lines operated by OCTA in June 2017; SURF = Pacific Surfliner line operated by Amtrak.

8.2. MEMORANDUM B: RIDERSHIP ELASTICITIES AND FORECASTING METHODOLOGY

8.2.1. Background

The Central Harbor Boulevard Transit Corridor Study relied on the OCTAM and STOPS models to estimate and infer ridership associated with each of the proposed draft alternatives. These models effectively helped determine estimates for the larger components of the alternatives such as mode (i.e., streetcar versus BRT) and alternative alignment. Smaller features such as transit signal priority and queue jump lanes were not included as they do not provide a large enough benefit by themselves to yield meaningful results through modeling.

8.2.2. Ridership Elasticities

The *Transit Capacity and Quality of Service Manual*, Third Edition (TCQSM)[15], and the *Bus Rapid Transit Practitioners Guide* (BRTPG)[16] both provide insight into research on transit ridership elasticities (i.e., the impact of one parameter on another, such as travel time and service modifications).

Research reviewed in the TCQSM shows that reducing travel time along a route can be the single largest source of ridership gain if the route is long enough. The typical reported ridership gain was 0.4 percent for each one percent reduction in travel time. Additionally, ridership impacts from headway changes on bus routes can range from zero to a one percent increase for each one percent increase in frequency. Based on that range, the most typical increases are 0.3-0.5 percent with higher increases observed on suburban routes since suburban routes tend to operate with longer headways.

Another elasticity variable reported in the TCQSM focused on headway regularity, i.e., when buses show up at predictable intervals, ridership tends to increase. The study found a 0.17 percent correlation between the reductions of variability in headway and ridership gain.

[15] The TCQSM, prepared by the Transportation Research Board, provides "guidance on transit capacity and quality of service issues and the factors influencing both" and includes "quantitative techniques for calculating the capacity and other operational characteristics of bus, rail, demand-responsive, and ferry transit services, as well as transit stops, stations, and terminals." Full document available at: www.trb.org/Main/Blurbs/169437.aspx
[16] The BRTPG, also prepared by the Transportation Research Board, "provides information on the costs, impacts, and effectiveness of implementing selected bus rapid transit components." Full document available at: http://www.trb.org/Publications/Blurbs/158960.aspx

These elasticities were inserted into the following formula suggested by the BRTPG to estimate ridership impacts:

$$R_2 = \frac{(E-1)X_1R_1 - (E+1)X_2R_1}{(E-1)X_2 - (E+1)X_1}$$

Where:
E = Elasticity
R_1 = Base Ridership
R_2 = Estimated Future Ridership
X_1 = Quantity of Base Attribute
X_2 = Quantity of Future Attribute

The BRTPG reports that on average, conversion of a regular bus route to BRT will result in a 25 percent increase in ridership beyond what could be predicted using ridership elasticities. That increase is broken down into the components of a BRT line as follows:

a) Exclusive running way: 5.00%
b) Improved stations: 3.75%
c) Limited stop service: 3.75%
d) Intelligent Transportation Systems (ITS) applications: 2.50%
e) Specialized branding: 2.50%
f) BRT “packaging” (i.e., bonus for featuring 12% or more of above items): 3.375%

The TCQSM provides a more comprehensive review of ridership elasticities and ranges of change based on a variety of characteristics, including the extent to which the above-listed components are provided.

8.2.3. Elasticities and Ridership Forecasting

The travel demand model was used to estimate the impacts of travel time changes, including those that result from a dedicated transit lane. The model was also used to evaluate differences between bus and streetcar alternatives.

The following elasticities were used to refine the estimates for items not captured by the model:

a) Travel time reductions: +0.4%
b) Headway changes: +0.3% (with existing service headways at less than 30 minutes, ridership gains from increased headways were minimal).
c) More regular headway intervals: +0.17%
d) Exclusive running way: +5% (in addition to the increase associated with reduced travel time).

e) Improved stops: +3.75% (i.e., when station stops are branded and equipped with shelters and benches).
f) Limited stop service: +3.75% (in addition to the increase associated with reduced travel time).
g) ITS applications: +2.5% (this applies to visible improvements such as real-time bus arrival information, bus tracking mobile apps, or other trip planning amenities).
h) Specialized branding: +0.0% (Bravo! 543 service is already branded, therefore the increase is minimal).
i) BRT Packaging: +3.375% (applied to alternatives that achieve at least a 9.5% increase through a combination of other BRT elements).

These initial assumptions were updated upon review of the travel time elasticity estimated by the travel demand model. Values were adjusted accordingly if ridership proved more/less elastic than anticipated.