AECOM

Los Angeles and San Bernardino Inter-County Transit and Rail Connectivity Study

Final Report

October 2018

Prepared for:

Southern California Association of Governments

Prepared by:

AECOM
One California Plaza
300 South Grand Avenue
Los Angeles
CA, 90071
USA

T: +1 (213) 593 8100
F: +1 (213) 593 8178
aecom.com

The contents of this report reflect the views of the author who is responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of SCAG. This report does not constitute a standard, specification or regulation.

Table of Contents

Figures

Tables

Executive Summary

The Southern California Association of Governments (SCAG), in cooperation with the San Bernardino County Transportation Authority (SBCTA) and the Los Angeles County Metropolitan Transportation Authority (LA Metro), has conducted the Inter-County Transit and Rail Connectivity Study to develop a multimodal corridor improvement plan in collaboration with stakeholders, agencies and the public that evaluates transit and rail service for this inter-county corridor connecting the eastern San Gabriel Valley in Los Angeles County with the western San Bernardino Valley in San Bernardino County, as well as connections to Ontario International Airport (ONT).

In the recent decades, a number of significant transportation improvements have been or are currently being planned in this corridor. While each of these projects seeks to improve accessibility and mobility within and between Los Angeles and San Bernardino Counties, concurrent planning for individual projects may also result in the potential for duplicative service and missed opportunities for efficiencies and coordination. Therefore, this study aims to:

- Assess the market for transit and rail travel in the corridor, including the geographic distribution of origins for employee and passenger trips to ONT,
- Estimate potential ridership, benefits, and capital/operating costs associated with transit and rail alternatives in the corridor,
- Recommend a path forward for cost-effective transit and rail service to best serve communities along the corridor and to/from ONT, with a focus on coordinating plans for Gold Line, Metrolink, and transit access to ONT.

The study area of this project consists of several cities in both counties (La Verne, Pomona, Claremont, Montclair, Upland, Ontario and Rancho Cucamonga). Travel market analysis conducted for this study found a strong inter-county pattern for commuting trips, as well as notable poly-centric travel patterns within the study area. The ability to move quickly and efficiently in the study area and to connect to destinations outside the study area is constrained by a mismatch between the existing east-west fixed transportation infrastructure (freeways and rail). While the fixed transportation infrastructure in the study area provides modal options for through trips and for trips from the study area to the west, infrastructure constraints and operational considerations limit the share of trips that can be well served by transit, particularly those between the study area and locations to the east.

To identify the best solutions for the mobility problem in the study area, an initial set of 38 build alternatives were developed based on recently completed studies and stakeholder input, and included the major relevant projects in this study area regardless of their funding or planning status. These first build alternatives were refined by the travel market analysis results, community comments from public open houses, and inputs received from the Technical Working Group (TWG, composed of representatives from SCAG, SBCTA, San Gabriel Valley Council of Governments (SGVCOG), Metro, Metrolink, Omnitrans, and Foothill Transit) and Stakeholder Review Committee (SRC, composed of all TWG members as well as representatives from Caltrans, the City of Pomona, City of Claremont, City of Montclair, City of Upland, City of Ontario, City of La Verne, City of Rancho Cucamonga, and Foothill Gold Line Construction Authority) created for the study. An initial screening was conducted to identify the four best service combinations for light rail, commuter rail, hybrid rail, and Bus Rapid Transit and Express bus, respectively. The four interim build alternatives were further detailed and refined to incorporate additional information and assumption as the Facility & Capacity

Analysis, Ridership Forecasting, Cost Estimating, and Benefit-Cost and Economic Impact Analysis progressed. A Final Screening was then conducted to synthesize the results of these technical analyses into findings related to the comparative performance of the final alternative(s) for the study corridor. The finalized alternatives for this study are:

- **No Build Alternative (NB Alt.)**: Includes the Gold Line extension to Montclair, the West Valley Connector (WVC) Phase 1 operating with existing infrastructure and planned 3.5-mile bus lane alignments within Ontario (dedicated lane segments extend from Holt/Benson to Holt/San Antonio and from Holt/Euclid to Holt/Vineyard), Redlands Passenger Rail Project between the San Bernardino Transit Center and the University of Redlands in Redlands, and everything in the 2016 SCAG Regional Transportation Plan/Sustainable Communities Strategy (RTP/SCS) Financially Constrained Plan, except Metrolink service improvements, BRT on Haven Avenue, BRT on Euclid Avenue, rail/bus to ONT, and transit projects in the study area. (See **Figure 1**)
- **Transportation Systems Management Alternative (TSM Alt.):** Increases Commuter Rail, BRT, and Municipal Bus operations, and double tracking projects along the Metrolink San Bernardino Line to accommodate the service enhancements. Includes the same double-tracking segments as in the Commuter Rail Phase 2 Alternative. Includes WVC BRT Phase 2 and a Montclair-ONT bus shuttle service. (See **Figure 2)**
- **Light Rail Alternative (LRT Alt.) Arterial Option:** LRT extension of the Metro Gold Line to ONT along an arterial alignment and conversion of the West Valley Connector BRT Phase 1 to LRT along Holt Avenue and Holt Boulevard (Holt Corridor) between downtown Pomona and ONT. Indian Hill Boulevard and the Holt Corridor were chosen as representative street-running alignments for technical analyses purposes only. The actual alignment selection requires further study to evaluate connecting LRT between the Holt Corridor, Metro Gold Line, Metrolink, and ONT. This alternative includes seven Mobility Hubs (including ONT, Ontario Mills, Pomona Transit Center, Rancho Cucamonga Civic Center, Rancho Cucamonga Metrolink Station, Montclair Metrolink Station, and Chaffey College) that are integrated with bike share, car share, shuttle service, and on-demand services. This alternative also includes LRT to Cal Poly Pomona as an optional connection. (See **Figure 3)**
- **Light Rail Alternative (LRT Alt.) Cucamonga Creek Option:** LRT extension of the Metro Gold Line to ONT along the Metrolink San Bernardino ROW east of Montclair and running adjacent to Cucamonga Creek and conversion of the West Valley Connector BRT Phase 1 to LRT along Holt Avenue and Holt Boulevard (Holt Corridor) between Downtown Pomona and ONT. The segment adjacent to Cucamonga Creek was chosen as a representative off-street alignment for technical analyses purposes only. The actual alignment selection requires further study to evaluate connecting LRT between the Holt Corridor, Metro Gold Line, Metrolink, and ONT. This alternative includes seven Mobility Hubs as described above. This alternative also includes LRT to Cal Poly Pomona as an optional connection. (See **Figure 4**)
- **Commuter Rail Alternative (Commuter Rail Alt.) Phase 1:** Increased commuter rail service on the Metrolink San Bernardino Line, double-tracking projects along the San Bernardino Line to accommodate the service increases, a commuter rail shuttle connecting Rancho Cucamonga to ONT, a new hybrid rail line connecting downtown Ontario to the University of Redlands, and a new station on the Metrolink Riverside Line in Downtown Ontario. This alternative includes seven Mobility Hubs as described above. (See **Figure 5)**
- **Commuter Rail Alternative (Commuter Rail Alt.) Phase 2:** All projects in the Commuter Rail Alternative Phase 1, additional service enhancements to the Metrolink San Bernardino Line, converting existing Metrolink commuter rail to hybrid rail service, additional double-tracking projects to accommodate the service enhancements, a spur on the San Bernardino Line to connect to ONT, an extension of the Ontario-Redlands line west to the City of Industry, and a re-routing of the Metrolink Riverside Line via ONT. This alternative includes seven Mobility Hubs as described above. (See **Figure 6**)

- **Hybrid Rail Alternative (Hybrid Rail Alt.)[1]:** Hybrid rail service added to the existing Metrolink San Bernardino Line, double-tracking projects to accommodate the service enhancements (the same double-tracking segments as in the Commuter Rail Alternative Phase 2), and a spur off the San Bernardino Line to connect to ONT. This alternative also includes Hybrid Rail to Cal Poly Pomona as an optional connection. This alternative includes seven Mobility Hubs as described above. (See **Figure 7**)
- **Bus Rapid Transit/Express Bus Alternative (BRT Alt.):** New express bus shuttle service between Montclair Gold Line station and ONT, rerouted OmniTrans express service between Montclair Gold Line station and Downtown San Bernardino connecting ONT, and new Haven Avenue BRT between Chaffey College and Edison Avenue. This alternative includes seven Mobility Hubs as described above. (See **Figure 8**)

[1] Following the completion of the facility and capacity analysis for this study, SBCTA and L.A. Metro completed a Metrolink San Bernardino Line Hybrid Rail Study. This Hybrid Rail Study further refines the concept of using hybrid rail on Metrolink tracks, similar to the Hybrid Rail Alternative evaluated in this study. The capacity analysis included in the Hybrid Rail study may be useful as a reference to this study, but the findings of the two reports are not comparable. The SCAG study includes the double tracking segments from Metrolink's SCORE proposal, which are necessary to accommodate the proposed 15-minute headways service plan in the Hybrid Rail Alternative. The Hybrid Rail Study makes different assumptions about service levels and double tracking needs for 30-minute headways than what is assumed in this study. The Metro/SBCTA Hybrid Rail Study results were not available in time to inform the analysis conducted for the SCAG study. More detailed information is available in Agenda Item 14 of the SBCTA Board of Directors meeting of June 6, 2018, available at: http://www.gosbcta.com/about-sbcta/agendas/2018/06-18-board.pdf

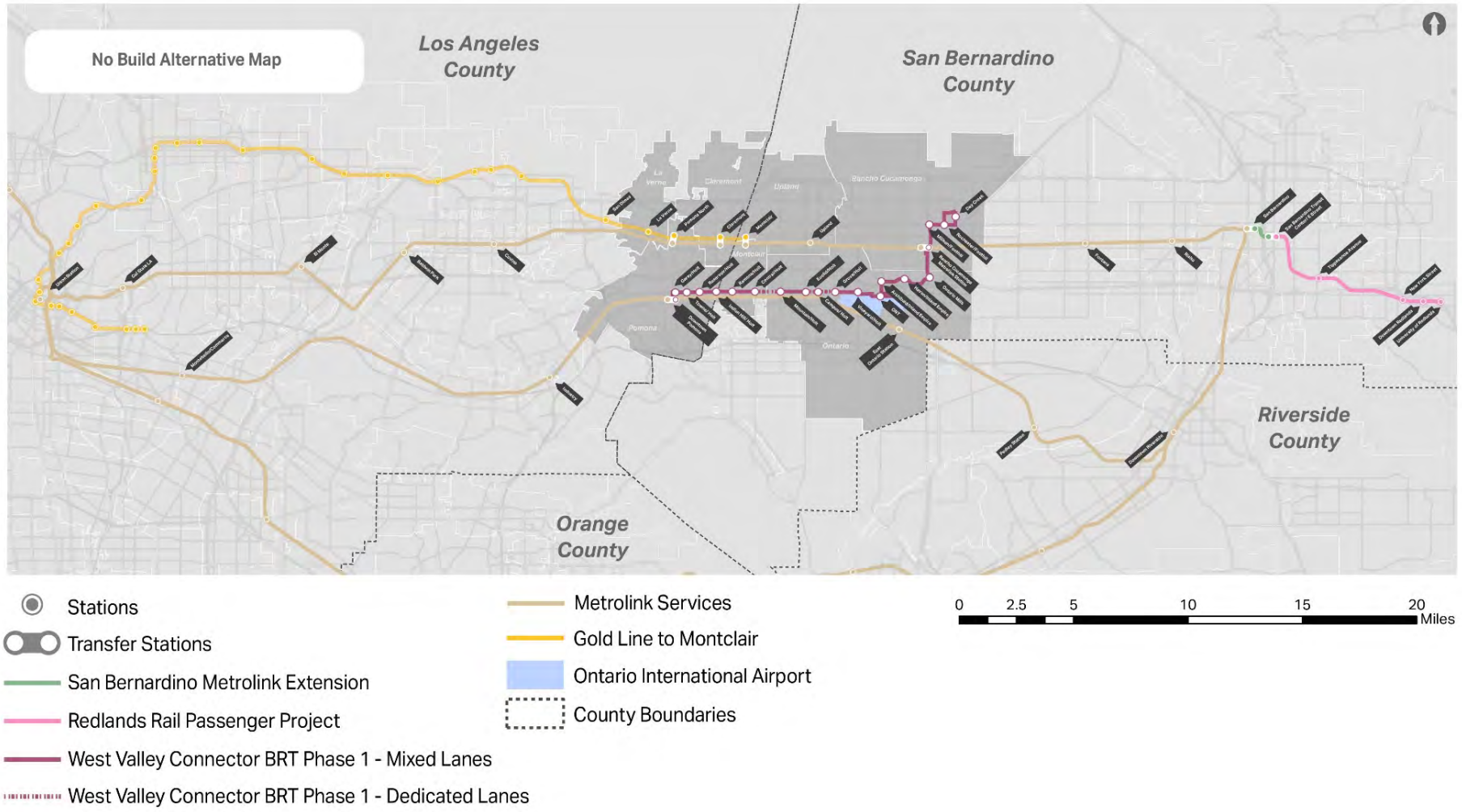


Figure 1 No Build Alternative

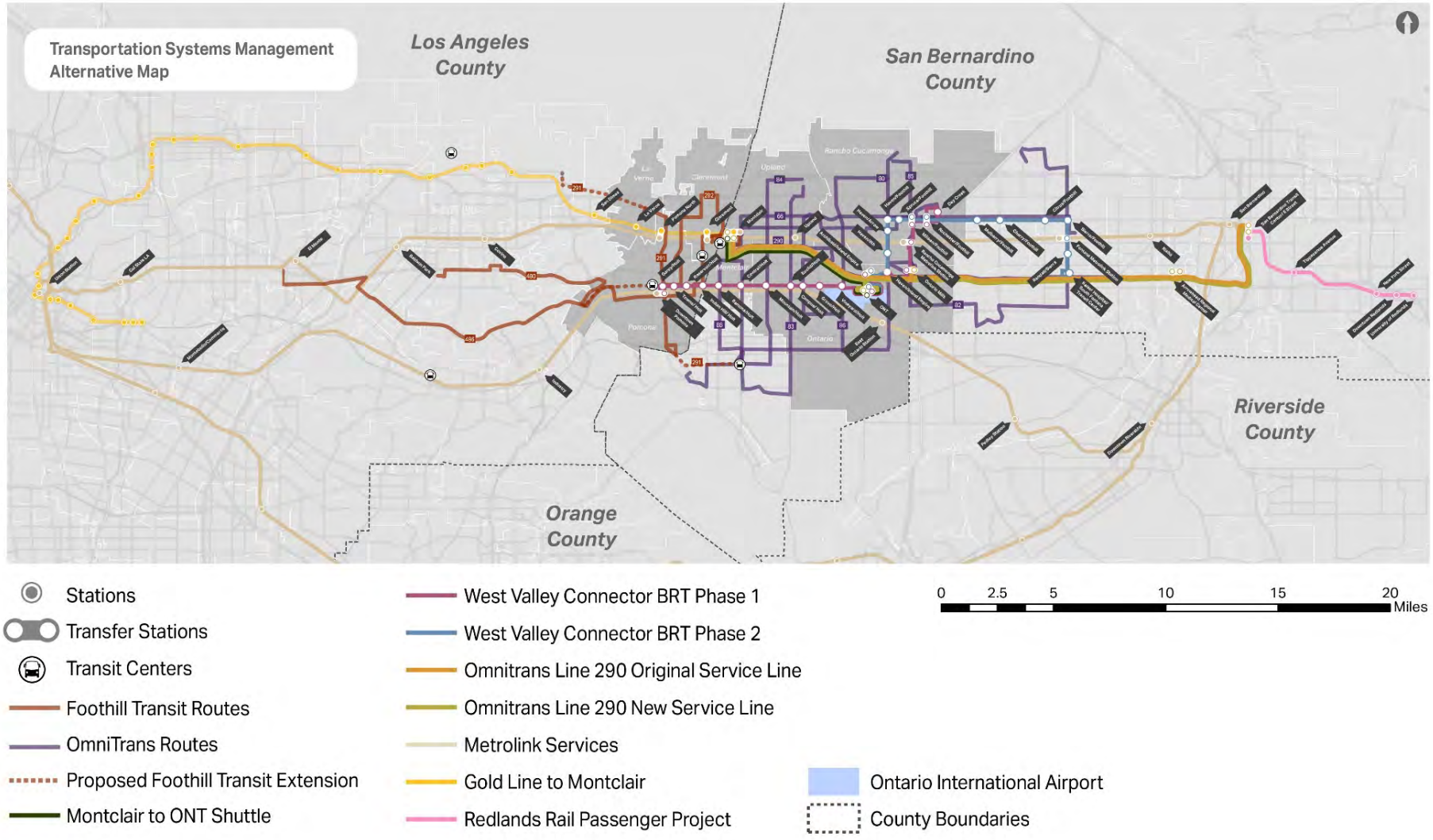


Figure 2 TSM Alternative

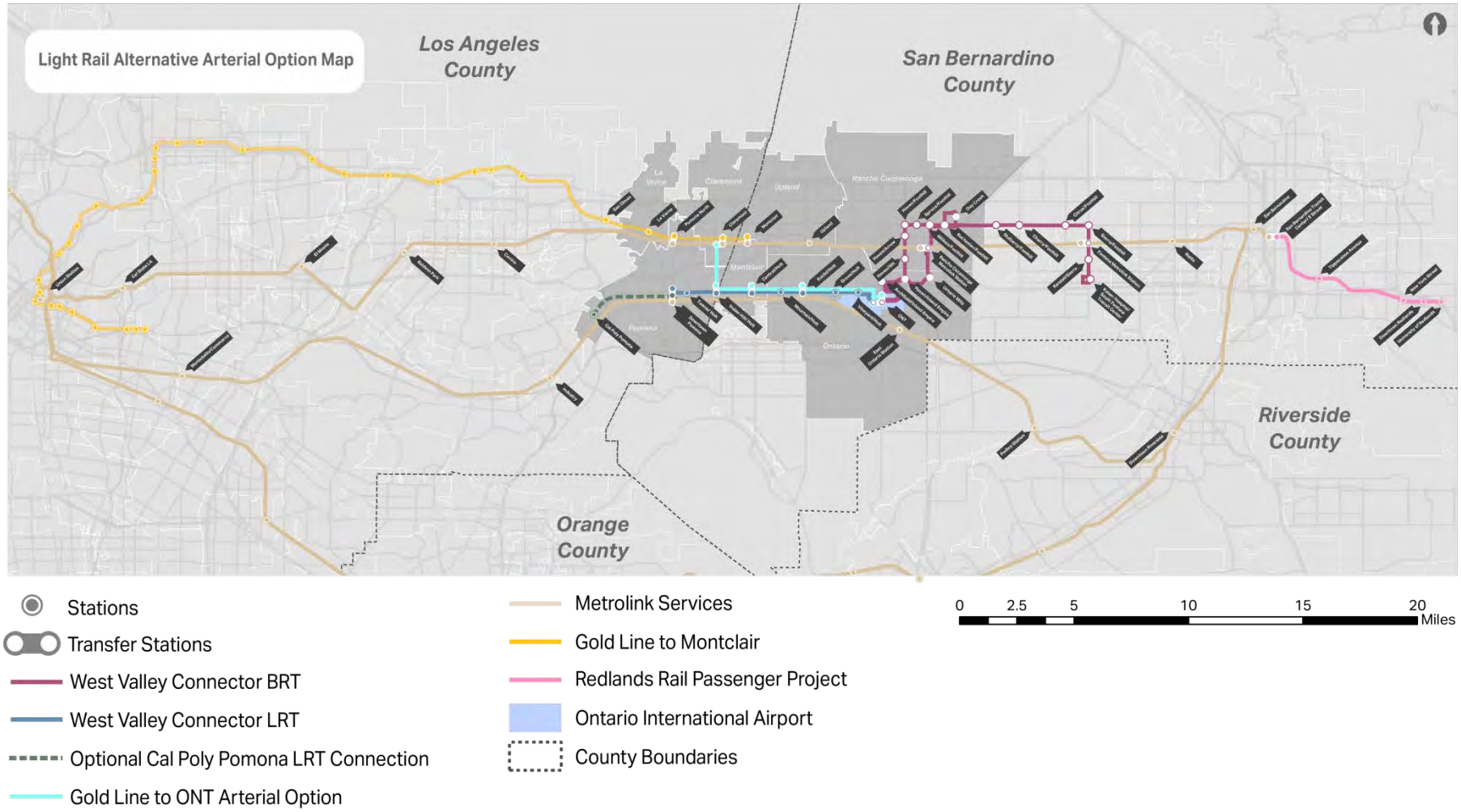


Figure 3 LRT Alternative Arterial Option[2]

[2] Indian Hill Boulevard and Holt Boulevard were assumed as example street-running alignments for technical analyses purposes only; the actual alignment selection requires further study.

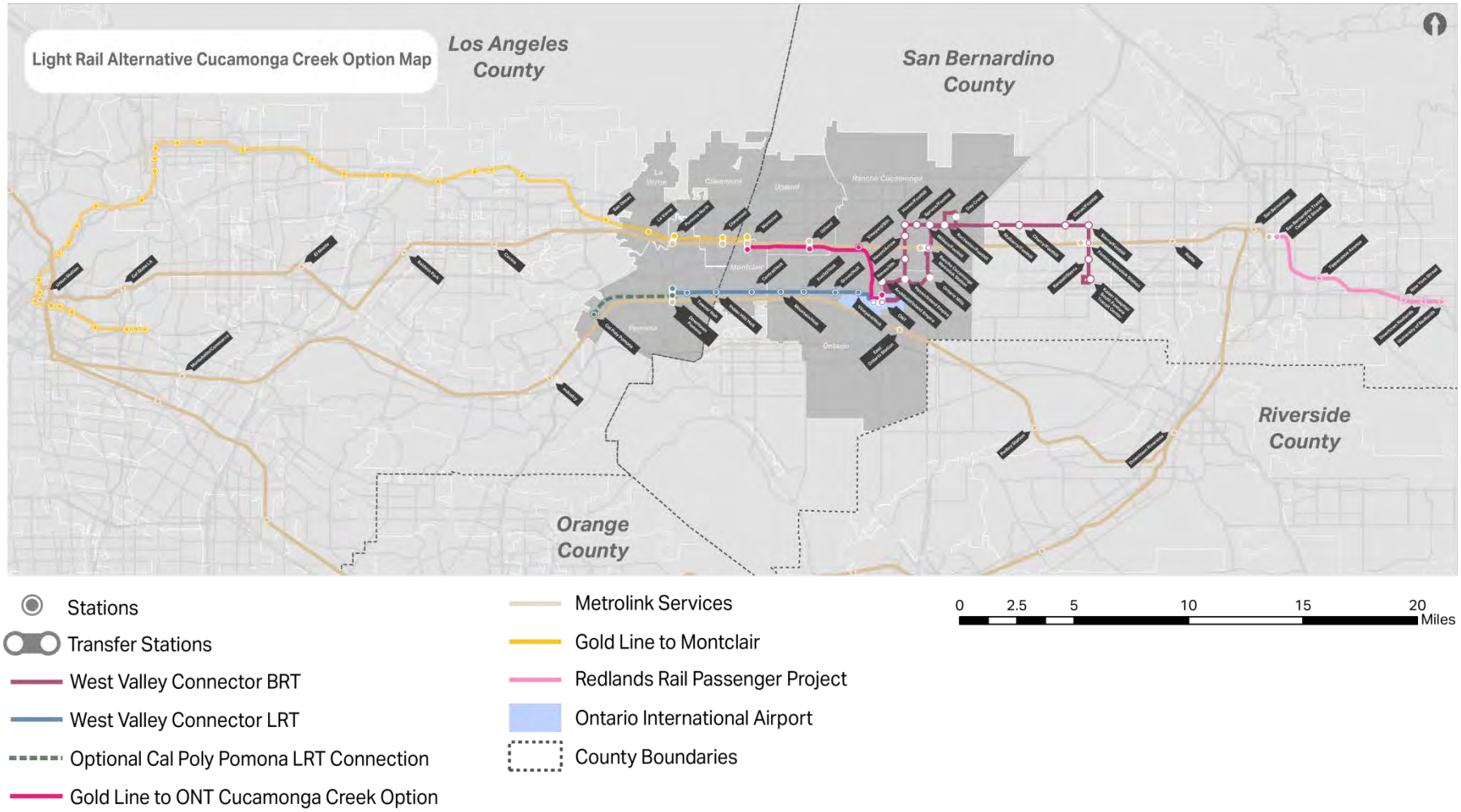


Figure 4 LRT Alternative Cucamonga Creek Option[3]

[3] Cucamonga Creek was assumed as an example off-street alignment for technical analyses purposes only; the actual alignment selection requires further study.

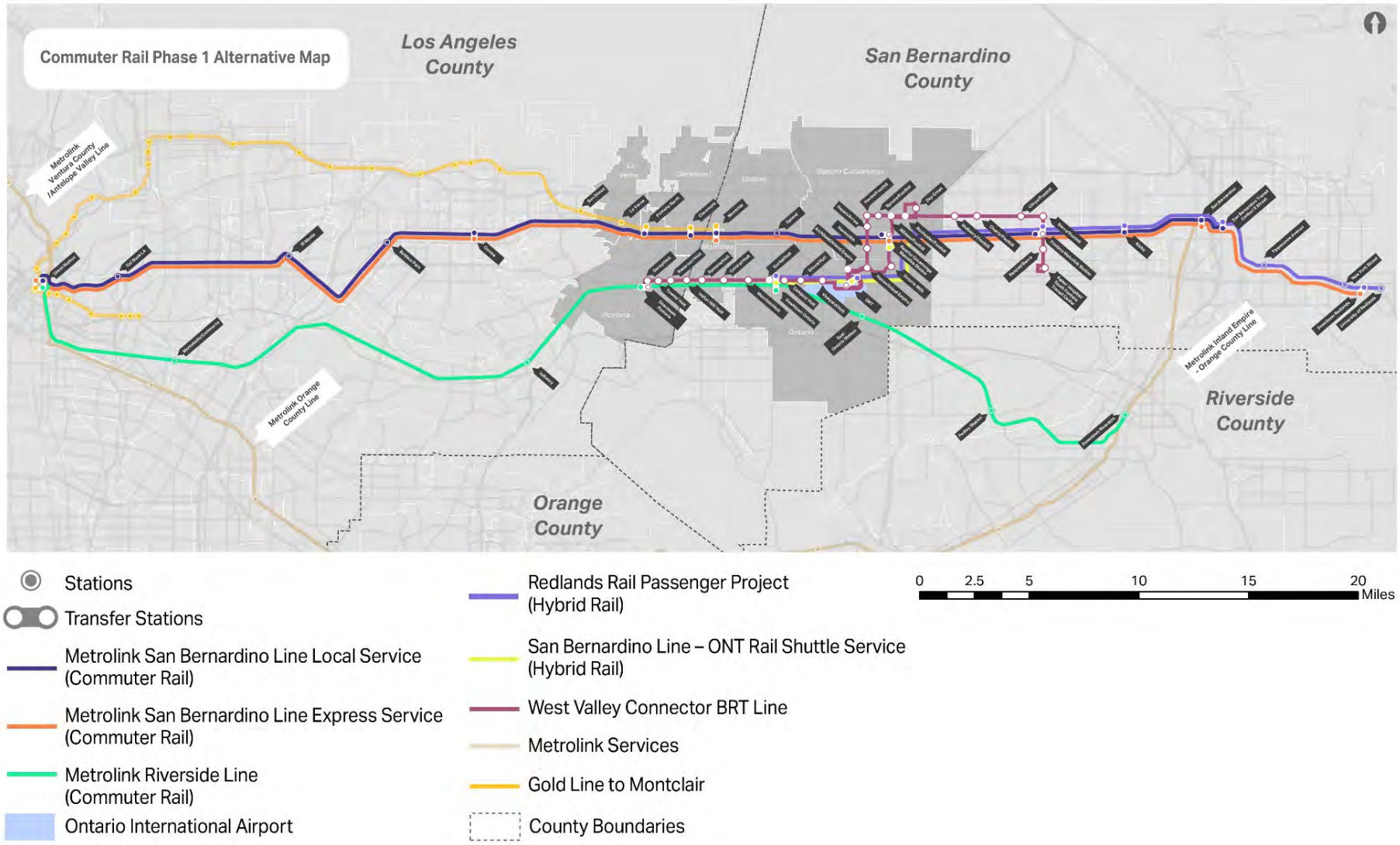


Figure 5 Commuter Rail Alternative Phase 1

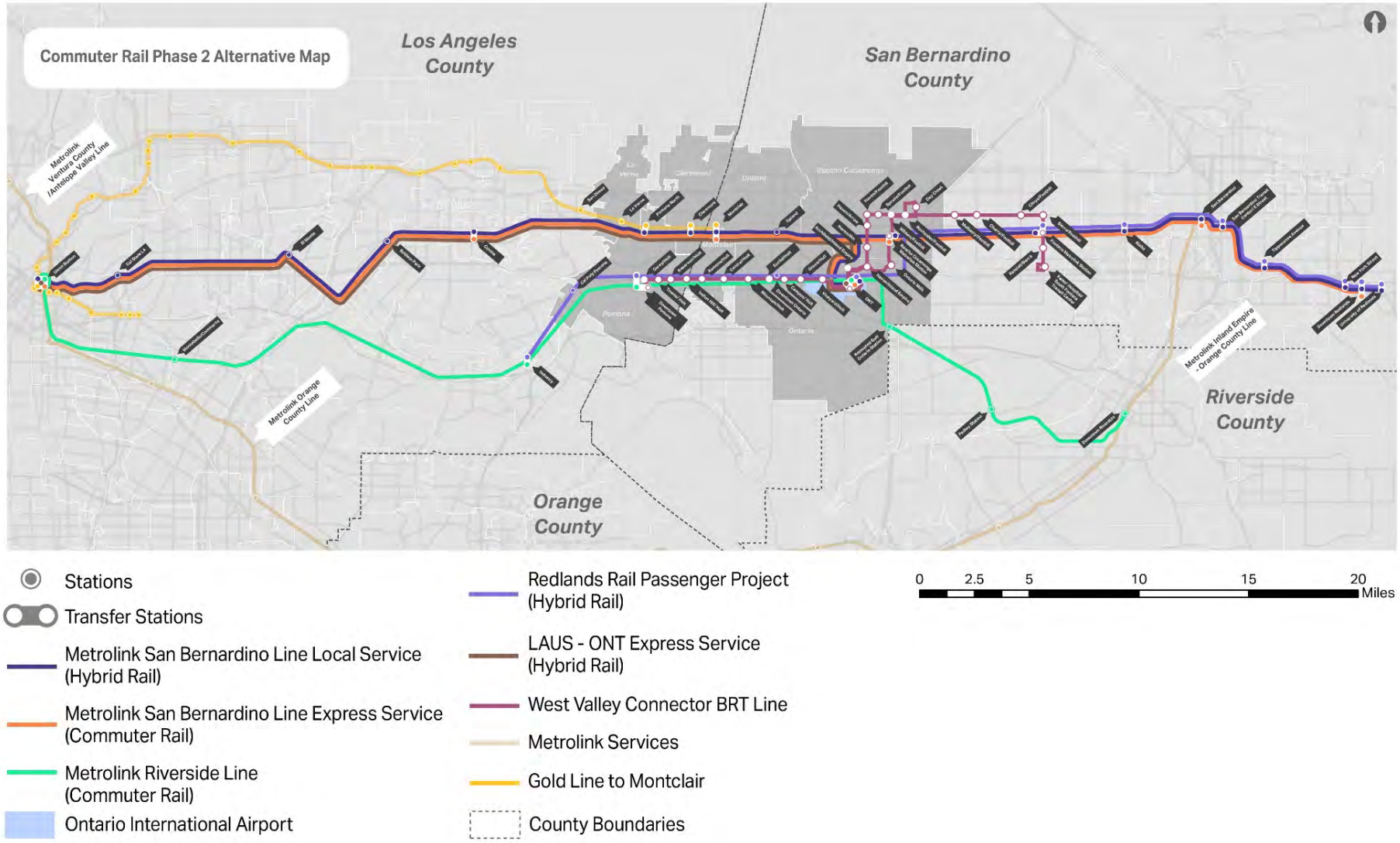


Figure 6 Commuter Rail Alternative Phase 2

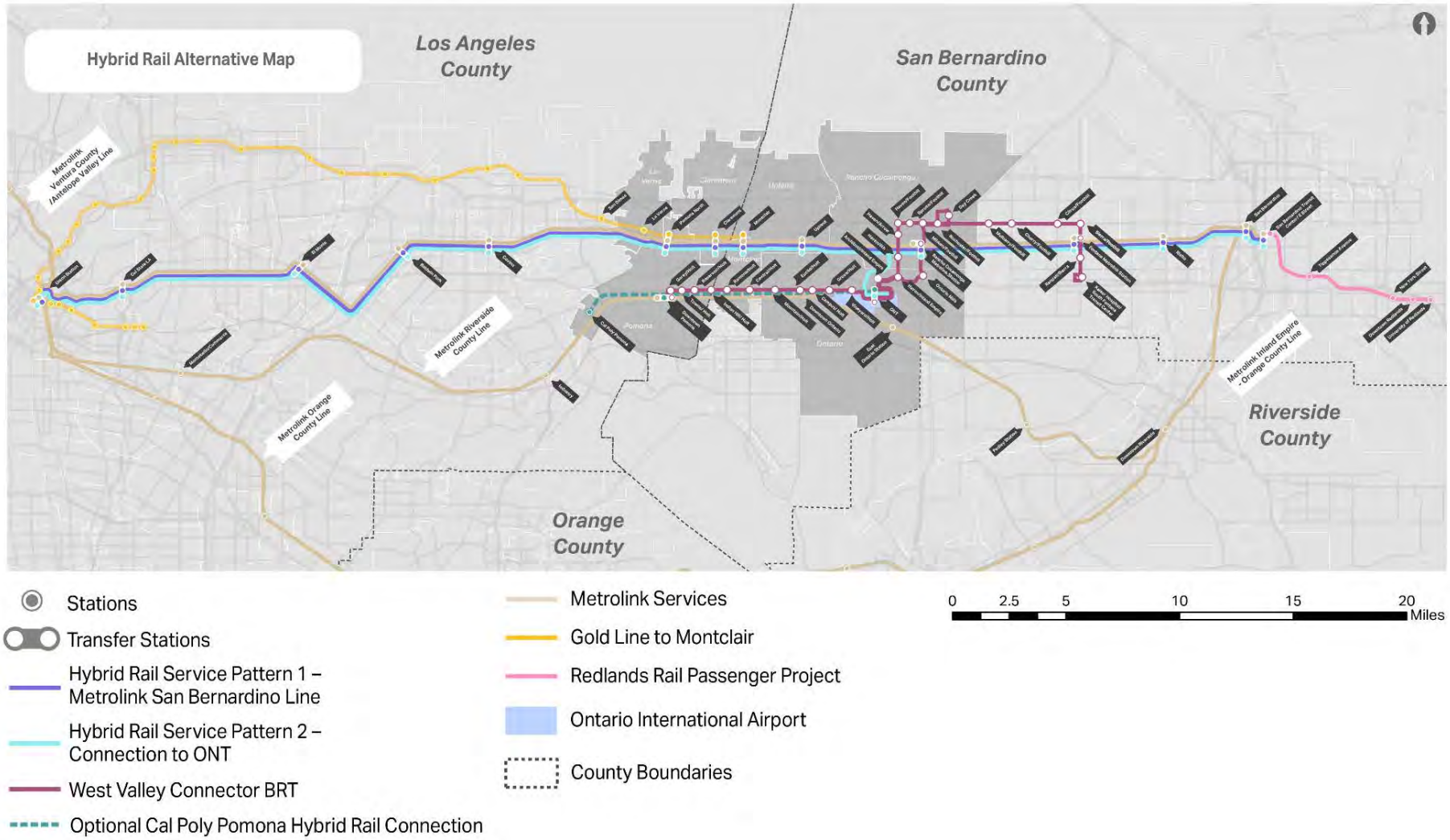


Figure 7 Hybrid Rail Alternative

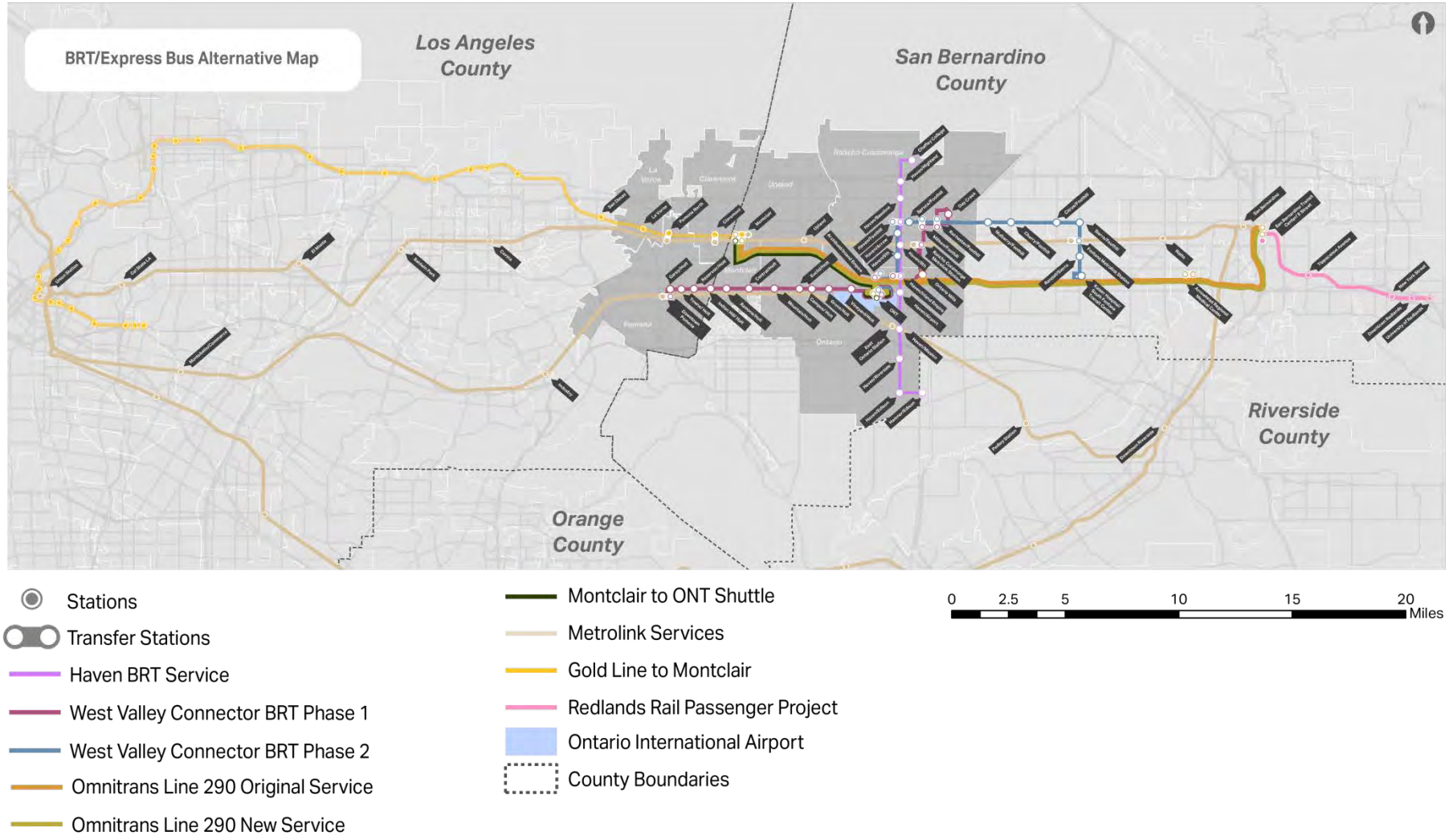


Figure 8 BRT/Express Bus Alternative

A series of technical analyses were conducted to support the screening and evaluation of the alternatives:

- **Facility and Capacity Analysis** measured the infrastructure facility impacts related to existing properties, traffic conditions, and the environment, as well as the ability for the existing and planned infrastructure to accommodate the proposed service improvements.
- **Ridership Forecasting** analyzed weekday travel demand and ridership for each alternative through metrics including daily boardings, new riders, vehicle miles of travel (VMT) reduction, trips on project, and user benefits (total travel time savings).
- **Cost Estimating** provided capital cost estimates and operations and maintenance (O&M) cost estimates.
- **Benefit-Cost Analysis** estimated travel time and cost savings, safety, and emissions over a 20-year period.
- **Economic Impacts Analysis** analyzed each alternative's impacts on economic factors, including impact to construction and O&M jobs, tax revenue, labor market accessibility, and housing affordability.

A high-level summary of the key performance metrics from the technical analyses performed are presented in **Table 1** below. The study concluded that all alternatives meet the goals of the study to varying degrees, and have merit for being carried forward into further analysis. **Table 2** provides an overview of the strengths and weaknesses of the alternatives.

The technical analysis is complex and was conducted at the planning level, meaning that much additional detail will be required on engineering, cost estimation, community and environmental impacts, ridership, funding sources, and relative benefits to local communities before any locally preferred alternatives and funding strategies can be identified. The alternatives analyzed in this study are broadly defined and financially unconstrained, and of a magnitude that neither county can currently afford. The relative benefits that may accrue from individual projects or project components and/or to the various communities in the corridor have not been quantified, nor have agency funding responsibilities been discussed.

It is not the intent of this study to recommend a preferred transit/rail alternative, nor is there sufficient information in this planning-level effort to do so. The recommended path forward is to transmit the study findings to the county transportation commissions for Los Angeles and San Bernardino Counties: Metro and SBCTA to determine next steps. It is intended that the information from this report will be useful in narrowing down the alternatives for more detailed studies in the future.

As the implementing agency in their respective county, Metro and SBCTA have the discretion to conduct further studies to determine a financially feasible alternative and to consider additional factors such as county-level funding constraints and benefits of the expanded service to county constituents, among others. Statements about funding and project delivery expectations should be directed to Metro and SBCTA.

Table 1 Summary of Key Performance Metrics by Alternative

Technical Analysis	Metric	NB	TSM	LRT Arterial	LRT Cucamonga Creek	Commuter Rail Phase 1	Commuter Rail Phase 2	Hybrid Rail	BRT/Express Bus
Ridership Forecasting	Regional Daily Ridership	765,993	785,645	833,251	849,692	792,281	798,723	785,225	780,987
	New Riders	0	6,884	33,565	42,902	15,202	17,132	11,530	7,822
	Weekday VMT Reduction (Miles)	0	-171,808	-1,061,222	-1,472,311	-629,696	-617,183	-392,549	-154,888
	Travel Time Savings (Hours)	0	8,606	32,801	37,612	13,104	14,227	10,684	7,271
	Boardings at ONT	700	2,100	12,800	20,100	1,600	8,200	1,500	1,100
	Air Passenger Boardings	100	200	800	1,700	300	1,500	400	300
Cost Estimating	Capital Cost (Avg) (2017$ Millions)	N/A	$ 1,719	$ 2,033	$ 2,904	$ 1,469	$ 3,812	$ 2,465	$ 274
	Annual O&M Cost (Avg) (2017$ Millions)	N/A	$ 71	$ 89	$ 44	$ 122	$ 111	$ 91	$ 19
	Capital Cost/New Rider (Avg) ($2017 Millions)	N/A	$ 249,679	$ 60,580	$ 67,686	$ 96,647	$ 222,521	$ 213,794	$ 35,044
	Annual Replacement Value ($2017 Millions)	N/A	$ 26	$ 40	$ 54	$ 25	$ 46	$ 28	$ 6
Benefit-Cost Analysis	Travel Cost Savings ($2017 Millions)	N/A	$ 61	$ 918	$ 1,294	$ 345	$ 277	$ 180	$ 95
	Emissions Avoided ($2017 Millions)	N/A	$ 14	$ 87	$ 121	$ 52	$ 51	$ 32	$ 13
	Residual Value ($2017 Millions)	N/A	$ 265	$ 271	$ 403	$ 208	$ 565	$ 377	$ 36
	Benefit-Cost Ratio (3%)	N/A	0.3	2.3	2.4	0.9	0.5	0.5	1.9
	Construction Job Impacts ($2017 Millions)	N/A	$ 808	$ 1,284	$ 1,935	$ 623	$ 1,970	$ 1,347	$ 175
	O&M Job Impacts ($2017 Millions)	N/A	$ 60	$ 76	$ 38	$ 103	$ 92	$ 77	$ 16
	Annual Housing & Commuting Savings per Household ($2017)	N/A	$ 7	$ 61	$ 98	$ (2)	$ (6)	$ 4	$ 1
Facility & Capacity Analysis	ROW Impacts (Acres)	N/A	121	34	50	89	240	136	3
	Intersection Impacts (Number of Crossings)	N/A	63	93	80	12	72	65	0
	Rail Adjacent to Residential Uses (Miles)	N/A	31	4	5	56	89	33	0
	Track Capacity Concerns (Y - Yes, N - No)	N/A	Y (Single Track Segments)	N	N	Y (Single Track Segments / Alhambra Subdivision)	Y (Single Track Segments/ Alhambra Subdivision)	Y (Single Track Segments)	N

Table 2 Summary of Strengths and Weaknesses

	TSM	LRT Arterial	LRT Cucamonga Creek	Commuter Rail Phase 1	Commuter Rail Phase 2	Hybrid Rail	BRT/Express Bus[4]
Strengths	• Relatively Low Capital Cost (<$2B) • Relatively lower cost per trip • High incremental job accessibility	• Relatively lower cost per trip • High Benefit-Cost Ratio • High Ridership • High Travel Time Savings • Large VMT/GHG Reduction • Low ROW Impacts • Strong TOD/TOC Potential	• Highest Ridership • High Benefit-Cost Ratio • High Travel Time Savings • Large VMT/GHG Reduction • Strong TOD/TOC Potential • High Accident Avoidance	• Lowest Capital Cost for Rail (<$1.5B) • Lowest cost per trip for Rail • Fast intercounty commute • Relatively large VMT/GHG Reduction • High incremental job accessibility	• Fast commute time LA-ONT • Double the Ridership of Commuter Phase 1 • Relatively large VMT/GHG Reduction • High incremental job accessibility • High residual benefits	• Fast commute time LA-ONT • Lower cost per trip than LRT Cucamonga and Commuter Rail Phase 2 • Lower O&M Cost than Commuter Rail • High incremental job accessibility	• Lowest Capital Cost (<$300M) • Lowest cost per trip • High Benefit-Cost Ratio • Low ROW Impacts • Enhances 1st/last mile connectivity
Weaknesses	• Limited Benefit-Cost Ratio • Large Capital Cost for Double Tracking • Relatively Low Ridership • Limited VMT/GHG Reduction • Large ROW Impacts • Limited Travel Time Savings	• High Capital Cost (>$2B) • Relatively limited incremental job accessibility	• High Capital Cost (>$2.5B) • Relatively higher cost per trip • Relatively limited incremental job accessibility	• Relatively Limited Ridership • High O&M Cost • Capacity issue: SB Single track segments cannot accommodate service headways	• Highest Capital Cost (>$3.5B) • Highest cost per trip • Limited Benefit-Cost Ratio • Large ROW Impacts • Capacity issue: SB single track segments cannot accommodate proposed service headways	• High Capital Cost (>$2.5B) (Includes Double Tracking) • Lowest Ridership Increase (Does not include express service) among rail alternatives • Low VMT/GHG Reduction • Large ROW Impacts • Capacity issue: SB single track segments cannot accommodate proposed service headways[5]	• Limited Ridership • Limited VMT/GHG Reduction • Limited Travel Time Savings • Limited intercounty connectivity • Limited Economic generation • Limited TOD Potential

[4] Note: The strengths and weaknesses are specific for the performance of this BRT/Express Bus Alternative, rather than for BRT services in general.
[5] Note: Following the completion of the facility and capacity analysis for this study, SBCTA and L.A. Metro prepared a Metrolink San Bernardino Line Hybrid Rail Study. This Hybrid Rail Study further refines the concept of using hybrid rail on Metrolink tracks, similar to the Hybrid Rail Alternative evaluated in this study. The capacity analysis included in the Hybrid Rail study may be used as a reference to this study, but the findings of the two reports are not comparable. This study includes the double tracking segments from Metrolink's SCORE proposal, which are necessary to accommodate the proposed service plan in the Hybrid Rail Alternative. The Hybrid Rail Study makes different assumptions about service levels and double tracking needs than what is assumed in this study. More detailed information is available in Agenda Item 6 of the SBCTA Transit Committee meeting of May 10, 2018, available at: http://www.gosbcta.com/about-sbcta/agendas/2018/05-18-transit.pdf

Introduction and Background

Study Area

The study area for the Inter-County Transit and Rail Connectivity Study is bounded on the west by State Route (SR-) 57 and on the east by Interstate (I-) 15, and encompasses parts of the Metro Gold Line Foothill Extension (Phases 2B and 2C), the Metrolink San Bernardino Line and Riverside Line, and I-10 freeway (**Figure 9**). Los Angeles County cities in the study area include La Verne, Claremont, and Pomona; San Bernardino County cities include Upland, Montclair, Rancho Cucamonga, and Ontario. Transportation corridors in the study area include the Metrolink San Bernardino Line, the Metrolink Riverside Line, and I-10.

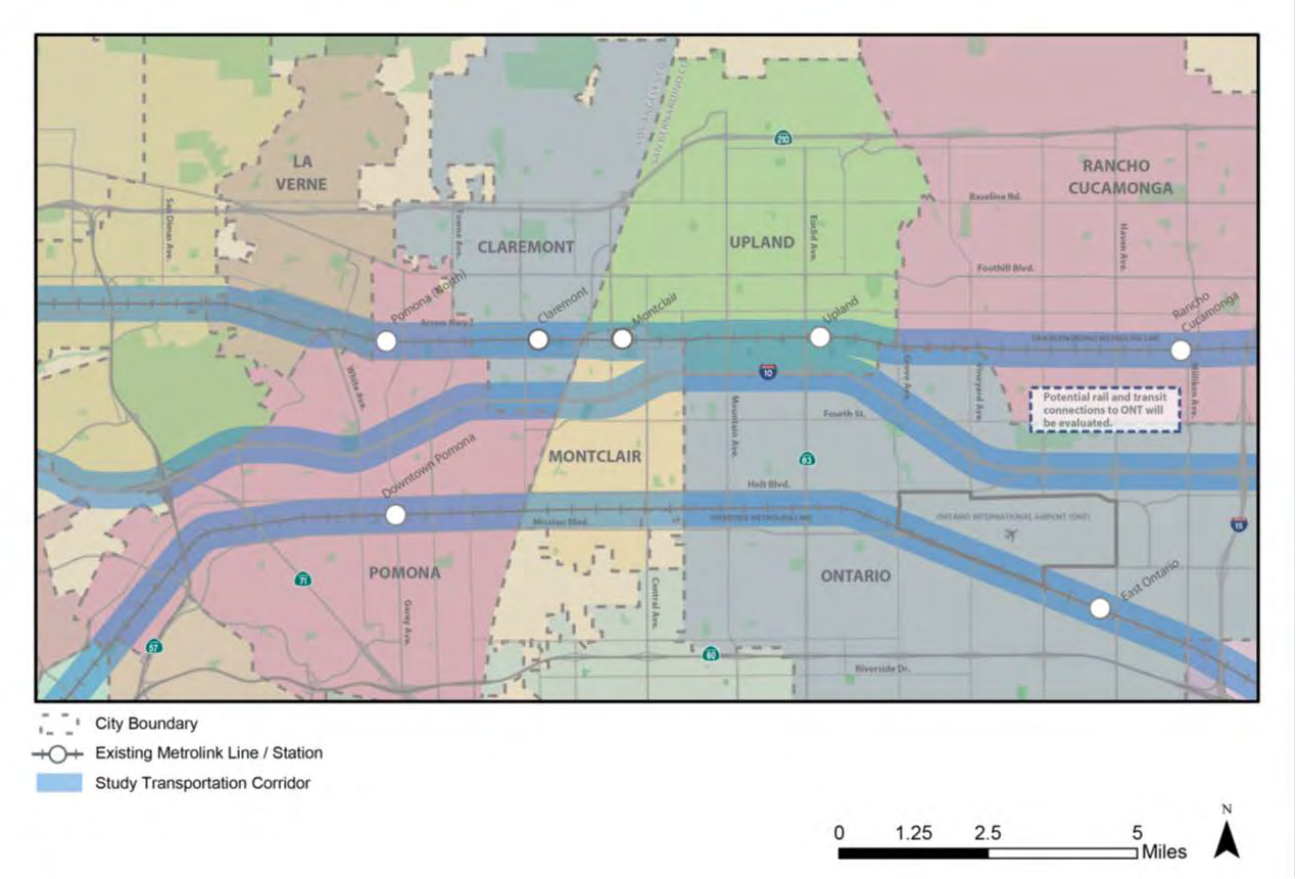


Figure 9 Inter-County Transit and Rail Connectivity Study Area

Mobility Problem Definition

The study area faces accessibility and mobility challenges that impact north-south trips in the study area and trips to and from the east or northern San Gabriel Valley. This study analyzes existing travel patterns and mode choice for trips utilizing the study area's transportation network to identify service gaps in the transit network to access the area's top origins and destinations.

As depicted in **Figure 1**, travel within the study area generates more trips than travel through or entering/exiting the study area; there are 1.7 million daily trips within the study area and 1.1 million trips that enter or leave the study area, almost all of which are made by car, at 85% and 97%, respectively. While through trips generally follow an east-west orientation, travel patterns within the study area are more complex.

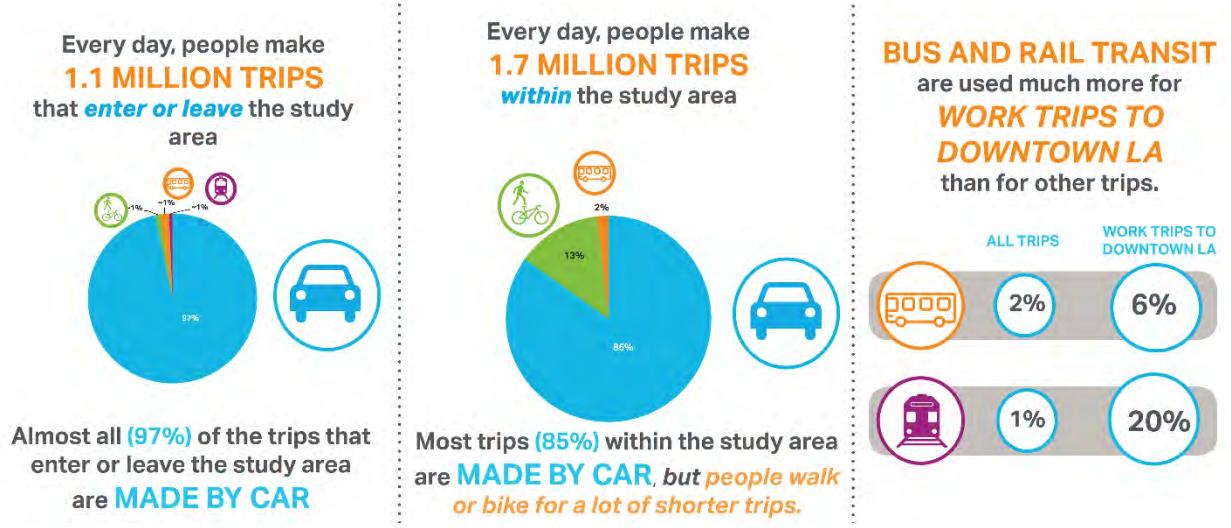


Figure 10 Options for Getting Around

Within the study area, travel patterns are polycentric; there are a large number of relatively short trips with longer trips focused on activity centers in Pomona and Ontario, resulting in trips between these cities and the northern portions of the study area (**Figure 11**). These non-east-west trips in the study area are not well served by the current fixed transportation infrastructure.

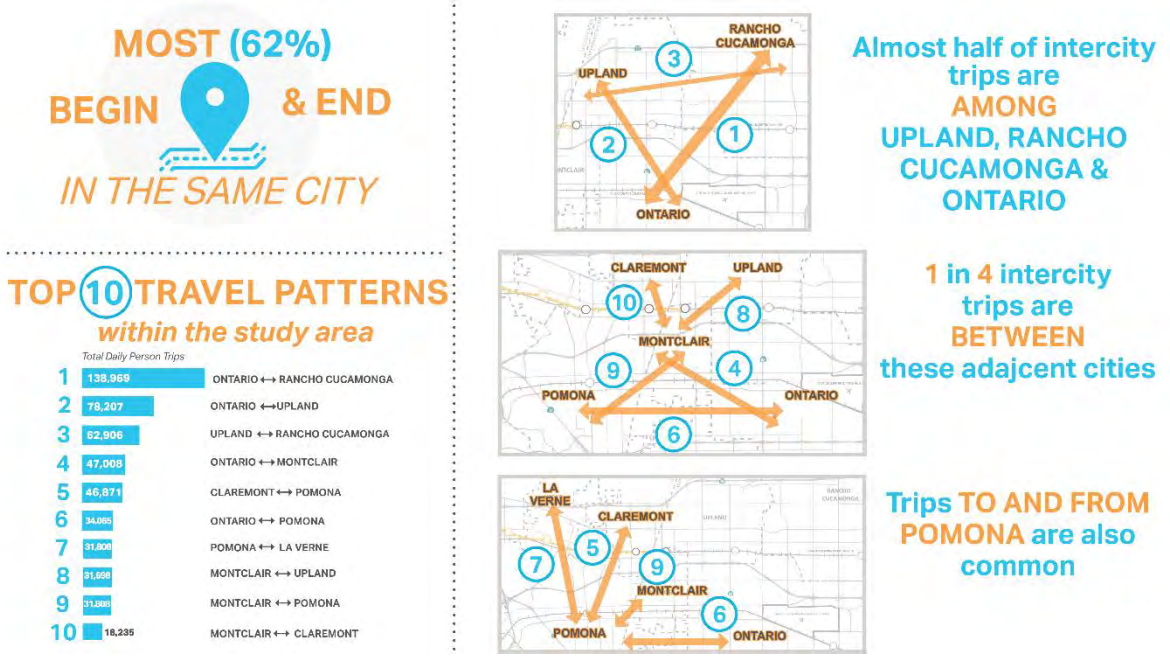


Figure 11 Travel Patterns Within The Study Area

The roadway and rail network in the study area provide modal options for through trips and for trips from the study area to the west. However, infrastructure constraints and operational considerations limit the share of trips that can be well served by rail transit, particularly those between the study area and locations to the east. For rail, these operational considerations limit the number of trains each day and, in particular, the number of trains in the off-peak direction.

Without any transit and/or rail improvements to expand the range of transportation options, accessibility and mobility issues will worsen in the future as demand for travel increases with forecasted growth in employment and population.

Purpose and Need

A number of significant transportation improvements have been or are currently being planned and constructed throughout the inter-county corridor, including the Metro Gold Line Foothill Extension Phases 2B and 2C; San Bernardino Metrolink Line improvements; Metrolink station area planning; improved transit access to ONT; BRT service; express bus service and; I-10 High Occupancy Vehicle (HOV) and High Occupancy Toll (HOT) lanes. Given the potential overlap of transit and rail improvements being considered for the corridor, there is a need to evaluate transit and rail services in a comprehensive, integrated, and coordinated manner.

The ability to move quickly and efficiently in the study area and to connect to destinations outside the study area is constrained by a mismatch between the existing east-west fixed transportation infrastructure (freeways and rail) and the complex travel patterns within the area. The study area faces mobility challenges today that will worsen in the future as demand for travel increases with forecast growth in population and employment; between 2012 and 2040, the study area's population is expected to increase by 27% (665,900 to 848,900) with employment increasing at a more rapid rate of 45% (308,700 to 446,300).[6] In 2008, there were 1.7 million daily trips within the study area (not including trips that enter or exit the area, or travel all the way through it). By 2035, an additional 500,000 daily trips will occur within the study area.

The goal of this study is to develop a multimodal corridor transit improvement plan in collaboration with stakeholders, agencies, and the public that evaluates transit and rail service in a comprehensive, integrated, and coordinated manner. The study objectives include:

- Assess the market for transit and rail travel in the corridor, including the geographic distribution of origins for employee and passenger trips to ONT;
- Estimate potential ridership, transportation and economic benefits, and capital/operating costs associated with transit and rail alternatives in the corridor; and
- Recommend a path forward for cost-effective transit and rail service to ONT, as well as to best serve communities along the corridor with a focus on coordinating plans for the Metro Gold Line, Metrolink, and OmniTrans, Foothill Transit, and Metro bus services.

[6] SCAG 2016-2040 RTP/SCS Regional Travel Demand Model

Study Methodology

The study followed a two-step screening process (**Figure 12**), with continuous and transparent collaboration from the Technical Working Group (TWG) and Stakeholder Review Committee (SRC) throughout. In addition, stakeholder and community input on the mobility needs in the corridor and Build Alternatives was obtained through two rounds of Open Houses.

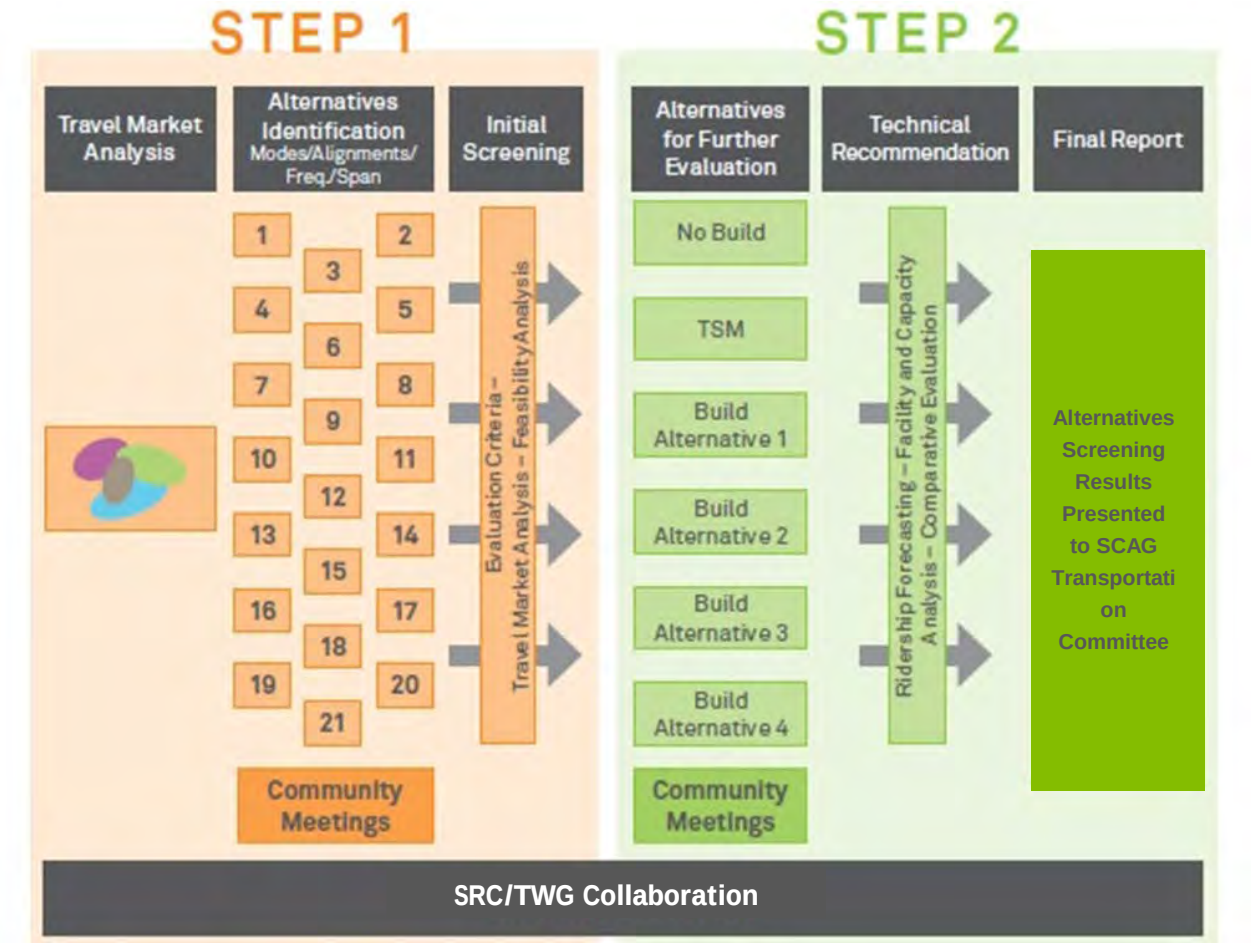


Figure 12 Alternatives Development and Screening Process

Step 1 of the alternatives development and screening consisted of a travel market analysis, alternatives identification, and an Initial Screening. In order to achieve the optimal mix and service levels of multiple modes, the top overall ranking alternatives from the Initial Screening were preliminarily grouped into four combinations of build alternatives that advanced to the next step of the screening process, and were later refined to be four Build Alternatives based on the Open House feedback and additional input from the SRC and TWG.

Step 2 of the alternatives analysis process further evaluated the final alternatives from the Initial Screening through Facility & Capacity Analysis, Ridership Forecasting, Cost Estimating, and Benefit-Cost and Economic Impact Analysis. The Build Alternatives were further detailed and refined as the analyses progressed to incorporate additional information and assumptions. A Final Screening was then conducted to synthesize the results of these technical analyses into findings related to the comparative performance of the final alternative(s) for the study corridor.

SCAG held two rounds of open houses in order to obtain input on the study area mobility needs and refinement of alternative components. During the first round of open houses in June 2016 in Pomona and Upland, people who live and/or work in the study area provided input on travel patterns and transportation priorities that helped to identify six build alternatives from the larger set of 38 initial screening alternatives. The second round of open houses was held in July 2017 in Claremont and Montclair to gather feedback on the preliminary draft build alternatives. Online surveys were also provided for both rounds of open houses for people who could not attend and comment in person. Over 1,000 responses were received for the first online survey, and approximately 700 were received for the second survey. The public open house advertising materials, presentation materials, and summary of input received were documented in the Open House Summaries (August 2016 and August 2017).

The following goals, objectives, evaluation criteria, and performance measures were used to evaluate the comparative performance of the alternatives (**Table 3**):

Table 3 Goals, Objectives, and Screening Steps

Objective	Evaluation Criteria	Performance Measure	Step 1 or 2
GOAL 1: Enhance Connectivity and Accessibility			
Improve inter-modal connectivity and accessibility between Los Angeles and San Bernardino counties	Ease of trips	Average trip time improvement (percentage, compared to No Build) of the sample trips	Step 1
	Ease of transfers between modes	Average transfer time improvement (percentage, compared to No Build) of the sample trips identified in Travel Market Analysis	Step 1
	Availability of effective opportunities to transfer	Average transfer number improvement (percentage, compared to No Build) of the sample trips	Step 1
Improve inter-modal connectivity and accessibility between Los Angeles and San Bernardino counties	Ease of trips	Average trip time improvement (percentage, compared to No Build) of the sample trips	Step 1
Align transit infrastructure with travel patterns	Consistency with travel market analysis	Alignment with future travel patterns	Step 1
	Number of trips served by transit	Total trips served by all new service components in each alternative based on ridership model output	Step 2
Maximize ability to connect current and potential trip origins and destinations and serve existing and proposed activity centers and trip generators	Frequency and availability of service from origins to destinations	Average weekday service span of all services in each alternative	Step 2
		Average weekday peak headway of all services in each alternative	Step 2
	User Benefits	Number of hours saved annually in travel time by alternative compared to No Build based on ridership model output	Step 2
Enhance first/last mile connectivity to transit stations and stops	Availability of active transportation infrastructure adjacent to existing and planned transit stops/stations	Percentage change of transit stations/stops directly served by existing and planned bike lanes as compared to NB for the length of all service components in each alternative	Step 2
	Use of shared vehicle or on-demand vehicle options to access existing and planned transit stations/stops	Number of stations located within a 2.5-mile radius of mobility hubs for each alternative	Step 2
Provide convenient access to ONT	Number of people who use transit to go to ONT for flights	Air Passenger Boardings at ONT based on ridership model output	Step 2
	Number of people who use transit to go to ONT (for reasons other than flights)	Non-Air Passenger Boardings at ONT based on ridership model output	Step 2

Objective	Evaluation Criteria	Performance Measure	Step 1 or 2
GOAL 2: Provide Cost Effective Transit and Rail Services			
Optimize capital and operating costs	Use of existing infrastructure or need for new infrastructure	Miles of track of new infrastructure	Step 1
	Feasibility of implementation	Alignment with current standards and practices	Step 1
	Capital cost per trip	Capital costs per trip for each alternative based on ratio of total capital cost estimate to total ridership	
	Operating cost per trip	Operating costs per trip for each alternative based on ratio of total O&M cost estimate to total ridership	
	Capital cost of each alternative	Total capital cost estimate for each alternative	Step 2
	O&M cost of each alternative	Total O&M cost estimate for each alternative	Step 2
Allow for efficient implementation and long-term scalability	Score estimated timeframe for initial improvements	Categorize alternatives into short (adding trains to existing track, minimal new infrastructure), medium (new construction on existing ROW), and long (entirely new infrastructure, off of rail right-of way).	Step 1
	Implementation timeframe for various stages of improvements	Scalability for future adjustments and longer-term improvements. Scores assigned based on the following nature of the alternatives: 1. Ability to be phased based on the number of service components. 2. Potential in future expansion. 3. Type of service improvements needed (new tracks, platform upgrades, fleet upgrades, etc.). 4. Assign scores 1-5 with 5 being most scalable and 1 being least scalable.	Step 2
Maximize use of existing infrastructure (rail)	Increased ridership on existing infrastructure	Number of additional passengers at existing stations in each alternative based on ridership model output	Step 2
Maximize use of existing infrastructure (roadway)	Increased roadway capacity for vehicles	Number of vehicles removed from roadway as highway trip reductions by alternative	Step 2
Increase transit productivity	Travel cost reduction	Reduction in average cost per trip based on benefit cost analysis of VMT reduction	Step 2
	Number of transit boardings	Total ridership increase by all services in each alternative compared to No Build based on ridership model output	Step 2
Residual Benefits	Non-user benefits	Residual value of infrastructure elements and assets end of 20-year analysis period discounted at 3%	Step 2

Objective	Evaluation Criteria	Performance Measure	Step 1 or 2
GOAL 3: Promote Sustainable Transportation			
Reduce vehicle miles traveled and greenhouse gas emissions	Reduction in VMT	VMT reduction based on ridership model output	Step 2
	Reduction in greenhouse gas emissions	CO2 emissions savings per VMT over the analysis period for each alternative based on EPA emission factors applied to VMT reduction	Step 2
Reduce automobile dependence	Mode shift	Percentage of increased transit ridership converted from driving based on ratio of new riders to ridership increase	Step 2
		Number of parking space needs avoided informed by number of new transit riders for each alternative, based on ridership model output	Step 2
Improve Safety	Accidents avoidance	Accident costs avoided over the analysis period based on VMT diversion from auto to transit	Step 2
Improve congestion level for roadway users	Non-user benefits	Congestion costs saved over 20-year analysis period based on VMT diversion from auto to transit	Step 2

Objective	Evaluation Criteria	Performance Measure	Step 1 or 2
GOAL 4: Support Transit-Oriented Development			
Support adaptive re-use, transit-oriented development and smart growth policies	Development opportunity areas served	Number of development opportunity areas served. Development opportunity areas identified based on adopted plans that would encourage TOD, adaptive re-use, mixed-use, or infill development	Step 1
	Level of enhancements and “permanence” of new transit	Total adjusted number of new stations, factoring in frequency of service and overlap with TOD opportunity areas. Calculation steps: 1. Identify new stations (Compared to NB) in each alternative. 2. Generate one-mile buffers for new rail stations and half-mile buffers for BRT stations are generated for the stations identified in Step 1. The buffer areas will be the stations' "TOD influence areas". 3. Select the stations whose "TOD influence areas" overlap the transit-oriented development Opportunity Areas identified in the Initial Screening in Step 2. 4. Calculate the average headway (for all services that stop at that station) for stations identified in Step 3. 5. Adjust stations numbers with frequency factors based on the formula below: Adjusted number for Station A = 1 + (average station headway for all stations – Station A headway from Step 4) / Station A headway from Step 4 6. For each alternative, the adjusted total number of new stations is the sum of the results from Step 4 for stations from Step 3. 7. Score = adjusted total number of new stations for each alternative from Step 6 / the maximum adjusted total number of new stations result from Step 6.	Step 2

Objective	Evaluation Criteria	Performance Measure	Step 1 or 2
Economic Impacts			
Construction/Operations Jobs Created	Construction jobs and O&M jobs created	Construction job annual earnings	Step 2
		O&M job annual earnings	Step 2
Incremental Job Accessibility	Labor Market impacts	Number of jobs accessible by transit (within 30-minute transit travel time via the service components in each alternative) from hub stations (including Claremont, Montclair, Ontario Airport, Downtown Pomona, San Bernardino Transit Center, and Rancho Cucamonga Metrolink Station)	Step 2
Tax Revenue Impacts	Anticipated level of economic development and associated tax revenue impacts	Estimated negative tax revenue impacts based on potential ROW takes	Step 2
Housing and Transportation Affordability	Assess change in housing and transportation costs	Change in housing and transportation costs in comparison to No Build based on H+T Affordability Index	Step 2

Initial Screening Results Summary

This section presents the alternatives identified based on the mobility needs and previous studies, a high-level summary of the Initial Screening results, as well as a refined set of alternatives for the second step of this study.

As depicted in **Table 3**, this initial stage evaluated preliminary criteria consistent with the development of the study's purpose and need for three of the four main goals, including the following:

- Enhance connectivity and accessibility
    - Ease of trips
    - Ease of transfer between modes
    - Availability of effective opportunities to transfer
    - Consistency with travel market analysis
- Provide cost effective transit and rail services
    - Use of existing infrastructure or need for new infrastructure
    - Feasibility of implementation
    - Estimated timeframe for initial improvements
- Support transit-oriented development
    - Development opportunity areas served

These criteria were selected as part of the Step 1 screening effort to provide a high-level assessment of the initial set of alternatives and their ability to achieve the study's goals and objectives. More in-depth evaluation criteria and performance measures were included during Step 2 to evaluate the condensed and refined set of alternatives. The goals, objectives, and evaluation criteria were developed in collaboration with the TWG/SRC, and final concurrence on the methodologies to evaluate each criteria was received in early February 2017.

The initial screening was completed using representative sample trips from the travel market analysis and the methodology described above in **Table 3** for each evaluation criteria/performance measure identified for each specific study goal and objective. The entire set of initial screening alternatives were evaluated and ranked on a relative score from 0.00 to 1.00 for their ability to serve the representative sample trips, as well as to meet other Step 1 criteria. Upon completion of the initial screening, four Build Alternatives were derived using the best ranking alternatives from each alternative set based on their dominant modes and the ability to address mobility needs in the study area (as documented in the Final Initial Screening Report, August 2017).

The following alternatives were identified for the Initial Screening (**Table 4** through **Table 6**):

Alternatives for Initial Screening

Table 4: No Build and TSM Alternative Descriptions

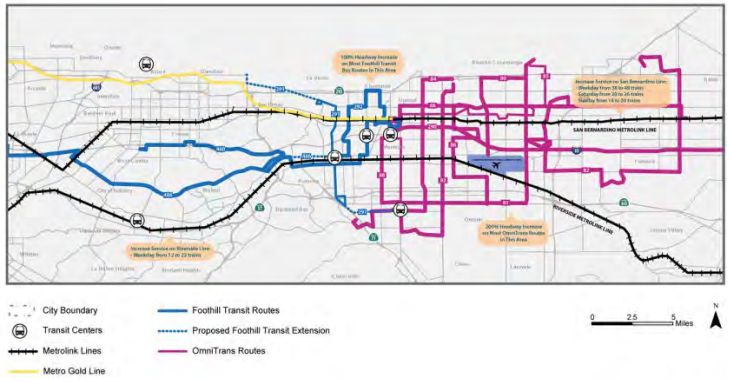
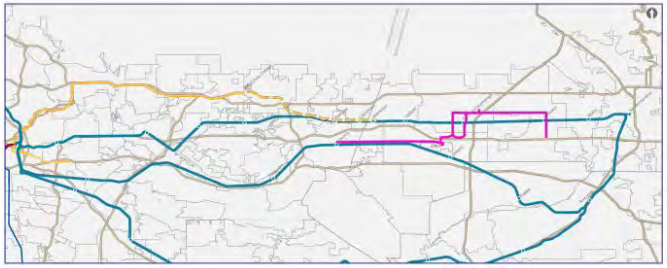
	Alternative	Description	
No Build			
	No Build	Includes the Gold Line extension to Montclair and everything in the SCAG RTP/SCS Financially Constrained plan, except: • Metrolink service improvements • BRT on Haven Avenue • BRT on Euclid Avenue • Rail/Bus to ONT • Transit Projects in the study area	
TSM			
	TSM	Bus service headway improvements (See Table 5) Bus extensions/new routes or services: • Foothill Transit 291 o Extend to the south/east to Chino Transit Center o Extend to the north/west to Glendora • Foothill Transit 486 o Extend east to Pomona • Omnitrans 290 o Increase service to 20 minute peak/60 minute off-peak • Omnitrans 66 o Increase service to 10 minute headways for unduplicated portion with West Valley Connector on the weekdays and to 20 minute headways for the entire route on the weekends Metrolink service improvements: • Increase number of scheduled trains on the San Bernardino Line (per Metrolink Strategic Plan) o Weekday from 38 to 48 trains o Saturday from 20 to 26 trains o Sunday from to 14 to 20 trains • Riverside Line o Increase service from 12 trains per weekday to 22 trains per weekday (per Metrolink Strategic Plan)	

Table 5: Current and Proposed Bus Headways for the TSM Alternative

	Current Headway				Proposed TSM Headway			
	Peak	Off Peak	Saturday	Sunday	Peak	Off Peak	Saturday	Sunday
OmniTrans 80	60	60	60	60	20	30	60	60
OmniTrans 81[7]	60	60	60	60	20	30	60	60
OmniTrans 82[8]	60	60	-	-	20	30	60	60
OmniTrans 83	60	60	60	60	20	30	30	60
OmniTrans 84	60	60	60	60	20	30	60	60
OmniTrans 85	30	30	60	60	20	30	30	60
OmniTrans 86	60	60	-	-	20	30	60	60
OmniTrans 88	60	60	60	60	20	30	60	60
Foothill Transit 291	15	15	30	30	15	15	30	30
Foothill Transit 292	30	-	-	-	20	60	-	-
Foothill Transit 480	30	30	30	30	20	30	30	30

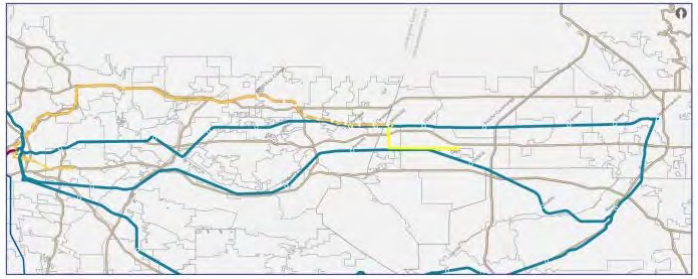
[7] OmniTrans Route 81 currently has 30 minute service on weekdays north of Foothill Boulevard.
[8] OmniTrans Route 82 currently does not serve the Milliken Avenue corridor on weekends.

Table 6: Build Alternatives

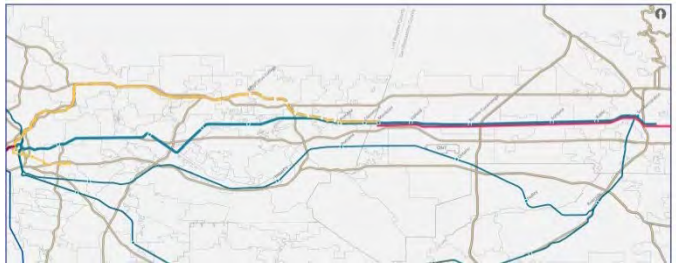
	Alternative	Description	
1	Adopted 2016 RTP/SCS	Reflects the currently adopted 2016 RTP/SCS, which includes construction and implementation of the Gold Line Phase 2B to Montclair	
2	West Valley Connector LRT	Transition West Valley Connector from BRT to LRT	
3a	Connection to ONT Alternative - 1	Connection to San Bernardino Line from Rancho Cucamonga from east and west. Commuter Rail shuttle service would run between Rancho Cucamonga and ONT with timed transfers.	

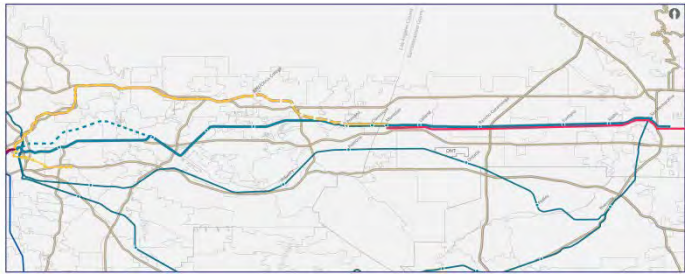
	Alternative	Description	
3b	Connection to ONT Alternative - 2	Connection to San Bernardino Line from Rancho Cucamonga + Connection to Riverside Line in Downtown Ontario. Connection to San Bernardino Line from Rancho Cucamonga from east and west. Commuter Rail shuttle service would run between Rancho Cucamonga and ONT with timed transfers and continue to connect Hybrid Rail with the Riverside Line at a station along Euclid Ave.	
3c	Connection to ONT Alternative - 3	Connection to San Bernardino Line from Rancho Cucamonga + Connection to Riverside Line in Downtown Ontario + Connection to Riverside Line from East. Connection to San Bernardino Line from Rancho Cucamonga from east and west. Commuter Rail shuttle service would run between Rancho Cucamonga and ONT with timed transfers and continue to connect Hybrid Rail with the Riverside Line at a station along Euclid Ave. Additionally, the Riverside Line would be re-routed to connect to the new station at the north side of ONT.	
3d	Connection to ONT Alternative - 4	Connection to San Bernardino Line from Rancho Cucamonga (Milliken and Euclid) + Connection to Riverside Line in Downtown Ontario + Connection to Riverside Line from East. Connection to San Bernardino Line from Rancho Cucamonga from east and west. Commuter Rail shuttle service would run between Rancho Cucamonga and ONT with timed transfers and continue to connect Hybrid Rail with the Riverside Line at a station along Euclid Ave. Additionally, the Riverside Line would be re-routed to connect to the new station at the north side of ONT. Finally, a new connection would be established along the San Bernardino Line from a station at Euclid to ONT. Under Service Pattern 1, The San Bernardino Line Trains could divert south directly to ONT.	

	Alternative	Description	
3e	Connection to ONT Alternative - 5	Connection to San Bernardino Line from Rancho Cucamonga (Milliken and Euclid) + Connection to Riverside Line in Downtown Ontario + Connection to Riverside Line from East. Connection to San Bernardino Line from Rancho Cucamonga from east and west. Commuter Rail shuttle service would run between Rancho Cucamonga and ONT with timed transfers and continue to connect Hybrid Rail with the Riverside Line at a station along Euclid Ave. Additionally, the Riverside Line would be re-routed to connect to the new station at the north side of ONT. Finally, a new connection would be established along the San Bernardino Line from a station at Euclid to ONT. Under Service Pattern 2, trains could cross between the San Bernardino and Riverside Lines	
3f	Connection to ONT Alternative - 6	Gold Line Connection via Metrolink/Cucamonga Channel	
3g	Connection to ONT Alternative - 7	Gold Line Connection via Metrolink/Vineyard/Holt	

	Alternative	Description	
3h	Connection to ONT Alternative - 8	Gold Line Connection via Baldwin Park Branch/Cucamonga Channel	
3i	Connection to ONT Alternative - 9	Rail Connection from Montclair	
3j	Connection to ONT Alternative - 10	Rail Connection from Claremont	

	Alternative	Description	
3k	Connection to ONT Alternative - 11	Rail Connection from Pomona along Holt and Garey	
4a	Hybrid Rail Alternative - 1	Convert the entire San Bernardino Line to Hybrid Rail (requires adequate track connection to Hybrid Rail)	
4b	Hybrid Rail Alternative - 2	Run Hybrid Rail along with Metrolink on SB Line	

	Alternative	Description	
4c	Hybrid Rail Alternative- 3	Extend Hybrid Rail to Claremont using existing Metrolink track/ROW	
4d	Hybrid Rail Alternative- 4	Extend Hybrid Rail to Montclair using existing Metrolink track/ROW	
4e	Hybrid Rail Alternative- 5	Extend Hybrid Rail to Claremont using existing Metrolink track/ROW and shifting Metrolink service to the Alhambra Subdivision between L.A. and El Monte	

	Alternative	Description	
4f	Hybrid Rail Alternative- 6	Extend Hybrid Rail to Montclair using existing Metrolink track/ROW and shifting Metrolink service to the Alhambra Subdivision between L.A. and El Monte	
4g	Hybrid Rail Alternative- 7	Terminate Gold Line at Montclair and Metrolink at Rancho Cucamonga with Hybrid Rail operating between Redlands and ONT via Rancho Cucamonga	
4h	Hybrid Rail Alternative- 8	Terminate Gold Line at Montclair, leave Metrolink as is, with Hybrid Rail operating between Redlands and ONT via Rancho Cucamonga	

	Alternative	Description	
4i	Hybrid Rail Alternative- 9	Hybrid Rail to Cal Poly Pomona and Mt. San Antonio College. Would share tracks with Metrolink until east of Rancho Cucamonga Station, would head south to connect with Riverside Line along creek ROW between Hermosa and Haven or Along Archibald. Includes new station north of ONT, station at Downtown Ontario, Downtown Pomona, and terminus at Cal Poly Pomona.	
5a	Metrolink San Bernardino Line- 1	Low level • Service increases at the same level as TSM (48 trains per weekday) per Metrolink Strategic Plan • Additional express trains- 3 AM Peak trains towards LAUS, one per hour 3 PM peak trains from LAUS, one per hour	
5b	Metrolink San Bernardino Line- 2	High level • Service increases to 56 trains per weekday (maximum from infrastructure study) • Additional express trains- 6 AM Peak express trains towards LAUS, two per hour • 6 PM peak express trains from LAUS, two per hour	
5c	Metrolink San Bernardino Line- 3	Metrolink express train from LAUS to ONT via Rancho Cucamonga	
5d	Metrolink San Bernardino Line- 4	Metrolink express train from LAUS to ONT via Pomona	
5e	Metrolink San Bernardino Line- 5	Metrolink express train from LAUS to ONT via Claremont	
6	Metrolink Riverside Line	New station in Ontario at Euclid Avenue • Close to employment areas in southwest Ontario • Close to OmniTrans Ontario Transit Center Increase service from 12 trains per weekday to 22 trains per weekday per Metrolink Strategic Plan • Requires negotiation with host railroad (Union Pacific) • Service would not operate on weekends • (Also in TSM now)	

	Alternative	Description	
7	Mobility Hubs/On-Demand Service	Integrates bike share/car share/shuttle service and on-demand services at key locations to feed into east-west fixed transit service and serve poly-centric trips	
8a	Bus Rapid Transit- 1	BRT along Euclid	
8b	Bus Rapid Transit- 2	BRT along Haven	
8c	Bus Rapid Transit- 3	BRT along Milliken	
8d	Bus Rapid Transit- 4	Infrastructure improvements to improve travel times on West Valley Connector	
8e	Bus Rapid Transit- 5	BRT alternative between ONT and Montclair Metrolink	
8f	Bus Rapid Transit- 6	Foothill transit BRT from Pomona to ONT along Holt	
8g	Bus Rapid Transit- 7	Extend the West Valley Connector from Downtown Pomona to Cal Poly Pomona	
9a	Express Bus- 1	Utilization of Interstate 10 Express Lanes • Service increases on OmniTrans 290 • New express route between Fontana/Rancho Cucamonga and El Monte	
9b	Express Bus- 2	Utilization of Interstate 10 Express Lanes • New express route between Chaffey College (Rancho Cucamonga) and Union Station connecting to Ontario Airport	

Initial Screening Results

The Initial Screening showed the average of the top scoring rail Build Alternatives (0.43) is higher than the average of the top non-rail Build Alternatives (0.41), despite the overall top ranked Build Alternative (Build 7 - Mobility Hubs/On-Demand Service) being a non-rail alternative. In general, non-rail alternatives demonstrated less ability to make improvements that reflected all three analysis goals, with the exception of Build 7 - Mobility Hubs/On-Demand Service. The following tables summarize the top ranking rail alternatives (**Table 7**), top ranking non-rail alternatives (**Table 8**), and top overall ranking alternatives (**Table 9**) which were used to create the combination alternatives that advanced to the next step of the screening process.

Table 7: Top Ranking Rail Alternatives

Rank	Alternative	Score
1	Build 2 - West Valley Connector LRT	0.55
2	Build 3e - Connection to ONT Alt. 5	0.48
3	Build 3d - Connection to ONT Alt. 4	0.46
4	Build 5c - Metrolink San Bernardino Line Alt.3	0.44
5	Build 4b - Hybrid Rail Alt. 2	0.43
6	Build 4d - Hybrid Rail Alt. 4	0.41
7	Build 4c - Hybrid Rail Alt. 3	0.41
8	Build 4a - Hybrid Rail Alt. 1	0.39
9	Build 5b - Metrolink San Bernardino Line Alt.2	0.38
10	Build 3g - Connection to ONT Alt. 7	0.37

Table 8: Top Ranking Non-Rail Alternatives

Rank	Alternative	Score
1	Build 7 - Mobility Hubs/On-Demand Service	0.87
2	Build 8d - Bus Rapid Transit Alt.4	0.42
3	Build 8b - Bus Rapid Transit Alt.2	0.41
4	Build 8f - Bus Rapid Transit Alt.6	0.41
5	Build 8a - Bus Rapid Transit Alt.1	0.40
6	Build 8c - Bus Rapid Transit Alt.3	0.40
7	Build 8g - Bus Rapid Transit Alt.7	0.40
8	Build 8e - Bus Rapid Transit Alt.5	0.39
9	Build 9b - Express Bus Alt.2	0.25
10	Build 9a - Express Bus Alt.1	0.16

Table 9: Top Overall Ranking Alternatives

Rank	Alternative	Score
1	Build 7 - Mobility Hubs/On-Demand Service	0.87
2	Build 2 - West Valley Connector LRT	0.55
3	Build 3e - Connection to ONT Alt. 5	0.48
4	Build 3d - Connection to ONT Alt. 4	0.46
5	Build 5c - Metrolink San Bernardino Line Alt.3	0.44
6	Build 4b - Hybrid Rail Alt. 2	0.43
7	Build 8d - Bus Rapid Transit Alt.4	0.42
8	Build 8b - Bus Rapid Transit Alt.2	0.41
9	Build 4d - Hybrid Rail Alt. 4	0.41
10	Build 8f - Bus Rapid Transit Alt.6	0.41

The initial screening identified six alternatives for the second step in the screening process including the No Build, TSM, and four combination Build Alternatives which were designed using the high-performing initial Build Alternatives to achieve the optimal mix and service levels of multiple modes (shown in **Table 10**), including Local/Regional LRT, Commuter Rail, Local/Regional Hybrid Rail, and BRT/Express Bus.

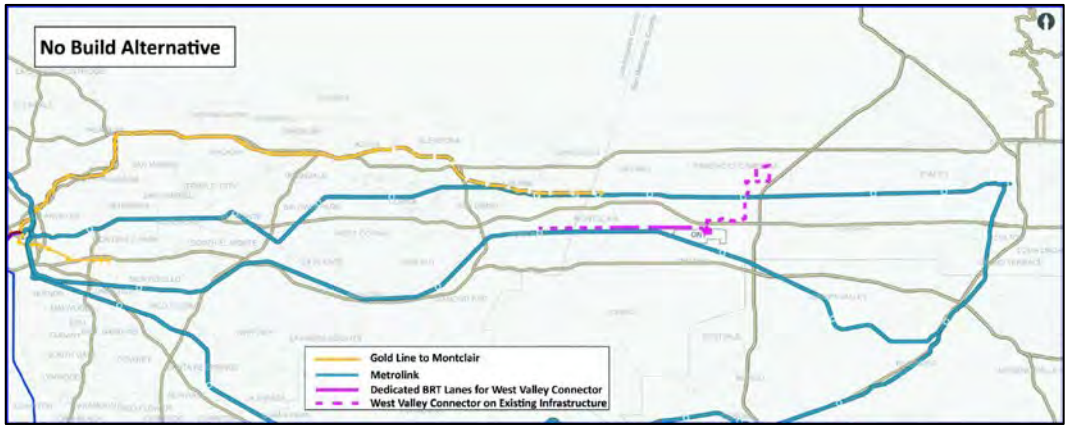
Table 10: Recommended Build Alternative Combinations

Modes	Mobility Hub/On-deman Service	Gold Line	Metrolink	Hybrid Rail	Express Train	Bus Rapid Transit	LRT	Express Bus
Alternative	7	3G	3E	4B	5C	8D	2	9B
Local/Regional LRT	✓	✓					✓	✓
Commuter Rail	✓		✓	✓	✓			
Local/Regional Hybrid Rail	✓			✓				✓
BRT/Express Bus	✓					✓		✓

The initial alternatives combination went through revisions in two rounds of SRC/TWG workshops and Open Houses, and concurrence on the final build alternatives was received from TWG/SRC in early February, 2017. The recommended alternatives based on the initial screening are presented below (**Table 11** through **Table 13**, as documented in the Final Alternatives Definition Report, November 2017):

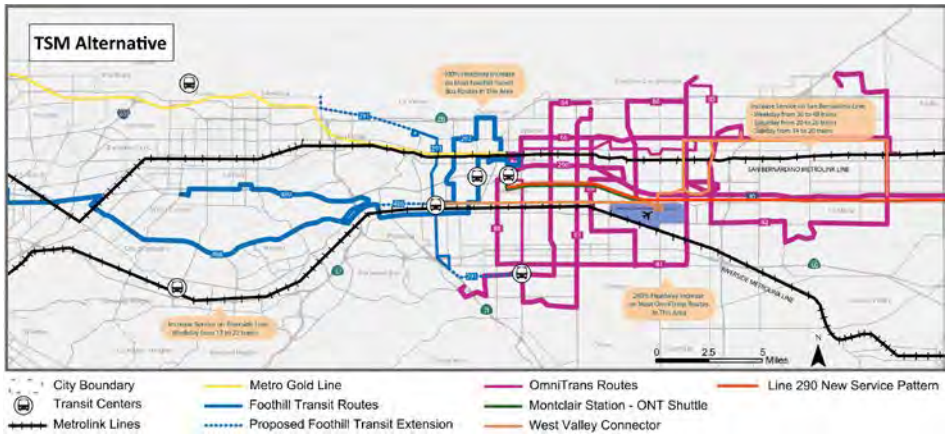
Alternatives Recommended for Step 2

Table 11: Revised No-Build Alternative

Alternative	Description
	The No Build Alternative for the 2040 condition will include the Gold Line extension to Montclair, the West Valley Connector operating with existing infrastructure and planned 3.5-mile alignments within Ontario (dedicated lane segment extends from Holt/Benson to Holt/San Antonio and from Holt/Euclid to Holt/Vineyard), and everything in the SCAG RTP/SCS Financially Constrained Plan, except: • Metrolink service improvements • BRT on Haven Avenue • BRT on Euclid Avenue • Rail/Bus to ONT • Transit Projects in the study area Additional operating details include:

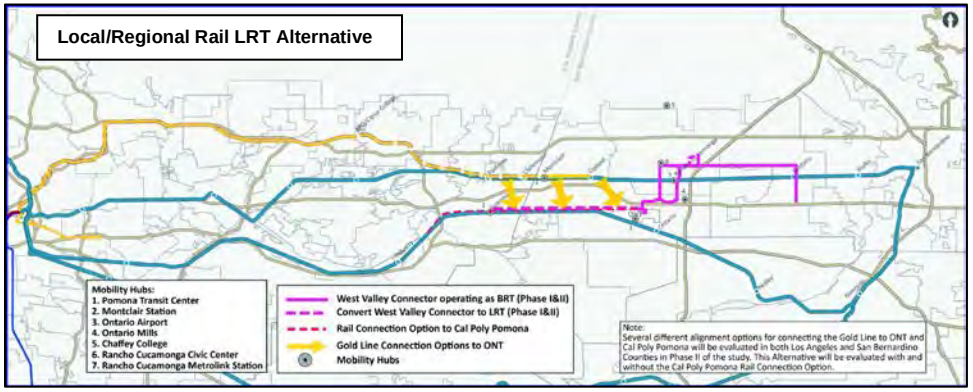
Alternative Service		# of Stations	Distance	Average Speed	Peak Headways	Off-Peak Headways
WVC BRT	Phase I	20	17.49	20.40	10	25

Table 12: Revised TSM Alternative

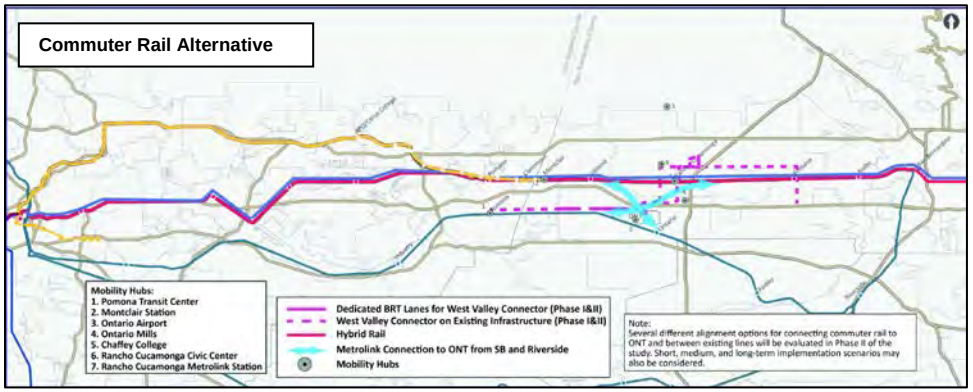
Alternative	Description
	The TSM Alternative would: • Improve north-south bus service headways on several OmniTrans and Foothill Transit Routes as shown in the table (currently, OmniTrans Route 81 has 30-minute headway service on weekdays north of Foothill Boulevard, and OmniTrans Route 82 does not serve the Milliken Avenue corridor on weekends.) • Extend Foothill Transit Route 291 south/east to Chino Transit Center and north/west to Glendora • Extend Foothill Transit Route 486 east to Pomona • Increase service headways on Omnitrans Route 290 to 20 minutes during peak periods and 60 minutes during non-peak periods • Increase service headways on Omnitrans Route 66 to 10 minutes for the portion that is unduplicated with the West Valley Connector on the weekdays and to 20 minute headways for the entire route on the weekends • Increase the number of scheduled trains on the San Bernardino Line (per the Metrolink Strategic Plan) from 38 to 48 trains on weekdays, from 20 to 26 trains on Saturdays, and from 14 to 20 trains on Sundays. • Increase service on Riverside Line from 12 trains per weekday to 22 trains per weekday per the Metrolink Strategic Plan • Provide access to ONT via West Valley Connector service • Provide shuttle service between Montclair Station and ONT • Includes Line 290's new service pattern • The shuttle from Montclair to ONT would operate in tandem, with the shuttle providing off-peak service to supplement Line 290 Additional operating details include:

Alternative Service		# of Stations	Distance	Average Speed	Peak Headways	Off-Peak Headways
WVC BRT	Phase I	20	17.49	20.40	10	25
	Phase II	17	16.48	20.00	10	25
Line 290	Original Service	4	30.40	34.42	30	N/A
	New Service to ONT	4	30.60	34.64	30	N/A
Montclair-ONT Shuttle		2	7.63	38.12	N/A	30

Table 13: Final Draft of Combination Build Alternatives

Alternative	Description
	The Local/Regional Light Rail Alternative includes Mobility Hubs, Gold Line, and BRT. In this Alternative: • Gold Line would be extended from Montclair to connect to ONT. Connection to ONT would be either along Cucamonga Creek or through an arterial LRT connection down to the Holt Corridor • Extending Rail Service to Cal Poly Pomona is an option of this alternative • The West Valley Connector would be converted from BRT to LRT along Holt Avenue between Downtown Pomona and ONT to improve service • Several different alternatives to connect Gold Line from Montclair to ONT will be studied in the next phase of the alternatives analysis, which would include alternative alignments in L.A. County as well as San Bernardino County • Mobility Hubs with bike share/car share/shuttle service and on-demand services would also be integrated at key activity centers (including ONT, Ontario Mills, Pomona Transit Center, Rancho Cucamonga Civic Center, Montclair Station, and Chaffey College) to feed into east-west fixed transit service and serve poly-centric trips Additional operating details include:

Alternative Service		# of Stations	Distance	Average Speed	Peak Headways	Off-Peak Headways
WVC LRT		9	9.78	23.83	10	20
Gold Line to ONT	Opt. 1 (L.A.)	5	9.95	22.68	6	12
	Opt. 2 (S.B.)	4	7.20	40.70	6	12
Cal Poly Pomona Connection		3	14.09	26.49	10	20

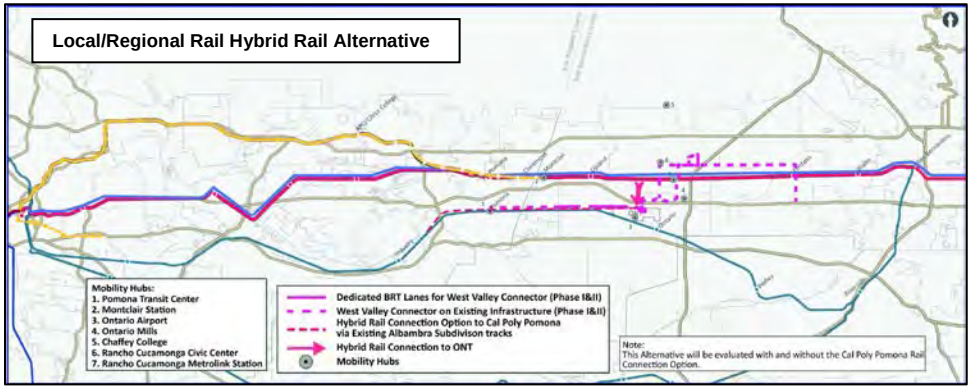


The Commuter Rail Alternative includes Mobility Hubs, Metrolink, Hybrid Rail, and BRT. In this Alternative:

- Regional Rail shuttle service would run between Rancho Cucamonga Metrolink Station and ONT with timed transfers and continue on to connect with the Riverside Line
- The Riverside Line would be re-routed to connect to the new station at the north side of ONT
- A new connection would be established along the San Bernardino Line to ONT
- Trains could cross between the San Bernardino and Riverside Lines
- Hybrid Rail would run along with Metrolink on the San Bernardino Line and use the same tracks, providing more frequent, flexible and less costly service along the San Bernardino Line
- Mobility Hubs with bike share/car share/shuttle service and on-demand services would also be integrated at key activity centers (including ONT, Ontario Mills, Pomona Transit Center, Rancho Cucamonga Civic Center, Montclair Station, and Chaffey College) to feed into east-west fixed transit service and serve poly-centric trips

Additional operating details include:

Alternative Service			# of Stations	Distance	Average Speed	Peak Headways	Off-Peak Headways
WVC BRT	Phase I		20	17.49	20.40	10	25
	Phase II		17	16.48	20.00	10	25
Metrolink Phase I	Commuter Rail	SB Express	6	64.10	43.10	30	60
		SB Local	14	56.20	38.32	30	60
		Riverside	8	58.60	42.36	30	60
	Hybrid Rail	Redlands	9	29.36	35.91	30	60
		SB - ONT	3	5.93	23.38	15	30
Metrolink Phase II	Commuter Rail	SB Express	6	64.10	43.10	30	60
		Riverside	9	59.55	41.16	30	60
	Hybrid Rail	SB Local	15	58.34	33.08	30	60
		Redlands	11	40.17	35.21	15	30
		ONT Express	2	42.08	45.11	30	60

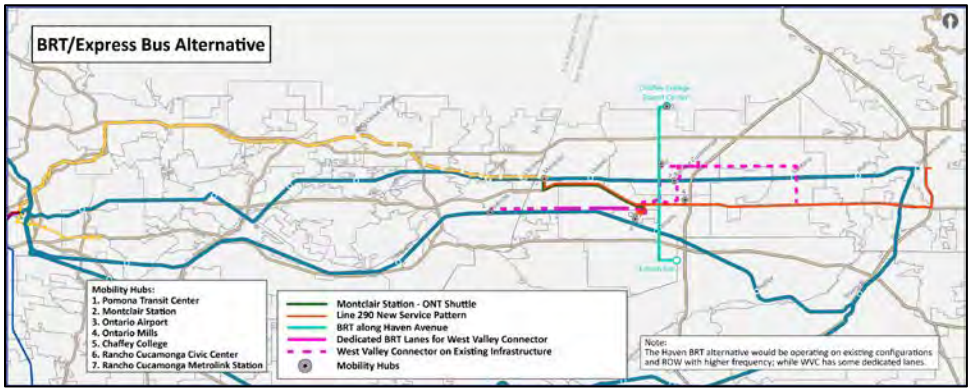


The Local/Regional Hybrid Rail Alternative includes Mobility Hubs, Hybrid Rail, and BRT. In this Alternative:

- Hybrid Rail would provide more frequent, flexible and less costly service along the San Bernardino Line by running along the Metrolink tracks, connecting to ONT from either Deer Creek or Cucamonga Creek, and could also include "T" junctions so both eastbound and westbound connections are possible
- Extending Hybrid Rail from ONT to Cal Poly Pomona via existing Alhambra Subdivision tracks is an option of this alternative
- Mobility Hubs with bike share/car share/shuttle service and on-demand services would also be integrated at key activity centers (including ONT, Ontario Mills, Pomona Transit Center, Rancho Cucamonga Civic Center, Montclair Station, and Chaffey College) to feed into east-west fixed transit service and serve poly-centric trips

Additional operating details include:

Alternative Service		# of Stations	Distance	Average Speed	Peak Headways	Off-Peak Headways
WVC BRT	Phase I	20	17.49	20.40	10	25
	Phase II	17	16.48	20.00	10	25
Cal Poly Pomona	Hybrid Rail	3	14.09	36.78	10	20
Hybrid Rail	Metrolink SB Alignment	14	56.20	34.49	30	60
	ONT Connection	15	58.34	44.55	30	60



The BRT/Express Bus Alternative includes Mobility Hubs and BRT. In this Alternative:

- Provide access to ONT via West Valley Connector service
- Provide shuttle service between Montclair Station and ONT
- Include Line 290 will be re-toured to serve ONT
- The shuttle from Montclair to ONT would operate in tandem, with the shuttle providing off-peak service to supplement Line 290
- The Haven BRT Alignment is a north/south BRT route with a northern terminal station at the park-and-ride lot at Chaffey College Transit Center north of Interstate 210. The 10.4 mile corridor has 9 stations, 3 park-and-rides lots and two connections to Metrolink lines
- Mobility Hubs with bike share/car share/shuttle service and on-demand services would also be integrated at key activity centers (including ONT, Ontario Mills, Pomona Transit Center, Rancho Cucamonga Civic Center, Montclair Station, and Chaffey College) to feed into east-west fixed transit service and serve poly-centric trips

Additional operating details include:

Alternative Service		# of Stations	Distance	Average Speed	Peak Headways	Off-Peak Headways
WVC BRT	Phase I	20	17.49	20.40	10	25
	Phase II	17	16.48	20.00	10	25
Haven BRT		11	11.35	20.39	10	15
Line 290	Original Service	4	30.40	34.42	30	N/A
	New Service	4	30.60	34.64	30	N/A
Montclair-ONT Shuttle		2	7.63	38.12	N/A	30

Final Screening Results Summary

This section provides a summary of the technical analyses performed during the second phase of the study (including Facility and Capacity Analysis, Cost Estimating, Ridership Forecasting, Benefit Cost Analysis, and Economic Impact Analysis), describes the complete set of the six final alternatives that were refined with inputs from the technical analyses, and presents the results of the final screening.

Technical Analyses for Final Screening

Facility and Capacity Analysis

The Facility and Capacity Analysis is aimed at measuring infrastructure facility impacts related to existing properties, traffic conditions, and the environment, as well as the ability for the existing and planned infrastructure to accommodate the proposed service improvements. The four main analyses include:

Facility Right-of-Way (ROW) Impacts Analysis provides a high level evaluation of the anticipated right-of-way impacts of the proposed new infrastructure.

Facility Traffic Analysis estimates the quantity of new potential at-grade crossings and closed streets associated with the different alternatives.

Facility Environmental Screening Analysis involves a high level qualitative discussion of potential noise and vibration impacts and ROW acquisition that would result from the build alternatives.

Infrastructure Capacity Analysis determines the capacity of the existing and new infrastructure identified in this study to accommodate the proposed operating plans.

Ridership Forecasting

For Ridership Forecasting, average weekday travel demand and ridership for each alternative were evaluated using the Los Angeles County Metropolitan Transportation Authority (Metro)'s latest validated 2017 Long Range Transportation Plan (LRTP) Metro Travel Demand Model (TDM) model as well as the SCAG Ontario Air Passenger model based on the LAX Air Passenger Model (APM), with ONT APM incorporated into the Metro model. The results are presented using route-level and station-level boardings, as well as with system-wide metrics including new riders, VMT reduction, trips on project, and user benefits (total travel time savings).

Cost Estimating

The scope of Cost Estimating effort consists of Capital Cost estimate and Operations & Maintenance (O&M) Cost estimate:

The **Capital Cost** estimates include all construction costs, design costs through final design, environmental costs and all other professional services, and program costs necessary to develop and deliver the projects to revenue service.

The **O&M Cost** estimates include all standard operations, equipment, repair, fuel, and energy costs used in typical operations.

Benefit-Cost Analysis

The Benefit-Cost Analysis determines whether an alternative yields a positive return on investment and thus focuses on the net changes attributable to the project. The benefits are measured in terms of travel time and cost savings, safety, and emissions over a 20-year period. The sum of these benefits is compared to the costs (capital and operating) to determine the merit of the alternatives. The results are presented in Net Present Value (NPV, which compares the discounted stream of net benefits (benefits minus costs) present values using the real discount rate assumption) and Benefit Costs Ratio (BCR, which expresses the relation of discounted benefits to discounted costs).

Economic Impacts Analysis

The Economic Impact Analysis analyzed each alternative's impacts on economic factors, including impact to construction and O&M jobs, tax revenue, labor market accessibility, and housing affordability. The Construction/Operations Jobs Created estimates jobs and earnings effects resulting from construction and operation, which are quantified using the Bureau of Economic Analysis (BEA) Regional Input-Output Modeling System (RIMS II) 2015 multipliers. The Tax Revenue impacts are estimated through ROW acquisitions. A GIS analysis is performed to assess the Labor Market Accessibility change. The Housing Affordability analysis is modeled after The Center for Neighborhood Technology's Housing + Transportation (H+T) Affordability Index and identifies the Census Block Groups (CBG) that surround stations along the corridor and assessed the housing and transportation burden for households in those CBG's.

Additional cost-effectiveness metrics such as cost per capita, cost per boarding, cost per new passenger, and cost per passenger mile for both O&M and capital costs further augment the evaluation.

Alternatives for Final Screening

The recommended alternatives from the Initial Screening were further detailed and refined based on requirements from the technical analyses described above, as well as input from the TWG. The finalized Alternatives for Final Screening include:

- **No Build Alternative (NB Alt.)**: Includes the Gold Line extension to Montclair, the West Valley Connector (WVC) Phase 1 operating with existing infrastructure and planned 3.5-mile bus lane alignments within Ontario (dedicated lane segments extend from Holt/Benson to Holt/San Antonio and from Holt/Euclid to Holt/Vineyard), Redlands Passenger Rail Project between the San Bernardino Transit Center and the University of Redlands in Redlands, and everything in the 2016 SCAG Regional Transportation Plan/Sustainable Communities Strategy (RTP/SCS) Financially Constrained Plan, except Metrolink service improvements, BRT on Haven Avenue, BRT on Euclid Avenue, rail/bus to ONT, and transit projects in the study area. (See **Figure 13**)
- **Transportation Systems Management Alternative (TSM Alt.):** Increases Commuter Rail, BRT, and Municipal Bus operations, and double tracking projects along the Metrolink San Bernardino Line to accommodate the service enhancements. The same double-tracking segments as in the Commuter Rail Phase 2. (See **Figure 14)**
- **Light Rail Alternative (LRT Alt.) Arterial Option:** LRT extension of the Metro Gold Line to Ontario International Airport (ONT) along an arterial alignment and conversion of the West Valley Connector BRT Phase 1 to LRT along Holt Avenue and Holt Boulevard (Holt Corridor) between downtown Pomona and ONT. Indian Hill Boulevard and the Holt Corridor were chosen as representative street-running alignments for technical analyses purposes only. The actual alignment selection requires further study to evaluate connecting LRT between the Holt Corridor, Metro Gold Line, Metrolink, and ONT. This alternative includes seven Mobility Hubs (including ONT, Ontario Mills, Pomona Transit Center, Rancho Cucamonga Civic Center, Rancho Cucamonga Metrolink Station, Montclair Metrolink Station, and Chaffey College) that are

integrated with bike share, car share, shuttle service, and on-demand services. This alternative also includes LRT to Cal Poly Pomona as an optional connection. (See **Figure 15)**

- **Light Rail Alternative (LRT Alt.) Cucamonga Creek Option:** LRT extension of the Metro Gold Line to ONT along the Metrolink San Bernardino ROW east of Montclair and running adjacent to Cucamonga Creek and conversion of the West Valley Connector BRT Phase 1 to LRT along Holt Avenue and Holt Boulevard (Holt Corridor) between Downtown Pomona and ONT. The segment adjacent to Cucamonga Creek was chosen as a representative off-street alignment for technical analyses purposes only. The actual alignment selection requires further study to evaluate connecting LRT between the Holt Corridor, Metro Gold Line, Metrolink, and ONT. This alternative also includes seven Mobility Hubs as described above. This alternative also includes LRT to Cal Poly Pomona as an optional connection. (See **Figure 16**)
- **Commuter Rail Alternative (Commuter Rail Alt.) Phase 1:** Increased commuter rail service on the Metrolink San Bernardino Line, double-tracking projects along the San Bernardino Line to accommodate the service increases, a commuter rail shuttle connecting Rancho Cucamonga to ONT, a new hybrid rail line connecting downtown Ontario to the University of Redlands, and a new station on the Metrolink Riverside Line in Downtown Ontario. This alternative includes seven Mobility Hubs as described above. (See **Figure 17)**
- **Commuter Rail Alternative (Commuter Rail Alt.) Phase 2:** All projects in the Commuter Rail Alternative Phase 1, additional service enhancements to the Metrolink San Bernardino Line, converting existing Metrolink commuter rail to hybrid rail service, additional double-tracking projects to accommodate the service enhancements, a spur on the San Bernardino Line to connect to ONT, an extension of the Ontario-Redlands line west to the City of Industry, and a re-routing of the Metrolink Riverside Line via ONT. This alternative includes seven Mobility Hubs as described above. (See **Figure 18**)
- **Hybrid Rail Alternative (Hybrid Rail Alt.)[9]:** Hybrid rail service added to the existing Metrolink San Bernardino Line, double-tracking projects to accommodate the service enhancements (the same double-tracking segments as in the Commuter Rail Alternative Phase 2), and a spur off the San Bernardino Line to connect to ONT. This alternative also includes Hybrid Rail to Cal Poly Pomona as an optional connection. This alternative also includes seven Mobility Hubs as described above. (See **Figure 19**)
- **Bus Rapid Transit/Express Bus Alternative (BRT Alt.):** New express bus shuttle service between Montclair Gold Line station and ONT, rerouted OmniTrans express service between Montclair Gold Line station and Downtown San Bernardino connecting ONT, and new Haven Avenue BRT between Chaffey College and Edison Avenue. This alternative also includes seven Mobility Hubs as described above. (See **Figure 20**)

[9] Following the completion of the facility and capacity analysis for this study, SBCTA and L.A. Metro completed a Metrolink San Bernardino Line Hybrid Rail Study. This Hybrid Rail Study further refines the concept of using hybrid rail on Metrolink tracks, similar to the Hybrid Rail Alternative evaluated in this study. The capacity analysis included in the Hybrid Rail study may be useful as a reference to this study, but the findings of the two reports are not comparable. The SCAG study includes the double tracking segments from Metrolink's SCORE proposal, which are necessary to accommodate the proposed 15-minute headways service plan in the Hybrid Rail Alternative. The Hybrid Rail Study makes different assumptions about service levels and double tracking needs for 30-minute headways than what is assumed in this study. The Metro/SBCTA Hybrid Rail Study results were not available in time to inform the analysis conducted for the SCAG study. More detailed information is available in Agenda Item 14 of the SBCTA Board of Directors meeting of June 6, 2018, available at: http://www.gosbcta.com/about-sbcta/agendas/2018/06-18-board.pdf

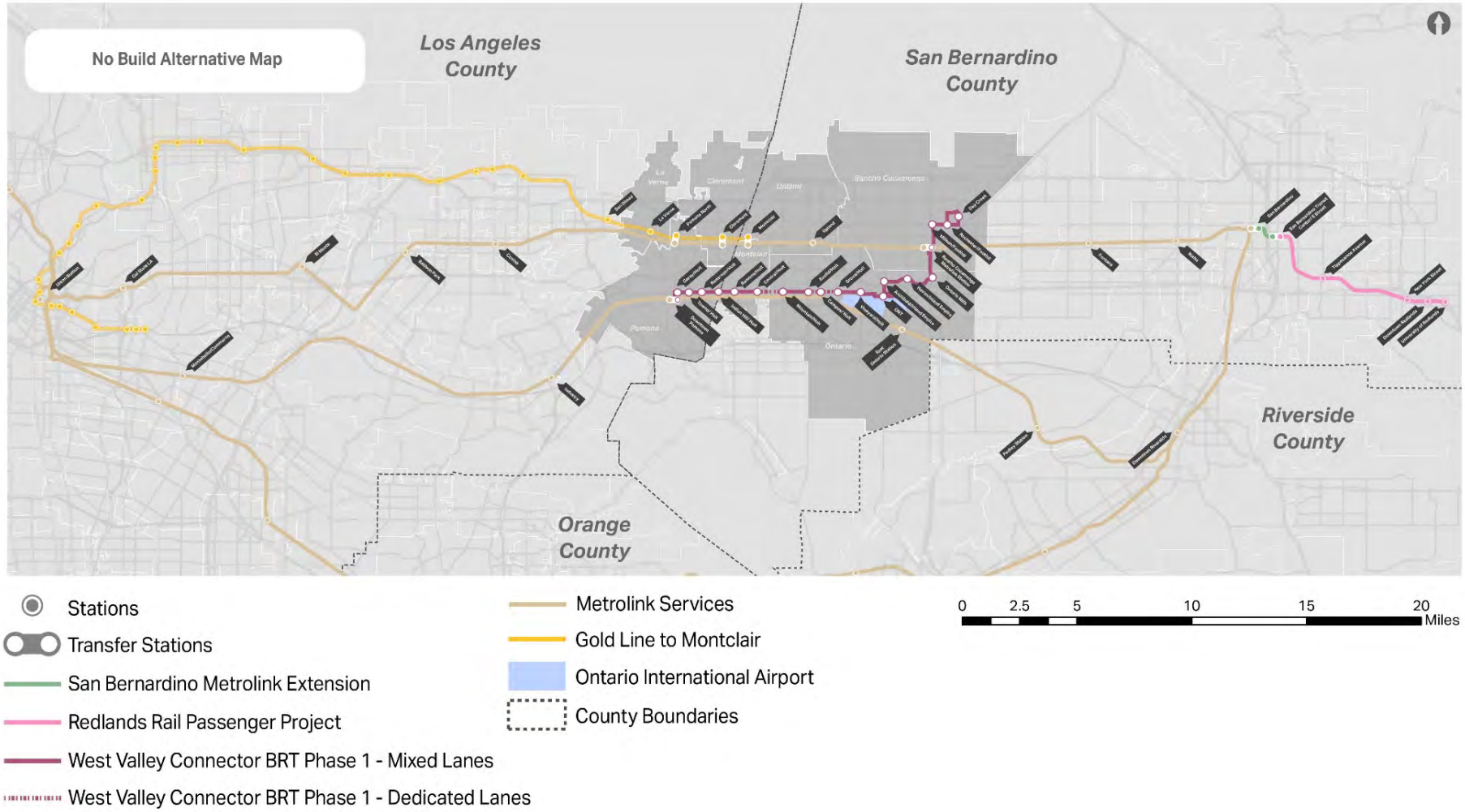


Figure 13 No Build Alternative

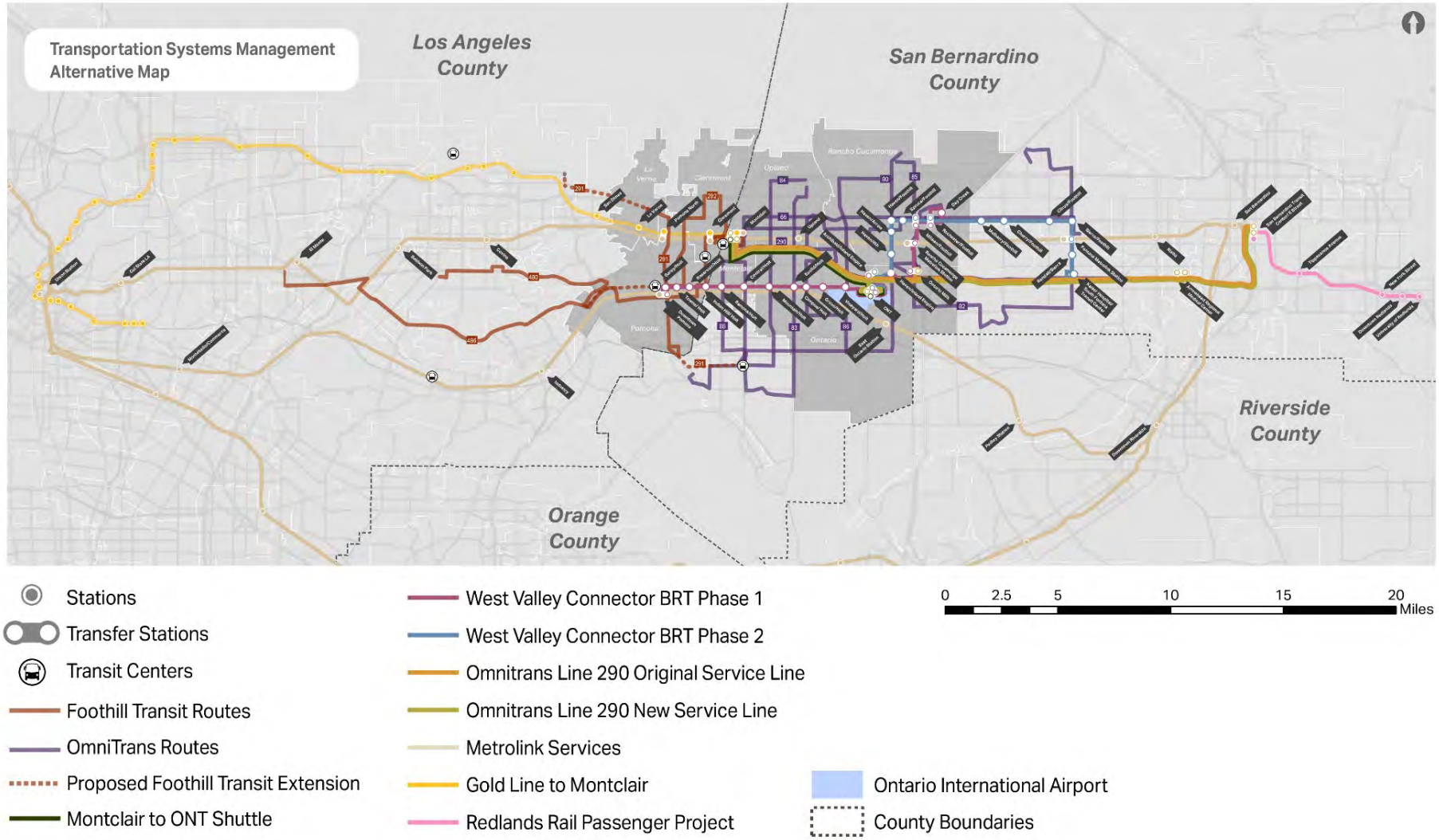


Figure 14 TSM Alternative

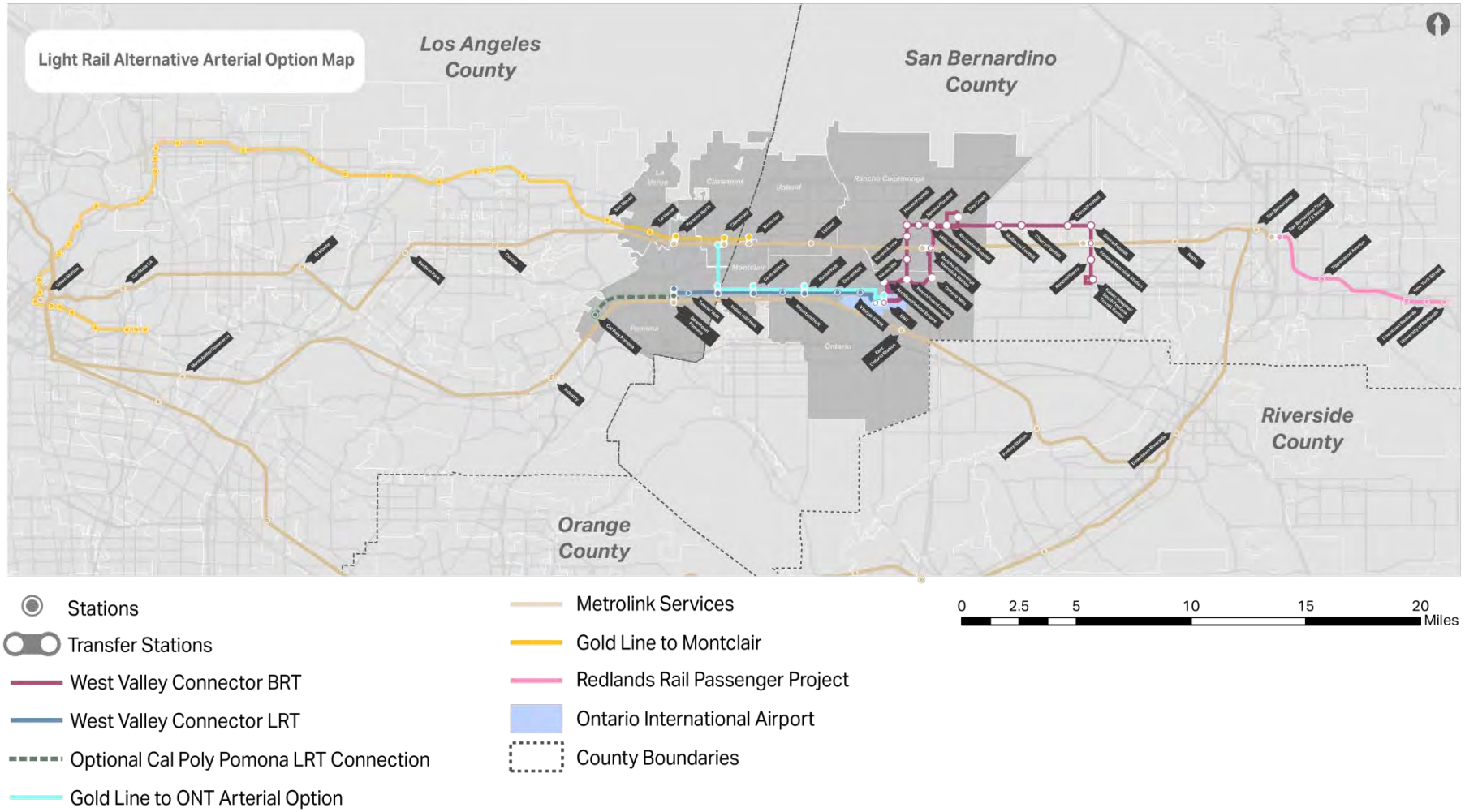


Figure 15 LRT Alternative Arterial Option[10]

[10] Indian Hill Boulevard and Holt Boulevard were assumed as example street-running alignments for technical analyses purposes only; the actual alignment selection requires further study.

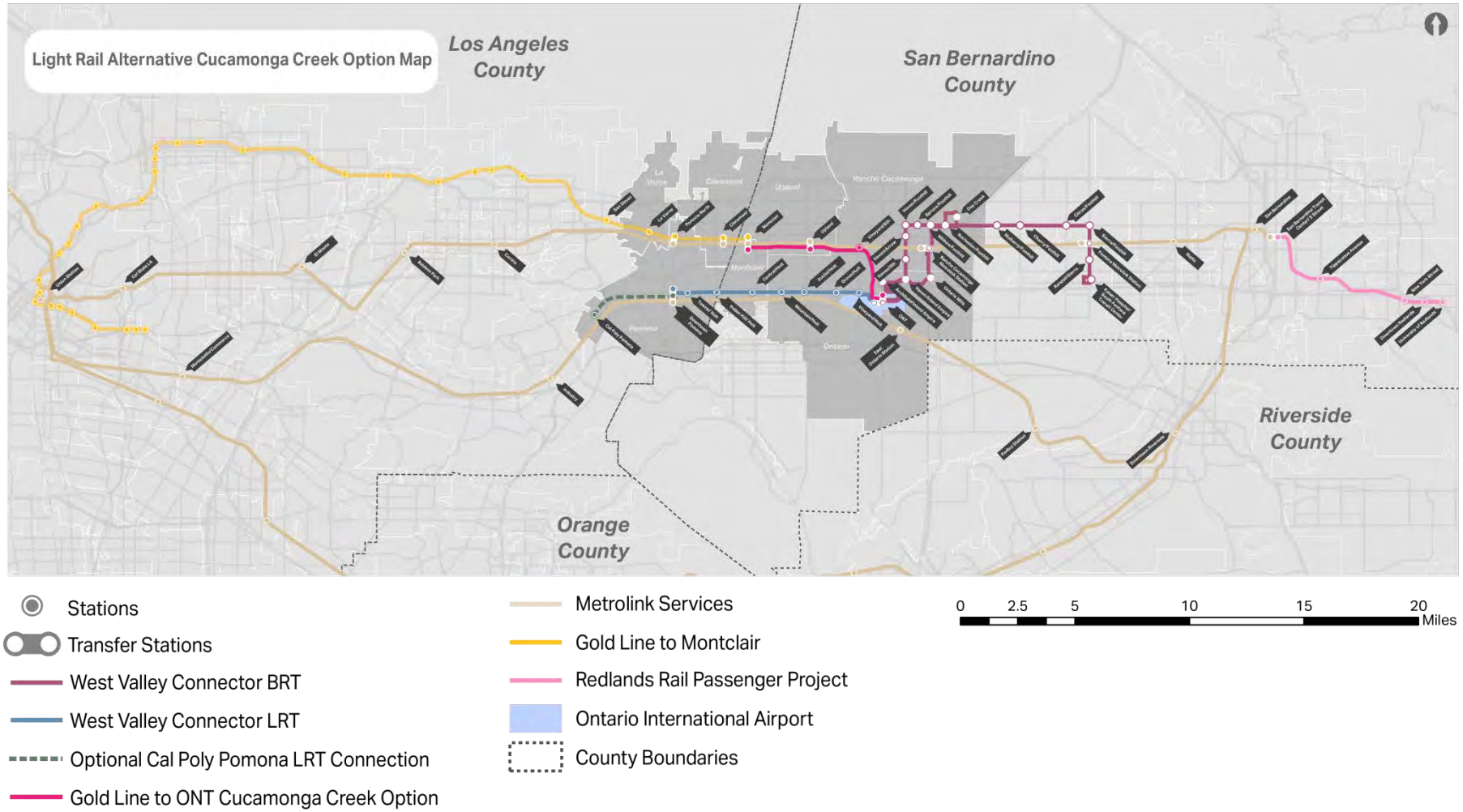


Figure 16 LRT Alternative Cucamonga Creek Option[11]

[11] Cucamonga Creek was assumed as an example off-street alignment for technical analyses purposes only; the actual alignment selection requires further study.

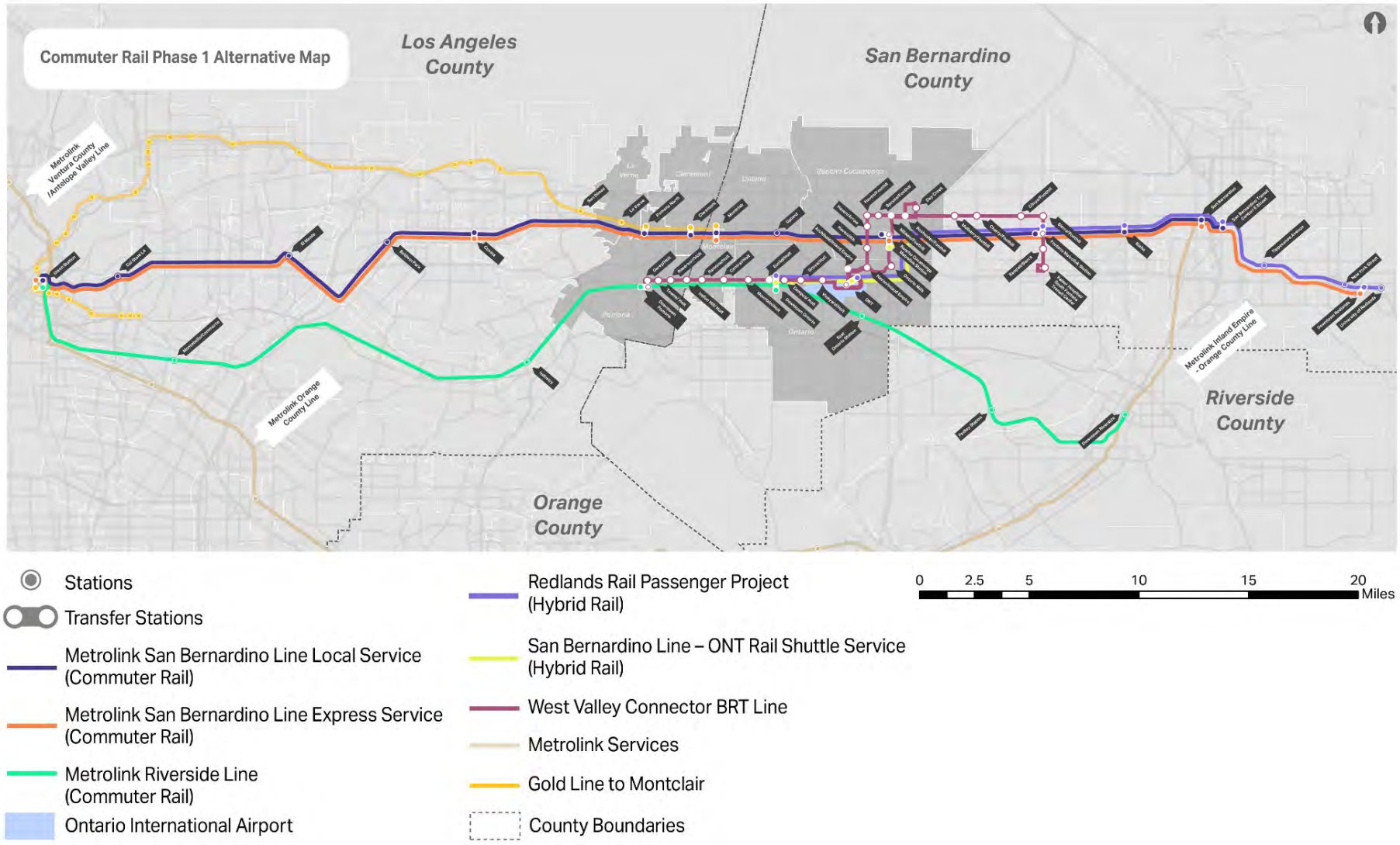


Figure 17 Commuter Rail Alternative Phase 1

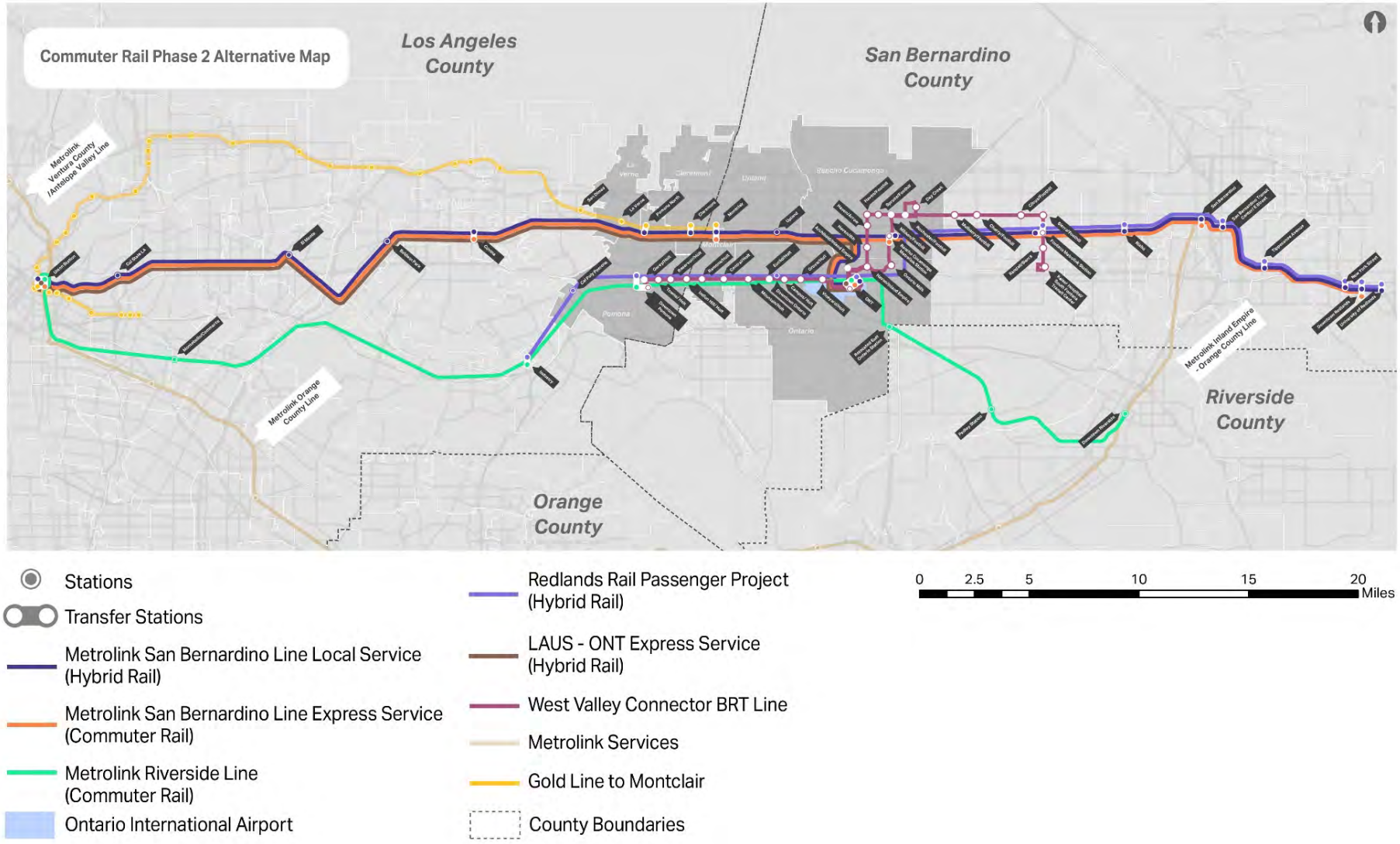


Figure 18 Commuter Rail Alternative Phase 2

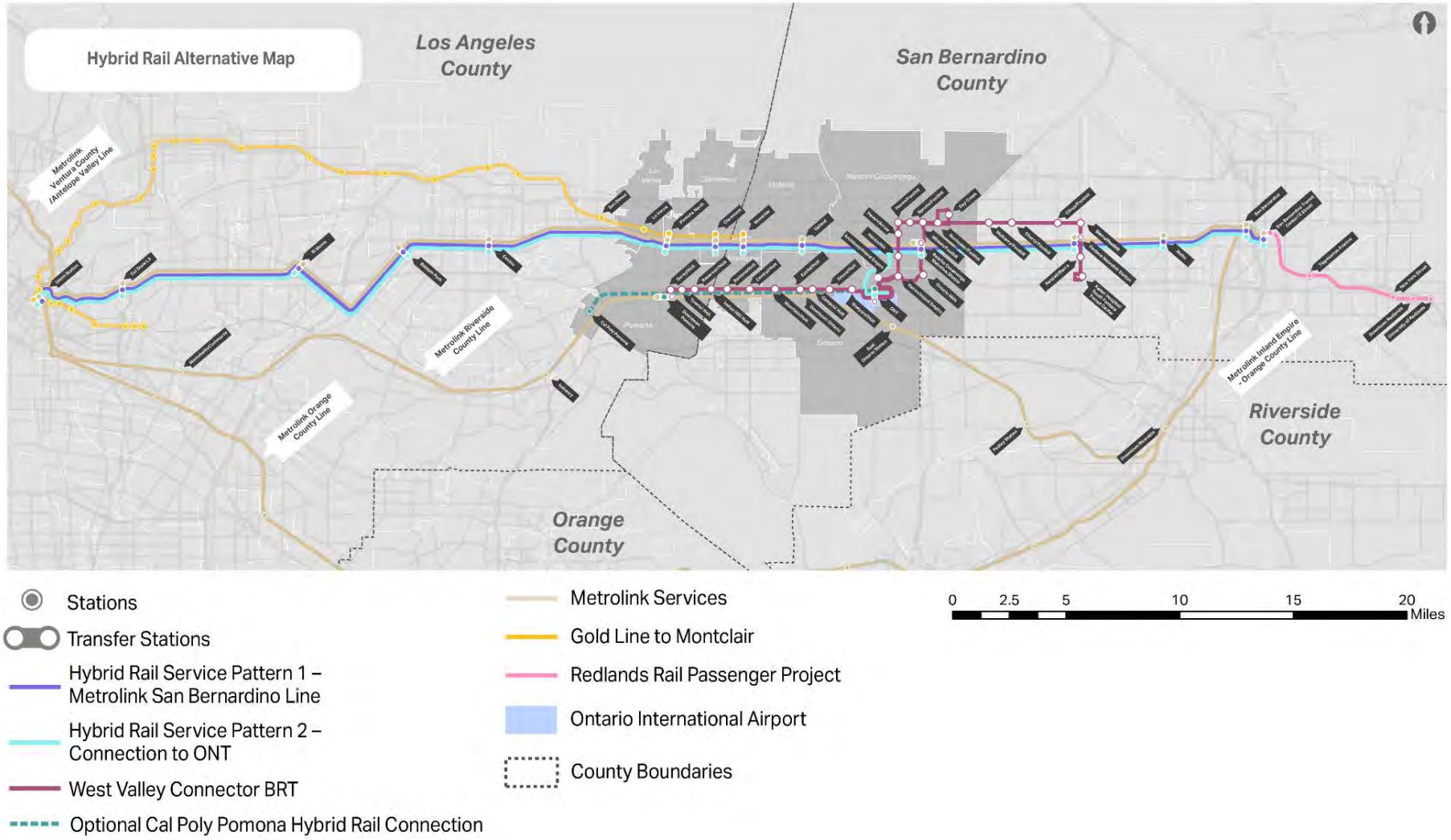


Figure 19 Hybrid Rail Alternative

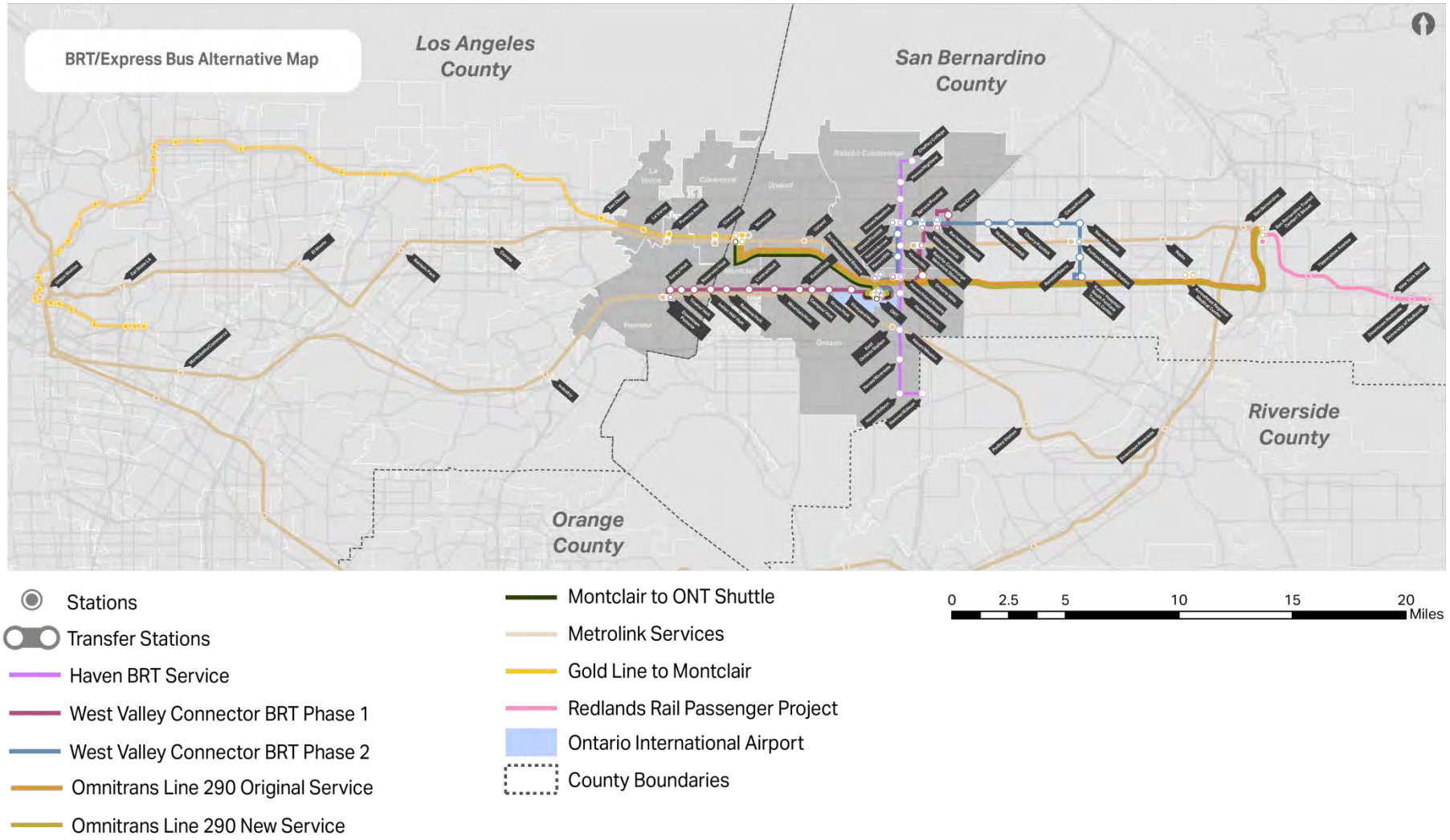


Figure 20 BRT/Express Bus Alternative

Final Screening Results

This section provides a summary of the results by alternative. Raw results from each evaluation criteria are presented to enable comparisons of the raw performance of each alternative (without normalization or conversion). Additionally, similar to the Initial Screening, the Final Screening deployed a Scoring Methodology to make the results of different measures more comparable and comprehensible. Depending on the value and nature of the different measures, the results for each goal are first transformed into percentages using the most appropriate methods from the following:

- Direct Conversion: for objectives that are measured in percentages (for example the objective “impacts on economic factors, including impact to construction and O&M jobs, tax revenue, labor market accessibility, and housing affordability” of Goal 4), the percentages are used directly with no normalization or conversion.
- Value/Range: for objectives that show more positive impacts if the numbers are greater in value (such as objectives that use inputs from ridership forecasting results), the value of each alternative is compared to the No Build Alternative, and then divided by the range of all alternatives’ values relative to the No Build Alternative to obtain a percentage of individual objective.
- 1-Value/Range: for objectives that show more negative impacts if the numbers are greater in value (such as objectives that use inputs from cost estimating results), the value of each alternative is compared to the No Build Alternative, then divided by the range of all alternatives’ values relative to the No Build Alternative to obtain a percentage, and the remainder of this percentage number from 100% is used for the individual objective.
- Value Difference/Range of Build Alternatives: for objectives that do not show enough deviation of raw results for different alternatives (and thus the alternatives cannot be differentiated against each other in terms performance), the value difference between the result of one alternative and that of the low-performing alternative is compared to the value range of all alternatives (the highest value minus the lowest value of all alternatives) for that metric to get a percentage for the individual objective.
- Average of Percentage Value/Range of Metrics: for objectives that have multiple technical metrics (for example the objective “enhance first/last mile connectivity to transit stations and stops” of Goal 1), the percentage value of each metric is calculated independently using one of the methods above as applicable, and then averaged into a percentage value for the individual objective.

The percentages are then multiplied by 10 to translate into a score between 0 and 10 (with 10 representing the best and 0 being the worst). For each alternative, the scores of all measures under one goal are averaged to get to a goal score; and the average score of the five goals is the final score for that alternative. For each study goal, detailed scores and rankings are presented in **Table 14** through **Table 23**.

Goal 1: Enhance Connectivity and Accessibility

Goal 1 evaluated the ability of alternatives to enhance connectivity and accessibility through the alignment of transit infrastructure with future travel patterns, the ability to connect current and potential trip origins and destinations and serve existing and proposed activity centers and trip generators, as well as the enhancement of first/last mile connectivity to transit stations and stops. The results for each objective in this goal are presented in **Table 14**, and the ranking of the alternatives is as shown in **Table 15**.

Table 14 Final Screening Results for Goal 1 Objectives by Alternative

GOAL 1: Enhance Connectivity and Accessibility										
Objective	**Criteria**	**Performance Measure**	**No Build**	**TSM**	**LRT Arterial**	**LRT Cucamonga Creek**	**Commuter Rail Phase 1**	**Commuter Rail Phase 2**	**Hybrid Rail**	**BRT**
Align transit infrastructure with travel patterns	Number of trips served by project	Trips on Project (direct model outputs)	0	6,000	45,500	62,300	5,900	10,900	3,800	9,300
Maximize ability to connect current and potential trip origins and destinations and serve existing and proposed activity centers and trip generators	Frequency and availability of service from origins to destinations	Service span (time of day) and headways	19	19	19	19	16	17	17	17
			37	19	9	9	20	21	18	18
	User Benefits	Number of hours saved annually in travel time compared to No Build	0	8,600	32,800	37,600	13,100	14,200	10,700	7,300
Enhance first/last mile connectivity to transit stations and stops	Availability of active transportation infrastructure adjacent to existing and planned transit stops/stations	Percentage of transit stations/stops served by existing and planned active transportation infrastructure as compared with existing conditions	0	8%	9%	9%	9%	9%	8%	15%
	Use of shared vehicle or on-demand vehicle options to access existing and planned transit stations/stops	# of stations that are located within convenient distance from mobility hubs	0	29	25	26	30	29	29	34
Provide convenient access to ONT	Number of people who use transit to go to ONT for flights	Air Passenger Boardings at ONT based on ridership model output	100	200	800	1,700	300	1,500	400	300
	Number of people who use transit to go to ONT (for reasons other than flights)	Non-Air Passenger Boardings at ONT based on ridership model output	700	2,100	12,800	20,100	1,600	3,500	1,500	1,100

Note: Numbers are rounded to the closest hundreds for presentation purposes.

The LRT Alternative Options have strong performance in Enhancing Connectivity and Accessibility through best aligning transit infrastructure with travel patterns and connecting trip origins and destinations, as well as providing connections to ONT. Commuter Rail Alternative Phase 2 has decent ridership and time savings, and performs especially well in bringing air passengers to ONT. While the BRT Alternative is relatively weak in generating time savings, it has more convenient stops and therefore does a relatively good job in enhancing first/last mile connection. The Commuter Rail Alternative Phase 1 and the Hybrid Rail Alternative perform relatively less well in this goal due to their service nature – these services tend to be more utilized for regional trips and have relatively shorter service spans and longer headways. The trips on project and potential time savings are also lower compared to the other alternatives.

Table 15 Ranking of Alternatives for Goal 1

No.	Alternative	Score
1	LRT Alt. Cucamonga Creek Opt.	8.02
2	LRT Alt. Arterial Opt.	5.95
3	Commuter Rail Alt. Phase 2	4.26
4	BRT/Express Bus Alt.	4.13
5	TSM Alt.	3.14
6	Commuter Rail Alt. Phase 1	2.96
7	Hybrid Rail Alt.	2.86

Goal 2: Provide Cost Effective Transit & Rail Services

Goal 2 evaluated the ability of the alternatives to provide cost effective transit and rail services through optimizing costs, allowing for efficient implementation and long-term scalability, maximizing use of existing infrastructure, increasing transit productivity, and infrastructure residual benefits. The results for each objective in this goal are presented in **Table 16**, and the ranking of the alternatives is as shown in **Table 17**.

Table 16 Final Screening Results for Goal 2 Objectives by Alternative

GOAL 2: Provide Cost Effective Transit and Rail Services										
Objective	**Criteria**	**Performance Measure**	**No Build**	**TSM**	**LRT Arterial**	**LRT Cucamonga Creek**	**Commuter Rail Phase 1**	**Commuter Rail Phase 2**	**Hybrid Rail**	**BRT**
Optimize capital and operating costs[12]	Capital cost per trip	Estimated capital costs per trip	0	$2,190	$2,440	$3,420	$1,850	$4,770	$3,140	$350
	Operating cost per trip	Estimated operating costs per trip	0	$90	$110	$50	$150	$140	$120	$30
	Capital cost of each alternative	Capital cost of each alternative (billions of 2017$)	0	$2	$2	$3	$1	$4	$2	$0
	O&M cost of each alternative	Annual O&M cost of each alternative (millions of 2017$)	0	$70	$90	$40	$120	$110	$90	$20
Allow for efficient implementation and long-term scalability	Implementation timeframe for various stages of improvements	Scalability for future adjustments and longer-term improvements. Scores assigned based on the following nature of the alternatives: 1. Ability to be phased based on the number of service components 2. Potential in future expansion 3. Type of service improvements needed (new tracks, platform upgrades, fleet upgrades, etc.)	0	5	2	1	3	5	1	1

[12] Note: Following the completion of the facility and capacity analysis for this study, SBCTA and L.A. Metro completed a Metrolink San Bernardino Line Hybrid Rail Study. This Hybrid Rail Study further refines the concept of using hybrid rail on Metrolink tracks, similar to the Hybrid Rail Alternative evaluated in this study. The capacity analysis included in the Hybrid Rail study may be useful as a reference to this study, but the findings of the two reports are not comparable. The SCAG study includes the double tracking segments from Metrolink's SCORE proposal, which are necessary to accommodate the proposed 15-minute headways service plan in the Hybrid Rail Alternative. The Hybrid Rail Study makes different assumptions about service levels and double tracking needs for 30-minute headways than what is assumed in this study. The Metro/SBCTA Hybrid Rail Study results were not available in time to inform the analysis conducted for the SCAG study. More detailed information is available in Agenda Item 14 of the SBCTA Board of Directors meeting of June 6, 2018, available at: http://www.gosbcta.com/about-sbcta/agendas/2018/06-18-board.pdf.

Objective	Criteria	Performance Measure	No Build	TSM	LRT Arterial	LRT Cucamonga Creek	Commuter Rail Phase 1	Commuter Rail Phase 2	Hybrid Rail	BRT
Maximize use of existing infrastructure (rail)	Increased ridership on existing infrastructure	Number of additional passengers at existing stations in each alternative	0	230,500	264,100	268,100	234,400	233,100	234,900	231,300
Maximize use of existing infrastructure (roadway)	Increased roadway capacity for vehicles	Number of vehicles removed from roadway	0	-5,300	-21,000	-26,400	-9,800	-11,600	-7,900	-5,300
Increase transit productivity	Travel cost reduction	Reduction in general cost of the same trip	0	$60	$920	$1,290	$350	$280	$180	$100
	Number of transit boardings	Total ridership increase from NB	0	19,700	67,300	83,700	26,300	32,700	19,200	15,000
Residual Benefits	Non-user benefits	Infrastructure elements/assets may have a useful life beyond the analysis period, translating to residual benefits (over the analysis period in millions of 2017$)	0	$270	$270	$400	$200	$570	$380	$40

Note: Numbers for certain metrics are rounded to the closest tens or hundreds for presentation.

The LRT Alternative Options perform best in Providing Cost Effective Transit & Rail Services as they have the highest ridership increase from the No Build and the greatest travel cost reduction. They also attract the most additional riders at existing rail stations, as well as remove the most vehicles from the roadway. The Commuter Rail Alternative Phase 2 has the largest residual benefits and when compared to the other rail alternatives it is more scalable and cheaper to operate and maintain when built out, despite having higher capital costs. The BRT/Express Bus Alternative is the most affordable alternative to build and operate, but has less benefits in attracting ridership and reducing overall travel costs. The Hybrid Rail Alternative performs weaker in maximizing use of existing infrastructure or allowing for long-term scalability, however, the double-tracking improvements bring high residual benefits that extend beyond the analysis period.

Table 17 Ranking of Alternatives for Goal 2

No.	Alternative	Score
1	LRT Alt. Cucamonga Creek Opt.	6.87
2	LRT Alt. Arterial Opt.	5.69
3	Commuter Rail Alt. Phase 2	4.51
4	BRT/Express Bus Alt.	4.00
5	TSM Alt.	3.31
6	Commuter Rail Alt. Phase 1	3.30
7	Hybrid Rail Alt.	2.93

Goal 3: Promote Sustainable Transportation

Goal 3 evaluated the ability of the alternatives to promote sustainable transportation through reducing VMT and greenhouse gas emissions, reducing automobile dependence, as well as improving safety and congestion. The results for each objective in this goal are presented in **Table 18**, and the ranking of the alternatives is as shown in **Table 19**.

Table 18 Final Screening Results for Goal 3 Objectives by Alternative

GOAL 3: Promote Sustainable Transportation										
Objective	**Criteria**	**Performance Measure**	**No Build**	**TSM**	**LRT Arterial**	**LRT Cucamonga Creek**	**Commuter Rail Phase 1**	**Commuter Rail Phase 2**	**Hybrid Rail**	**BRT**
Reduce vehicle miles traveled and greenhouse gas emissions	Reduction in VMT	Total vehicle miles traveled based on travel demand model data.	0	-171,800	-1,061,200	-1,472,300	-629,700	-617,100	-392,500	-154,900
	Reduction in greenhouse gas emissions	Greenhouse gas emissions based on VMT using Environmental Protection Agency conversion factors. (CO2 Emission Savings over the analysis period in millions of 2017$)	0	$10	$90	$120	$50	$50	$30	$10
Reduce automobile dependence	Mode shift	Estimated split of travel between modes using modeling procedures	0%	35%	50%	51%	58%	52%	60%	52%
		Parking avoidance- # of parking spaces or trips avoided	0	6,900	33,600	42,900	15,200	17,100	11,500	7,800
Improve Safety	Accidents avoidance	Reduction of exposure to risks (Accident costs avoided over the analysis period in millions of 2017$)	0	$120	$750	$1,040	$440	$430	$280	$110
Improve congestion level for roadway users	Non-user benefits	Congestion Cost Savings (over the analysis period in millions of 2017$)	0	$60	$350	$490	$210	$210	$130	$50

Note: Numbers for certain metrics are rounded to the closest tens or hundreds for presentation.

The LRT Alternative Options score high in Promoting Sustainable Transportation, as they are projected to have the largest VMT reduction, which is related to substantial diversion from auto to transit (a safer, higher-capacity mode), which further translates to accident cost and congestion costs savings. This is followed by Commuter Rail Alternative Phase 1 and 2, which produce notable VMT and greenhouse gas (GHG) emissions reductions. Even though not ranking high at the goal level, it should be noted that the Hybrid Rail Alternative experiences the highest mode shift from auto to transit, greatly reducing automobile dependence. The BRT Alternative performs relatively weak compared to the rail alternatives for this goal.

Table 19 Ranking of Alternatives for Goal 3

No.	Alternative	Score
1	LRT Alt. Cucamonga Creek Opt.	9.19
2	LRT Alt. Arterial Opt.	6.94
3	Commuter Rail Alt. Phase 1	4.41
4	Commuter Rail Alt. Phase 2	4.33
5	Hybrid Rail Alt.	3.22
6	BRT/Express Bus Alt.	1.87
7	TSM Alt.	1.63

Goal 4: Support Transit-Oriented Development

Goal 4 evaluated the ability of the alternatives to support transit-oriented development, which is informed by the proposed alignment and level of investment for transit services. The adjusted number of new stations in each alternative based on frequency that are within the vicinity to transit-oriented development Opportunity Areas identified in the Initial Screening phase is utilized to evaluate the performance of alternatives for this goal. The results are presented in **Table 20**, and the ranking of the alternatives is as shown in **Table 21**.

Table 20 Final Screening Results for Goal 4 Objectives by Alternative

GOAL 4: Support Transit-Oriented Development										
Objective	**Criteria**	**Performance Measure**	**No Build**	**TSM**	**LRT Arterial**	**LRT Cucamonga Creek**	**Commuter Rail Phase 1**	**Commuter Rail Phase 2**	**Hybrid Rail**	**BRT**
Support adaptive re-use, transit-oriented development and smart growth policies	Level of enhancements and "permanence" of new transit	Total adjusted number of new stations, factoring in frequency of service and overlap with TOD opportunity areas. (refer to Page 23 for detailed calculation)	0	4.8	19.7	18.1	6.7	7.6	5.1	5.7

Several factors influence the extent to which transit investments may support transit-oriented development, including the quality of transit service, station permanence, existing context and land use conditions, and land use plans and zoning. The 2016 SCAG RTP/SCS defines transit-oriented development as planning that links land use and transportation around bus and rail stations (usually within ½ mile). In addition to transit-oriented development around rail stations, the Institute for Transportation & Development Policy's (ITDP) research report *More Development For Your Transit Dollar*[13], notes that BRT, as a lower cost mass transit solution, could also be used to leverage transit-oriented development investments. Several cities in the U.S. (for example, Cleveland and Pittsburgh) have already demonstrated the success of using BRT investments as a cost-effective way to stimulate economic development through government interventions and strategic planning for TOD sites. The report found that:

- Per dollar of transit investment, and under similar conditions, Bus Rapid Transit leverages more transit-oriented development investment than Light Rail Transit or streetcars.
- Both BRT and LRT can leverage many times more TOD investment than they cost.
- Government support for TOD is the strongest predictor of success.

[13]Institute for Transportation & Development Policy, *More Development for Your Transit Dollar*, 2013, accessed: https://3gozaa3xxbpb499ejp30lxc8-wpengine.netdna-ssl.com/wp-content/uploads/2013/11/More-Development-For-Your-Transit-Dollar_ITDP.pdf.

- The strength of the land market around the transit corridor is the secondary indicator of success.
- The quality of the transit investment –how well it meets the best-practices detailed in the BRT Standard—is the tertiary indicator of success.

Table 21 Ranking of Alternatives for Goal 4

No.	Alternative	Score
1	LRT Alt. Arterial Opt.	10.00
2	LRT Alt. Cucamonga Creek Opt.	9.19
3	Commuter Rail Alt. Phase 2	3.87
4	Commuter Rail Alt. Phase 1	3.39
5	BRT/Express Bus Alt.	2.90
6	Hybrid Rail Alt.	2.58
7	TSM Alt.	2.42

For purposes of this study BRT and rail stations are included as potential areas for transit-oriented development (BRT stations are assumed to be permanent stations that are able to provide similar incentives for TOD and smart growth as rail stations). Several factors that impact the interaction between transportation and land use (frequency of transit service, level of investment in station areas) are already captured under other evaluation and screening metrics in this analysis. Per the findings of the ITDP report cited above, in order to differentiate and evaluate the alternative's potential support for TOD, this metric evaluates how well new station areas for each alternative align with locations where local government have supported mixed-use and/or transit oriented development (refer to Page 23 for detailed calculation methodology).

The LRT Alternative Options score the best and provide the most benefits in Supporting Transit-Oriented Development by having the highest number of new stations with better frequencies in the vicinity to TOD sites, as the new stations are generally associated with development opportunities. These are followed by the Commuter Rail Alternative Phase 2 and 1, The BRT/Express Bus Alternative, and the Hybrid Rail Alternative. The BRT/Express Bus Alternative and the Hybrid Rail Alternative have the same number of new stations close to the identified TOD opportunity sites, however, the rail connection to ONT in Hybrid Rail has lower headways than the BRT connection to the airport, resulting in the Hybrid Rail Alternative scoring lower in this goal. The TSM Alternative has WVC BRT Phase 2 and Montclair-ONT shuttle as new services, thus can also produce potential benefits in this goal.

Economic Impacts

Economic Impacts of the alternatives were evaluated through the lenses of construction/operations jobs created, incremental job accessibility, tax revenue impacts, and housing affordability. The results for each objective in this analysis are presented in **Table 22**, and the ranking of the alternatives is as shown in **Table 23**.

Table 22 Final Screening Results for Economic Impacts Objectives by Alternative

Economic Impacts										
Objective	**Criteria**	**Performance Measure**	**No Build**	**TSM**	**LRT Arterial**	**LRT Cucamonga Creek**	**Commuter Rail Phase 1**	**Commuter Rail Phase 2**	**Hybrid Rail**	**BRT**
Construction/Operations Jobs Created	Construction jobs and O&M jobs created	Estimates are based on - Capital Costs	$0	$810	$1,280	$1,930	$620	$1,970	$1,350	$180
		- O&M Costs	$0	$60	$80	$40	$100	$90	$80	$20
Incremental Job Accessibility	Labor Market impacts	Number of jobs accessible (within 30-minute transit travel time) by transit services available in each alternative from hub stations (including Claremont, Montclair, Ontario Airport, Downtown Pomona, San Bernardino Transit Center, and Rancho Cucamonga Metrolink Station)	0	24,900	9,900[14]	13,300[15]	38,900	43,200	38,700	32,900
Tax Revenue Impacts	Anticipated level of economic development and associated tax revenue impacts	Anticipated level of economic development and associated tax revenue impacts (millions in 2017$)	$0	$5	$1	$2	$4	$11	$6	$0
Housing and Transportation Affordability	Assess change in housing and transportation costs	Perform (H+T) analysis. Assess change in housing and transportation costs (dollars per year).	$0	$7	$61	$98	-$2	-$6	$4	$1

Note: Numbers for certain metrics are rounded to the closest tens or hundreds for presentation.

[14,9] Note: Four WVC BRT stations (Garey/Holt, Reservoir/Holt, Ramona/Holt and Campus/Holt) were eliminated in LRT Alt. Arterial Opt. and LRT Alt. Cucamonga Creek Opt. to accommodate the LRT conversion of the originally planned BRT service. There are in total 9,933 jobs within a half-mile of the four stations, which have been deducted from the total newly accessible jobs calculated for the two LRT Alt. Options.

Table 23 Ranking of Alternatives for Economic Impacts

The Commuter Rail Alternative has strong performance in making more jobs accessible by transit and creating large numbers of construction and operations and maintenance jobs throughout the analysis period, but at the same time, it is found to slightly increase the Annual Household Housing and Transportation Costs for the Study Area and has potentially greater negative Tax Revenue Impacts due to larger right-of-way acquisition needs. This is followed by the Hybrid Rail Alternative and the BRT/Express Bus Alternative. While the BRT/Express Bus Alternative is relatively weak in creating as many jobs as the rail alternatives, it has negligible negative tax revenue impacts and a large contribution in increasing incremental job accessibility. The LRT Alternative Options perform relatively less well in making more jobs accessible (as they already provide good access to jobs), but they outperform all other alternatives in reducing Annual Household Housing and Transportation Costs.

No.	Alternative	Score
1	Commuter Rail Alt. Phase 1	8.04
2	Commuter Rail Alt. Phase 2	7.51
3	Hybrid Rail Alt.	7.42
4	BRT/Express Bus Alt.	7.15
5	TSM Alt.	6.39
6	LRT Alt. Arterial Opt.	5.44
7	LRT Alt. Cucamonga Creek Opt.	4.42

Table 24 Overall Alternatives Ranking

No.	Alternative	Score
1	LRT Alt. Cucamonga Creek Opt.	37.7
2	LRT Alt. Arterial Opt.	34.0
3	Commuter Rail Alt. Phase 2	23.3
4	Commuter Rail Alt. Phase 1	22.1
5	BRT/Express Bus Alt	20.6
6	Hybrid Rail Alt.	19.0
7	TSM Alt.	17.6

The Final Screening shows that on average across all of the goals, objectives, and screening criteria considered the LRT Alt. Options score better than other alternatives due to their relatively strong performance in enhancing connectivity and accessibility, providing cost effective transit and rail services, and promoting sustainable transportation. The BRT/Express Bus Alt. is a cost-effective solution that especially improves first/last mile connectivity, but its limited capacity may require further expansion or system upgrade in the future if the demand increases. The Commuter Rail Alt. Phase 1 and 2 outperform the other rail alternatives in creating construction and operation and maintenance jobs and making more jobs accessible through transit. Finally, the Hybrid Rail Alt. has good potential in bringing in positive economic impacts, but suffers from high infrastructure investment costs, limited ability to reduce VMT or support TOD.

Figure 21 illustrates how the alternatives perform under individual goals, as well as how the scores sum up to determine their final rankings, which is also provided in **Table 24.** The total score in **Figure 21** is presented as the sum of the five goal scores, while **Table 24** shows an average of the five goal scores.

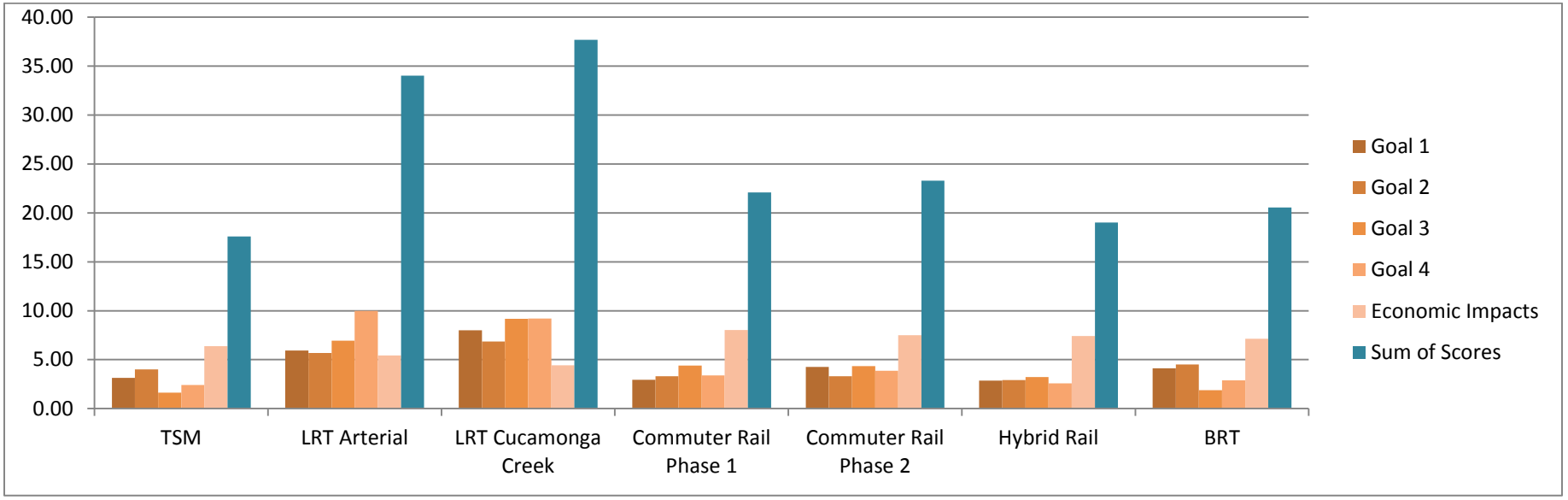


Figure 21 Goal Scores by Alternative

Conclusions and Next Steps

All the alternatives meet the goals of the study to varying degrees, and have merit for being carried forward into further study. **Table 25** provides an overview of the strengths and weaknesses of the Alternatives based on a review of the Final Screening and pertinent findings from the technical analyses. Strengths include areas that one alternative performs well in as compared to the other alternatives, or specific technical findings that can be used as a catalyst for carrying forward into further studies. Weaknesses are where one alternative performs relatively low compared to the other alternatives, or identified weaknesses that can be a focus for refinement and improvement in future studies.

It is worth noting that Phase 2 of the Commuter Rail Alternative proposes to convert the existing Metrolink San Bernardino Line (SB Line) service to Hybrid Rail service, and the Hybrid Rail Alternative proposes to add Hybrid Rail service to the existing Metrolink SB Line corridor in Los Angeles County. Both of these scenarios were evaluated in the SBCTA study on the operation of Hybrid Rail service on the Metrolink San Bernardino Line. A partnership between SBCTA and Metro, the SBCTA Hybrid Rail study provided a preliminary high level estimate on the capital and operational costs of the Hybrid Rail service based on the infrastructure requirements with various operating scenarios. The introduction of Hybrid Rail service on the Metrolink San Bernardino Line requires more study and close coordination between SBCTA and Metro, and a final determination has not been made by either agency.

At this time, it is unknown what the more detailed capital and operational costs are to partially convert existing Metrolink locomotive services on the San Bernardino Line to Hybrid Rail service. An extensive evaluation and assessment would be required to further advance the concept of operating Hybrid Rail service on the San Bernardino Line. Any recommendations to convert existing service on the San Bernardino Line to Hybrid Rail service would ultimately need to be service neutral and cost beneficial to Metro, meaning that the Hybrid Rail service will not impact or decrease the existing rail services provided in Los Angeles County.

The technical analysis is complex and was conducted at the planning level, meaning that much additional detail will be required on engineering, cost estimation, community and environmental impacts, ridership, funding sources, and relative benefits to local communities before any locally preferred alternatives and funding strategies can be identified. The alternatives analyzed in this study are broadly defined and financially unconstrained, and of a magnitude that neither county can currently afford. The relative benefits that may accrue from individual projects or project components and/or to the various communities in the corridor have not been quantified, nor have agency funding responsibilities been discussed.

It is not the intent of this study to recommend a preferred transit/rail alternative, nor is there sufficient information in this planning-level effort to do so. The recommended path forward is to transmit the study findings to the county transportation commissions for Los Angeles and San Bernardino Counties: the LA Metro and SBCTA to determine next steps. It is intended that the information from this report will be useful in narrowing down the alternatives for more detailed studies in the future.

As the implementing agency in their respective county, Metro and SBCTA have the discretion to conduct further studies to determine a financially feasible alternative and to consider additional factors such as county-level funding constraints and benefits of the expanded service to county constituents, among others. Statements about funding and project delivery expectations should be directed to Metro and SBCTA.

Table 25 Summary of Strengths and Weaknesses

	TSM	LRT Arterial	LRT Cucamonga Creek	Commuter Rail Phase 1	Commuter Rail Phase 2	Hybrid Rail	BRT/Express Bus[16]
Strengths	• Relatively Low Capital Cost (<$2B) • Relatively lower cost per trip • High incremental job accessibility	• Relatively lower cost per trip • High Benefit-Cost Ratio • High Ridership • High Travel Time Savings • Large VMT/GHG Reduction • Low ROW Impacts • Strong TOD/TOC Potential	• Highest Ridership • High Benefit-Cost Ratio • High Travel Time Savings • Large VMT/GHG Reduction • Strong TOD/TOC Potential • High Accident Avoidance	• Lowest Capital Cost for Rail (<$1.5B) • Lowest cost per trip for Rail • Fast intercounty commute • Relatively large VMT/GHG Reduction • High incremental job accessibility	• Fast commute time LA-ONT • Double the Ridership of Commuter Phase 1 • Relatively large VMT/GHG Reduction • High incremental job accessibility • High residual benefits	• Fast commute time LA-ONT • Lower cost per trip than LRT Cucamonga and Commuter Rail Phase 2 • Lower O&M Cost than Commuter Rail • High incremental job accessibility	• Lowest Capital Cost (<$300M) • Lowest cost per trip • High Benefit-Cost Ratio • Low ROW Impacts • Enhances 1st/last mile connectivity
Weaknesses	• Limited Benefit-Cost Ratio • Large Capital Cost for Double Tracking • Relatively Low Ridership • Limited VMT/GHG Reduction • Large ROW Impacts • Limited Travel Time Savings	• High Capital Cost (>$2B) • Relatively limited incremental job accessibility	• High Capital Cost (>$2.5B) • Relatively higher cost per trip • Relatively limited incremental job accessibility	• Relatively Limited Ridership • High O&M Cost • Capacity issue: SB Single track segments cannot accommodate service headways	• Highest Capital Cost (>$3.5B) • Highest cost per trip • Limited Benefit-Cost Ratio • Large ROW Impacts • Capacity issue: SB single track segments cannot accommodate proposed service headways	• High Capital Cost (>$2.5B) (Includes Double Tracking) • Lowest Ridership Increase (Does not include express service) among rail alternatives • Low VMT/GHG Reduction • Large ROW Impacts • Capacity issue: SB single track segments cannot accommodate proposed service headways[17]	• Limited Ridership • Limited VMT/GHG Reduction • Limited Travel Time Savings • Limited intercounty connectivity • Limited Economic generation • Limited TOD Potential

[16] Note: The strengths and weaknesses are specific for the performance of this BRT/Express Bus Alternative, rather than for BRT services in general.

[17] Note: Following the completion of the facility and capacity analysis for this study, SBCTA and L.A. Metro prepared a Metrolink San Bernardino Line Hybrid Rail Study. This Hybrid Rail Study further refines the concept of using hybrid rail on Metrolink tracks, similar to the Hybrid Rail Alternative evaluated in this study. The capacity analysis included in the Hybrid Rail study may be used as a reference to this study, but the findings of the two reports are not comparable. This study includes the double tracking segments from Metrolink's SCORE proposal, which are necessary to accommodate the proposed service plan in the Hybrid Rail Alternative. The Hybrid Rail Study makes different assumptions about service levels and double tracking needs than what is assumed in this study. More detailed information is available in Agenda Item 6 of the SBCTA Transit Committee meeting of May 10, 2018, available at: http://www.gosbcta.com/about-sbcta/agendas/2018/05-18-transit.pdf