Inland Empire Railroad Main Line Study
Final Report
Contract 04-010

Prepared for

Southern California Association of Governments

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NOTE: 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 or U.S. DOT. This report does not constitute a standard, specification or regulation.

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Executive Summary

The Inland Empire Railroad Main Line Study examines railroad infrastructure needs and operations for both freight and passenger trains in Southern California. The firm of Leachman and Associates LLC was contracted by the Southern California Association of Governments to perform this study. Assisting Leachman and Associates in this study are George R. Fetty & Associates, Gill V. Hicks & Associates, Inc., and Weston Solutions, Inc.

This document serves as the Final Report for this study. The existing railroad main line infrastructure from downtown Los Angeles east and north to Barstow and Indio is described. Passenger and freight traffic patterns are documented, and future train volumes are forecast. Alternatives for routing future main-line train movements are formulated and analyzed. Results are presented from simulating Year 2010 and Year 2025 train operations in scenarios of increasing track capacity. These results identify track capacity improvements for each alternative required to maintain Year 2000 transit times while accommodating forecasted 2010 and 2025 traffic levels. Capital costs for these infrastructure improvements are estimated. Emissions from locomotives powering through train movements and from vehicular delays at grade crossings are estimated. Finally, the alternatives are ranked along the dimensions of capital costs, total emissions, population exposure to main-line freight train operations, and population access to passenger train operations.

Frequencies of main-line train operations vary from day to day. Train movement counts in this study are expressed per peak-day, defined as the 90th percentile of the statistical distribution of daily train movements. On lines in the study area, this is about 20% higher than the average daily train movement count.

Southern California is served by two major freight railroads: Burlington Northern Santa Fe, and Union Pacific. Figures 1 and 2 provide diagrams of the main line rail network in the study area (not to scale). Not shown in the figures are numerous low-density branch lines for originating and terminating carload freight.

BNSF operates a single main line extending from downtown Los Angeles to Barstow. Intermodal terminals are operated by BNSF at Hobart (adjoining the City of Commerce) and San Bernardino. UP trains utilize trackage rights over the BNSF line from West Riverside to Barstow. The entire BNSF line has at least two main tracks, reverse-signaled under centralized traffic control (CTC), with three main tracks over relatively short stretches in various locales. Expansion of three-main-track territory is underway. Most recently, a third main track was completed in late 2004 over 6.5 miles of line between Baseline Road in San Bernardino and Verdemont, and expansion of three-main-track territory is currently underway to encompass the entire run between Hobart and Fullerton.

In Year 2000, 87 freight trains and two Amtrak passenger trains per peak day traversed the portion of the BNSF Line crossing Cajon Pass. These figures are forecast to rise to

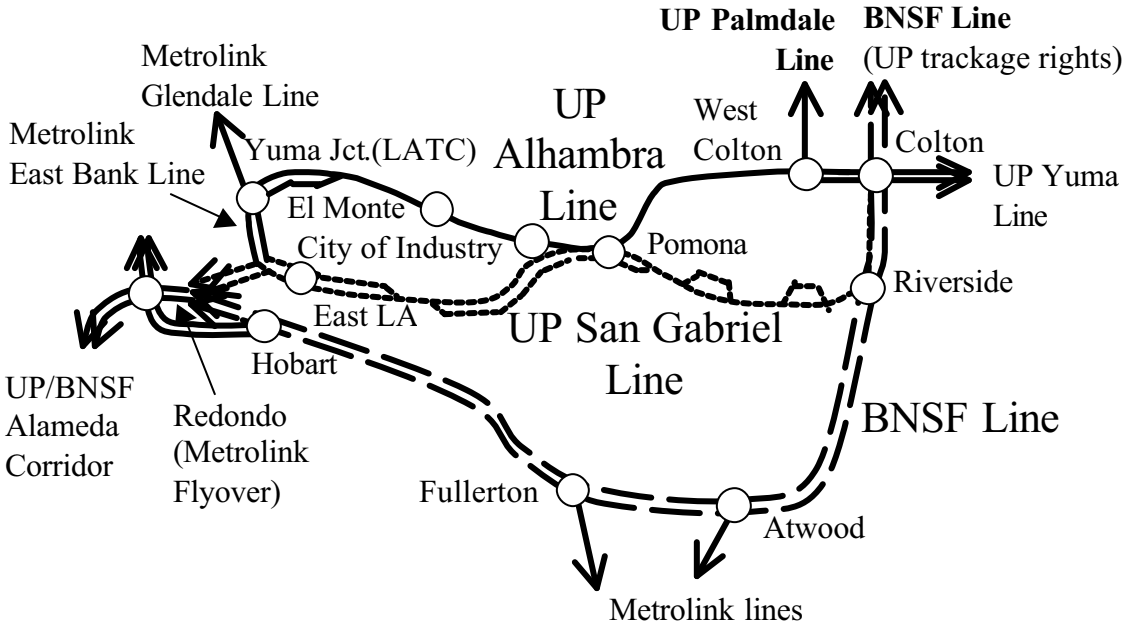

Figure 1. Main Line Rail Network, West of Colton Crossing

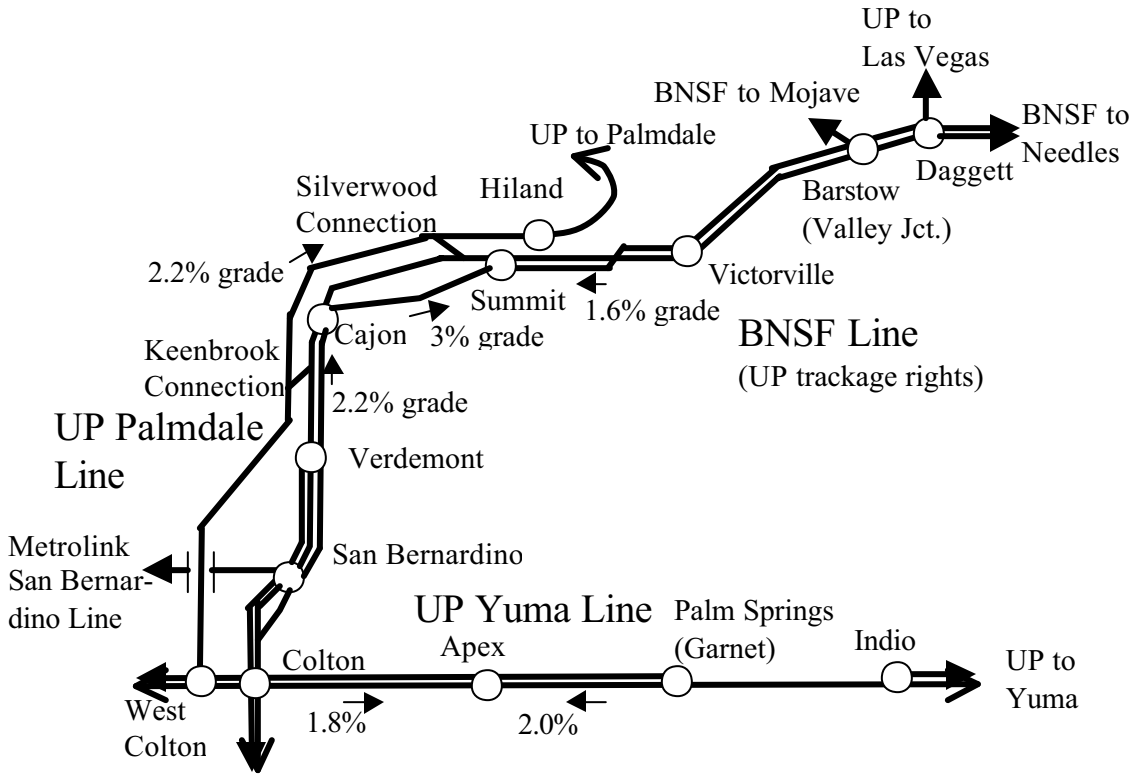

Figure 2. Main Line Rail Network, North and East of Colton Crossing

123 freight trains and 6 passenger trains in 2010, and 178 freight trains and 8 passenger trains in 2025. Passenger train movements over the BNSF Line are heaviest between Fullerton and Los Angeles. In Year 2000, this segment had 46 passenger trains and 57 freight trains per peak day. Those figures are forecast to rise to 76 passenger trains and 82 freight trains in 2010 and 106 passenger trains and 121 freight trains in 2025.

UP operates two main lines between downtown Los Angeles and Colton Crossing. In this report, these lines are designated as the UP San Gabriel Line and the UP Alhambra Line. These lines consist of a mixture of single-track and two-main-track territories operated under CTC. The UP Alhambra Line is mostly single-track, while the UP San Gabriel Line is mostly two-main-track. Intermodal terminals are operated by UP at East Los Angeles (at the west end of the UP San Gabriel Line), Los Angeles Transportation Center (at the west end of the UP Alhambra Line) and City of Industry (midway on the UP Alhambra Line). A large carload freight classification yard is located at West Colton (at the east end of the Alhambra Line). North from West Colton, UP operates the single-track-CTC Palmdale Line to Northern California and Pacific Northwest points. This line closely parallels the BNSF Line as they climb the south slope of Cajon Pass. Compared to other main lines in the study area, the UP Palmdale Line is lightly trafficked.

East from Colton Crossing to Indio, UP operates its transcontinental Sunset Route main line, designated in this report as the UP Yuma Line. The first 48 miles of this line have two main tracks under CTC, the remaining 24 miles to Indio is a single-track-CTC line. Eastward extension of the second main track was completed in September, 2004 over the ten-mile stretch from Fingal to Garnet. Extension of the second main track eastward is planned.

In Year 2000, UP operated 59 through freight trains per peak day collectively over the UP San Gabriel and UP Alhambra Lines. This figure is forecast to rise to 83 trains in 2010 and 117 trains in 2025. On the Yuma Line, UP operated 42 freight trains per peak day in Year 2000. That figure is forecast to grow to 60 trains in 2010 and 87 trains in 2025.

Passenger train movements over UP tracks in the study area are heaviest on the UP San Gabriel Line. Including both Metrolink and Amtrak, in Year 2000, there were 12 trains per peak day over this line, forecast to rise to 22 trains in 2010 and 36 trains in 2025. In contrast, passenger movements over the UP Alhambra and Yuma Lines are very light, only 2 trains per peak day in Year 2000, forecast to rise to 4 trains in 2010 and 8 trains in 2025. There are no regular passenger movements over the UP Palmdale Line.

Discrete-event computer simulations of railroad operations ("train dispatch simulation") were carried out by the consultant for each routing alternative as well as for the Year 2000 Base Case. Given train volumes and trackage configuration as input, one hundred peak days of train operations were simulated and statistics on transit times and delays were compiled. The criterion for planning track capacity in this study is to maintain Year 2000 average transit times under 2010 and 2025 traffic scenarios. From iterative

simulation experiments, required trackage configurations were identified for the 2010 and 2025 traffic scenarios meeting this criterion.

The Status Quo alternative represents an allocation of through trains to routes proportional to the actual average allocation occurring in the Year 2000 Base Case. Under the Status Quo routing alternative, roughly 60% of UP through train movements operating between Colton Crossing and downtown Los Angeles points are routed via the San Gabriel Line, the other 40% are routed via the Alhambra Line (Figure 3). Under this alternative, the UP Palmdale Line is utilized predominantly by UP trains to and from Northern California, while almost all UP trains via Barstow utilize the BNSF Line between West Riverside and Barstow.

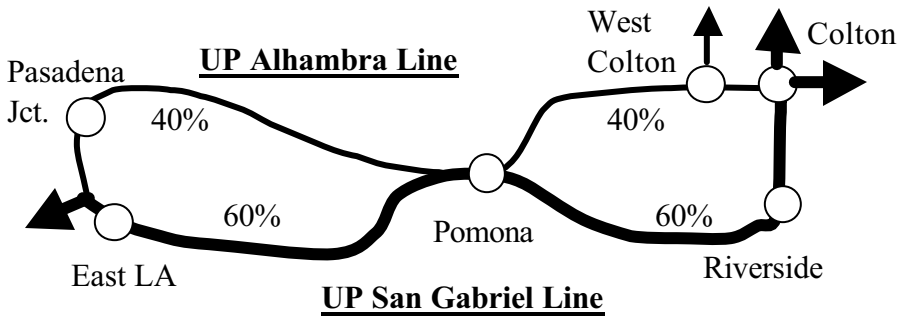

Figure 3: Status Quo Routing

Three routing alternatives to the Status Quo are formulated and analyzed in this report. The motivation for consideration of these alternatives stems from the following factors:

- The UP Palmdale Line is relatively underutilized, whereas the BNSF Line through Riverside, San Bernardino and over Cajon Pass is heavily utilized. By 2025, it will be impossible to achieve Year 2000 transit times unless a significant fraction of UP Barstow trains are routed via the UP Palmdale Line, West Colton and the UP Alhambra Line. Moreover, integrating the UP Palmdale Line to be flexibly dispatched as if it were another BNSF track on the south slope of Cajon Pass, would significantly reduce track capacity expenditures needed to accommodate 2010 and 2025 traffic levels.
- Routing trains via the UP San Gabriel Line involves use of trackage rights over the BNSF Line between Colton Crossing and West Riverside. This is the most heavily utilized line segment in the Los Angeles Basin. Expansion of the capacity of this segment to accommodate 2025 traffic levels is relatively difficult and expensive under the Status Quo alternative, requiring a fourth main track plus flying junctions to enter and exit BNSF tracks. Expansion of capacity of the UP Alhambra Line between West Colton and Pomona is more practical and less costly.

- Shifting UP trains operating between Cajon Pass and Pomona off the BNSF Line and the UP San Gabriel Line and onto the UP Palmdale and UP Alhambra Lines reduces conflicts between Metrolink commuter trains and UP freight operations, thereby reducing track capacity expenditures needed to accommodate 2010 and 2025 traffic levels.
- Shifting UP trains operating between Cajon Pass and Pomona off the BNSF and UP San Gabriel Lines and onto the UP Palmdale and UP Alhambra Lines reduces total population exposure to through train movements and total vehicular delays at grade crossings.

All three alternatives to the Status Quo are identical east of Pomona. Compared to the Status Quo, they reduce the total through train counts in downtown San Bernardino and downtown Riverside by 22% and 31%, respectively. These three alternatives concentrate about 88% of UP through train movements via West Colton versus only 12% via the UP San Gabriel Line through Riverside. Under these alternatives, only Metrolink (blue line in Figures 4 – 6) and UP through freight trains utilizing the Mira Loma auto terminal or the carload interchange yard at Montclair are normally operated via the UP San Gabriel Line between Colton Crossing and Pomona. The rest operate via the UP Alhambra Line.

The three alternatives to the Status Quo differ only in the routing of UP through train movements west of Pomona, summarized as follows:

- *Alternative 1a:* About 85% of UP through train movements between Pomona and downtown Los Angeles points are routed via the UP San Gabriel Line (Figure 4). Only UP through freight trains utilizing the City of Industry or LATC terminals, plus UP freight trains operating to/from the Glendale Line, are routed via the UP Alhambra Line west of Pomona.

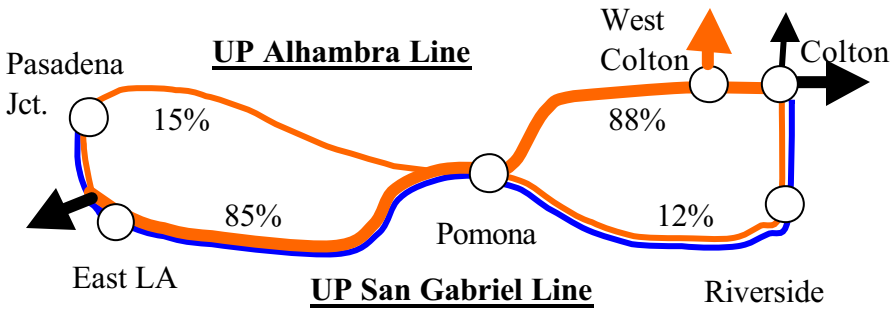

Figure 4: Routing Alternative 1a

- *Alternative 1b:* Same as Alternative 1a, but with the additional feature that Metrolink Riverside – Pomona – Los Angeles trains are re-routed via the UP

Alhambra Line west of Pomona (blue line, Figure 5). The station stop at City of Industry would be re-sited on the Alhambra line, the station stop at Montebello would be closed (with passengers re-directed to the Commerce station on the BSNF Line), and a new station stop at Alhambra would be introduced. Under this alternative, Metrolink operations and heavy UP through train movements are largely disjoint, thereby reducing track capacity requirements.

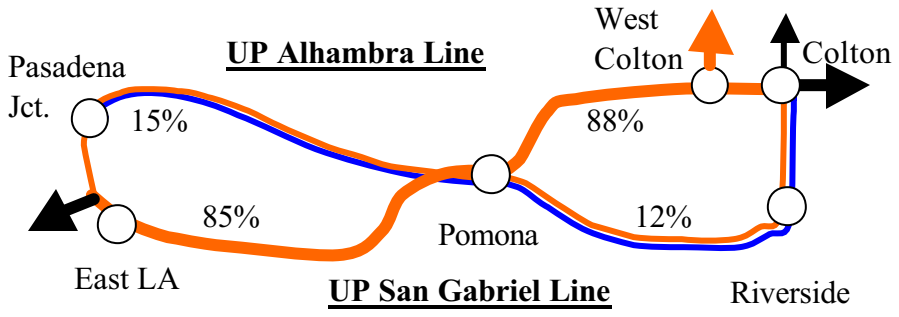

Figure 5: Routing Alternative 1b

- *Alternative 2:* About 85% of UP through train movements between Pomona and downtown Los Angeles points are routed via the UP Alhambra Line (Figure 6). Metrolink operations continue via the UP San Gabriel Line. Only UP through freight trains utilizing the East Los Angeles terminal are routed via the UP San Gabriel Line west of Pomona. Under this alternative, Metrolink operations and heavy UP through train movements are largely disjoint, except they share trackage along the Metrolink East Bank Line (see Figure 1).

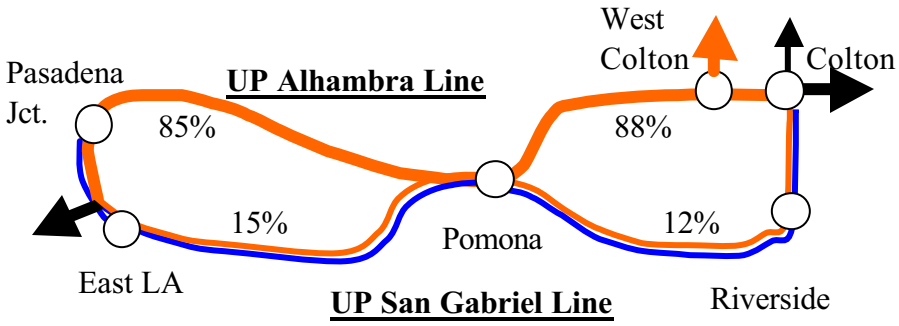

Figure 6: Routing Alternative 2

Infrastructure improvements required west and south of Colton Crossing were determined in an earlier phase of this study.[1] For completeness, these improvements are tabulated in this report, integrated with the list of improvements required east and north of Colton Crossing.

In both 2010 and 2025 scenarios, all three alternatives to the Status Quo have common trackage configurations on the BNSF Line, as well as east of Pomona on all UP Lines. Those configurations are summarized and compared to the improvements required for the Status Quo alternative in Tables 1, 2, and 3. (Increments in track capacity are highlighted with bold type.)

The key economies in capital requirements afforded by the three alternatives to the Status Quo are as follows.

- BNSF and UP trains operating on the BNSF Line are envisioned to make use of the UP Palmdale Line between Devore Road (Keenbrook) and Silverwood as if it were another BNSF main track. This avoids construction of a costly 2.2%-graded main track through the mountains between Devore Road (Keenbrook) and Silverwood. A new connection at Devore Road (Keenbrook) is required to enable this flexibility.
- By routing all UP Barstow trains via the UP Palmdale Line between West Colton and Devore Road (Keenbrook), construction of an additional main track between San Bernardino and Devore Road on the BNSF Line is avoided. However, a second main track on the UP Palmdale Line is required between West Colton and Devore Road by 2025.
- By routing most UP Yuma Line trains and all UP Barstow trains via West Colton instead of via Riverside, the need for costly flying junction connections at Colton Crossing and West Riverside and the need for a fourth main track on the BNSF Line between those points are avoided.
- Metrolink commute operations and UP through freight operations between Pomona and Riverside/Colton are made mostly disjoint under these alternatives. However, a Metrolink fly-over at Pomona is required by 2025.

[1] *Los Angeles – Inland Empire Railroad Main Line Advanced Planning Study,* prepared for the Southern California Association of Governments by the Los Angeles Economic Development Corporation,, Contract number 01-077, Work element number 014302, October 1, 2002.

Table 1.
Summary of Required Track Capacity on BNSF Line,
South and West of Colton Crossing
(Figures express required numbers of main tracks.)

		Status Quo		**Alternatives 1 and 2**	
Line Segment	**Existing in 2005**	**2010**	**2025**	**2010**	**2025**
BNSF Line					
Hobart – Bandini	3	3	**4**	3	**4**
Bandini – Basta	2	**3**	**4**	**3**	**4**
Bandini – Fullerton Jct.	3	3	**4**	3	**4**
Fullerton Jct. – Atwood	2	2	**3**	2	**3**
Atwood – Esperanza	2	**3**	3	**3**	3
Esperanza – Prado Dam	3	3	3	3	3
Prado Dam – West Riverside	2	**3**	3	**3**	3
West Riverside jct. with UP	At grade	At grade	**Flying jct.**	At grade	At grade
West Riverside – Highland	3	3	**4**	3	3
Highland – Colton Crossing	2	**3**	**4**	**3**	3
Colton Crossing	At grade	At grade	**Separated, with flying jct. to UP**	At grade	**Separated**

Note: A "flying junction" allows connecting movements to proceed without fouling the route of opposing through traffic, much like a freeway interchange.

In 2010, the BNSF Line will require a minimum of three main tracks over the entire extent between Colton Crossing and Barstow (Table 2). To match Year 2000 transit times, four main tracks are required on the steep mountain grade between Devore Road (Keenbrook) and Summit (Table 2). Under the alternatives to the Status Quo, integration of the UP Palmdale Line with the BNSF main tracks avoids the costly construction of a new 2.2%-gradient track climbing the south slope of Cajon Pass. In order to economize on construction costs, the new fourth main track can be constructed as a second, 3%-gradient downhill track on the south slope of Cajon Pass (Table 2). On the other hand, under the Status Quo, both new 2.2%-gradient and 3%-gradient tracks are required (Table 2).

In 2025, the BNSF Line will require a minimum of four main tracks over the entire extent between Devore Road (Keenbrook) and Barstow (Table 2). Under the Status Quo, four main tracks also are required San Bernardino – Devore Road (Keenbrook). In contrast, three tracks are sufficient between San Bernardino and Devore Road (Keenbrook) under the alternatives to the Status Quo (Table 2). This is because the alternatives to the Status Quo re-route UP Barstow trains via West Colton. Offsetting this savings, there is a requirement in 2025 under the alternatives to the Status Quo for two main tracks on the UP Palmdale Line from West Colton to connections with the BNSF Line at Devore Road (Keenbrook).

Table 2.
Summary of Required Track Capacity on BNSF Line,
North of Colton Crossing

(Figures express required numbers of main tracks. Percentages express track gradients.)

		Status Quo		**Alternatives 1 and 2**	
Line Segment	**Existing in 2005**	**2010**	**2025**	**2010**	**2025**
BNSF Line					
Colton Crossing – Rana	2	**3**	3	**3**	3
Rana – San Bernardino	4	4	4	4	4
San Bernardino – Verdemont	3	**4**	4	3	3
Verdemont – Devore Road	2	**4**	4	**3**	3
Devore Rd. (Keenbrook) connection	One conn.	One conn.	One conn.	Univ. conns.	Univ. conns.
Devore Road – Cajon	2	**4**	4	**3**	**4**
Cajon – Silverwood	One 2.2%, one 3%	**Two 2.2%, two 3%**	**Two 2.2%, three 3%**	**One 2.2%, two 3%**	**One 2.2%, three 3%**
Silverwood connection	One conn.	One conn.	One conn.	One conn.	One conn.
Sliverwood - Summit	One 2.2%, one 3%	**Two 2.2%, two 3%**	**Two 2.2%, three 3%**	**Two 2.2%, two 3%**	**Two 2.2%, three 3%**
Summit – Barstow	2	**3**	**4**	**3**	**4**

Note: "One connection" indicates only two out of four possible connecting movements are feasible.
"Universal connections" indicates all four possible connecting movements are feasible.

Table 3.
Summary of Required Track Capacity on UP Lines East of Pomona
(Figures express required numbers of main tracks.)

		Status Quo		Alts. 1 and 2	
Line Segment	**Existing in 2005**	**2010**	**2025**	**2010**	**2025**
UP Yuma Line					
Colton Crossing – Garnet	2	2	2	2	2
Garnet – Salvia	1	**2**	2	**2**	2
Salvia - Indio	1	1	**2**	1	**2**
UP Palmdale Line					
West Colton – Devore Rd. (Keenbrook)	1	1	1	1	**2**
Devore Rd. (Keenbrook) – Hiland	1	1	1	1	1
UP San Gabriel Line					
West Riverside – Streeter	1	**2**	2	1	1
Streeter - Arlington	2	2	2	2	2
Arlington - Pedley	1	**2**	2	1	1
Pedley – Bon View	2	2	2	2	1
Bon View - Pomona	1	**2**	2	1	1
UP Alhambra Line					
Colton Crossing – West Colton	2	2	2	2	2
Jct. with Palmdale Line at West Colton	Partial flying	Partial flying	**Full flying**	Partial flying	**Full flying**
West Colton – Pomona	1	1	1	**2**	2
Pomona route connections	At-grade cross-overs	At-grade cross-overs	At-grade cross-overs	At-grade cross-overs	**Metro-link fly-over**

Note: A "flying junction" allows connecting movements to proceed without fouling the route of opposing through traffic, much like a freeway interchange. A "partial flying junction" partially eliminates conflicts between through and connecting movements. A "fly-over" is a grade-separated crossing of rail lines. Movements connecting between routes by using at-grade crossovers block through traffic.

Under the Status Quo alternative, a fifth main track is required in 2025 between Cajon station and Summit (Table 2). It is recommended that this track be constructed to a 2.2% gradient to serve flexibly as either an uphill or a down hill track. Under the alternatives to the Status Quo, integration of the UP Palmdale Line with the BNSF main tracks means that one 2.2%-gradient track and one 3%-gradient track must be constructed to accommodate 2025 traffic levels. Under the Status Quo, two 2.2%-gradient and one 3%-gradient track must be constructed (Table 2).

Despite these ambitious improvements, passenger trains on both the UP Yuma Line and the BNSF Line will experience relatively slow transit times, about 2 hours Colton

Crossing – Yuma and 3 hours, 5 minutes Colton Crossing – Barstow. These figures are longer than free-running transit times by about 60 minutes and about 10 minutes, respectively. This is due to the need to follow slower-moving freight trains operating on the same tracks over the mountain grades. Should faster transit times for passenger trains be desired, an additional track will be required where grades exceed 1.5%. This applies to the segments Victorville to San Bernardino on the BNSF Line and Colton to Garnet (Palm Springs station) on the UP Yuma Line.

Under all alternatives, in 2010, the UP Yuma Line will require two main tracks from Colton Crossing east to Salvia (about 20 miles from Indio). In 2025, two main tracks are required over the entire extent to Indio (Table 3).

Under all alternatives, a full flying junction of the UP Palmdale and Alhambra Lines and approaches to West Colton Yard also is required, enabling Palmdale Line trains to enter and exit the Yard or the Alhambra Line without fouling opposing movements on the Alhambra Line main tracks (Table 3).

Between Colton Crossing and Pomona, the alternatives to the Status Quo concentrate UP trains on the UP Alhambra Line. This requires a second main track in 2010 between West Colton and Pomona (Table 3). On the other hand, the Status Quo requires a second main track West Riverside – Pomona on the UP San Gabriel Line (Table 3). In addition, in 2025, the Status Quo requires flying junction connections with BNSF tracks at Colton Crossing and West Riverside, as well as a fourth main track on the BNSF Line between Colton Crossing and West Riverside (Table 1).

West of Pomona, the alternatives take different strategies with consequent different required trackage configurations, as summarized in Tables 4 and 5. The Status Quo requires two main tracks on the UP San Gabriel Line west of Pomona in 2010 and two main tracks on the Alhambra Line west of Pomona in 2025 (Table 4). Alternative 1a, concentrating UP through freight operations on the UP San Gabriel Line west of Pomona where they share right of way with Metrolink operations, requires three main tracks on that line by 2025 (Table 5). Alternative 1b, shifting Metrolink over to the Alhambra Line west of Pomona, is able to meet transit time goals with two main tracks west of Pomona on the San Gabriel Line in 2010 and no improvements to the Alhambra Line west of Pomona (Table 5). In terms of track capacity expenditures, this is the most efficient alternative. Alternative 2, concentrating UP through freight operations on the UP Alhambra Line west of Pomona and leaving Metrolink on the UP San Gabriel Line, requires full double-tracking of the Alhambra Line, double-tracking of the San Gabriel Line west of Pomona, triple-tracking of the East Bank Line, and a fly-over at Pasadena Jct. for the Metrolink San Bernardino Line (Table 5). This alternative is more costly than Alternative 1b, but less than Alternative 1a and the Status Quo.

Table 4. Summary of Required Track Capacity on UP Lines West of Pomona For Status Quo Alternative
(Figures express required numbers of main tracks.)

Line Segment	Existing in 2005	2010	2025
UP San Gabriel Line			
Pomona – Roselawn	1	**2**	2
Roselawn – Bartolo	2	2	2
Bartolo – Pico Rivera	1	**2**	2
Pico Rivera – Redondo	2	2	2
UP Alhambra Line			
Pomona - Alhambra	1	1	**2**
Alhambra – Yuma Jct.	2	2	2
Yuma Jct. – Pasadena Jct.	1	1	1
Metrolink crossing at Pasadena Jct.	At grade	At grade	At grade
Pasadena Jct. – Ninth St.	2	2	2
Ninth St. - Redondo	1	1	1

Table 5.
Summary of Required Track Capacity on UP Lines West of Pomona For Alternatives to Status Quo Routing
(Figures express required numbers of main tracks.)

	Existing in 2005	2010			2025		
		Alt 1a	**Alt 1b**	**Alt 2**	**Alt 1a**	**Alt 1b**	**Alt 2**
San Gabriel Line							
Pomona – Roselawn	1	**2**	**2**	1	**3**	2	**2**
Roselawn – Bartolo	2	2	2	2	**3**	2	2
Bartolo – Pico Rivera	1	**2**	**2**	1	**3**	2	**2**
Pico Rivera – Redondo	2	2	2	2	**3**	2	2
Alhambra Line							
Pomona – Alhambra	1	1	1	**2**	1	1	**2**
Alhambra – Yuma Jct.	2	2	2	2	2	2	2
Yuma Jct. – Pasadena Jct.	1	1	1	**2**	1	1	2
Metrolink crossing at Pasadena Jct.	At grade	At grade	At grade	At grade	At grade	At grade	**Fly-over**
Pasadena Jct. – Ninth St.	2	2	2	2	2	2	**3**
Ninth St. – Redondo	1	1	1	**2**	1	1	2

Note: A "fly-over" is a grade-separated crossing of rail lines.

Total capital costs required to raise track capacity from the Year 2000 Base Case to configurations that accommodate Year 2010 traffic levels range from 1.2 to 1.4 billion dollars among the alternatives. Total capital costs required to raise track capacity from the Year 2000 Base Case to configurations that accommodate Year 2025 traffic levels range from 2.2 to 2.7 billion dollars. The Status Quo Alternative is the most costly, and Alternative 1(b) is least costly, about 300 million dollars less than the Status Quo.

Considering the improvements that have already been completed or are now fully funded and under construction, it is estimated these improvements account for 253 million dollars worth of the total Year 2025 investment requirements. In terms of net expenditures still required, the ranking of alternatives is as follows:

- Alternative 1(b) - $2.05 billion
- Alternative 2 - $2.27 billion
- Alternative 1(a) - $2.33 billion
- Status Quo - $2.35 billion

The $253 million in funded capacity improvements to date represents about 18% of the required capital outlays to raise capacity under the Status Quo Alternative from Year 2000 traffic levels to Year 2010 levels and about 21% of the required outlays under Alternative 1b. Yet half of the decade has passed. Clearly, improvements in track capacity are not keeping up with the rising traffic levels; in fact, capacity requirements are growing at more than double the rate of growth in capacity. As a result, the quality of freight and passenger services in the Los Angeles Basin is declining. In view of this trend, recent severe delays to Amtrak and Metrolink trains and “melt-downs” in rail freight operations are not surprising.

As an input to an emissions analysis of the routing alternatives, vehicular delays at grade crossings in the study area were estimated for the Year 2000 Base Case and the 2010 and 2025 future scenarios. For delays in future years, it was assumed that 10 existing grade crossings would be grade separated and one would be closed by 2010, and it was assumed that an additional 38 streets would be grade separated by 2025. Vehicle-hours of delay per day for these streets were “zeroed out” in the final results. The list of assumed grade separations was derived from the high priority listings of various jurisdictions involved: San Gabriel Valley Council of Governments and the Alameda Corridor-East Construction Authority, SANBAG, RCTC, OCTA, Caltrans, OnTrac and the Gateway Cities Council of Governments.

Year 2000 emissions were then calculated for BNSF and UP through freight trains and passenger trains along BNSF and UP main lines operating over main lines between the north end of the Alameda Corridor and Barstow and Indio. Locomotive emissions were calculated based on the average through train movements per day and idling emissions from traffic delay were estimated based on total vehicle hours of delay at railroad crossings at grade. Emissions are categorized by reactive organic gases, carbon monoxide, nitrogen oxides, particulate matter, and sulfurous oxides. Estimates of Year 2000 Base-Case and future emissions under the Status Quo routing are summarized in

Table 6. These emissions are comprised of approximately 95% rail emissions and 5% vehicle delay emissions generated at grade crossings.

Table 6.
Locomotive and Vehicle Delay Emissions from the Main Line Rail Network, Year 2000 Base Case, Year 2010 and Year 2025, Under Status Quo Routing
(Emissions expressed in tons)

Year	ROG	CO	NOx	PM10	SOx
2000	508.08	821.74	15437.95	348.10	958.45
2010	581.36	2940.13	10576.70	385.03	117.28
2025	868.10	4351.38	15890.83	578.55	11.65

In future years, Basin-wide ROG, CO and PM10 emissions from rail operations are projected to rise substantially, while SOx emissions will be dramatically reduced. NOx emissions will be reduced in 2010 but will revert to about Year 2000 levels in 2025. The accommodation of substantially increased rail traffic without increases in NOx and SOx results from mitigation afforded by the phased introduction of "Tier II" locomotives plus the completion of eleven grade separation projects in 2010 and 38 more grade separations in 2025.[2]

Each of the alternatives to the Status Quo reduces emissions. This reduction results from decreases in freight and passenger train total travel times, plus concentration of heavy freight train operations on routes that are more grade-separated. Table 7 summarizes the emission benefits within the Main Line Rail Network for the alternatives to the Status Quo.

Table 7
Future Basin-wide Emission Benefits from Routing Alternatives
(Emission Reductions in tons compared to Status Quo Alternative)

	ROG		CO		NOx		PM10		SOx	
Alternative	2010	2025	2010	2025	2010	2025	2010	2025	2010	2025
1a	92	167	469	839	1671	3059	60.85	111.45	18.52	2.25
1b	99	163	504	818	1802	2984	65.64	108.69	19.99	2.19
2	98	156	491	782	1801	2865	65.50	104.21	19.98	2.09

[2] Emission factors for "Tier I" locomotives used in this analysis are based on actual locomotive duty cycles. Lacking data on actual "Tier II" locomotive duty cycles, emission factors assumed for "Tier II" locomotives reflect the EPA Tier II standards. Locomotive fleets were 100% Tier I in 2000 but will be 100% Tier II or equivalent by 2010. EPA Tier II standards for ROG and CO are more lenient than actual Tier I locomotive emissions, more lenient by a factor of three in the case of CO. The CO emissions of Tier II locomotives may turn out to be much less than the EPA standard, and therefore the projected factor-of-five increase in CO emissions from 2000 to 2025 may be an anomaly resulting from the lack of data.

Finally, the four alternatives were evaluated along the following four dimensions:

- Total capital costs required to raise track capacity from Year 2005 configurations to configurations accommodating Year 2025 traffic forecasts with transit times comparable to the Year 2000 Base Case.
- Total emissions from through train movements and vehicles delayed at grade crossings.
- Total population exposure to heavy freight train operations, defined as the total 2025 population residing within 0.5 miles of trackside multiplied by the forecast number of peak-day through freight train movements.
- Total population access to passenger train operations, defined as the total 2025 population residing within 0.5 miles of trackside multiplied by the forecast number of weekday passenger trains.

Table 8 summarizes the evaluation. Figures are expressed as percentage improvements over the Status Quo Alternative.

Table 8
Ranking of Routing Alternatives
(Figures express percentage Year 2025 improvement over Status Quo Alternative)

Alternative	Capital Cost	Emissions	Population Exposure To Freight Trains	Population Access To Passenger Trains
1(a)	1.1%	19.2%	4.6%	0.0%
1(b)	13.1%	18.8%	4.6%	4.7%
2	3.4%	18.0%	0.1%	0.0%

In the dimensions of cost, population exposure to freight trains and population access to passenger trains, Alternative 1(b) ranks best. In the emissions dimension, Alternative 1(a) ranks best, but Alternative 1(b) contributes only about 0.6% more emissions. Compared to the Status Quo, Alternative 1(b) offers about 13% less capital cost, about 19% less emissions, about 5% less population exposure to main-line freight train operations, and about 5% more population access to passenger train operations.

1. Introduction

The Inland Empire Railroad Main Line Study examines railroad infrastructure needs and operations for both freight and passenger trains in Southern California. Major objectives of the study include:

* Maximize goods movement carrying capacity of the railroad main lines extending from downtown Los Angeles to Barstow and Indio;
* Guarantee that existing levels of reliability and existing train speeds can be maintained or increased such that the rail freight mode will continue to be competitive with trucking for long-haul, time-sensitive shipments including marine port and domestic traffic;
* Reduce the impacts of increasing levels of freight train traffic on communities traversed by these rail lines;
* Facilitate Metrolink and other passenger rail use of the rail corridors and ensure that the potential to enhance and improve commuter and other transit service will be maintained;
* Identify new facilities and infrastructure needs, and their respective implementation and phasing requirements.

A previous phase of this study examined infrastructure needs from downtown Los Angeles to Colton Crossing.[3] The subsequent phase, the subject of this report, extends the scope eastward and northward over rail main lines to Barstow and Indio.

The firm of Leachman and Associates LLC was contracted by the Southern California Association of Governments to perform this study. Subconsultants assisting Leachman and Associates in the work reported herein include Gill V. Hicks & Associates and George R. Fetty & Associates.

This document serves as the final report for the study. This report was authored by Dr. Robert C. Leachman, who is solely responsible for the accuracy and completeness of the contents. Dr. Maged M. Dessouky of Leachman and Associates LLC was a key technical contributor to the simulation modeling and analysis reported in sections 6 and 7. Mr. Gill Hicks was a key technical contributor and co-author of section 9, capital costs. Messrs. Michael Rieger and Gill Hicks were key technical contributors and primary authors of section 10, emissions analysis. Mr. George Fetty made important contributions to the determination of current traffic levels and traffic forecasts, formulation of routing alternatives, estimation of capital costs, and quantification of population exposure to train operations.

This study has benefited from data, comments and suggestions received from representatives of BNSF, UP and Metrolink. However, the conclusions and evaluations expressed herein are those of the consultant, and do not necessarily represent the views of the railroads or of any governmental agency.

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[3] Los Angeles Economic Development Corporation, *Los Angeles – Inland Empire Railroad Main Line Advanced Planning Study,* Prepared for the Southern California Association of Governments, Contract number 01-077, Work element number 014302, October 1, 2002.

2. The Main Line Rail Network

Southern California is served by two major freight railroads, Burlington Northern Santa Fe (BNSF) and Union Pacific (UP). These are competing carriers operating their own terminals and rail networks. On several important segments within the study area, one carrier exercises trackage rights over lines owned by the other. There also are certain segments of the network owned and controlled by Metrolink over which the freight railroads exercise trackage rights.

Through freight trains on both railroads may be classified as intermodal (trailers and containers on rail flat cars), carload (mixed freight in carload lots, mostly bulk commodities), unit auto trains (solid trains of multilevel vehicle-carrying cars) and unit bulk (grain, coal, soda ash and oil trains, both loaded and empty). Intermodal trains may be further sub-classified into expedited intermodal (trailers and some double-stacked domestic container traffic), and non-expedited intermodal (mostly double-stacked marine container traffic).

Figures 1 and 2 provide diagrams of the main line rail network in the study area (not to scale). Not shown in the figures are numerous low-density branch lines for originating and terminating carload freight. An overview of through freight train operations and terminals in this network for each freight railroad follows.

BNSF Overview

BNSF operates a single main line (hereafter referred to as the "BNSF Line") in the study area, extending 152 miles from Barstow at the northeastern end to Redondo (near downtown Los Angeles) on the southwestern end. This line comprises two crew districts. All BNSF through freight trains change crews at San Bernardino and Barstow.

At Barstow, BNSF lines to Northern California and to eastern points diverge. A large carload classification yard is located there. All BNSF carload through freight trains in the study area originate or terminate here. BNSF intermodal, auto and unit bulk trains operating in the study area generally bypass the Barstow classification yard. Beyond Barstow, the vast majority of them operate over the line to/from eastern points rather than the line to/from Northern California.

From Daggett westward to West Riverside, UP freight trains on the UP Las Vegas Line operate over the BNSF Line under a long-standing trackage rights agreement. Some UP trains cross over to/from the UP Palmdale Line using connections installed at Silverwood or Keenbrook. Others may use connections at Colton Crossing or West Riverside to reach home rails.

Between Victorville and San Bernardino, the BNSF Line crosses Cajon Pass. The ascending grade southbound to Summit is 1.6%. From San Bernardino to Summit, the ascending grade northbound is 2.2% on the track ordinarily used by uphill trains. On the

track ordinarily used by downhill trains, the grade is 3% from Summit to Cajon station, rejoining the other track at that point to run parallel for the remainder of the descent to San Bernardino.

These are steep grades. Northbound, non-expedited intermodal trains typically require remotely-controlled or manned pusher engines San Bernardino – Summit, as do some northbound carload trains. Southbound, loaded unit bulk trains typically require pusher engines Victorville – San Bernardino. For safety reasons, all southbound trains leaving Summit on the 3%-gradient track are subject to a minimum 30-minute time lag to the departure of the previous train descending to Cajon station.

At San Bernardino, BNSF operates a large intermodal terminal. Some intermodal trains to/from eastern points originate/terminate here. Others to/from Los Angeles may stop to pick up or set out intermodal traffic. BNSF also operates a terminal for unit auto trains in San Bernardino. One carload train per day in each direction enters/exits the BNSF main line at San Bernardino, operating to/from a carload freight train terminal at Kaiser station, located along the Metrolink San Bernardino Line about 10 miles west of San Bernardino.

Metrolink commuter trains operate over the BNSF line between San Bernardino and Hobart. Some of these trains originate/terminate at San Bernardino, some at Riverside. Some diverge from the BNSF line at Atwood, while others enter the BNSF line at Fullerton. Amtrak Surfliner trains also operate over the BNSF line between Fullerton and Hobart. At Hobart, passenger trains diverge on passenger-only tracks that fly over the entrance to the Alameda Corridor at Redondo.

At Colton, BNSF and UP main lines cross at grade. A connecting track in the southeast quadrant of the crossing allows UP trains to/from the UP Yuma Line to operate over the BNSF line between Colton and West Riverside under trackage rights. A connecting track in the northwest quadrant of the crossing allows UP trains to/from the UP Las Vegas Line to connect to the UP Alhambra Line to West Colton. BNSF operates one carload train each way between Barstow and UP's West Colton classification yard, also using the connecting track in the northwest quadrant.

At Atwood, a Metrolink-owned line to Orange County points diverges from the BNSF line. This line is used by BNSF through freight trains to/from San Diego.

At Fullerton, another Metrolink-owned line to Orange County junctions with the BNSF line. This line does not see through freight train operations, but it does see heavy use by Amtrak and Metrolink passenger trains.

At La Mirada and Pico Rivera (about 8 miles and 15 miles west of Fullerton, respectively), BNSF operates small terminals for interchanging carload freight traffic to/from local freight switching operations. Through carload freight trains stop to set out or pick up at these points.

At Hobart BNSF operates a large intermodal terminal and a locomotive facility (at the adjacent Commerce station). Most expedited BNSF intermodal trains operating in the study area originate or terminate here. The crews and locomotives for carload freight trains serving La Mirada and Pico Rivera also originate and terminate here.

At Redondo, the BNSF main line ends in a connection with the Alameda Corridor. BNSF trains to/from terminals in the vicinity of the Ports of Los Angeles and Long Beach operate through Redondo. These include non-expedited intermodal trains, carload trains, and occasional unit bulk trains (grain, coal or white bulk such as soda ash).

UP Overview

UP operates a more complicated main line network in Southern California, a legacy of merging Southern Pacific into Union Pacific in 1996.

UP's principal carload freight classification terminal in the study area is located at West Colton. Almost all UP carload freight trains in the study area originate or terminate here. Regional carload freight trains termed Haulers operate between West Colton and various points in the Los Angeles Basin. Long-distance carload freight trains operate in/out of West Colton to Northern California via the Glendale Line, to Northern California and the Pacific Northwest via the Palmdale Line, and to eastern points via the Yuma Line. Long-distance carload freight trains to/from the Las Vegas line typically utilize the Palmdale line as far as Keenbrook or Silverwood, then crossing over onto the BNSF Cajon line and exercising trackage rights as far as Daggett. As described above, an alternate route for these trains is to use the connecting track in the northwest quadrant of Colton Crossing, exercising trackage rights over BNSF from that point to Daggett.

Extending east from Colton Crossing is UP's main line to Yuma, El Paso and eastern points. Within the limits of the study area, this line extends 72 miles from Colton Crossing to Indio. The line ascends a 1.8% grade eastbound to Apex station (near the town of Beaumont). Westbound, the line ascends a 2.0% grade from Garnet station (location of the Palm Springs passenger station) to Apex. Most eastbound carload trains and many eastbound intermodal trains require pusher engines Colton – Apex. Most westbound carload trains and some westbound intermodal trains require pusher engines Garnet – Apex.

Extending north from West Colton is UP's main line to Palmdale, Bakersfield, Northern California and Pacific Northwest points. The line ascends grades of up to 2.2% northbound for 29 miles to Hiland station. As remarked earlier, connections to the BNSF Cajon line exist at Keenbrook and Silverwood. Some northbound carload trains require pusher engines West Colton – Hiland. In contrast to the heavy traffic volumes on the BNSF Line over Cajon Pass, traffic volumes on the UP Palmdale Line are light. UP intermodal trains between Los Angeles and the Pacific Northwest exit the Los Angeles Basin via the Glendale Line, and unit oil and white bulk trains heading to the Southern California ports from Central California also normally use the Glendale Line. This leaves

only UP carload traffic to/from Northern California and the Pacific Northwest as the principal traffic on the Palmdale Line, forecast to reach only 9 trains per peak day in 2025. (This count excludes UP trains to/from Barstow that may be routed to use this route as far north as Keenbrook or Silverwood.)

From Colton Crossing to the downtown Los Angeles area, UP has two main line routes. The San Gabriel Line uses trackage rights over BNSF south from Colton Crossing to West Riverside, then turns westward. Metrolink commuter trains to/from Riverside operate over the UP San Gabriel Line from West Riverside to a connection with Metrolink's East Bank Line near East Los Angeles. The Alhambra Line extends westward from West Colton to Yuma Jct. (at the Los Angeles Transportation Center intermodal terminal) where connections with the Glendale Line and the East Bank Line are made. The junction of the connecting track with the East Bank Line is known as Pasadena Jct. The Metrolink San Bernardino Line is crossed at grade at is point.

The San Gabriel and Alhambra Lines come alongside each other at Pomona, where connections allow trains to cross over from one route to the other.

Along the Alhambra Line, UP operates a major intermodal terminal and a unit auto train terminal at City of Industry. West of City of Industry, there are no significant rail freight terminals until LATC is reached at the western end of the line (adjacent to Yuma Jct.). LATC originates and terminates a modest number of UP intermodal trains. Other intermodal trains, unit auto trains and one carload (Hauler) train each way utilize the Metrolink East Bank Line to secure a route connection between the Alhambra Line and the Alameda Corridor.

The Glendale Line contributes unit oil trains that traverse the East Bank Line en route to the Alameda Corridor. Empty unit oil trains make a reverse movement.

Along the San Gabriel Line, the UP operates a terminal for unit auto trains at Mira Loma (about 13 miles east of Pomona). A small terminal for interchanging carload freight traffic to/from local operations is located at Montclair (about 3 miles east of Pomona). At East Los Angeles, UP operates a large intermodal terminal. Expedited UP intermodal trains operate to and from this terminal. Carload trains also originate and terminate at East Los Angeles.

At Soto St. Jct. (located just west of East Los Angeles), Metrolink trains from Riverside diverge on to Metrolink's East Bank Line and proceed north along the Los Angeles River towards Los Angeles Union Passenger Terminal (LAUPT). Just across the bridge over the Los Angeles River, the San Gabriel Line terminates at Redondo, the start of the Alameda Corridor. Intermodal, carload, unit auto and occasional unit bulk trains from the San Gabriel line enter/exit the Corridor at this point.

Track Configuration

In this section, current track configuration of the main line network is summarized. Detailed track schematics for the Year 2000 network are provided in Appendix A.

All main lines in the study area are controlled under a system known as Centralized Traffic Control (CTC). Switches and signals are controlled remotely by a traffic controller known as a train dispatcher. Both UP and BN dispatchers for lines in the study are located in the same building in San Bernardino. Being co-located allows dispatchers from the two railroads to converse and jointly plan the movement of trains needing to exercise trackage rights. Metrolink dispatchers are located in downtown Los Angeles.

BNSF Trackage

The BNSF Line features reverse-signaled multiple tracks over its entire length. Power crossovers are located every several miles for flexible routing of trains.

Starting the review at Redondo, parallel two-main-track passenger and freight lines merge to become three main tracks 2 miles east at Hobart, narrowing to two main tracks at Bandini (about 5 miles east of Hobart). Three main tracks resume at Basta (2 miles west of Fullerton) and extend 2.5 miles to Fullerton Jct., where most Amtrak and Metrolink trains diverge. A third main track between Bandini and Basta is currently under construction.

The BNSF Line has two main tracks from Fullerton Jct. through Atwood to Esperanza, where three main tracks resume. The third main track ends about 6 miles further east at Prado Dam. At West Riverside (where the UP San Gabriel Line trains enter the BNSF Line on trackage rights), a third main track resumes and extends 4.5 miles to Highgrove. From Highgrove across Colton Crossing to Rana (4.5 miles), there are two main tracks. Single-track connections to Union Pacific tracks at West Riverside and Colton Crossing are at-grade junctions.

From Rana to San Bernardino, there are four main tracks. One main track (known as Main 4) takes a shorter route than the other three, but it has an at-grade, puzzle-switch junction with the Metrolink San Bernardino Line. Both through Metrolink movements and equipment movements between the San Bernardino station and lay-over/servicing tracks foul this junction. As a result, Main 4 is generally restricted to passenger train operations.

Between San Bernardino and Verdemont (7.5 miles), there are three main tracks, collapsing to two main tracks at Verdemont. The 6.5-mile segment of third main track from Baseline to Verdemont was completed and entered service in late 2004. A connecting track between the UP Palmdale Line and the BNSF Line is installed at Keenbrook, located about a half mile north of Devore Road on the BNSF Line and a half mile north of Dike Road on the UP Palmdale Line.

Two-main-track operation extends 10.5 miles from Verdemont to Cajon, where the two tracks diverge to take separate routes to Summit. Operation is normally left-handed in order to take advantage of more favorable grades. Main 1, the usual northbound track, has a 2.2% gradient to Summit, while Main 2 has a 3% gradient Cajon – Summit. Another connecting track with the UP Palmdale Line is located at Silverwood, connecting only to Main 1. A UP train operating on BNSF Main 2 southward from Victorville must use one of the crossovers to Main 1 at or before Summit in order to utilize this connection.

In deference to the steep and dangerous grade on Main 2, BNSF has instituted a policy of spacing southbound trains leaving Summit on Main 2 by at least 30 minutes. This spacing requirement does not apply to UP trains using the Silverwood connecting track.

From Summit north about 1.5 miles to Martinez, there is a third main track. This track entered service in October, 2003.

From Martinez northward 50 miles to Valley Jct. (the south end of Barstow), there are two main tracks. The tracks reverse positions at Frost (1.3 miles south of Victorville), with Main 2 (the usual southbound track) flying over the top of Main 1.

UP Trackage

The UP San Gabriel Line extends 55.1 miles from Redondo to West Riverside, where UP trains switch on to the BNSF Line exercising trackage rights as discussed above. The Line is mostly two-main-track CTC, with several stretches of single track, summarized as follows.

The San Gabriel Line has two or three main tracks over the entire stretch from Redondo to Pico Rivera, a distance of 9.3 miles. At that point it narrows to single track for 1.5 miles to Bartolo, where two-main-track operation resumes for the next 19 miles to Roselawn. In the Year 2000 Base Case, this line was single track for 3.8 miles between East Montebello and Bartolo, with a controlled siding at Pico Rivera. It also was single track for 2.3 miles between Diamond Bar and Spadra, located between Bartolo and Roselawn. Improvements made to the line since then eliminated the single-track segments East Montebello – Pico Rivera and Diamond Bar – Spadra.

A complicated at-grade junction with the UP Alhambra Line is located in the vicinity of Pomona. A short single-track segment extends 0.3 miles from Roselawn to Oak (station names for the junction switches 1-1.5 miles west of Pomona). At Roselawn and Oak, there are parallel connecting tracks to the UP Alhambra Line whereby eastbound trains on the San Gabriel Line can cross over to continue eastward on the Alhambra Line. Westbound movements on the UP Alhambra Line also can use this connection to cross over and continue westward on the UP San Gabriel Line.

From Oak through Pomona to Antonio (2.2 miles), the line once again has two main tracks. There are universal crossovers between the north main track of the UP San Gabriel Line and the UP Alhambra Line 0.4 miles east of Oak (named Hamilton station on the UP Alhambra Line), permitting trains in either direction on either line to cross over between the routes. Pomona station is located 0.7 miles east of Hamilton and 0.7 miles west of Antonio.

The San Gabriel Line continues as a single track for 5.4 miles from Antonio to Bon View, with a controlled passing siding midway at Montclair. Two-main-track operation resumes for 11.8 miles from Bon View to Limonite, with single-track operation over the next 2.7 miles to Arlington. This is followed by 2.9 miles of two-main-track operation to Streeter, in turn followed by 1.2 miles of single track to the BNSF connection at West Riverside.

The UP Alhambra Line extends 56.2 miles from Yuma Jct. (adjacent to LATC) to Colton Crossing. The line is mostly single-track CTC with passing sidings, summarized as follows.

The Alhambra Line has two main tracks extending from connections with Metrolink East Bank Line at Yuma Jct. 5.5 miles eastward to Alhambra. Over the next 50 miles to West Colton, the line is single track with controlled passing sidings. Usable sidings are located at El Monte (5.2 miles from Alhambra), Bassett (4.5 miles further east), City of Industry – Marne (three connected sidings in a row), Walnut (4.5 miles east of Marne), Hamilton-Reservoir (7 miles east of Walnut, albeit this passing track actually is one of the two main tracks of the San Gabriel Line), North Montclair (3 miles from Hamilton - Reservoir), North Ontario (3 miles from North Montclair), Guasti (4 miles from North Ontario), and South Fontana (5.5 miles from Guasti, at the approach to West Colton Yard). From West Colton to Colton Crossing, the line has two main tracks.

The UP Palmdale Line is single-track CTC with controlled passing sidings over the 29 miles from West Colton to Hiland. Passing tracks are located at Slover (1.7 miles from West Colton), Dike (10 miles from Slover), Canyon (11 miles from Dike), and Hiland. The Keenbrook connection to the BNSF Line is located 1.2 miles north of the north switch of Dike siding. The Silverwood connection to the BNSF Line is located 1.1 miles south of the south switch of Hiland siding.

In the Year 2000 Base Case, the UP Yuma Line had two main tracks from Colton Crossing eastward 39.0 miles to Fingal. From that point to Indio, the line was single track. Another 8.5 miles of second main track was opened in September, 2004, from Fingal to Garnet, absorbing the controlled siding at West Palm Springs. Two main tracks now cover the entire 24.5-mile west-side 1.8% grade to the summit at Apex plus 23.5 miles of the 2.0% east-side grade. A controlled siding serving the Palm Springs passenger station is located at Garnet.

The remaining 23.4 miles to Indio is single track, with grades opposing westward trains ranging up to 1.1%. Controlled passing sidings are located at Salvia (5 miles from

Garnet), Rimlon (4 miles from Salvia), Thousand Palms (5 miles from Rimlon, long enough to accommodate three trains), and Myoma (4 miles from Thousand Palms). Double track begins at West Indio (2.5 miles from Myoma), covering the last 1.3 miles into Indio.

Metrolink Trackage

The Metrolink East Bank Line is used by UP trains operating via the Alameda Corridor and the Alhambra Line. A single-track connection with the Corridor at Redondo crosses the Los Angles River and joins the two main tracks of the East Bank Line at Ninth Street. (Metrolink commuter trains from Riverside diverge from the UP San Gabriel Line at Soto St. Jct. and proceed over the 0.3 miles from Soto St Jct. to Ninth Street.) From Ninth Street to Pasadena Jct. (2.6 miles), the East Bank Line has two main tracks. At Pasadena Jct., UP freight trains to the Alhambra Line diverge from the East Bank Line and proceed 0.4 miles on the Balloon Track (single track) to Yuma Jct., where they enter the UP Alhambra Line. There is an at-grade crossing with the Metrolink San Bernardino Line at Pasadena Jct.

3. Freight Traffic Levels

Rail freight traffic mix and overall levels exhibit considerable variability by day of week and time of year. For the purposes of simulation analysis of track capacity, a series of "peak days" is simulated. Assumed traffic levels on a peak day reflect the 90th percentile of the statistical distribution of daily train movements. This is done to insure a robust design for trackage configuration is achieved.

Base Year Methodology

The counts given on following pages are for the sum of through freight train movements in both directions on a peak day. Excluded from these counts are light engine movements and local freight trains providing carload customer pick-up and delivery service. Peak-day counts of 57 trains per peak day on BNSF[4] and 55 trains per peak day on UP Lines[5] in year 2000 are assumed. These counts were developed from information obtained from the railroads and from previous studies, summarized as follows.

Freight train movements are classified into the following types: domestic intermodal, international intermodal (including double-stack and "bare table" movements), unit auto, unit coal, unit white bulk, unit oil, and mixed carload. Some intermodal trains haul exclusively domestic traffic, some haul exclusively international traffic, while others haul a mixture of domestic and international traffic. The consultant assumed overall domestic-international splits of intermodal traffic equal to 45:55 for BNSF and 25:75 for UP.

BNSF supplied information on average-day, 90th-percentile day[6] and theoretical peak-day[7] movements by type of freight train and line segment for year 2000. For the purposes of this study, the consultant established year 2000 peak-day BNSF train counts consistent with the BNSF counts on a 90th-percentile day, except counts of certain regional carload distribution trains were held fixed. (In the BNSF data, a 90th-percentile day has about 20% more train movements than an average day.)

The consultant obtained unofficial UP average-day total freight train counts by line segment for year 2001. A distribution of these counts among types of freight trains was made by the consultant based on field observations, published UP train counts[8], and the distribution reported in the 1991 ACTC rail capacity study.[9] To define year 2000 peak-day UP train counts, a 20% peaking factor was applied to the year 2001 average train counts, except counts of regional carload distribution trains ("Haulers") were held fixed.

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[4] The figure given applies between Atwood and San Bernardino. The BNSF peak-day count drops to 50 west of Atwood.
[5] The figure given applies at Pomona. The UP peak-day count at Colton rises to 64.
[6] 90th percentile-day means 90% of the year did not exceed the train count on this day.
[7] Theoretical peak-day includes the maximum daily count for each train type, but the maxima occur on different days of the year.
[8] UP average-day train counts by route were published in the Nov., 2001 issue of *Trains* magazine.
[9] Leachman and Associates, *Final Report: Railroad Capacity and Operations Analysis for the Alameda Consolidated Transportation Corridor Project*, December, 1991, prepared for DMJM and the Ports of Los Angeles and Long Beach.

For the purposes of this study, the consultant assumed year 2000 international-traffic intermodal trains that originate and terminate at East Yard (UP), LATC (UP) and Hobart (BNSF) to operate through the Alameda Corridor (although the Corridor actually did not open until 2002). This was done to facilitate comparative analysis in simulations of year 2000, year 2010 and year 2025 dispatching delays.

Future Traffic Levels

In the first phase of the Inland Empire Main Line Rail Study, LAEDC estimated growth rates that apply to various types of freight traffic.[10] Applying LAEDC's growth rates (specified below), the through freight train counts rise to 82 BNSF and 81 UP in Year 2010, and to 121 BNSF and 117 UP in Year 2025.

Zero growth rates were applied to certain carload trains providing local origination and termination services. Specifically, counts of the UP "Hauler" carload trains between West Colton Yard and City of Industry (Anaheim Hauler), between West Colton Yard and the Alameda Corridor (J Yard and Dolores Haulers), are held fixed. Similarly, counts of the BNSF carload trains between Barstow and the Alameda Corridor (Watson trains) also were held fixed.

International intermodal traffic is assumed to undergo 80.6% growth over the period 2000 – 2010 (6.09% per year), and a 77.3% growth over the period 2010-2025 (3.89% per year). Domestic intermodal traffic is assumed to undergo 28.0% growth over the period 2000-2010 (2.5% per year) and a 25.0% growth over the period 2010-2025 (1.5% per year).

Unit oil, auto, white bulk, and coal movements, and all other carload traffic, are assumed to undergo a 16.1% growth over the period 2000 – 2010 (1.5% per year), and 16.1% growth over the period 2010-2025 (1.0% per year).

[10] Los Angeles Economic Development Corporation, *Los Angeles – Inland Empire Railroad Main Line Advanced Planning Study,* Prepared for the Southern California Association of Governments, Contract number 01-077, Work element number 014302, October 1, 2002.

UP

Train type	2000	2010	2025
6,000' Dom. Intermodal, East Yard – Indio (via Montclair)	2.0	2.6	3.2
8,000' Dom. Intermodal, East Yard – Barstow (via Montclair)	2.0	2.6	3.2
Unit auto, East Yard – Indio (flex. routing, via Montclair in 2000)	0.8	0.9	1.1
Carload, East Yard – Barstow (via Montclair)	4.0	4.6	5.4
Carload, East Yard – Barstow (flex, via Montclair in 2000)	3.2	3.7	4.3
Unit coal, Alameda Corr. – Barstow (flex, via Montclair in 2000)	4.8	5.6	6.5
Unit white bulk, Ala. Corr. – Barstow (flex, via Montclair in 2000)	0.6	0.7	0.8
8,000' Intermod., Ala. Corr. – Bars. (flex, via Montclair in 2000)	7.6	13.7	24.3
6,000' Intermod., Ala. Corr. – Indio (flex, via Alhambra in 2000)	10.0	18.1	32.1
6,000' Intermod., Ala. Corr. – Indio (flex, via Montclair in 2000)	5.6	10.1	17.9
Unit auto, Alameda Corridor – Indio (flex, via Montclair in 2000)	0.6	0.7	0.8
Carload, Ala. Corr. – West Colton (flex, via Alhambra in 2000)	4.0	4.0	4.0
6,000' Dom. Intermodal, LATC – Indio (via Alhambra)	4.0	5.1	6.4
Carload, Glendale Line – West Colton Yard (via Alhambra)	3.4	3.9	4.6
Carload, City of Industry – West Colton Yard	2.0	2.0	2.0
Subtotal, UP LATC – West Colton plus UP East Yard – Mira Loma[1]	54.6	78.3	116.6
Carload, West Colton Yard – Indio	15.0	17.4	20.2
Unit auto, Mira Loma – Indio (via Riverside)	4.0	4.6	5.4
Subtotal, UP West Colton – Colton Crossing plus UP Mira Loma – Colton Crossing[2]	64.2	90.4	131.6
Trains using UP Colton Connection[3]	13.0	18.9	28.4
Subtotal, UP Yuma Line[4]	42.0	59.5	87.1
Unit oil, Alameda Corridor – Glendale Line	4.0	4.6	5.4
Unit white bulk, Alameda Corridor – Glendale Line	0.4	0.5	0.5
Subtotal, Metrolink East Bank Line[5]	24.0	27.2	42.0
Carload, West Colton Yard – Hiland	6.5	7.5	8.8
Subtotal, UP Palmdale Line	6.5	7.5	8.8

Notes: 1. Sum of preceding trains. 2. Sum of preceding trains less trains whose eastern terminal is West Colton. 3. Sum of Indio trains via Montclair. 4. Sum of all Indio trains. 5. Sum of Alameda Corridor trains via Alhambra or via Glendale Line.

BNSF

Train type	2000	2010	2025
Carload, Alameda Corridor – Barstow (BNSF)	2.0	2.0	2.0
Unit coal, Alameda Corridor – Barstow (BNSF)	1.0	1.2	1.3
8,000' Intermodal, Alameda Corridor - Barstow (BNSF)	11.0	19.9	35.2
6,000' Intermodal, Alameda Corridor – Bartow (BNSF)	11.0	19.9	35.2
Unit auto, Alameda Corridor – Barstow (BNSF)	2.0	2.3	2.7
6,000' Dom. intermodal, Hobart Yard – Barstow (BNSF)	18.0	23.0	28.8
Carload, Hobart Yard – Barstow (BNSF)	3.0	3.5	4.0
Unit auto, Hobart Yard – Barstow (BNSF)	2.0	2.3	2.7
Carload, Atwood – Barstow (BNSF)	3.0	3.5	4.0
Unit white bulk, Atwood – Barstow (BNSF)	2.0	2.3	2.7
Unit auto, Atwood – Barstow (BNSF)	2.0	2.3	2.7
Subtotal, BNSF Atwood – Colton Crossing	57.0	82.2	121.3
Subtotal, Alameda Corridor (UP & BNSF)	64.6	103.3	168.7

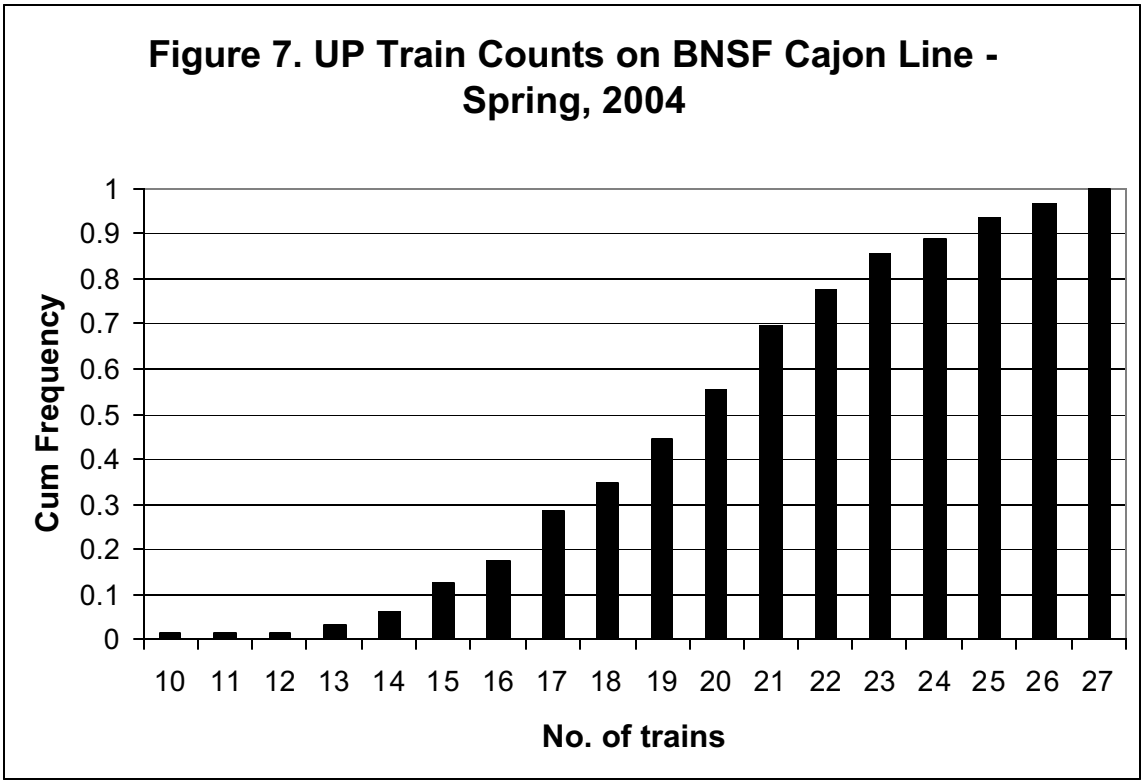
Additional Through Train Movements

The previous phase of the Inland Empire Rail Study did not encompass trackage between Colton Crossing and Barstow nor between Colton Crossing and Indio. Because no UP through freight trains originate or terminate at points between Colton and Indio, UP traffic counts developed in the previous phase remain applicable for the extended study area. However, there exist a number of BNSF through freight trains operating between Barstow and San Bernardino that originate or terminate at San Bernardino. Counts of these trains were excluded from the previous phase but are included in the analysis reported herein. Assumed peak-day counts for these movements are as follows:

Carload, San Bernardino – Barstow (BNSF)	2.0	2.0	2.0
Unit auto, San Bernardino – Barstow (BNSF)	2.0	2.3	3.7
6,000' Intermodal, San Bernardino – Barstow (BNSF)	4.0	5.1	6.4
Subtotal, BNSF Cajon Line (UP & BNSF)	87.2	122.5	177.9
Subtotal, UP Palmdale Line	6.5	7.5	8.8
Subtotal, UP Yuma Line	42.0	59.5	87.1

Validation of Freight Train Forecasts

BNSF provided the consultant with actual daily train counts on the BNSF Cajon Line for the 63-day period March 22 – May 23, 2004, inclusive. Figures 7 and 8 display frequency distributions for UP and BNSF through freight trains on this line. (Light pusher engine movements are excluded.) As may be seen, UP averaged 20 trains per day and its 90th percentile was about 24 trains per day. BNSF averaged 71 trains per day and its 90th percentile was about 78 trains per day. This gives a total of 91 trains per average day and 102 freight trains per peak day. Figure 9 displays the frequency distribution for total through freight trains on the BNSF Cajon Line. This figure shows 91 freight trains per average day and 100 freight trains per peak day. (The 90th percentile count is moderated slightly from the sum of BNSF and UP peak-day counts because peak days for the two railroads do not always occur on the same day of the week.)



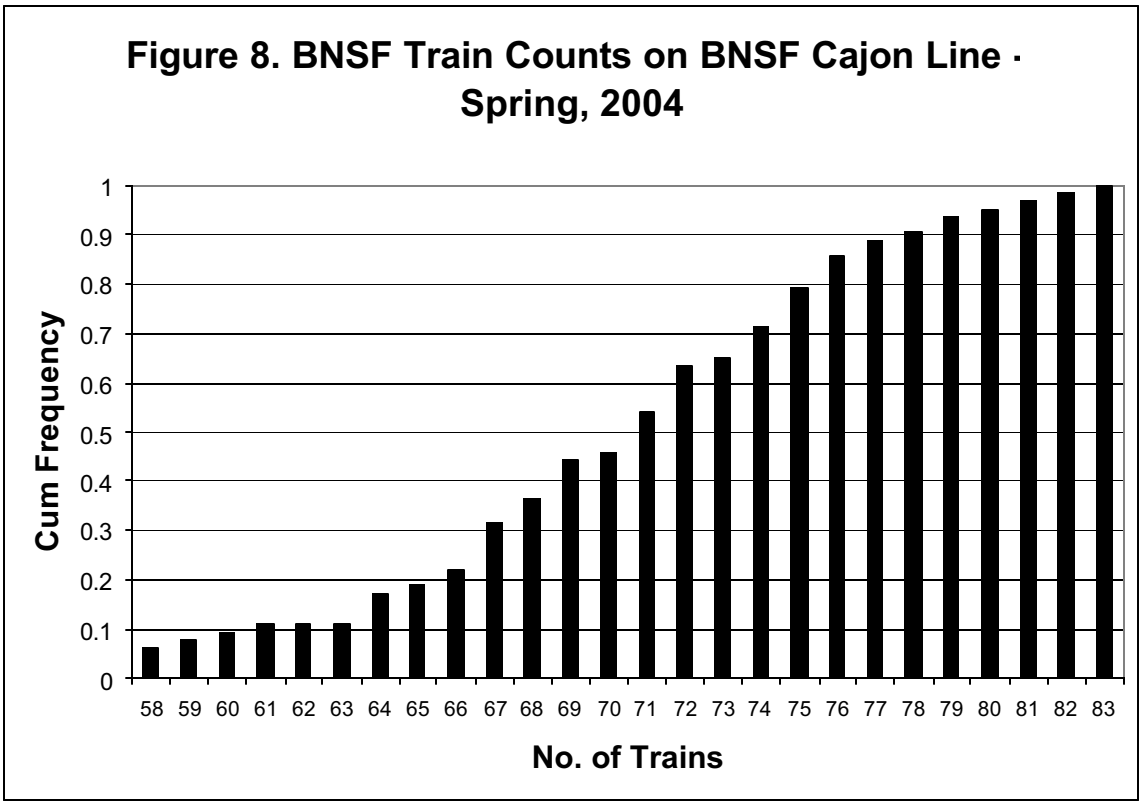


Figure 8. BNSF Train Counts on BNSF Cajon Line · Spring, 2004
Cum Frequency
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83
No. of Trains

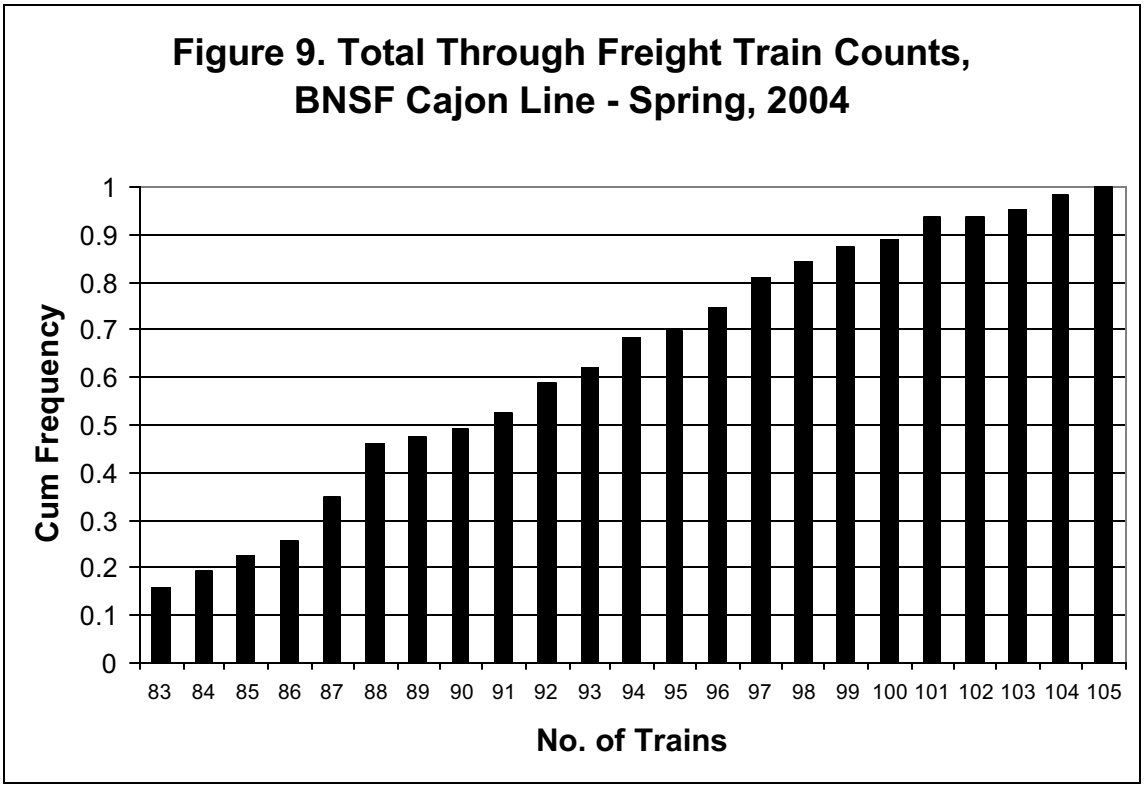


Figure 9. Total Through Freight Train Counts, BNSF Cajon Line - Spring, 2004
Cum Frequency
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105
No. of Trains

Applying the LAEDC growth rates to the Base Year (2000) train counts, we calculated the expected numbers of train movements per peak day over Cajon Pass four years later (i.e., 2004). These are summarized in Table 9. As may be seen, total forecast train counts track reasonably closely with the actual train counts. We remark, however, that the *mix* of freight trains is different than it was in 2000. While actual unit auto and carload train movements are very close to their forecasts, unit bulk train movements have declined rather than increased, domestic intermodal has grown faster than forecast, and international intermodal has grown slower than forecast.[11] Also, railroad market shares have evolved. BNSF intermodal has grown faster than forecast, while UP intermodal has grown more slowly. On the other hand, UP auto traffic has grown faster than forecast, while BNSF has grown more slowly.

Table 9. Comparison of Peak-Day Forecast and Actual Through Freight Train Movements, BNSF Cajon Line

	Year 2000 (Base Year)	Year 2004 Forecast	Year 2004 Actual
UP	22.2	25.2	24
BNSF	65.0	74.3	78
Total	87.2	99.5	100

Note: Peak-day is defined by the 90th percentile of daily train movements. Year 2004 actual figures are 90th percentiles for the period March 22 – May 23, 2004.

Because the forecasted *total* train count is accurate, we believe the forecasts discussed above are suitable for planning track capacity in 2010 and 2025, and so they have been adopted for the track capacity analysis reported herein.

Future Intermodal Terminals

The rapid growth in Southern California of value-added processing, warehousing and transloading of imported goods has strained the capacity of existing rail intermodal terminals in the study area. There is limited or no space available for expansion of the terminals in San Bernardino (BNSF), City of Industry (UP), East Yard (UP), LATC (UP), and Hobart (BNSF). This has prompted several proposals for new terminals. Suitable locations are scarce, and no concrete proposals for new terminals in the Inland Empire acceptable to all stakeholders are known to the consultant as of this writing. However, prospects seem better for shifting marine traffic now handled at Hobart to a new terminal

[11] This disparity in domestic and international intermodal train growth rates reflects a nomenclature inadequacy rather than a decline in import-export trade. For the purposes of this study, we define an international intermodal train as one hauling primarily double-stacked marine containers. A domestic intermodal train hauls primarily trailers and/or double-stacked domestic containers (which have a much larger cubic capacity than marine containers). Imported goods are increasingly transloaded into larger domestic containers. As a result, a substantial fraction of imported goods are hauled by "domestic" intermodal trains.

proposed near the Port of Los Angeles, which would open up more terminal capacity at Hobart for handling domestic containers.

Alternative UP Routings

As discussed above, Union Pacific has two routes between downtown Los Angeles and Colton Crossing (the Alhambra Line and the San Gabriel Line). In Year 2000, total freight train movements were divided about 40% Alhambra Line and 60% San Gabriel Line. Similar percentages are assumed in 2010 and 2025 under the Status Quo Alternative. While some freight movements must use one route or the other (because of the location of terminals), many others are flexible. The preferred allocation of trains to routes is a function of available track capacity, other traffic on the routes (especially passenger movements) and congestion at on-line freight terminals. Thus the actual allocation could vary compared to the scenarios studied here.

A related case of flexibility concerns UP trains operating between downtown Los Angeles and Barstow. Such trains operate over the San Gabriel Line and then can exercise trackage rights over BNSF from West Riverside to Barstow. Alternatively, they can be operated over the Alhambra Line to West Colton and then via the Palmdale Line, gaining access to the BNSF Cajon Line for furtherance to Barstow at either Keenbrook or Silverwood. In Year 2000, nearly all such UP trains operated via Riverside, and the 2010 and 2025 Status Quo scenarios assume continued predominance of such a routing. However, the actual allocation from day to day may vary according to conditions and congestion on the alternative lines.

Looking at the UP more broadly, the railroad has two routes from Southern California to Chicago: one via Barstow, Las Vegas, Salt Lake City and Omaha (the so-called Overland Route); the other via Indio, El Paso and Kansas City (the so-called Sunset and Golden State Route). As in the above case, some freight movements must use one route or the other (because of the location of terminals), but many others are flexible. The route via El Paso is shorter to Chicago, but its capacity is limited. The actual allocation of trains to transcontinental routes is a function of available track capacity, other traffic on the routes and balancing crew workloads. In Year 2000, total UP freight train movements were divided about 66% via Indio and 33% via Barstow. Similar percentages are assumed in our 2010 and 2025 forecasts.

In 2004 UP announced a long-term program to expand capacity of its line between Colton and El Paso (the Sunset Route). Because of this program or for other reasons, it is conceivable that the allocation of UP trains to route could vary from the scenarios studied here.

4. Passenger Traffic Levels

On following pages are projected passenger train frequencies on various rail lines within the study area. These projections were obtained directly from the operating agencies by the consultant. In the previous phase of the study, the consultant interviewed engineering and planning staff from Metrolink (Mr. M. E. McGinley and Ms. J. Capelle) on 6/11/01 and planning staff from Amtrak on 6/18/01 (Mr. D. E. Johnson) to obtain these inputs.

Year 2000 train counts on the following pages are the actual year 2001 service frequencies.

Metrolink provided planned service levels for the next three decades on their various lines. The first-decade level has been used as a 2010 forecast; the second-decade level has been used as a 2020 forecast; and a level mid-way between second- and third-decade levels has been used as a 2025 forecast.

Amtrak provided their Twenty-Year Improvement Plan for California. The "Near-Term" service levels were taken as the 2010 forecast, and the "Vision" service levels were taken as the 2020 forecast. Mr. D. E. Johnson, Planning Director for Amtrak West, provided specific 2010 and 2025 forecasts for new passenger train services to Las Vegas and Palm Springs passing through the study area. He confirmed that service levels on other lines could be assumed to be the same in 2025 as the "Vision" level of their plan.

An overall summary of the specific passenger train counts detailed on following pages is provided in Table 10.

Table 10. Peak-Day Passenger Train Counts by Railroad Line

RR Line	2000	2010	2020	2025
BNSF Line, Hobart – Fullerton Jct.	46	76	96	106
BNSF Line, Fullerton Jct. - Atwood	5	20	30	34
BNSF Line, Atwood - Riverside	15	38	54	62
BNSF/UP Line, Riverside – San Bernardino	11	24	32	36
BNSF/UP Line, San Bernardino – Barstow	2	6	8	8
UP San Gabriel Line	12	22	30	36
UP Alhambra Line (east of El Monte only)	2	4	8	8
UP Yuma Line, Colton – Garnet (Palm Springs)	2	4	8	8
UP Yuma Line, Garnet - Indio	2	2	2	2
Metrolink San Bernardino Line, crossing at grade of the Metrolink East Bank Line (UP freight route) at Pasadena Jct.	30	42	50	50
Metrolink San Bernardino Line, crossing at grade of BNSF Main 4 at San Bernardino	30	42	50	50

Passenger trains – Year 2000

1. Amtrak Sunset Limited (one train each way three days per week)
LAUPT – [Pasadena Jct.] via Metrolink, crossing UP freight corridor at Pasadena Jct.
[Pasadena Jct.] – [El Monte] via Metrolink San Bernardino Line (out of study area)
[El Monte] – Pomona – Indio via UP Alhambra and Yuma Lines

2. Amtrak Southwest Limited (one train each way daily)
LAUPT-[Hobart] via Metrolink (out of study area)
[Hobart] – Fullerton – Barstow via BNSF

3. Amtrak Pacific Surfliners (eleven trains each way daily)
LAUPT-[Hobart] via Metrolink (out of study area)
[Hobart]-Fullerton-[Fullerton Jct.] en route San Diego via BNSF

4. Metrolink San Bernardino Line (fifteen trains each way, ten in peak)
LAUPT – [Pasadena Jct.] via Metrolink, crossing UP freight corridor at Pasadena Jct.
[Pasadena Jct.] – San Bernardino via Metrolink San Bernardino Line (out of study area), also crossing BNSF Main 4 at San Bernardino

5. Metrolink Riverside Line (six trains each way, five in peak)
LAUPT – [Pasadena Jct.] via Metrolink (out of study area)
[Pasadena Jct.] – [Soto St. Jct.] via Metrolink
[Soto St. Jct.]-Montebello-Industry-Pomona-East Ontario-Pedley-Riverside via UP San Gabriel Line

6. Metrolink Orange County Line (nine trains southward per day, six in peak, and ten trains northward per day, eight in peak)
LAUPT – [Hobart] via Metrolink (out of study area)
[Hobart]-Commerce-Norwalk-Fullerton-[Fullerton Jct.] via BNSF

7. Metrolink Inland Empire – Orange County Line (six trains each way per day, five in peak)
San Bernardino – Riverside via BNSF (four out of six trains southward and five out of six trains northward)
Riverside-La Sierra-West Corona-[Atwood] en route Irvine via BNSF

8. Metrolink Riverside-Fullerton-Los Angeles (two trains southward and one train northward per day, all off-peak)
Riverside-La Sierra-West Corona-Fullerton-Norwalk-Commerce-[Hobart] via BNSF
[Hobart]-LAUPT via Metrolink (out of study area)

Re-cap of Year 2000 peak-day passenger trains by railroad line:

BNSF Hobart – Fullerton Jct.: 46

BNSF Fullerton Jct. – Atwood: 5
BNSF Atwood – Riverside: 16
BNSF/UP Riverside – San Bernardino: 11, plus 30 crossing Main 4 at San Bernardino
BNSF/UP San Bernardino – Barstow: 2
UP San Gabriel Line: 12
UP Alhambra Line: 2, plus 30 crossing main tracks at Pasadena Jct.
UP Yuma Line: 2

Passenger Trains – Year 2010

1. Amtrak Sunset Limited (one train each way three days per week)
LAUPT – [Pasadena Jct.] via Metrolink, crossing UP freight corridor at Pasadena Jct.
[Pasadena Jct.] – [El Monte] via Metrolink San Bernardino Line (out of study area)
[El Monte] – Pomona – Indio via UP Alhambra and Yuma Lines

2. Amtrak Southwest Limited (one train each way daily)
LAUPT-[Hobart] via Metrolink (out of study area)
[Hobart] – Fullerton – Barstow via BNSF

3. Amtrak Pacific Surfliners (sixteen trains each way daily; leave terminals hourly 6am-10pm)
LAUPT-[Hobart] via Metrolink (out of study area)
[Hobart]-Fullerton-[Fullerton Jct.] en route San Diego via BNSF

4. Metrolink San Bernardino Line (twenty-two trains each way, thirteen in peak)
LAUPT – [Pasadena Jct.] via Metrolink, crossing UP freight corridor at Pasadena Jct.
[Pasadena Jct.] – San Bernardino via Metrolink San Bernardino Line (out of study area), also crossing BNSF Main 4 in San Bernardino

5. Metrolink Riverside Line (ten trains each way, eight in peak)
LAUPT – [Pasadena Jct.] via Metrolink (out of study area)
[Pasadena Jct.] – [Soto St. Jct.] via Metrolink
[Soto St. Jct.]-Montebello-Industry-Pomona-East Ontario-Pedley-Riverside via UP San Gabriel Line

6. Metrolink Orange County Line (twelve trains each way per day, ten in peak)
LAUPT – [Hobart] via Metrolink (out of study area)
[Hobart]-Commerce-Norwalk-Fullerton-[Fullerton Jct.] via BNSF

7. Metrolink Inland Empire – Orange County Line (nine trains each way per day, six in peak)
San Bernardino – Riverside from/to San Bernardino via BNSF
Riverside-La Sierra-West Corona-[Atwood] en route Irvine via BNSF

8. Metrolink Riverside-Fullerton-Los Angeles (eight trains each way per day, five in peak)
Riverside-La Sierra-West Corona-Fullerton-Norwalk-Commerce-[Hobart] via BNSF
[Hobart]-LAUPT via Metrolink (out of study area)

9. Amtrak Las Vegas Holiday Special via Pomona (one train each way per day)
LAUPT – [Pasadena Jct.] via Metrolink (out of study area)
[Pasadena Jct.] – [Soto St. Jct.] via Metrolink
[Soto St. Jct.]-Pomona-Riverside via UP San Gabriel Line
Riverside – Barstow via BNSF

10. Amtrak Las Vegas Holiday Special via Fullerton (one train each way per day)
LAUPT – [Hobart] via Metrolink (out of study area)
[Hobart] – Fullerton – Riverside – Barstow via BNSF

11. Amtrak Palm Springs Holiday Special (one train each way per day)
LAUPT – [Pasadena Jct.] via Metrolink, crossing UP freight corridor at Pasadena Jct.
[Pasadena Jct.] – [El Monte] via Metrolink (out of study area)
[El Monte] – Ontario – Palm Springs via UP Alhambra and Yuma Lines

Re-cap of Year 2010 peak-day passenger trains by railroad line:

BNSF Hobart – Fullerton Jct.: 76
BNSF Fullerton Jct. – Atwood: 20
BNSF Atwood – Riverside: 38
BNSF/UP Riverside – San Bernardino: 24, plus 42 crossing Main 4 at San Bernardino
BNSF/UP San Bernardino – Barstow: 6
UP San Gabriel Line: 22
UP Alhambra Line: 4, plus 42 crossing main tracks at Pasadena Jct.
UP Yuma Line, Colton – Garnet: 4
UP Yuma Line, Garnet – Indio: 2

Passenger Trains – Year 2020

1. Amtrak Sunset Limited (one train each way three days per week)
LAUPT – [Pasadena Jct.] via Metrolink, crossing UP freight corridor at Pasadena Jct.
[Pasadena Jct.] – [El Monte] via Metrolink San Bernardino Line (out of study area)
[El Monte] – Pomona – Indio via UP Alhambra and Yuma Lines

2. Amtrak Southwest Limited (one train each way daily)
LAUPT-[Hobart] via Metrolink (out of study area)
[Hobart] – Fullerton – Barstow via BNSF

3. Amtrak Pacific Surfliners (sixteen trains each way daily; leave terminals hourly 6am-10pm)
LAUPT-[Hobart] via Metrolink (out of study area)
[Hobart]-Fullerton-[Fullerton Jct.] en route San Diego via BNSF

4. Metrolink San Bernardino Line (twenty-five trains each way, sixteen in peak)
LAUPT – [Pasadena Jct.] via Metrolink, crossing UP freight corridor at Pasadena Jct.
[Pasadena Jct.] – San Bernardino via Metrolink San Bernardino Line (out of study area), also crossing BNSF Main 4 at San Bernardino

5. Metrolink Riverside Line (fourteen trains each way, nine in peak)
LAUPT – [Pasadena Jct.] via Metrolink (out of study area)
[Pasadena Jct.] – [Soto St. Jct.] via Metrolink
[Soto St. Jct.]-Montebello-Industry-Pomona-East Ontario-Pedley-Riverside via UP San Gabriel Line

6. Metrolink Orange County Line (seventeen trains each way per day, fourteen in peak)
LAUPT – [Hobart] via Metrolink (out of study area)
[Hobart]-Commerce-Norwalk-Fullerton-[Fullerton Jct.] via BNSF

7. Metrolink Inland Empire – Orange County Line (twelve trains each way per day, seven in peak)
San Bernardino – Riverside from/to San Bernardino via BNSF
Riverside-La Sierra-West Corona-[Atwood] en route Irvine via BNSF

8. Metrolink Riverside-Fullerton-Los Angeles (twelve trains each way per day, seven in peak)
Riverside-La Sierra-West Corona-Fullerton-Norwalk-Commerce-[Hobart] via BNSF
[Hobart]-LAUPT via Metrolink (out of study area)

9. Amtrak Las Vegas Holiday Special via Pomona (one train each way per day)
LAUPT – [Pasadena Jct.] via Metrolink (out of study area)
[Pasadena Jct.] – [Soto St. Jct.] via Metrolink
[Soto St. Jct.]-Pomona-Riverside via UP San Gabriel Line
Riverside – Barstow via BNSF

10. Amtrak Las Vegas Holiday Special via Fullerton (two trains each way per day)*
LAUPT – [Hobart] via Metrolink (out of study area)
[Hobart] – Fullerton – Riverside – Barstow via BNSF

11. Amtrak Palm Springs Holiday Special (three trains each way per day)*
LAUPT – [Pasadena Jct.] via Metrolink, crossing UP freight corridor at Pasadena Jct.
[Pasadena Jct.] – [El Monte] via Metrolink (out of study area)
[El Monte] – Ontario – Palm Springs via UP Alhambra and Yuma Lines

*Note: No Amtrak forecast for year 2020 is available. These train counts are from year 2025 Amtrak forecast.

Re-cap of Year 2020 peak-day passenger trains by railroad line:

BNSF Hobart – Fullerton Jct.: 96
BNSF Fullerton Jct. – Atwood: 30
BNSF Atwood – Riverside: 54
BNSF/UP Riverside – San Bernardino: 32, plus 50 crossing Main 4 at San Bernardino
BNSF/UP San Bernardino – Barstow: 8
UP San Gabriel Line: 30
UP Alhambra Line: 8, plus 50 crossing main tracks at Pasadena Jct.
UP Yuma Line, Colton – Garnet: 8
UP Yuma Line, Garnet – Indio: 2

Passenger Trains – Year 2025

1. Amtrak Sunset Limited (one train each way three days per week)
LAUPT – [Pasadena Jct.] via Metrolink, crossing UP freight corridor at Pasadena Jct.
[Pasadena Jct.] – [El Monte] via Metrolink San Bernardino Line (out of study area)
[El Monte] – Pomona – Indio via UP Alhambra and Yuma Lines

2. Amtrak Southwest Limited (one train each way daily)
LAUPT-[Hobart] via Metrolink (out of study area)
[Hobart]-Fullerton – Barstow via BNSF

3. Amtrak Pacific Surfliners (sixteen trains each way daily; leave terminals hourly 6am-10pm)
LAUPT-[Hobart] via Metrolink (out of study area)
[Hobart]-Fullerton-[Fullerton Jct.] en route San Diego via BNSF

4. Metrolink San Bernardino Line (twenty-five trains each way, sixteen in peak)
LAUPT – [Pasadena Jct.] via Metrolink, crossing UP freight corridor at Pasadena Jct.
[Pasadena Jct.] – San Bernardino via Metrolink San Bernardino Line (out of study area), also crossing BNSF Main 4 at San Bernardino

5. Metrolink Riverside Line (seventeen trains each way, eleven in peak)
LAUPT – [Pasadena Jct.] via Metrolink (out of study area)
[Pasadena Jct.] – [Soto St. Jct.] via Metrolink
[Soto St. Jct.]-Montebello-Industry-Pomona-East Ontario-Pedley-Riverside via UP San Gabriel Line

6. Metrolink Orange County Line (twenty trains each way per day, sixteen in peak)
LAUPT – [Hobart] via Metrolink (out of study area)
[Hobart]-Commerce-Norwalk-Fullerton-[Fullerton Jct.] via BNSF

7. Metrolink Inland Empire – Orange County Line (fourteen trains each way per day, eight in peak)
San Bernardino – Riverside via BNSF
Riverside-La Sierra-West Corona-[Atwood] en route Irvine via BNSF

8. Metrolink Riverside-Fullerton-Los Angeles (fourteen trains each way per day, eight in peak)
Riverside-La Sierra-West Corona-Fullerton-Norwalk-Commerce-[Hobart] via BNSF
[Hobart]-LAUPT via Metrolink (out of study area)

9. Amtrak Las Vegas Holiday Special via Pomona (one train each way per day)
LAUPT – [Pasadena Jct.] via Metrolink (out of study area)
[Pasadena Jct.] – [Soto St. Jct.] via Metrolink
[Soto St. Jct.]-Pomona-Riverside via UP San Gabriel Line
Riverside – Barstow via BNSF

10. Amtrak Las Vegas Holiday Special via Fullerton (two trains each way per day)
LAUPT – [Hobart] via Metrolink (out of study area)
[Hobart] – Fullerton – Riverside – Barstow via BNSF

11. Amtrak Palm Springs Holiday Special (three trains each way per day)
LAUPT – [Pasadena Jct.] via Metrolink, crossing UP freight corridor at Pasadena Jct.
[Pasadena Jct.] – [El Monte] via Metrolink (out of study area)
[El Monte] – Ontario – Palm Springs via UP Alhambra and Yuma Lines

Re-cap of year 2025 passenger trains by railroad line:

BNSF Hobart – Fullerton Jct.: 106
BNSF Fullerton Jct. – Atwood: 34
BNSF Atwood – Riverside: 62
BNSF Riverside – San Bernardino: 36, plus 50 crossing Main 4 at San Bernardino
BNSF San Bernardino – Barstow: 8
UP San Gabriel Line: 36
UP Alhambra Line: 8, plus 50 crossing main tracks at Pasadena Jct.
UP Yuma Line, Colton – Garnet: 8
UP Yuma Line, Garnet – Indio: 2

Validation of Passenger Train Forecasts Against Year 2004 Movements

Current (2004) Metrolink and Amtrak schedules were retrieved by the consultant. These are compared to actual Year 2000 and to forecast Year 2010 movements in Table 11.

Table 11. Comparison of Peak-Day Passenger Train Counts

Train Route	Year		
	2000	**2004**	**2010**
Metrolink			
Covina - Los Angeles	30(20)	34(20)	44(26)
San Bernardino – Covina	30(20)	30(20)	40(26)
San Bernardino – Riverside	9(4)	9(4)	18(12)
Riverside – Atwood	15(10)	21(16)	34(22)
Atwood – Fullerton	3(0)	9(6)	16(10)
Fullerton – Los Angeles	22(14)	28(23)	40(30)
Riverside – Pomona – Los Angeles	12(10)	12(10)	20(16)
Amtrak			
Fullerton – Los Angeles	22	23	32
El Monte – Indio	2	2	4
Los Angeles – Fullerton – Barstow	2	2	4
Los Angeles – Pomona – Barstow	0	0	2

Note: Figures in parentheses for Metrolink trains are train counts during peak hours. Figures for years 2000 and 2004 are actual movements, figures for 2010 are forecasts.

As may be seen, actual train counts for Year 2004 are generally consistent with the forecasted growth towards Year 2010 levels. For this reason, we used the forecasts discussed above in planning track capacity in 2010 and 2025 scenarios.

Recapitulation of Traffic Forecasts

A recapitulation of peak-day train movements for selected line segments is provided in Table 12. Further detail, providing counts for all line segments in the study area, is provided in Tables B-1 through B-12 in Appendix B.

Table 12. Total Through Train Movements per Peak Day by Line Segment

Line Segment	Train type	2000	2010	2025
BNSF Hobart – Fullerton Jct.	Freight	50.0	74.1	111.9
	Psgr	46	96	106
	Total	96.0	170.1	207.9
BNSF Fullerton Jct., - Atwood	Freight	50.0	74.1	111.9
	Psgr	5	20	34
	Total	55.0	94.1	145.9
BNSF Atwood – West Riverside	Freight	57	82.2	121.3
	Psgr	16	38	62
	Total	73.0	120.2	183.3
West Riverside – Colton	UP Freight	35.2	49.8	72.9
	BNSF Freight	57.0	82.2	121.3
	Psgr	11	24	36
	Total	103.2	156.0	230.2
Colton Crossing	BNSF Line	90.2	137.1	201.8
	UP Yuma Line	31.0	44.6	64.7
	Total	121.2	181.7	266.5
Colton – San Bernardino	UP Freight	22.2	30.9	44.5
	BNSF Freight	57.0	82.2	121.3
	Psgr	11	24	36
	Total	68.0	106.2	157.3
Lines over Cajon Pass (including BNSF/UP Cajon Line and UP Palmdale Line)	Freight	93.7	130.0	186.7
	Psgr	2	6	8
	Total	95.7	136.0	194.7
UP Mira Loma – W. Riverside plus UP West Colton – Colton	Freight	64.2	90.4	126.2
	Psgr	14	26	44
	Total	78.2	116.4	170.2
UP Yuma Line	Freight	42.0	59.5	87.1
	Psgr	2	4	8
	Total	44.0	63.5	95.1

Discussion of Traffic Levels

The 2010 and 2025 train counts are very large and unprecedented in western U.S. railroading history. For the moment, suppose we take fifty trains per day per track as a very rough metric of track capacity. This metric is within reason for multiple-main-track territory where all trains move at comparable speeds. Where there is great disparity in speeds, such as on mountain grades, capacity may be much less. Over short stretches where all trains move at the same speed without switching, capacity could be more.

Given this metric, in 2025 the BNSF Line would require four main tracks Hobart to Fullerton (vs. two or three now), three main tracks Fullerton to Atwood (vs. two now), four main tracks Atwood to Riverside (vs. two or three now), and five main tracks Riverside to Colton (vs. two or three now). Colton Crossing clearly would need to be grade-separated. On UP Lines between Los Angeles and Riverside/Colton, there would need to be a total of four main tracks (vs. two or three now). Over Cajon Pass there would need to be at least four main tracks (vs. three now). The UP's Colton – Indio Line would need to have two main tracks over the entire distance (vs. one or two now).

Thus it is obvious that large capital outlays for substantial infrastructure improvements are required to accommodate these forecasts. Specific plans for these improvements are developed below.

Capacity Planning Strategy

Rigorously speaking, there is not a fixed capacity figure appropriate for any given rail line. Average dispatching delays increase whenever more trains are added to a line. Each increment in delay reduces the quality of service and increases the cost of operating the rail line; passenger schedules and freight delivery schedules must be slowed down and more rolling stock is required per unit traffic. Figure 10 illustrates the general trade-off between transit time and traffic level. The trade-off is worse, i.e., the transit times rise more sharply, when the line handles a mix of trains that travel at different speeds (e.g., freight and passenger).

Discrete-event simulation of railroad traffic is used in this study to examine possible upgrades to the rail lines in order to handle the rising freight and passenger volumes. The general analytical strategy taken in this study is to first simulate the Year 2000 Base Case and take note of the simulated average transit times for BNSF and UP through freight trains. Next, we devise promising track capacity improvements and test them in iterative simulations of 2010 and 2025 traffic scenarios. This process continues until we identify for each scenario a program of track capacity improvements that provides simulated average transit times close to Year 2000 levels. In this way, we plan track capacity just sufficient to offer rail freight services comparable to that offered in the Year 2000 Base Case.

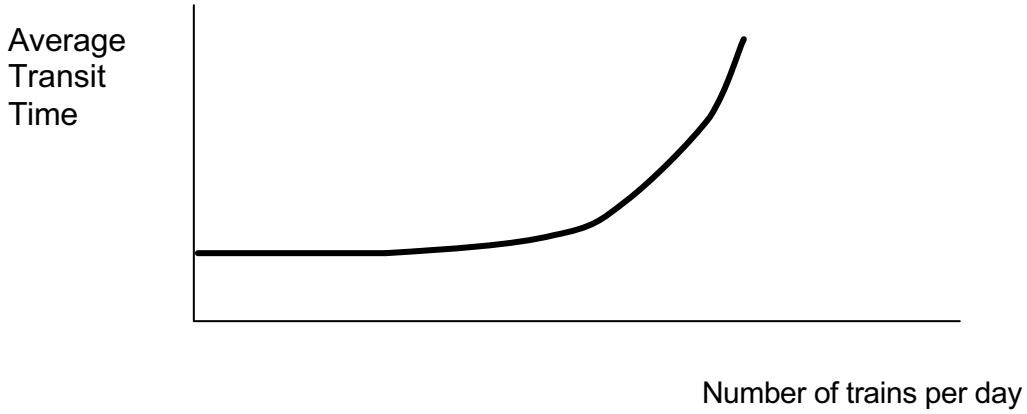


Figure 10
Rail Line Capacity:
The Trade-Off Between Train Volume and Delay

5. Routing Alternatives

Three routing alternatives to the Status Quo are formulated and analyzed in this report. The motivation for consideration of these alternatives stems from the following factors:

- The UP Palmdale Line is relatively underutilized, whereas the BNSF Line through Riverside, San Bernardino and over Cajon Pass is heavily utilized. By 2025, it will be impossible to achieve Year 2000 transit times unless a significant fraction of UP Barstow trains are routed via the UP Palmdale Line, West Colton and the UP Alhambra Line. Moreover, integrating the UP Palmdale Line to be flexibly dispatched as if it were another BNSF track on the south slope of Cajon Pass, would significantly reduce track capacity expenditures needed to accommodate 2010 and 2025 traffic levels.
- Routing trains via the UP San Gabriel Line involves use of trackage rights over the BNSF Line between Colton Crossing and West Riverside. This is the most heavily utilized line segment in the Los Angeles Basin. Expansion of the capacity of this segment to accommodate 2025 traffic levels is relatively difficult and expensive under the Status Quo alternative, requiring a fourth main track plus flying junctions to enter and exit BNSF tracks. Expansion of capacity of the UP Alhambra Line between West Colton and Pomona is more practical and less costly.
- Shifting UP trains operating between Cajon Pass and Pomona off the BNSF Line and the UP San Gabriel Line and onto the UP Palmdale and UP Alhambra Lines reduces conflicts between Metrolink commuter trains and UP freight operations, thereby reducing track capacity expenditures needed to accommodate 2010 and 2025 traffic levels.
- Shifting UP trains operating between Cajon Pass and Pomona off the BNSF and UP San Gabriel Lines and onto the UP Palmdale and UP Alhambra Lines reduces total population exposure to through train movements and total vehicular delays at grade crossings.

All three alternatives to the Status Quo have identical train counts on the BNSF Line and on UP Lines east of Pomona. As shown in Table 13, these alternatives reduce the through train counts in downtown San Bernardino and downtown Riverside by approximately 22% and 31%, respectively.

Table 13
Forecasted Peak-Day Through Freight Train Counts in Downtown Riverside and Downtown San Bernardino

	Riverside		San Bernardino	
	2010	**2025**	**2010**	**2025**
Status Quo	132	194	123	178
Alternatives 1 or 2	91	132	96	139
Delta	41	62	27	39

The three alternatives all concentrate about 88% of UP through train movements via West Colton versus only 12% via the UP San Gabriel Line between West Riverside and Pomona. The three alternatives to the Status Quo differ only in the routing of UP through train movements west of Pomona, summarized as follows:

- *Alternative 1a:* About 85% of UP through train movements between Pomona and downtown Los Angeles points are routed via the UP San Gabriel Line. Only UP through freight trains utilizing the City of Industry or LATC terminals, plus UP freight trains operating to/from the Glendale Line, are routed via the UP Alhambra Line west of Pomona.
- *Alternative 1b:* Same as Alternative 1a, but with the additional feature that Metrolink Riverside – Pomona – Los Angeles trains are re-routed via the UP Alhambra Line west of Pomona. The station stop at City of Industry would be re-sited on the Alhambra line, the station stop at Montebello would be closed (with passengers re-directed to the Commerce station on the BSNF Line), and a new station stop at Alhambra would be introduced. Under this alternative, Metrolink operations and heavy UP through train movements are largely disjoint, thereby reducing track capacity requirements.
- *Alternative 2:* About 85% of UP through train movements between Pomona and downtown Los Angeles points are routed via the UP Alhambra Line. Metrolink operations continue via the UP San Gabriel Line. Only UP through freight trains utilizing the East Los Angeles terminal are routed via the UP San Gabriel Line west of Pomona. Under this alternative, Metrolink operations and heavy UP through train movements are largely disjoint, except they share trackage along the Metrolink East Bank Line.

The rationale for formulating and analyzing these three alternatives is as follows. It is clear that future UP freight traffic needs to be concentrated on the UP Alhambra Line west of Pomona, in order to avoid the congestion on the Riverside – Colton Crossing segment that would result from overlaying UP traffic on top of heavy BNSF and Metrolink traffic. But it is not clear *a priori* how UP freight traffic should be routed west of Pomona. Alternatives 1a and 1b test concentration of UP freight traffic on the UP San Gabriel Line, while Alternative 2 tests concentration of UP freight traffic on the UP Alhambra Line. Alternative 1b tests the additional feature of re-routing Metrolink trains onto the Alhambra Line (west of Pomona) and away from heavy UP freight traffic.

We now turn to the results of evaluating the alternatives using simulation.

6. Train Dispatching Simulations

Discrete-event simulation of railroad traffic is used to examine possible upgrades to the rail lines in order to handle the rising freight and passenger volumes. The general analytical strategy is to find the average delay per train in Year 2000 and devise promising track capacity improvements that maintain Year 2000 levels of delay in train dispatching simulations of 2010 and 2025 traffic levels.

The Simulation Model

Since 1983, Leachman and Associates has progressively developed simulation methodology to model the complicated rail networks in the Los Angeles-Inland Empire trade corridor region. The simulation model is based on a discrete event methodology and developed using the Awesim© Simulation Language.[12] Physical resources modeled include rail junctions for crossover movement in a rail network, and physical track divided into track segments with uniform speed limits. The simulation network comprises of nodes and arcs, where nodes consist of one or more contiguous segments, and arcs represent movement from one node to another.

Simulation statistics are compiled for 100 consecutive peak-days (which effectively "stress-tests" the improvements). Freight train departure times are randomized, while passenger train departure times are fixed. The model incorporates assumptions about train lengths and tonnages, acceleration and deceleration rates, track configurations and speed limits. The model also incorporates traffic control logic to resolve conflicts and thereby "dispatch" the railroad. Technical discussions of the traffic control logic and simulation methodology are summarized below. Further details are available in the open academic literature.[13]

Figure 11 provides a simplified overview of the rail dispatch model. Data inputs to the model include Train Schedule, Train Type, and Track Network. Train Schedule with origin station generates Departing Train Entities and is stored in the Event Calendar. Event Calendar interacts with the Central Dispatching Algorithm to decide on moving the train entity or on stopping the train. Moving the train will seize resources and generate next events, while stopping the train will cause the train to decelerate, stop, and be placed in a queue to wait. Finally, in case the arrival train terminates, information is recorded. The primary simulation outputs are the average delay and flow times of the trains.

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[12] Pritsker, A. B. and J. J. O'Reilly. 1999. *Simulation with Visual SLAM and Awesim.* John Wiley & Sons, Inc., New York.

[13] Lu, Quan, Maged Dessouky, and Robert C. Leachman, "Modeling Train Movements Through Complex Rail Networks," *ACM Transactions on Modeling and Computer Simulation,* Vol. 14, No. 1, January, 2004, p. 48-75. See also Dessouky, Maged, Robert C. Leachman and Quan Lu, "Using Simulation Modeling to Assess Rail Track Infrastructure in Densely Trafficked Metropolitan Areas," *Proceedings of the2002 Winter Simulation Conference*, E. Yücesan, C.-H. Chen, J. L. Snowdon, and J. M. Charnes, eds., 2002.

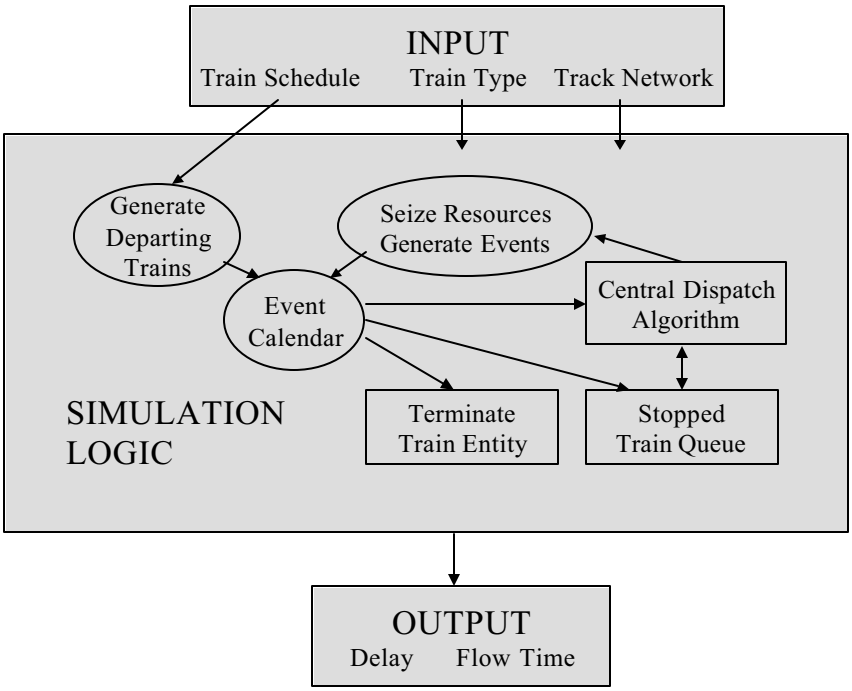

Figure 11. Overview of Rail Dispatch Model Structure

Input data to the model includes the rail network (line segments, junction and crossover switches, speed limits), train types (priority, origin, destination, length, maximum speed, acceleration and deceleration rates), and train schedules (origin and destination, train type, starting times). For the purposes of the current study, maximum speed and acceleration rates were made a function of line gradient in order to accurately simulate operation of heavy trains over mountain grades. Values for maximum speed and acceleration rate as a function of gradient were pre-computed based on train tonnage; locomotive horsepower, weight and tractive effort; and standard assumptions for rolling resistance and locomotive efficiency and adhesion.

The simulation logic is briefly summarized as follows. An event calendar is maintained within the simulation containing events for trains ready to depart and train arrivals at junctions and end points of track segments. A central dispatching algorithm is called to process each event and decide whether the train should continue moving (i.e., take possession of additional track resources) or begin to decelerate to a stop. A train is simulated to begin decelerating to a stop either when the necessary track segment or junction resource has been awarded to some other movement, or a continuation of its movement would cause a deadlock. If the train is stopped, the train is placed in a queue to wait for an available track resource.

If the central dispatching algorithm decides to move the train, the algorithm determines the following:

- The distance the train travels within the awarded resource
- The time of travel over the resource, accounting for change-of-speed points
- The successor track resources that could be possessed by the train

The algorithm assigns the track resources to the train and schedules "resource-free" events that release track resources the train no longer needs during this movement. Ultimately, an event is scheduled to represent the time the train finishes movement.

When a resource-free event is processed, all the trains in the stopped train queue are checked to see whether this released resource can trigger a movement for one of the stopped trains. The triggered train in the queue is the one with the highest priority and longest waiting time. Its movement will be determined by the central dispatching algorithm in the same manner as described above.

Finally, if the event is a train arrival at its destination terminal, statistics concerning the train movement will be recorded and the train will be terminated from the system. When the simulation finishes, the primary outputs are the average delay and transit time by train type and origin-destination pair.

Input and Output Files

Input data for the train dispatching simulation model is categorized in terms of the Track Network, Train Types, and Train Schedules.

The Track Network data (i.e., the physical rail network) is represented in terms of two types of resources: track segments and junction switches. Each segment of track has a specified uniform speed limit and extends between other segments with different speed limits or junctions in the network for crossover or diverging movement. Parallel tracks are distinct segments. Maximum speed over junction switches also is specified in this data.

The Train Type data specifies the train length, maximum speed, and acceleration and deceleration rates for each train type. The latter three parameters are a function of the line gradient.

The Train Schedule data specifies the train type, origin and destination for each train ID. It also specifies inter-arrival times (i.e., times between consecutive departure times for the same train ID). Inter-arrival times may be fixed as a schedule or they may be randomized by the simulation according to user-specified probability distributions.

Year 2000, Year 2010 and Year 2025 Train Schedule data for all main line rail movements west and south of Colton Crossing were developed by Leachman and

Associates in the previous phase of this study.[14] These include all movements over main line tracks from the south end of the Alameda Corridor to Colton Crossing via Union Pacific and Burlington Northern Santa Fe main lines. Metrolink lines utilized by UP and BNSF main line trains also are included. In the current phase, Train Schedule data was expanded to include the movements over the UP Yuma Line (Colton – Indio), the BNSF Cajon Line (Colton – Barstow), and the UP Palmdale Line (West Colton – Hiland).

Output data from the simulation consists of text files of statistical summaries by train ID and by location. The summary by train ID specifies the following information for each train ID:

- Transit time: mean, standard deviation, minimum, maximum
- Delay: mean, standard deviation, minimum, maximum
- Mileage: mean, standard deviation, minimum, maximum (Note: mileage may vary when there are alternative routes through the rail network for a given train ID)
- Size of queue of waiting trains at origin station: average, maximum
- Wait time at origin station: average over trains that waited
- Probability train waits at origin station (i.e., fraction of simulated trains that were delayed from starting)

The summary by location ("node") specifies the following information for each location and train ID:

- Probability train is stopped at that location (i.e., fraction of simulated trains that were stopped at that location)
- Average wait time when train was stopped

Model Validation

The Leachman and Associates' train dispatching model was validated in an earlier study.[15] A brief summary of that validation is provided here.

A data set of 25 actual Burlington Northern Santa Fe double-stack container train movements operating over a thirty-day period (mid-April to mid-May, 2003) was obtained from the railroad. These trains originated at the Maersk/APM on-dock rail terminal in the Port of Los Angeles and were destined to eastern points, primarily Chicago. The data set provided by BNSF included passing times at selected points for the

[14] Los Angeles Economic Development Corporation, *Los Angeles – Inland Empire Railroad Main Line Advanced Planning Study,* prepared for Southern California Association of Governments, Contract number 01-077, Work element number 014302, October 1, 2002.

[15] Mallon, Larry G., J. D. Hwang and R. C. Leachman, *Optimization of Military and Commercial Goods Movement Through Southern California Using Information Technology*, prepared for US Navy Space and Naval Warfare Systems Center, Center for Commercial Deployment of Transportation Technologies, Cal-State University at Long Beach, Sept., 2003.

actual Maersk container train movements. The southernmost passing point is CP Sepulveda (1.3 miles north of Long Beach Jct., the junction between lines to Terminal Island and the Port of Long Beach proper); the northernmost passing point is Colton Crossing.

Operation of these same 25 trains was simulated between Long Beach Jct. and Colton Crossing, juxtaposed with all the Year 2000 traffic levels described in earlier sections of this report. Simulation results for the 25 Maersk stack trains between CP Sepulveda and Colton Crossing were compared to statistics on the actual transit times between these points in order to validate the simulation model.

Undertaking a train-by-train review of the passing times of the actual train movements, two anomalies were discovered. Train #19 experienced a three-hour delay between Hobart and Pico Rivera, and train #22 experienced a 2 hour, 45 minute delay between Riverside and Colton. Evidently there were disruptions (e.g., trackside detector alarms, pickups or setouts, change of locomotives, etc.) impacting these two train movements. Such disruptions are not included in our simulations. Thus, we did the comparison without these two trains.

Considering the 23 BNSF trains (trains #19 and 22 removed), statistics on actual and simulated transit times CP Sepulveda - Colton Crossing are displayed in Table 14. As may be seen, the statistics on actual and simulated trains are remarkably close. The very minor differences are well within the levels of expected variability for 23 train movements.

Table 14. Actual vs. Simulated Transit Times, CP Sepulveda – Colton Crossing

Statistic	Actual	Simulated
Mean	3 hours, 26 minutes	3 hours, 28 minutes
Standard deviation	0 hour, 43 minutes	0 hours, 51 minutes
Minimum	2 hours, 10 minutes	2 hours, 27 minutes
Maximum	4 hours, 53 minutes	5 hours, 01 minutes

Source: Mallon, Larry G., J. D. Hwang and R. C. Leachman, *Optimization of Military and Commercial Goods Movement Through Southern California Using Information Technology*, prepared for US Navy Space and Naval Warfare Systems Center, Center for Commercial Deployment of Transportation Technologies, Cal-State University at Long Beach, Sept., 2003.

7. Simulation Results

In the previous phase of this study, track capacity was analyzed from downtown Los Angeles to and including Colton Crossing.[16] Lines south and west of Colton Crossing were thoroughly simulated in the previous phase of this study, so detailed simulation results for those lines will not be repeated here. A summary of the required track capacity improvements south and west of Colton Crossing is provided in Section 8 of this report.

In the current phase, we focus on track capacity from Colton Crossing northward to Barstow and eastward to Indio. In this section the detailed simulation results for lines east and north of Colton Crossing are integrated with results west of Colton Crossing to provide complete track capacity plans for the study area.

UP Yuma Line

Results for the UP Yuma Line are presented in Table 15. These results apply to all routing alternatives. Shown are average minutes of delay and average transit times between Colton Crossing and West Indio for freight and passenger trains in various scenarios. Delay times account for periods when trains are stopped as well as extra transit time when trains move more slowly than their free-running speed.

In the Base Case (Year 2000), there are 42 trains per peak day utilizing about 30 miles of single-track-CTC line between Fingal and Indio and 40 miles of two-main-track-CTC line between Colton and Fingal. This results in average delays of 48 minutes per passenger train and 35 minutes per passenger train. With concerted effort in traffic control, the delay per passenger train could be reduced somewhat, but at the expense of much greater delays to freight trains. In any case, delays on this line are significant, and the lack of capacity is a barrier to improving rail service. This is already recognized. As noted above, extension of the second main track over the 8.5 miles eastward from Fingal to Garnet was completed in early 2005.

In 2010, to sustain the Base Case level of delays, it will be necessary to extend the two-main-track capacity eastward another 9 miles through Garnet (location of the Palm Springs passenger station) to Salvia (absorbing the existing passing track at that point). This extension will put all of the grades on the line in excess of 1.2% within two-main-track territory.

In 2025, to sustain the Base Case level of delays, it will be necessary to have two main tracks in operation over the entire line to Indio. Once this is done, train delays will be significantly less than the Base Case, even when accommodating a doubling of traffic on the line.

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[16] Los Angeles Economic Development Corporation, *Los Angeles – Inland Empire Railroad Main Line Advanced Planning Study,* prepared for Southern California Association of Governments, Contract number 01-077, Work element number 014302, October 1, 2002.

It should be noted that even in the case the entire line is equipped with two main tracks, passenger trains still experience an average of about 25 minutes of delay compared to their free-running times between Colton and Palm Springs. This is because of the slow speeds of freight trains climbing and descending the mountain grades Colton – Apex and Garnet – Apex. If faster passenger schedules than this are desired for the proposed passenger services to Palm Springs, a third main track over the mountain grades will be required.

Table 15. Simulation Results, Colton Crossing – Indio
(Results applicable to all routing alternatives)

		Freight		Passenger	
Year	**Trackage Configuration**	**Average Delay (mins)**	**Average Transit Time (mins)**	**Average Delay (mins)**	**Average Transit Time (mins)**
2000	**Two main tracks, Colton – Fingal**	**48.4**	**193.3**	**35.3**	**132.3**
2010	Two main tracks, Colton – Fingal	63.5	208.9	66.1	163.2
2010	Two main tracks, Colton – Garnet	52.1	197.0	38.0	135.0
2010	**Two main tracks, Colton – Salvia**	**47.5**	**193.5**	**21.3**	**118.2**
2025	Two main tracks, Colton – Salvia	101.1	246.5	67.4	164.3
2025	Two main tracks, Colton – Rimlon	82.4	228.6	36.0	134.0
2025	Two main tracks, Colton – 1000 Palms	71.7	219.8	30.8	130.4
2025	Two main tracks, Colton – Myoma	53.5	203.1	24.8	126.7
2025	**Two main tracks, Colton – Indio**	**28.6**	**175.5**	**23.7**	**120.9**

Note: The Base Case and future scenarios with adequate track capacity are shown in bold face type. Other scenarios offer inadequate track capacity.

BNSF Cajon Line and UP Palmdale Line

Results from simulating the rail main lines over Cajon Pass are presented in Tables 16, 17 and 18. In the Base Case (Year 2000), freight trains to/from Barstow average 223 minutes in transit time between Colton Crossing and Valley Jct. (Barstow), while passenger trains on this line average about 193 minutes in transit. UP Palmdale Line trains average about one and one half hours on the West Colton – Hiland run. Not shown in the table are delays and transit times for Metrolink passenger trains between Colton Crossing and San

Bernardino. Delay times are less than a minute and transit times are 8-9 minutes for these trains in all scenarios, so these Metrolink operations are not at issue.

Considering the minimum 30-minute spacing of southbound trains leaving Summit on the 3%-gradient downhill track, there exists a capacity constraint of 48 westbound trains per day, i.e., 96 total trains per day. In 2004 and 2005, this count was reached or exceeded on many days, i.e., the BNSF Cajon Line is already operating at capacity. The only way current peak-day traffic volumes can be accommodated is by diverting some southbound UP trains over the Silverwood connection to use the UP Palmdale and UP Alhambra Lines (i.e., as in the alternatives to the Status Quo).

Table 16. Simulation Results, Colton Crossing – Barstow and West Colton – Hiland, 2000 and 2010

		Barstow Freight	**Hiland Freight**	**Barstow Passenger**
Year	**Trackage Configuration**	**Avg. Transit Time (mins)**	**Avg. Transit Time (mins)**	**Avg. Transit Time (mins)**
2000	**Base Case** UP Palmdale Line separate, BNSF Line with 2 main tracks Baseline – Barstow	223.0	88.5	193.1
2010	**Status Quo** UP Palmdale Line separate, BNSF Line with 3 main tracks Baseline – Barstow	239.9	90.7	191.2
2010	**Status Quo** UP Palmdale Line separate, BNSF Line with 4 main tracks San Bernardino – Summit, 3 main tracks Summit - Barstow	225.2	90.7	184.1
2010	**Alts. 1, 2** Integration of UP Palmdale Line with BNSF Line Devore Rd. – Silverwood, BNSF Line with 3 main tracks San Bernardino – Devore Rd. and Silverwood – Barstow, 2 main tracks Devore Rd. – Silverwood	234.0	139.0	181.9
2010	**Alts. 1, 2** Integration of UP Palmdale Line with BNSF Line Devore Rd. – Silverwood, BNSF Line with 3 main tracks San Bernardino - Barstow (two 3% and one 2.2% track, Cajon – Summit)	225.2	135.3	181.8

Table 17. Simulation Results, Colton Crossing – Barstow and West Colton – Hiland, 2025

		Barstow Freight	Hiland Freight	Barstow Passenger
Year	**Trackage Configuration**	**Avg. Transit Time (mins)**	**Avg. Transit Time (mins)**	**Avg. Transit Time (mins)**
2025	**Status Quo** UP Palmdale Line separate, BNSF Line with 4 main tracks San Bernardino - Barstow	238.7	90.3	191.3
2025	**Status Quo** UP Palmdale Line separate, BNSF Line with 4 main tracks San Bernardino – Barstow, plus fifth main track Cajon – Summit (2.2%)	237.7	90.3	182.6
2025	**Status Quo** UP Palmdale Line separate, BNSF Line with 4 main tracks San Bernardino – Barstow, plus fifth main track Cajon – Summit (2.2%) and Baseline – Devore Rd.	232.9	90.3	181.9
2025	**Alts. 1, 2** UP Palmdale Line with 2 main tracks West Colton - Devore Rd., integration of UP Palmdale Line with BNSF Line Devore Rd. – Silverwood, BNSF Line with 3 main tracks San Bernardino – Silverwood (one 2.2% and two 3%, Cajon – Summit), and 4 main tracks Silverwood – Barstow	248.4	142.5	201.4
2025	**Alts. 1, 2** UP Palmdale Line with 2 main tracks West Colton - Devore Rd., integration of UP Palmdale Line with BNSF Line Devore Rd. – Silverwood, BNSF Line with 3 main tracks San Bernardino – Cajon, and 4 main tracks Cajon – Barstow (two 2.2% and two 3%, Cajon – Summit)	246.6	139.6	181.8
2025	**Alts. 1, 2** UP Palmdale Line with 2 main tracks West Colton - Devore Rd., integration of UP Palmdale Line with BNSF Line Devore Rd. – Silverwood, BNSF Line with 3 main tracks San Bernardino – Devore Rd., and 4 main tracks Devore Rd. – Barstow (two 2.2% and two 3%, Cajon – Summit)	242.0	139.1	181.6

At a minimum, three main tracks accommodating BNSF and UP Barstow trains are required in 2010 and four main tracks are required in 2025. Considering both the UP Palmdale Line and the BNSF Cajon Line, three main tracks already exist between Keenbrook and Silverwood (two with a 2.2% grade and one with a 3% grade between Cajon and Silverwood), but these are not flexibly dispatched as a single rail line. At present, only UP trains to/from West Colton may use the UP Palmdale Line track. Under the Status Quo alternative, it is assumed the Palmdale Line remains exclusively for operation of UP freight trains. This means a new main track (2.2%) must be constructed along the BNSF Line Devore Rd. - Summit in 2010, and another main track (3%) must be constructed in 2025.

On the other hand, in the simulations of 2010 and 2025 scenarios under Alternatives 1 and 2, it has been assumed that the UP Palmdale Line and the BNSF Cajon Line may be flexibly dispatched as a single railroad line, whereby another connection would be constructed at Devore Road (Keenbrook) permitting northbound (uphill) trains on the BNSF Cajon Line to use (as an option) the UP Palmdale Line main track from Keenbrook to Silverwood. Capacity for Barstow trains basically equivalent to the Status Quo alternative as above is achieved with no new main tracks in 2010 between Devore Rd. and Silverwood, and with only one new main track (3%) in 2025.

Even for these ambitious improvements, average transit times for Barstow freight trains are above the Year 2000 levels. Compared to Year 2000, Barstow freight trains experience an average of 10 – 20 more minutes of transit time using three main tracks in 2010, and 15 – 25 more minutes of transit time using four main tracks in 2025. So the addition of more trackage was tested in simulations.

In 2010, under both the Status Quo and the alternatives to the Status Quo, configurations offering four main tracks between Devore Road and Silverwood usable by all Barstow freight trains are just adequate to allow Barstow freight trains to match Year 2000 transit times (Table 17). We therefore identify these sets of improvements as the ones that are required for Year 2010.

For Year 2025, we first simulated the addition of a fifth main track between Cajon and Silverwood (3%) for use by all Barstow freight trains. As can be seen in Table 17, this improvement only reduced simulated average transit times by about a minute (although Amtrak transit times improved about 10 minutes over the Base Case). Next, we tested extension of this fifth track between Cajon and Devore Road. As can be seen, average transit times for Barstow freights still ended up 15 – 23 minutes above Year 2000 levels.

To totally restore Year 2000 transit times in the 2025 scenario, even more track would be required. We therefore tested extending the 5th main track between Devore Road and San Bernardino (4th main track in the case of Alternatives 1 and 2). As shown in Table 18, for the alternatives to the Status Quo, this configuration eliminates the excess over Year 2000 average transit time for Barstow freights, even bettering it by about 4 minutes. But the Status Quo transit times are still about 7 minutes worse. This is evidently because the

Status Quo attempts to accommodate all Barstow trains on five tracks between Keenbrook and Colton, whereas the alternatives to the Status Quo spread these trains over six tracks (two on the Palmdale Line and four on the BNSF Line).

Table 18. Additional Simulation Results, Colton Crossing – Barstow and West Colton – Hiland, 2025

		Barstow Freight	Hiland Freight	Barstow Passenger
Year	**Trackage Configuration**	**Avg. Transit Time (mins)**	**Avg. Transit Time (mins)**	**Avg. Transit Time (mins)**
2025	**Status Quo** UP Palmdale Line separate, BNSF Line with 5 main tracks San Bernardino – Summit and four main tracks Summit - Barstow	230.4	90.3	174.5
2025	**Alts. 1, 2** UP Palmdale Line with 2 main tracks West Colton - Devore Rd., integration of UP Palmdale Line with BNSF Line Devore Rd. – Silverwood, BNSF Line with 4 main tracks San Bernardino – Silverwood (two 2.2% and two 3%, Cajon – Summit), and 4 main tracks Silverwood – Barstow	219.0	140.3	181.3

In the consultant's judgment, the practicality of constructing a five-track BNSF Line San Bernardino – Summit is questionable, and a six-track line seems out of the question. In that sense, it is *impossible* for the Status Quo to sustain Year 2000 transit times under 2025 traffic levels. To achieve this, a significant fraction of the Barstow freights *must* be routed via the Palmdale Line, as under the alternatives to the Status Quo.

To carry out a reasonably fair comparison of alternatives, we shall assume in 2025 comparable configurations for the alternatives offering average transit times 15 – 19 minutes longer than the Year 2000 times, i.e., five main tracks Cajon – Summit (three 2.2%, two 3%) and four main tracks Devore Road – Cajon. East of Summit, there would be four main tracks. West of Devore Road, there would be three main tracks on the BNSF Line and two on the UP Palmdale Line (Alternatives 1 and 2), or four on the BNSF Line and one on the UP Palmdale Line (Status Quo alternative).

As was the case for the UP Yuma Line, passenger trains are not able to achieve their free-running transit times, due to the need to follow slow-moving freight trains operating on the same track over the steep mountain grades. In all three scenarios, simulated running times for passenger trains Colton Crossing – Barstow on this high-volume, mixed-traffic line average about 3 hours, 15 minutes, or about one hour longer than the free-running

transit time. Shorter transit times for passenger trains would require the construction of a separate main track for passenger trains over the mountain grades San Bernardino – Summit – Victorville.

8. Summary of Track Capacity Improvements

Improvements Required West and South of Colton Crossing

Table 19 summarizes the track capacity improvements required on the BNSF Line west and south of Colton Crossing, as determined in the previous phase of this study. (Increments in track capacity are highlighted in bold type.)

Table 19. Summary of Required Track Capacity on BNSF Line, South and West of Colton Crossing
(Figures express required numbers of main tracks.)

		Status Quo		**Alternatives 1 and 2**	
Line Segment	**Existing in 2005**	**2010**	**2025**	**2010**	**2025**
BNSF Line					
Hobart – Bandini	3	3	**4**	3	**4**
Bandini – Basta	2	**3**	**4**	**3**	**4**
Bandini – Fullerton Jct.	3	3	**4**	3	**4**
Fullerton Jct. – Atwood	2	2	**3**	2	**3**
Atwood – Esperanza	2	**3**	3	**3**	3
Esperanza – Prado Dam	3	3	3	3	3
Prado Dam – West Riverside	2	**3**	3	**3**	3
West Riverside jct. with UP	At grade	At grade	**Flying jct.**	At grade	At grade
West Riverside – Highland	3	3	**4**	3	3
Highland – Colton Crossing	2	**3**	**4**	**3**	3
Colton Crossing	At grade	At grade	**Separated, with flying jct. to UP**	At grade	**Separated**

Note: A "flying junction" allows connecting movements to proceed without fouling the route of opposing through traffic, much like a freeway interchange.

Table 20 summarizes the track capacity improvements required under the Status Quo on the UP Lines west of Colton Crossing, as determined in the previous phase of this study.

As shown in the tables, under the Status Quo Alternative the BNSF Line must be expanded to 3 or 4 main tracks Hobart to Colton Crossing. The UP San Gabriel Line must be expanded to 2 main tracks over its entire extent. The UP Alhambra Line must be expanded to 2 main tracks west of Pomona. Flying junctions are required at West Riverside and West Colton, and the Colton Crossing must be grade-separated.

Table 20. Summary of Required Track Capacity on UP Lines West of Colton Crossing – Status Quo Alternative
(Figures express required numbers of main tracks.)

Line Segment	Existing in 2005	2010	2025
UP San Gabriel Line			
West Riverside – Streeter	1	**2**	2
Streeter – Arlington	2	2	2
Arlington – Pedley	1	**2**	2
Pedley – Bon View	2	2	2
Bon View – Pomona	1	**2**	2
Pomona – Roselawn	1	**2**	2
Roselawn – Bartolo	2	2	2
Bartolo – Pico Rivera	1	**2**	2
Pico Rivera – Garfield Ave.	2	2	2
Garfield Ave. – East Los Angeles	3	3	3
East Los Angeles – Downey Road	2	2	2
Downey Road – Soto St. Jct.	3	3	3
Soto St. Jct. – Redondo	2	2	2
UP Alhambra Line			
Colton Crossing – West Colton	2	2	2
Jct. with Palmdale Line at West Colton	Partial flying	Partial flying	**Full flying**
West Colton – Pomona	1	1	1
Pomona route connections	At-grade crossovers	At-grade crossovers	At-grade crossovers
Pomona - Alhambra	1	1	**2**
Alhambra – Yuma Jct.	2	2	2
Yuma Jct. – Pasadena Jct.	1	1	1
Metrolink crossing at Pasadena Jct.	At grade	At grade	At grade
Pasadena Jct. – Ninth St.	2	2	2
Ninth St. - Redondo	1	1	1

Note: A "flying junction" allows connecting movements to proceed without fouling the route of opposing through traffic, much like a freeway interchange.

Five routing alternatives to the Status Quo were investigated west of Colton Crossing in the previous phase of this study. Three were found to be practical, identified in the previous phase of this study as Alternatives 1(a), 1(b) and 2. As explained in section 4 of this report, all three of these alternatives are identical east of Pomona. They minimize UP through freight trains over the UP San Gabriel Line between Colton Crossing and Pomona, thereby avoiding the need for expensive flying-junction route connections at Colton Crossing and West Riverside and also avoiding the need for a fourth main track on the BNSF between Colton Crossing and West Riverside. Table 21 summarizes the track capacity improvements between Pomona and Colton/Riverside for these alternatives. As may be seen, the alternatives require double-tracking of the UP Alhambra

Line from West Colton to Pomona. In common with the Status Quo alternative, by 2025 they require a full flying junction of the UP Alhambra and Palmdale Lines.

Table 21.
Summary of Required Track Capacity on UP Lines
Colton and Riverside to Pomona for Alternatives to Status Quo Routing
(Figures express required numbers of main tracks.)

	Existing in 2005	**2010**	**2025**
UP San Gabriel Line			
West Riverside – Streeter	1	1	1
Streeter - Arlington	2	2	2
Arlington - Pedley	1	1	1
Pedley – Bon View	2	2	1
Bon View - Pomona	1	1	1
UP Alhambra Line			
Colton Crossing – West Colton	2	2	2
Jct. with Palmdale Line at West Colton	Partial flying	Partial flying	**Full flying**
West Colton – Pomona	1	**2**	2
Pomona route connections	At grade crossovers	At grade crossovers	**Metrolink fly-over**

Note: A "flying junction" allows connecting movements to proceed without fouling the route of opposing through traffic, much like a freeway interchange. A "partial flying junction" partially eliminates conflicts between through and connecting movements. A "fly-over" is a grade-separated crossing of rail lines. Movements connecting between routes by using at-grade crossovers block through traffic.

Because these three alternatives route UP freight traffic differently west of Pomona, their improvement plans are different between Pomona and downtown Los Angeles. Table 22 summarizes these improvements. As may be seen, in 2025, Alternative 1a requires triple-tracking of the UP San Gabriel Line west of Pomona. Alternative 2 requires double-tracking of the UP Alhambra Line west of Pomona, double-tracking of the connections to the Metrolink East Bank Line, triple-tracking of the Metrolink East Bank Line itself, and a separation of the Metrolink crossing at Pasadena Jct. Alternative 1(b) is more economic in terms of track capacity, with two tracks on the UP San Gabriel Line and one track on the UP Alhambra Line west of Pomona.

Improvements Required East and North of Colton Crossing

Tables 23 and 24 summarize track capacity improvements required east and north of Colton Crossing. On the UP Yuma Line, required improvements are common to all alternatives. The second main track must be progressively extended towards Indio. Completion as far as Salvia is required for Year 2010 traffic levels, and completion all the way to Indio is required for Year 2025 traffic levels. These levels of track capacity enable only relatively slow passenger train schedules of about two hours running time

over the 50 miles between Colton and Palm Springs. This is due to the need to follow slow-moving freight trains up and down the mountain grades. If faster transit times are desired for passenger trains, a third main track will be required between Colton and Palm Springs.

Table 22.
Summary of Required Track Capacity on UP Lines West of Pomona
For Alternatives to Status Quo Routing
(Figures express required numbers of main tracks.)

	Existing in 2005	**2010**			**2025**		
		Alt 1a	**Alt 1b**	**Alt 2**	**Alt 1a**	**Alt 1b**	**Alt 2**
San Gabriel Line							
Pomona – Roselawn	1	**2**	**2**	1	**3**	2	**2**
Roselawn – Bartolo	2	2	2	2	**3**	2	2
Bartolo – Pico Rivera	1	**2**	**2**	1	**3**	2	**2**
Pico Rivera – Garfield Ave.	2	2	2	2	**3**	2	2
Garfield Ave. – East Los Angeles	3	3	3	3	3	3	3
East Los Angeles – Downey Road	2	2	2	2	2	2	2
Downey Road – Soto St. Jct.	3	3	3	3	3	3	3
Soto St. Jct. – Redondo	2	2	2	2	2	2	2
Alhambra Line							
Pomona – Alhambra	1	1	1	**2**	1	1	**2**
Alhambra – Yuma Jct.	2	2	2	2	2	2	2
Yuma Jct. – Pasadena Jct.	1	1	1	**2**	1	1	2
Metrolink crossing at Pasadena Jct.	At grade	At grade	At grade	At grade	At grade	At grade	**Fly-over**
Pasadena Jct. – Ninth St.	2	2	2	2	2	2	**3**
Ninth St. – Redondo	1	1	1	**2**	1	1	2

Note: A "fly-over" is a grade-separated crossing of another rail line.

On the UP Palmdale Line, two main tracks are required in 2025 under the alternatives to the Status Quo. This is the result of re-routing all UP Barstow through freight trains via this line. Moreover, in both 2010 and 2025 under these alternatives, the Palmdale Line becomes utilized by BNSF trains between route connections at Devore Road (Keenbrook) and Silverwood.

Table 23.
Summary of Required Track Capacity
on UP Lines North and East of Colton Crossing
(Figures express required numbers of main tracks.)

		Status Quo		**Alts. 1 and 2**	
	Existing in 2005	**2010**	**2025**	**2010**	**2025**
UP Yuma Line					
Colton Crossing – Garnet	2	2	2	2	2
Garnet – Salvia	1	**2**	2	**2**	2
Salvia - Indio	1	1	**2**	1	**2**
UP Palmdale Line					
West Colton – Devore Rd. (Keenbrook)	1	1	1	1	**2**
Devore Rd. (Keenbrook) – Hiland	1	1	1	1	1

On the BNSF Line, the very-high traffic volumes will require a minimum of three main tracks in 2010 and four main tracks in 2025 (Table 24). To match Year 2000 transit times, an additional track will be needed over the most steeply-graded segment of the line. Between Devore Road (Keenbrook) and Silverwood, four tracks are required in 2010 (two on a 2.2% grade, two on a 3% grade) and five tracks in 2025 (two on a 2.2% grade, three on a 3% grade).

Considering the BNSF Cajon Line and the UP Palmdale Line collectively, there already exist three main tracks over Cajon Pass, two constructed to a 2.2% grade. Construction of a crossover at Devore Road (Keenbrook) and institutional agreements between UP and BNSF allowing BNSF trains to use the UP track could obviate the need to build an expensive duplicate 2.2%-gradient main track for the BNSF Line between Devore Road (Keenbrook) and Silverwood. Under the alternatives to the Status Quo, this scheme is proposed (Table 24). Moreover, UP Barstow trains are proposed to be re-routed via the UP Palmdale Line between West Colton and Devore Road (Keenbrook), thereby eliminating the need for a fourth track on the BNSF between San Bernardino and Devore Road (Keenbrook). However, as noted above, the UP Palmdale Line between West Colton and Devore Road (Keenbrook) must be double-tracked to smoothly accommodate the proposed concentration of UP traffic on this line (Table 24). Universal crossover connections at Devore Road (Keenbrook) also are required.

Table 24.
Summary of Required Track Capacity on BNSF Line
North of Colton Crossing
(Figures express required numbers of main tracks. Percentages express track gradients.)

		Status Quo		**Alts. 1 and 2**	
	Existing in 2005	**2010**	**2025**	**2010**	**2025**
BNSF Line					
Colton Crossing – Rana	2	**3**	3	**3**	3
Rana – San Bernardino	4	4	4	4	4
San Bernardino – Verdemont	3	**4**	4	3	3
Verdemont – Devore Road	2	**4**	4	**3**	3
Devore Rd. (Keenbrook) connection	One conn.	One conn.	One conn.	Univ. conns.	Univ. conns.
Devore Road – Cajon	2	**4**	4	**3**	**4**
Cajon – Silverwood	One 2.2%, one 3%	**Two 2.2%, two 3%**	**Two 2.2%, three 3%**	**One 2.2%, two 3%**	**One 2.2%, three 3%**
Silverwood connection	One conn.	One conn.	One conn.	One conn.	One conn.
Silverwood – Summit	One 2.2%, one 3%	**Two 2.2%, two 3%**	**Two 2.2%, three 3%**	**Two 2.2%, two 3%**	**Two 2.2%, three 3%**
Summit – Barstow	2	**3**	**4**	**3**	**4**

Note: "One connection" indicates only two out of four possible connecting movements are feasible.
"Universal connections" indicates all four possible connecting movements are feasible.

9. Capital Costs for Main Line Rail Infrastructure

Estimates of construction costs for the improvements listed in section 8 were developed as follows.

Unit Cost Assumptions

Year 2004 unit costs were developed by applying an inflation factor to Year 2001 unit costs for new railroad construction.[17] The inflation factor that was applied was based on the US Army Corps of Engineers Indices for years 2001, 2002, 2003 and 2004 applicable to road, rail and bridge construction projects.[18] That 2004/2001 factor is 1.08588. It should be noted, however, that the price of steel has risen sharply in the last year, meaning that 2005 prices for rail construction are probably higher than those reported for this study. Table 25 summarizes the unit cost assumptions for 2004.

Table 25.
Unit Cost Assumptions
(All figures in 2004 dollars)

Item	**Cost per track-mile**
For new main-line track:	
Roadbed	$151,200
Drainage	$32,600
Track	$803,500
Signals	$1,085,900
Utility relocation	$542,900
Right of way, east and north of Colton	$128,500
Right of way, west of Colton	$2,717,400
Subtotals:	
Cost per track-mile, east and north of Colton	$2,744,600
Cost per track-mile, west of Colton	$5,333,500
Exceptional items	**Unit cost**
Bridges	$54,294 per track-foot
Power-switch crossovers	$407,200 each
Exceptional earthmoving or property-taking	case-by-case basis
Separated crossings	case-by-case basis
Flying junctions	case-by-case basis
New Metrolink stations	case-by-case basis

[17] Parsons Brinckerhoff, *Inland Empire Mainline Trade Corridor Cost Benefit Study, Order of Magnitude Cost for Railroad Infrastructure*, Draft Report prepared for *Southern California Association of Governments*, Fall 2001.
[18] U.S. Army Corps of Engineers Cost Index, released September 24, 2004.

As may be seen, basic main-line costs amount to about $2.7 million per mile east and north of Colton and $5.3 million per mile west of Colton. To these costs must be added the costs for exceptional items, including bridges, crossovers, separated crossings and junctions, and exceptional earthmoving or property-taking situations.

Estimates for Case-by-Case Exceptional Items

Costs for exceptional earthmoving, separated crossings flying junctions and new stations were estimated as follows. These are preliminary estimates based on sketches of the required track layouts and field reconnaissance of the geometry and other challenges involved. Preliminary engineering was not carried out.

Separated Crossings

Colton Crossing (all alternatives in 2025) - $90,000,000. Assumes UP Yuma Line is elevated over existing BNSF tracks. UP Yuma Line would have 1% approach grades in both directions. Costs for a flying-junction connection of the UP Yuma Line to the BNSF Line are not included in this figure but are separately tabulated under Flying Junctions below.

Pasadena Jct. Metrolink Fly-over (Alternative 2 in 2025) - $40,000,000.

Flying Junctions

West Colton (Rancho) Full Flying Junction of UP Palmdale and Alhambra Lines and yard approaches (all alternatives in 2025) - $60,000,000

Pomona Metrolink Fly-over and route connections (Alternatives 1a, 1b and 2 in 2025) - $40,000,000.

Colton Crossing Flying Junction connection of UP Yuma Line to BNSF Line (Status Quo alternative in 2025) - $20,000,000 (as an add-on to the Colton Crossing separation)

West Riverside Flying Junction connection of UP San Gabriel Line to BNSF Line (Status Quo alternative in 2025) - $30,000,000

(Note: The above two flying junction connections work in concert, one for EB trains and one for WB trains.)

Exceptional Earthmoving or Property-Taking

BNSF Line, Cajon to Summit (one added 2.2% track and one added 3% track for the Status Quo alternative in 2010, one added 3% track for other alternatives in 2010, one more added 2.2% track for the Status Quo alternative in 2025, one added 2.2% track for

other alternatives in 2025) - $40,000,000 per 3% track, $48,000,000 for first new 2.2% track, $40,000,000 for subsequent 2.2% tracks. Numerous deep cuts and high fills are required on this segment. Two tunnels on main 1 (the existing 2.2% track) would be day-lighted when the first 2.2% track is added, requiring removal of a substantial quantity of overburden.

BNSF Line, Keenbrook to Cajon (2 added tracks for the Status Quo alternative in 2010, 1 added track for other alternatives in 2010) - $30,000,000 per track. Several deep cuts and high fills are required on this segment.

UP San Gabriel Line, Streeter – West Riverside (Status Quo alternative in 2010) - $25,000,000. Excavation of the side of a large hill in West Riverside is required, involving the protection of nearby high-value residences and re-alignment to a sharper curve. Retaining walls on both sides of the track would be required.

New Metrolink Stations

Alternative 1(b) re-routes Metrolink Riverside trains west of Pomona to operate via the UP Alhambra Line. This necessitates a new station at City of Industry to replace the current station situated on the UP San Gabriel Line. It also necessitates closing the Montebello station (with passengers diverted to the Commerce station on the BNSF Line). To replace the lost stop, a new station stop at Alhambra is proposed. The costs for each of these new stations, including property acquisition and construction, are estimated as follows.

City of Industry Station

The cost for a parking space at ground level is $2,500 per space. (A vertical parking structure would be $12,000 per space, but ground-level parking is assumed here.) There are 100 parking spaces per acre. The existing City of Industry station currently experiences loadings of 1,000 people each work day, and parking is inadequate. It is the highest demand station on the system and has the fastest growth. Property acquisition would be about $800,000 per acre. To accommodate future growth, a 15-acre facility is assumed. The station stop would be a minimum of 745' feet in length (at $3000 per foot) to accommodate an 8-car train hauled by one locomotive. It is assumed that UP would want the station stop clear of the main track. Costs for additional track and signals are estimated to total $1 million.

Re-capitulation:

Property acquisition	$12,000,000	
Parking site preparation	3,750,000	
Track and signal	1,000,000	
Station	2,235,000	
TOTAL	$18,985,000	say $19,000,000.

Alhambra Station

It is believed that one acre would be sufficient for parking. Nearly all passengers detraining or entraining at Montebello are bused to or from City of Commerce work locations (the bus system connects to Metrolink). Therefore, the need for vehicle parking should be minimal.

Re-capitulation:

Property acquisition	$1,000,000	
Parking site preparation	250,000	
Station shelter (at street level)	1,000,000	
Station overpass	1,500,000	
Loading strip (both tracks)	1,490,000	
Access from street level to #2 track	2,000,000	
Total	$7,240,000	say, $7,200,000

NOTE: Access to station platform along #1 track would be along right-of-way of abandoned industrial track corridor rising from trench to street level.

Cost Estimation Procedure

BNSF and UP track charts were consulted to obtain line segment distances, bridge locations and bridge lengths. Generally, when new main tracks were planned to be added, existing bridges were assumed to be replicated for the new tracks. Where power crossovers were located, additional crossovers were assumed to connect up the new track. Where single-track CTC territory was converted to two-main track territory, one set of universal power crossovers was assumed at each existing controlled siding location. Where new or improved route connections were proposed, crossovers enabling movement between all main tracks were assumed.

Costs by Line Segment

Table 26 provides a listing of the estimated capital costs broken out by routing alternative, line segment and year. Costs for improvements at connections and junctions between BNSF and UP Lines have been included under the BNSF Line segment amounts. Costs for the Pomona fly-over and connections have been included under the West Colton – Pomona segment of the UP Alhambra Line.

Table 26.
Summary of Estimated Rail Infrastructure by Line Segment
(millions of 2004 dollars)

Line Segment	2010	2025
UP Yuma Line		
Colton Crossing – Indio, all alternatives	$24.1	$72.9
UP Palmdale Line		
West Colton – Devore Road, Status Quo	$0.0	$0.0
West Colton – Devore Road, Alternatives 1a, 1b, 2	$0.0	$160.9
Devore Road – Hiland	$0.0	$0.0
BNSF Line		
Barstow – Summit, all alternatives	$142.8	$150.1
Summit – San Bernardino, Status Quo	$582.3	$190.6
Summit – San Bernardino, Alternatives 1a, 1b, 2	$325.1	$198.6
San Bernardino – West Riverside, Status Quo	$63.8	$218.6
San Bernardino – West Riverside, Alternatives 1a, 1b, 2	$63.8	$90.0
West Riverside – Redondo, all alternatives	$321.5	$312.7
UP Alhambra Line		
Colton Crossing – West Colton, all alternatives	$0.0	$60.0
West Colton – Pomona, Status Quo	$0.0	$0.0
West Colton – Pomona, Alternatives 1a, 1b, 2	$192.7	$40.0
Pomona – Yuma Jct., Status Quo	$0.0	$190.5
Pomona – Yuma Jct., Alternative 2	$190.5	$0.0
Pomona – Yuma Jct., Alternative 1a	$0.0	$0.0
Pomona – Yuma Jct., Alternatives 1b	$26.2	$0.0
Yuma Jct. – Redondo, Alternative 2	$8.1	$55.5
Yuma Jct. – Redondo, Status Quo and Alternatives 1a, 1b	$0.0	$0.0
UP San Gabriel Line		
West Riverside – Pomona, Status Quo	$160.6	$0.0
West Riverside – Pomona, Alternatives 1a, 1b, 2	$0.0	$0.0
Pomona – Redondo, Status Quo	$116.5	$0.0
Pomona – Redondo, Alternative 1a	$116.5	$307.9
Pomona – Redondo, Alternative 1b	$116.5	$0.0
Pomona – Redondo, Alternative 2	$0.0	$116.5

Total Costs by Alternative

Table 27 summarizes the total capital costs by routing alternative.

Table 27.
Estimated Rail Infrastructure Costs by Routing Alternative
(billions of 2004 dollars)

Alternative	2010	2025	Total	Total less improvements already completed or fully funded
Status Quo	$1.412	$1.195	$2.607	$2.354
1a	$1.187	$1.393	$2.580	$2.327
1b	$1.213	$1.085	$2.298	$2.045
2	$1.269	$1.257	$2.526	$2.273

As may be seen, the total costs of the alternatives range between $1.2 and $1.4 billion dollars to raise Year 2000 track capacity to accommodate Year 2010 traffic levels, and between 2.2 and 2.7 billion dollars to raise capacity to accommodate Year 2025 traffic levels. Accounting for track capacity improvements already completed or fully funded and under construction subsequent to Year 2000 (discussed below), this range is reduced to $2.0 to $2.4 billion. Alternative 1b is least costly at $2.02 billion, about $300 million less than the Status Quo and Alternative 1a.

The capital costs listed in the second, third and fourth columns of the table start with the Year 2000 track configuration as a base. As of mid-2005, the following improvements to that configuration had been completed or were fully funded and under construction. (For purposes of comparison, the cost figures listed below were developed using our cost estimation methodology and are not actual expenditure amounts.)

- Second main track on UP Yuma Line, Fingal milepost 578.8 – Garnet MP 585.0, funded by UP: $17.8 million. (Improvement required for all alternatives in 2010.)
- Third main track on BNSF Line Baseline (San Bernardino) MP 79.9 – Verdemont MP 73.9, funded by BNSF: $21.3 million. (Improvement required for all alternatives in 2010.)
- Second main track on UP San Gabriel Line, E. Montebello MP 8.6 - E. Pico Rivera MP 10.7 and Diamond Bar MP 25.5 - Sandra MP 27.8, funded by Metrolink: $50.1 million. (Improvement required for Status Quo and Alternatives 1a and 1b in 2010, required for Alternative 2 in 2025.)
- Third main track on BNSF Line, Bandini MP 149.8 – Basta MP 163.0, funded by Caltrans: $163.9 million (under construction). (Improvement required for all alternatives in 2010.)
- Total for capacity improvements already funded: $253.1 million.

The $253 million in funded capacity improvements to date represents about 18% of the required capital outlays to raise capacity under the Status Quo Alternative from Year 2000 traffic levels to Year 2010 levels and about 21% of the required outlays under Alternative 1b. Yet half of the decade has passed. Clearly, improvements in track capacity are not keeping up with the rising traffic levels; in fact, capacity requirements

are growing at more than double the rate of growth in capacity. As a result, the quality of freight and passenger services in the Los Angeles Basin is declining. In view of this trend, recent severe delays to Amtrak and Metrolink trains and “melt-downs” in rail freight operations are not surprising.

10. Emissions Analysis

Emissions from locomotives powering through train movements and from vehicular delays at grade crossings are a function of how trains are routed through the Main Line Network. For the years 2000, 2010 and 2025 and for the various routing alternatives, emissions were calculated for BNSF and UP through freight trains and passenger trains over main lines between the north end of the Alameda Corridor and Barstow and Indio. Locomotive emissions were calculated based on the average through train movements per day and idling emissions from traffic delay were estimated based on total vehicle hours of delay at railroad crossings at grade. Emissions are categorized by reactive organic gases, carbon monoxide, nitrogen oxides, particulate matter, and sulfurous oxides.

10.1 Grade Crossing Analysis

Traffic delays have been estimated for all grade crossings in the study area and for all routing scenarios for 2005, 2010 and 2025. Thirty-three linked spreadsheets were developed, including a master that lists train volumes by train type and by segment of railroad track for all scenarios.

The measure chosen for this study is vehicle hours of delay per day (VHDD). One VHDD is equal to 60 vehicle minutes of delay. This is equivalent to 60 vehicles delayed one minute, or one vehicle delayed 60 minutes. The VHDD measure is used in the calculation of emissions from vehicles waiting to cross the railroad tracks.

The delay equations used for this analysis are the same ones used in SCAG's San Pedro Bay Ports Access Study published in 1984.[19] These equations have been used in every grade crossing delay study in the SCAG region ever since, including several EIRs for major projects such as the Alameda Corridor and for the Alameda Corridor-East Trade Corridor Plan (April 2001).[20] The equations were originally developed by James Powell in a paper submitted to the Transportation Research Board in 1982.[21]

The spreadsheets first calculate a gate-down time for each train and rail crossing. Then based on assumed vehicular arrival and departure rates, vehicular delay is calculated for each train event. These events are summed for all trains over a 24-hour period to develop an estimate of VHDD. This allows a comparison of the relative impact of each scenario on traffic delays in the study area.

Important inputs to the analysis include:

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[19] SCAG, *San Pedro Bay Ports Access Study: Phase 2: Railroad Access*, October 1984.
[20] ACE Construction Authority, SANBAG, RCTC, OCTA, OnTrac, *Alameda Corridor-East Trade Corridor Plan*, April 2001.
[21] Powell, James L., *Effects of Rail-Highway Grade Crossings on Highway Users*, presentation to *Transportation Research Board*, January 19, 1982, p.12.

- Average Daily Traffic (ADT) at the crossing and distribution of traffic volumes over four time periods of the day: a.m. peak period, midday, p.m. peak period and night (determines vehicular arrival rate)
- Number of lanes at the crossing (affects queue storage)
- Speed of the train (affects gate down time)
- Vehicular departure rate (depends on number of trucks in the queue)
- Number of trains by length and distribution of trains by time of day.

ADT estimates and number of lanes were taken from data files of the Public Utilities Commission (which has jurisdiction over grade crossings). Base year ADT values were adjusted for future years by inflating the original values by 1% per year, an admittedly simplistic assumption. Clearly it would have been preferable to have a complete new set of ADT counts for all crossings and to develop forecasts based on regional modeling efforts, but this was beyond the scope of this study. Unfortunately, PUC files are not always up to date, so we also compared these ADT figures and resulting VHDD estimates with the results of the Alameda Corridor-East Trade Corridor Plan. (See discussion of the comparison later on in this section).

Train speeds were taken from railroad track charts. The estimates of freight train volumes by type and length developed in this study by Leachman and Associates were assumed, as documented in Appendix B. For the grade crossing analysis, train volumes were assumed to be evenly distributed over 24 hours, but passenger train volumes by time period were based on published schedules.

The gate-down time depends on train length and speed, lead time and lag time (time the gate goes down before the train arrives and when it goes up after the train clears the crossing), and on the width of the intersection. Vehicular delay is a function of the square of the gate-down time, as follows:

$$\text{Delay in vehicle-hours} = \left(\frac{1}{2}\right)\frac{aT_G^{\,2}}{\left(1-\frac{a}{d}\right)}\left(\frac{1}{60}\right)$$

where T_G is the gate-down time expressed in minutes, a is the vehicular arrival rate expressed in vehicles per minute and d is the vehicular departure rate expressed in vehicles per minute.

For future years it was assumed that certain major crossings would be grade separated. VHDD for these streets were "zeroed out" in the final results. The list of grade separations was derived from the high priority listings of various jurisdictions involved: San Gabriel Valley Council of Governments and the Alameda Corridor-East Construction Authority, SANBAG, RCTC, OCTA, Caltrans, OnTrac and the Gateway Cities Council of Governments. As shown in Table 28, it was assumed that 10 existing grade crossings would be grade separated and one would be closed by 2010. As shown in Table 29, it was assumed that an additional 38 streets would be grade separated by 2025. On the UPRR

Yuma Line, Dillon Road and Avenue 50 are on RCTC's top ten list, but these two crossings are outside of the study area, which ends at West Indio MP 610.90. In Placentia, the Melrose Street grade separation was completed in 2005, and thus is not included in the list below.

Table 28
Streets Assumed to Be Grade-Separated by 2010

Rail Line	PUC #	Street Name	Jurisdiction
OnTrac			
BNSF San Bernardino	2B-43.60	Placentia Avenue	Placentia
BNSF San Bernardino	2B-43.00	Bradford Avenue*	Placentia
		* Street closure.	
ACE Construction Authority (Phase I)			
UPRR Alhambra	1B-504.80	Nogales Street	Industry/LA County
UPRR Los Angeles	3-33.50	East End Avenue	Pomona
UPRR Alhambra	1B-515.40	Reservoir Street	Pomona
UPRR Alhambra	1B-495.10	Ramona Blvd.	El Monte
UPRR Alhambra	1B-510.50	Temple Avenue	LA County
UPRR Los Angeles	3-24.90	Brea Canyon Road	Industry/LA County
UPRR Alhambra	1B-499.20	Sunset Avenue	Industry/LA County
UPRR Alhambra	1B-493.60	Baldwin Avenue	LA County
UPRR Los Angeles	3-22.40	Nogales Street	Industry/LA County

Table 29
Streets Assumed to Be Grade-Separated by 2025
(in addition to those assumed to be grade-separated by 2010)

Rail Line	PUC #	Street Name	Jurisdiction
OnTrac			
BNSF San Bernardino	2B-42.50	Kramer Blvd.	Placentia
BNSF San Bernardino	2B-41.80	Orangethorpe Ave.	Placentia
BNSF San Bernardino	2B-41.50	Tustin Ave./ Rose Drive	Placentia
BNSF San Bernardino	2B-41.00	Jefferson Street	Placentia
BNSF San Bernardino	2B-40.70	Van Buren Street	Placentia
BNSF San Bernardino	2B-40.40	Richfield Road	Placentia
BNSF San Bernardino	2B-39.90	Lakeview Avenue	Placentia
BNSF San Bernardino	2B-39.20	Kellogg Drive	Placentia
Caltrans			
BNSF San Bernardino	2B-38.40	Imperial Highway	Caltrans
ACE Construction Authority (Phase II)			
UPRR Alhambra	1B-485.80	Valley Boulevard	City of LA
UPRR Alhambra	1B-490.20	Ramona Street	San Gabriel
UPRR Alhambra	1B-490.30	Mission Road	San Gabriel
UPRR Alhambra	1B-490.70	Del Mar Avenue	San Gabriel
UPRR Alhambra	1B-491.20	San Gabriel Blvd.	San Gabriel
UPRR Alhambra	1B-498.20	Puente Avenue	Industry/LA County
UPRR Alhambra	1B-505.75	Fairway Drive	Industry/LA County
UPRR Los Angeles	3-8.50	Montebello Blvd.	Montebello
UPRR Los Angeles	3-12.30	Rose Hills Road	LA County
UPRR Los Angeles	3-17.20	Turnbull Canyon Rd	LA County
UPRR Los Angeles	3-23.40	Fairway Drive	Industry

Table 29 (cont.)
Streets Assumed to Be Grade-Separated by 2025
(in addition to those assumed to be grade-separated by 2010)

Rail Line	PUC #	Street Name	Jurisdiction
Gateway Cities			
BNSF San Bernardino	2-153.10	Norwalk Blvd.	Santa Fe Springs
BNSF San Bernardino	2-151.45	Passons Blvd.	Pico Rivera
San Bernardino Co.			
UPRR Yuma	1B-541.00	Hunts Lane	SB City/SB County
BNSF Cajon	2-76.60	State Street University Parkway	SB County
UPRR Los Angeles	3-43.40	Milliken Ave.	Riverside County
UPRR Alhambra	1B-516.90	Ramona Avenue	Montclair
UPRR Alhambra	1B-517-40	Monte Vista Ave.	Montclair
BNSF Cajon	2-5.70	Lenwood Road	SB County
BNSF Cajon	2-74.00	Palm Avenue	SB County
BNSF San Bernardino	2B-3.10	Valley Blvd.	Colton
Riverside County			
BNSF San Bernardino	2B-9.50	3rd St	City of Riverside
BNSF San Bernardino	2B-7.30	Iowa Av	City of Riverside
BNSF San Bernardino	2B-21.20	McKinley St	Corona
BNSF San Bernardino	2B-20.30 & 20.35	Magnolia Ave E&W	Riverside County
BNSF San Bernardino	2B-8.10	Chicago Av	City of Riverside
UPRR Los Angeles	3-53.80	Streeter Av	City of Riverside
BNSF San Bernardino	2B-8.80	Spruce St	City of Riverside

Summary results for each scenario broken down by year and line segment are displayed in Table 30.

Table 30
Grade Crossing Impacts: Total Gate-Down Time and Total Vehicle-Hours of Delay
(Assumes high-priority grade separations are in place)

Line Segment and Routing Alternative	Total Gate (Hours)	Total VHDD (Hours)	Total Gate % Increase From 2000	Total VHDD % Increase From 2000
BNSF Cajon Line (Barstow – San Bernardino)				
2000 Baseline	42	86	0%	0%
2010 Status Quo	61	140	43%	62%
2010 Alts. 1 or 2	61	140	43%	62%
2025 Status Quo	67	61	57%	-29%
2025 Alts. 1 or 2	67	61	57%	-29%
BNSF Line (San Bernardino – Redondo)				
2000 Baseline	159	1,223	0%	0%
2010 Status Quo	233	2,039	46%	67%
2010 Alts. 1 or 2	210	1,904	32%	56%
2025 Status Quo	245	2,036	54%	66%
2025 Alts. 1 or 2	221	1,939	39%	59%
UP Yuma Line				
2000 Baseline	26	60	0%	0%
2010 Status Quo	37	94	42%	58%
2010 Alt. 1a	37	94	42%	58%
2010 Alt. 1b	37	94	42%	58%
2010 Alt. 2	37	94	42%	58%
2025 Status Quo	52	156	97%	161%
2025 Alt. 1a	52	156	97%	161%
2025 Alt. 1b	52	156	97%	161%
2025 Alt. 2	52	156	97%	161%
UP Alhambra Line				
2000 Baseline	39	631	0%	0%
2010 Status Quo	49	766	26%	21%
2010 Alt. 1a	17	241	-58%	-62%
2010 Alt. 1b	28	319	-29%	-49%
2010 Alt. 2	98	1,618	151%	156%
2025 Status Quo	58	766	47%	21%
2025 Alt. 1a	16	203	-58%	-68%
2025 Alt. 1b	32	300	-20%	-52%
2025 Alt. 2	120	1,704	205%	170%

Table 30 (cont.)
Grade Crossing Impacts: Total Gate-Down Time and Total Vehicle-Hours of Delay
(Assumes high-priority grade separations are in place)

Line Segment and Routing Alternative	Total Gate (Hours)	Total VHDD (Hours)	Total Gate % Increase From 2000	Total VHDD % Increase From 2000
UP San Gabriel Line				
2000 Baseline	59	621	0%	0%
2010 Status Quo	83	948	42%	53%
2010 Alt. 1a	55	659	-7%	6%
2010 Alt. 1b	50	630	-14%	1%
2010 Alt. 2	27	251	-55%	-60%
2025 Status Quo	107	1,169	82%	88%
2025 Alt. 1a	65	637	11%	3%
2025 Alt. 1b	60	611	2%	-2%
2025 Alt. 2	31	241	-48%	-61%
Grand Total				
2000 Baseline	326	2,622	0%	0%
2010 Status Quo	464	3,987	42%	52%
2010 Alt. 1a	379	3,039	16%	16%
2010 Alt. 1b	386	3,088	18%	18%
2010 Alt. 2	433	4,007	33%	53%
2025 Status Quo	528	4,188	62%	60%
2025 Alt. 1a	421	2,996	29%	14%
2025 Alt. 1b	431	3,067	32%	17%
2025 Alt. 2	489	4,101	50%	56%

The grade separations listed in Tables 28 and 29 would eliminate 4,000 VHDD in the 2025 Status Quo scenario. If these were not built, the total VHDD for the Status Quo 2025 scenario would be 8,188 VHDD for all crossings.

Comparison to Previous Studies

These results were compared to the estimates prepared by Korve Engineers for the Alameda Corridor-East Trade Corridor Plan (April 2001)[22]. Korve estimated about 8,700 "unadjusted" VHDD and about 13,346 "adjusted" VHDD for 2020. Although the number of crossings assumed in this study is not exactly the same as that studied by Korve, the VHDD results in this study are about 50 to 60% lower than Korve's "adjusted" results. Emissions estimates from vehicular delays would be about double what is reported if Korve's higher VHDD figures were used.

[22] ACE Construction Authority, SANBAG, RCTC, OCTA, OnTrac, *Alameda Corridor-East Trade Corridor Plan*, April 2001.

Korve's unadjusted figures were a compilation of results from various studies from different jurisdictions. It is unknown what train speeds and what number of lanes were assumed in those studies. Korve's adjusted figures represented escalations of the unadjusted data based on more recent information (in 2001) about the number of projected trains on the network. Korve's results were based on ADT figures that are about 48% higher overall than those assumed in this study.

The discrepancies may be significant, but the structure of the files prepared for this study are such that future updates of this work can be done from one comprehensive data base, rather than attempting to piece together several studies with varying methodologies. It is recommended that a new set of ADT figures be developed for all crossings in the study area for 2005, and that forecasts of ADT be developed from modeling results for the region.

10.2 Characterization of Emissions

10.2.1. Baseline Emissions

Locomotive Traffic Emissions in 2000

To establish a baseline, year 2000 emissions for trains operating along the BNSF, UP and passenger routes were calculated using assumed standard locomotive consists for actual train traffic data, and are summarized in Table 31.[23] In year 2000 about 60% of UP freight trains traveled on the UP San Gabriel line and 40% traveled on the UP Alhambra subdivision line. The year 2000 allocation of trains to routes is hereafter referred to as the Status Quo routing of train movements. The locomotive emissions (lbs/day) were calculated by multiplying the daily power consumption with the corresponding emission factors, which were derived from the actual locomotive duty cycles. The daily power consumption was calculated by multiplying the number of trains per day, with average train-hours on the Status Quo regional train routes (BNSF, UP and passenger), average locomotive cycle horsepower, and the corresponding number of locomotives per train. In addition pusher locomotives in mountain areas were incorporated into the emissions inventory for the specific segments where operated. Average daily locomotive emissions from BNSF, UP and passenger trains were then annualized (tons/year).

Vehicle Delay Emissions in 2000

In order to calculate the emission reductions associated with elimination of vehicular delays at grade crossings, the number of vehicles and delay times were estimated by Gill V. Hicks and Associates, Inc. from actual traffic count data scaled to account for growth factors and then translated into vehicular delay using a standard formula. (See section 3 above.) Total vehicle hours of delay in year 2000 were calculated to be 2,622 hours per

[23] Locomotive consists and train counts used in this and all other scenarios analyzed in this section are provided in Appendix B

peak day. To establish a year 2000 baseline, idling emissions were calculated by multiplying total vehicle hours of delay at grade crossings with vehicle emission factors, using year 2000 CARB EMFAC[24] vehicle emissions profiles. The daily idling emissions were annualized and converted from grams/hour to tons/year. These vehicle delays results in the idling emissions summarized in Table 32.

Table 31: Year 2000 Main Line Rail Network Emissions from BNSF, UP and Passenger Trains
(Emissions expressed in tons)

Year 2000	ROG	CO	NOx	PM10	SOx
BNSF	238.06	325.76	7235.67	162.88	448.55
UP	253.72	347.20	7711.83	173.60	478.07
Passenger	6.65	48.33	476.60	11.08	31.74
Cumulative	**498.43**	**721.29**	**15424.10**	**347.56**	**958.36**

Table 32: Year 2000 Main Line Rail Network Emissions from Traffic Delay
(tons)

Year	ROG	CO	NOx	PM10	SOx
2000	9.65	100.46	13.85	0.54	0.09

Overall Emissions in 2000

The overall 2000 emissions generated from train emissions and vehicle delays at grade crossings are summarized in Table 33. Cumulatively the emissions are: 508 tons of ROG; 822 tons of CO; 15438 tons of NOx; 348 tons of PM; and 958 tons of SOx.

Table 33: Overall Emissions for Year 2000
(tons)

	ROG	CO	NOx	PM10	SOx
Rail Emissions	498.43	721.29	15424.10	347.56	958.36
Traffic Delay Emissions	9.65	100.46	13.85	0.54	0.09
Cumulative Emissions	**508.08**	**821.74**	**15437.95**	**348.10**	**958.45**

10.2.2 Benefits of Routing Alternatives in 2010

By the year 2010, freight train movements are forecasted to increase by 41% on BNSF and 40% and UP lines, whereas passenger trains are projected to increase by 70%, when

[24] California Air Resources Board, *EMFAC 2002, Version 2.20, Calculating emission inventories for vehicles in California.*

compared to the 2000 baseline. There are two types of future air quality benefits to be realized in the various alternatives analyzed; those related to increased rail efficiency which result in reduced travel times as well as reduced vehicle delay at grade crossings due to implementation of grade separations. The year 2010 was chosen to represent benefits in the near future, when 22% (11 out of 49) of the grade separations will be implemented. These grade separations would allow vehicular traffic (cars, trucks and buses) to travel unobstructed on surface streets along the BNSF and UP rail lines. Therefore, emissions of idling vehicles that previously were delayed at grade crossings waiting for trains to pass would be eliminated.

The assumptions used to quantify control measure improvements in future years are as follows: Future year 2010 assumptions incorporate emission reductions based on South Coast Air Quality Management Plan control measure M-14, which assumes that cleaner locomotive engines (those compliant with federal Tier II standards) will be operating in California and in the South Coast Air Basin. As a result of M-14, CARB, the railroads and EPA signed a Memorandum of Understanding providing for early introduction of clean locomotive units and requiring that a fleet average equivalent to EPA's Tier II standards be achieved by 2010. Emission factors for "Tier I" locomotives used in the analysis are based on actual locomotive duty cycles, whereas emission factors of "Tier II" locomotives reflect the EPA Tier II standard, with more lenient emission standards for ROG and in particular for CO. This difference results in an anomalous increase in CO emissions from 2000 to 2025 as the EPA Tier II standard for CO emissions is well in excess (by a factor of 3) of actual Tier I locomotive performance.[25]

Status Quo Emissions in 2010

In the 2010 Status Quo scenario, about two-thirds (60%) of UP freight trains travel on the UP San Gabriel subdivision line and one-third (40%) travel on the UP Alhambra subdivision line. Emissions for trains following BNSF, UP and passenger routes were calculated using assumed standard locomotive powering practices for various types of trains.

Emission Benefits 2010 Alternative 1a

In the year 2010 Alternative 1 concentrates UP freight trains on the UP San Gabriel Line subdivision west of Pomona (85%) and on the UP Alhambra Line subdivision east of Pomona (Figure 4: bold orange route). This freight train concentration in turn shifts a number of UP trains off the BNSF Line between Colton and Cajon Pass and onto the UP Palmdale Line as far north as Silverwood (Figure 2). Alternative 1a maintains the status quo routing of Metrolink Riverside passenger trains on the UP San Gabriel Line (Figure 4: blue route). The locomotive emissions (lbs/day) in this scenario were calculated by multiplying the daily power consumption with the corresponding emission factors, which were derived from the actual locomotive duty cycles. The daily power consumption was

[25] Environmental Protection Agency Regulatory Announcement, *Final Emissions Standards for Locomotives*, December 1997.

calculated by multiplying number of trains per day, with average train-hours on the regional train routes (BNSF, UP and passenger), average locomotive cycle horsepower, and the corresponding number of locomotives per train. In addition pusher locomotives in mountain areas were accounted for on the specific segments where operated. The daily locomotive emissions were then annualized (tons/year).

Emissions were calculated for the "Status Quo" and "Alternative 1a" scenarios. The "Alternative 1a" emissions were then subtracted from the "Status Quo" emissions to quantify the year 2010 emissions reductions. The benefits from increased rail efficiency for Alternative 1a are 91 tons of ROG, 455 tons of CO, 1668 tons of NOx, 61 tons of PM and 19 tons of SOx, which are summarized in Table 34.

Table 34: Basin-wide Emission Reduction Benefits from Rail Efficiency in 2010, Alternative 1a

(tons)

2010	ROG	CO	NOx	PM	SOx
Status Quo - BNSF	285.35	1426.73	5231.33	190.23	58.02
Status Quo - UP	269.21	1346.05	4935.51	179.47	54.74
Status Quo - Passenger	21.80	109.02	399.76	14.54	4.43
Cumulative	**576.36**	**2881.80**	**10566.59**	**384.24**	**117.19**
Alternative 1a - BNSF	280.54	1402.69	5143.21	187.03	57.04
Alternative 1a - UP	183.95	919.74	3372.39	122.63	37.40
Alternative 1a - Passenger	20.88	104.38	382.73	13.92	4.24
Cumulative	**485.36**	**2426.82**	**8898.33**	**323.58**	**98.69**
Benefits Alternative 1a	**91.00**	**454.98**	**1668.27**	**60.66**	**18.50**

As before, emissions from vehicular hours of delay were calculated and added to emissions from the trains. The calculated vehicular hours of delay per peak day in 2010 are 3,987 for Status Quo and 3,039 for Alternative 1a. Emission benefits from eliminated vehicle delay for Alternative 1a were calculated by multiplying total reduced vehicle hours of delay at grade crossings with emission factors, using year 2010 CARB EMFAC vehicle emissions profiles, which are summarized in Table 35. Cumulative emission benefits from Alternative 1a are also presented in this table.

Emission Benefits 2010, Alternative 1b

As outlined in Alternative 1b, UP freight trains are concentrated on the UP San Gabriel Line subdivision west of Pomona (85%) and on the UP Alhambra Line subdivision east of Pomona (Figure 4: bold orange route). This alternative in turn shifts a number of UP trains off the BNSF Line between Colton and Cajon Pass and onto the UP Palmdale Line as far north as Silverwood (Figure 2). Alternative 1b reroutes the Metrolink Riverside passenger trains via the Alhambra UP subdivision line west of Pomona (Figure 5: blue line).

Table 35: Basin-wide Combined Emission Reduction Benefits from Rail Efficiency and Vehicle Delay Elimination in 2010, Alternative 1a

(tons)

2010	ROG	CO	NOx	PM	SOx
Status Quo	5.00	58.34	10.11	0.79	0.09
Alternative 1a	3.81	44.45	7.70	0.60	0.07
Benefits	**1.19**	**13.88**	**2.41**	**0.19**	**0.02**
Cumulative Benefits 1a	**92.19**	**468.87**	**1670.67**	**60.85**	**18.52**

The benefits from increased rail efficiency for Alternative 1b are 98 tons of ROG, 491 tons of CO, 1800 tons of NOx, 65 tons of PM and 20 tons of SOx, and are summarized in Table 36. Cumulative emission benefits from Alternative 1b are also presented in this table.

Table 36: Basin-wide Emission Reduction Benefits from Rail Efficiency in 2010, Alternative 1b

(tons)

2010	ROG	CO	NOx	PM	SOx
Status Quo - BNSF	285.35	1426.73	5231.33	190.23	58.02
Status Quo - UP	269.21	1346.05	4935.51	179.47	54.74
Status Quo - Passenger	21.80	109.02	399.76	14.54	4.43
Cumulative	**576.36**	**2881.80**	**10566.59**	**384.24**	**117.19**
Alternative 1b - BNSF	280.54	1402.69	5143.21	187.03	57.04
Alternative 1b - UP	176.87	884.35	3242.62	117.91	35.96
Alternative 1b - Passenger	20.76	103.80	380.60	13.84	4.22
Cumulative	**478.17**	**2390.84**	**8766.43**	**318.78**	**97.23**
Benefits Alternative 1b	**98.19**	**490.95**	**1800.16**	**65.46**	**19.97**

As before, emissions from vehicular hours of delay were calculated and added to emissions from the trains. The calculated vehicular hours of delay per peak day in 2010 are 3,987 for Status Quo and 3,088 for Alternative 1b. Emission benefits from eliminated vehicle delay for Alternative 1b were calculated by multiplying total reduced vehicle hours of delay at grade crossings with emission factors, and were summarized in Table 37. Cumulative emission benefits from Alternative 1b are also presented in this table.

Table 37: Basin-wide Combined Emission Reduction Benefits from Rail Efficiency and Vehicle Delay Elimination in 2010, Alternative 1b

(tons)

2010	ROG	CO	NOx	PM	SOx
Status Quo	5.00	58.34	10.11	0.79	0.09
Alternative 1b	3.87	45.18	7.83	0.61	0.07
Benefits	**1.13**	**13.16**	**2.28**	**0.18**	**0.02**
Cumulative Benefits 1b	**99.32**	**504.11**	**1802.44**	**65.64**	**19.99**

Emission Benefits 2010, Alternative 2

For the year 2010 Alternative 2 concentrates UP freight trains on the UP Alhambra subdivision Line west of Pomona with 85% and on the UP Alhambra Line subdivision east of Pomona with 88% (Figure 6: bold orange route). This alternative in turn shifts a number of UP trains off the BNSF Line between Colton and Cajon Pass and onto the UP Palmdale Line as far north as Silverwood (Figure 2). The Metrolink Riverside passenger trains remain on the UP San Gabriel Line (Figure 6: blue route). The locomotive emissions (lbs/day) in this scenario were calculated by multiplying the daily power consumption with the corresponding emission factors, which were derived from the actual locomotive duty cycles. The daily power consumption was calculated by multiplying number of trains per day, with average train-hours on pre-existing regional train routes (BNSF, UP and passenger), average locomotive cycle horsepower, and the corresponding number of locomotives per train. In addition pusher locomotives in mountain areas are accounted for on the specific segments where operated. Average daily locomotive emissions were then annualized (tons/year).

The benefits from increased rail efficiency for Alternative 2 are 98 tons of ROG, 491 tons of CO, 1801 tons of NOx, 66 tons of PM and 20 tons of SOx, which are summarized in Table 38.

Table 38: Basin-wide Emission Reduction Benefits from Rail Efficiency in 2010, Alternative 2

(tons)

2010	ROG	CO	NOx	PM	SOx
Status Quo - BNSF	285.35	1426.73	5231.33	190.23	58.02
Status Quo - UP	269.21	1346.05	4935.51	179.47	54.74
Status Quo - Passenger	21.80	109.02	399.76	14.54	4.43
Cumulative	**576.36**	**2881.80**	**10566.59**	**384.24**	**117.19**
Alternative 2 - BNSF	280.54	1402.69	5143.21	187.03	57.04
Alternative 2 - UP	177.16	885.82	3248.02	118.11	36.02
Alternative 2 - Passenger	20.41	102.03	374.09	13.60	4.15
Cumulative	**478.11**	**2390.54**	**8765.32**	**318.74**	**97.22**
Benefits Alternative 2	**98.25**	**491.26**	**1801.28**	**65.50**	**19.98**

As before, emissions from vehicular hours of delay were calculated and added to emissions from the trains. The calculated vehicular hours of delay per peak day in 2010 are 3,987 for Status Quo and 4,007 for Alternative 2. Emission benefits from eliminated vehicle delay for Alternative 2 were calculated by multiplying total reduced vehicle hours of delay at grade crossings with emission factors, which were summarized in Table 39. Cumulative emission benefits from Alternative 2 are also presented in this table.

Table 39: Basin-wide Combined Emission Reduction Benefits from Rail Efficiency and Vehicle Delay Elimination in 2010, Alternative 2

(tons)

2010	ROG	CO	NOx	PM	SOx
Status Quo –	5.00	58.34	10.11	0.79	0.09
Alternative 2	5.03	58.63	10.16	0.80	0.09
Benefits	**-0.03**	**-0.29**	**-0.05**	**0.00**	**0.00**
Cumulative Benefits 2	**98.23**	**490.96**	**1801.22**	**65.50**	**19.98**

10.2.3 Main Line Rail Network Benefits in 2025

By the year 2025 freight traffic on BNSF and UP lines is forecasted to increase by 105% and 86% respectively, whereas passenger trains are projected to increase by 147% when compared to the 2000 baseline. There are two types of future air quality benefits to be realized; those related to increased rail efficiency with reduced travel times, and those related to reduced vehicle delay at grade crossings due to implementation of grade separations. The year 2025 represents benefits in a future year when grade separations are implemented and additional control measures that reduce the locomotive emissions profile will have been fully implemented. The Main Line Rail Network assumes implementation of 38 grade separations by 2025, which allow vehicular traffic (cars, trucks and buses) to travel unobstructed on surface streets along the BNSF and UP rail lines. Therefore, emissions of idling vehicles that previously were delayed at grade crossings waiting for trains to pass are eliminated.

The assumptions used to quantify control measure improvements are as follows: Future year 2025 assumptions incorporate emission reductions based on South Coast Air Quality Management Plan control measure M-14, which assumes that cleaner locomotive engines (those compliant with federal Tier II standards) will be operating in California and in the South Coast Air Basin. As a result of M-14, CARB, the railroads and EPA signed a Memorandum of Understanding providing for early introduction of clean locomotive units and requiring that a fleet average equivalent to EPA's Tier II standards be achieved by 2010. The emissions profile for future year locomotives also assumes the implementation of the California low-sulfur diesel fuel regulations (for which locomotives will have to comply by January 1, 2012).

Emission Benefits 2025, Alternative 1a

In the year 2025 Alternative 1 concentrates UP freight trains on the UP San Gabriel Line subdivision west of Pomona (85%) and on the UP Alhambra Line subdivision east of Pomona (Figure 4: bold orange route). This alternative in turn shifts a number of UP trains off the BNSF Line between Colton and Cajon Pass and onto the UP Palmdale Line as far north as Silverwood (Figure 2). Alternative 1a maintains the status quo routing of Metrolink Riverside passenger trains on the UP San Gabriel Line (Figure 4: blue route). The locomotive emissions (lbs/day) in this scenario were calculated by multiplying the daily power consumption with the corresponding emission factors, which were derived from the actual locomotive duty cycles. The daily power consumption was calculated by multiplying number of trains per day, with average train-hours on regional train routes (BNSF, UP and passenger), average locomotive cycle horsepower, and the corresponding number of locomotives per train. In addition pusher locomotives in mountain areas are accounted for on the specific segments where operated. The daily locomotive emissions were then annualized (tons/year).

The 2025 benefits from increased rail efficiency for Alternative 1a are 167 tons of ROG, 834 tons of CO, 3058 tons of NOx, 111 tons of PM and 2 tons of SOx, which are summarized in Table 40.

Table 40: Basin-wide Emission Reduction Benefits from Rail Efficiency in 2025, Alternative 1a

(tons)

2025	ROG	CO	NOx	PM	SOx
Status Quo - BNSF	429.64	2148.18	7876.64	286.42	5.73
Status Quo - UP	406.00	2030.00	7443.33	270.67	5.41
Status Quo - Passenger	30.98	154.90	567.97	20.65	0.41
Cumulative	**866.62**	**4333.08**	**15887.94**	**577.74**	**11.55**
Alternative 1a - BNSF	421.65	2108.26	7730.29	281.10	5.62
Alternative 1a - UP	247.07	1235.36	4529.64	164.71	3.29
Alternative 1a - Passenger	31.07	155.34	569.57	20.71	0.41
Cumulative	**699.79**	**3498.96**	**12829.51**	**466.53**	**9.33**
Net Change	**166.82**	**834.12**	**3058.44**	**111.22**	**2.22**

As before, emissions from vehicular hours of delay were calculated and added to emissions from the trains. The calculated vehicular hours of delay per peak day in 2025 are 4,188 for Status Quo and 2,996 for Alternative 1a. The 2025 emission benefits from eliminated vehicle delay for Alternative 1a were calculated by multiplying total reduced vehicle hours of delay at grade crossings with emission factors, and are summarized in Table 41. Cumulative emission benefits from Alternative 1a are also presented in this table.

Table 41: Basin-wide Combined Emission Reduction Benefits from Rail Efficiency and Vehicle Delay Elimination in 2025, Alternative 1a
(tons)

2025	ROG	CO	NOx	PM	SOx
Status Quo –	1.48	18.31	2.89	0.81	0.09
Alternative 1a	1.06	13.10	2.07	0.58	0.07
Benefits	**0.42**	**5.21**	**0.82**	**0.23**	**0.03**
Cumulative Benefits 1a	**167.25**	**839.33**	**3059.26**	**111.45**	**2.25**

Emission Benefits 2025, Alternative 1b

As outlined in Alternative 1b, UP freight trains are concentrated on the UP San Gabriel Line subdivision west of Pomona (85%) and on the UP Alhambra Line subdivision east of Pomona (Figure 5: bold orange route). This alternative in turn shifts a number of UP trains off the BNSF Line between Colton and Cajon Pass and onto the UP Palmdale Line as far north as Silverwood (Figure 2). Alternative 1b reroutes the Metrolink Riverside passenger trains via the Alhambra UP subdivision line west of Pomona (Figure 5: blue line).

The 2025 benefits from increased rail efficiency for Alternative 1b are 163 tons of ROG, 814 tons of CO, 2983 tons of NOx, 108 tons of PM and 2 tons of SOx, which are summarized in Table 42.

Table 42: Basin-wide Emission Reduction Benefits from Rail Efficiency in 2025, Alternative 1b
(tons)

2025	ROG	CO	NOx	PM	SOx
Status Quo - BNSF	429.64	2148.18	7876.64	286.42	5.73
Status Quo - UP	406.00	2030.00	7443.33	270.67	5.41
Status Quo - Passenger	30.98	154.90	567.97	20.65	0.41
Cumulative	**866.62**	**4333.08**	**15887.94**	**577.74**	**11.55**
Alternative 1b - BNSF	421.65	2108.26	7730.29	281.10	5.62
Alternative 1b - UP	248.20	1241.02	4550.40	165.47	3.31
Alternative 1b - Passenger	34.04	170.21	624.12	22.70	0.45
Cumulative	**703.90**	**3519.49**	**12904.81**	**469.27**	**9.39**
Net Change	**162.72**	**813.58**	**2983.13**	**108.48**	**2.17**

As before, emissions from vehicular hours of delay were calculated and added to emissions from the trains. The calculated vehicular hours of delay per peak day in 2025 are 4,188 for Status Quo and 3,067 for Alternative 1b. The 2025 emission benefits from eliminated vehicle delay for Alternative 1b were calculated by multiplying total reduced vehicle hours of delay at grade crossings with emission factors, which were summarized

in Table 43. Cumulative emission benefits from Alternative 1b are also presented in this table.

Table 43: Basin-wide Combined Emission Reduction Benefits from Rail Efficiency and Vehicle Delay Elimination in 2025, Alternative 1b

(tons)

2025	ROG	CO	NOx	PM	SOx
Status Quo –	1.48	18.31	2.89	0.81	0.09
Alternative 1b	1.09	13.41	2.11	0.59	0.07
Benefits	**0.40**	**4.90**	**0.77**	**0.22**	**0.02**
Cumulative Benefits 1b	**163.11**	**818.48**	**2983.90**	**108.69**	**2.19**

Emission Benefits 2025, Alternative 2

In the year 2025 Alternative 2 concentrates UP freight trains on the UP Alhambra subdivision Line west of Pomona with 85% and on the UP Alhambra Line subdivision east of Pomona with 88% (Figure 6: bold orange route). This alternative in turn shifts a number of UP trains off the BNSF Line between Colton and Cajon Pass and onto the UP Palmdale Line as far north as Silverwood (Figure 2). The Metrolink Riverside passenger trains remain on the UP San Gabriel Line (Figure 6: blue route). The locomotive emissions (lbs/day) in this scenario were calculated by multiplying the daily power consumption with the corresponding emission factors, which were derived from the actual locomotive duty cycles. The daily power consumption was calculated by multiplying number of trains per day, with average train-hours on regional train routes (BNSF, UP and passenger), average locomotive cycle horsepower, and the corresponding number of locomotives per train. In addition pusher locomotives in mountain areas are accounted for on the specific segments where operated. The daily locomotive emissions were then annualized (tons/year).

The 2025 benefits from increased rail efficiency for Alternative 2 are 156 tons of ROG, 781 tons of CO, 2865 tons of NOx, 104 tons of PM and 2 tons of SOx, which are summarized in Table 44.

As before, emissions from vehicular hours of delay were calculated and added to emissions from the trains. The calculated vehicular hours of delay per peak day in 2010 are 4,188 for Status Quo and 4,101 for Alternative 2. The 2025 emission benefits from eliminated vehicle delay for Alternative 2 were calculated by multiplying total reduced vehicle hours of delay at grade crossings with emission factors, which are summarized in Table 45. Cumulative emission benefits from Alternative 2 also are presented in this table.

Table 44: Basin-wide Emission Reduction Benefits from Rail Efficiency in 2025, Alternative 2

(tons)

2025	ROG	CO	NOx	PM	SOx
Status Quo - BNSF	429.64	2148.18	7876.64	286.42	5.73
Status Quo - UP	406.00	2030.00	7443.33	270.67	5.41
Status Quo - Passenger	30.98	154.90	567.97	20.65	0.41
Cumulative	**866.62**	**4333.08**	**15887.94**	**577.74**	**11.55**
Alternative 2 - BNSF	421.65	2108.26	7730.29	281.10	5.62
Alternative 2 - UP	258.62	1293.12	4741.42	172.42	3.45
Alternative 2 - Passenger	30.04	150.22	550.82	20.03	0.40
Cumulative	**710.32**	**3551.60**	**13022.54**	**473.55**	**9.47**
Net Change	**156.30**	**781.48**	**2865.41**	**104.20**	**2.08**

Table 45: Basin-wide Combined Emission Reduction Benefits from Rail Efficiency and Vehicle Delay Elimination in 2025, Alternative 2

(tons)

2025	ROG	CO	NOx	PM	SOx
Status Quo –	1.48	18.31	2.89	0.81	0.09
Alternative 2	1.45	17.93	2.83	0.79	0.09
Benefits	**0.03**	**0.38**	**0.06**	**0.02**	**0.00**
Cumulative Benefits 2	**156.33**	**781.85**	**2865.47**	**104.21**	**2.09**

10.3 Summary and Conclusions of Emissions Analysis

Phased implementation of Tier II locomotives by year 2010, ultra-low sulfur diesel fuel regulations by year 2012 as well as a total of 49 grade separations partially mitigate the increases in emissions associated with more than doubling the number of train movements in the Basin from 2000 to 2025. By 2025, SOx emissions will be virtually eliminated. In 2025 NOx emissions will be either comparable to year 2000 NOx emissions or as much as 16% lower, depending on routing alternative. However, even under the most effective routing alternative, ROG and PM10 emissions are projected to increase by more than 30%, and CO emissions are projected to increase by a factor of more than four. The very large increase in CO emissions from 2000 to 2025 may be an anomaly, as it is based on the fact that the EPA Tier II standard for CO emissions is well in excess (by a factor of 3) of actual Tier I locomotive performance. Actual Tier II locomotive performance may turn out to be much better than the standard.

In 2010 the alternatives to the Status Quo increase rail efficiency and therefore provide emission benefits. Additional emission benefits are achieved by reducing vehicular delays at grade crossings due to the implementation of 11 grade separation projects by 2010. Alternative 1b provides the highest emission reduction benefits, which are

projected as follows: 99 tons of ROG; 504 tons of CO; 1802 tons of NOx; 66 tons of PM and 20 tons of SOx.

Projected 2025 emission benefits take into account the increase in rail efficiency by rerouting freight trains, imposition of control measures for locomotives, and the implementation of 49 grade crossing separation projects by 2025. Alternative 1a provides the highest emission reduction benefits, which are projected as follows: 167 tons of ROG; 839 tons of CO; 3059 tons of NOx; 111 tons of PM and 2 tons of SOx.

Table 46: Future Basin-wide Emission Benefits from the Main Line Rail Network
(Emission reductions in tons compared to Status Quo Alternative)

	ROG		CO		NOx		PM10		SOx	
Alternative	2010	2025	2010	2025	2010	2025	2010	2025	2010	2025
1a	92	167	469	839	1671	3059	60.85	111.45	18.52	2.25
1b	99	163	504	818	1802	2984	65.64	108.69	19.99	2.19
2	98	156	491	782	1801	2865	65.50	104.21	19.98	2.09

11. Ranking of Alternatives

The routing alternatives are ranked along the dimensions of capital costs for required Year 2025 infrastructure improvements, total Year 2025 emissions, total Year 2025 population exposure to main-line freight train movements, and total Year 2025 population access to passenger train movements.

Capital Costs

Table 47 ranks capital costs of the alternatives. These are costs for construction of track capacity improvements necessary to achieve Year 2000 transit times for forecasted Year 2010 and Year 2025 traffic levels.

Table 47.
Estimated Rail Infrastructure Costs by Routing Alternative
(billions of 2004 dollars)

Alternative	2010	2025	Total	Total less improvements already completed or fully funded
1(b)	$1.213	$1.085	$2.298	$2.045
2	$1.269	$1.257	$2.526	$2.273
1(a)	$1.187	$1.393	$2.580	$2.327
Status Quo	$1.412	$1.195	$2.607	$2.354

Source: Inland Empire Main Line Rail Study, Interim Report on Task 6, prepared for the Southern California Association of Governments by Leachman and Associates LLC and Gill V. Hicks & Associates, Inc., June 18, 2005.

As may be seen, Alternative 1(b) is least expensive, followed by Alternative 2, then Alternative 1(a), and finally the Status Quo, the most expensive alternative. Total capital costs left to be spent for Alternative 1(b) are estimated to be 13.1% less than for the Status Quo. Alternative 2 is next best, about 3.4% less than the Status Quo. Alternative 1(a) is only about 1.1% less.

Emissions

Table 48 ranks emissions of the alternatives. These are estimated tons of emissions per year from through train operations and from vehicles delayed at grade crossings. Emissions are categorized by reactive organic gases, carbon monoxide, nitrogen oxides, particulate matter, and sulfurous oxides.

Table 48.
Estimated Total Emissions by Routing Alternative in Year 2025
(tons)

Alternative	ROG	CO	NOx	PM10	SOx
1(a)	701	3692	12832	467.1	9.40
1(b)	705	3713	12907	469.9	9.46
2	712	3749	13026	474.4	9.56
Status Quo	868	4531	15891	578.6	11.65

Source: Inland Empire Main Line Rail Study, Interim Report on Task 7, prepared for the Southern California Association of Governments by Weston Solutions, Inc. and Gill V. Hicks & Associates, Inc., June 18, 2005.

As may be seen, all of the alternatives to the Status Quo are effective at reducing emissions. There are only very small differences between them, encompassing a range of 80.8 – 82.0% of the Status Quo emissions. The outputs of the various pollutants under each alternative exhibit almost exactly the same fixed mix, so the ranking of alternatives is uniform across the pollutant types. Alternative 1(a) is best, reducing emissions from the Status Quo by approximately 19.2%. Alternative 1(b) is a close second, reducing emissions from the Status Quo by approximately 18.8%. Alternative 2 reduces emissions from the Status Quo by approximately 18.0%.

Population Exposure to Main-Line Freight Train Operations

To analyze population exposure to main-line freight train operations, we estimated the population living within 0.5 miles of the study-area main lines, and then tallied these populations for each line segment. These populations were then weighted by the train traffic density on the line segment as explained below.

The unit of data on population is termed a Traffic Analysis Zone (TAZ). The TAZ population data was produced by SCAG over a three year period of time commencing in calendar year 2001. U.S. census data for year 2000 was used as the baseline. In turn, TAZ data was incorporated into the 2004 Regional Transportation Plan, "Destination 2030". The 2030 TAZ projections and the methodology used to calculate them can be found on the SCAG website, WWW.SCAG.CA.GOV. entitled "Destination 2030", Appendix A. The appendix is approximately 70 pages long and is referenced herein for those seeking more detail concerning the forecasting methodology

There are literally hundreds of TAZ's located along the railroad corridors studied in this report. Some are less than one mile wide and some are much larger. In developing population inside a one-mile zone, i.e., one-half mile on either side of the rail corridor, the relationship of the total TAZ area to the one-mile corridor area was calculated. It was assumed that the population density was evenly distributed throughout the entire TAZ. Thus, if a TAZ had a population of 100, and the area within 0.5 miles on each side of the rail corridor was calculated to be 10% of the total TAZ area, the study projects that 10 people would be impacted by a train passing through that TAZ.

After calculating the estimated population impacted by a rail line segment in each TAZ in years 2000 and 2025, these figures were multiplied by the number of projected train movements for years 2000 and 2025, respectively, to derive the number of people impacted as a function of train density.

Table 49 summarizes the total population exposure to peak-day through freight train movements in 2025. The figures in the table express 2030 population (in millions) living within 0.5 miles of trackside, multiplied by the number of 2025 peak-day through freight trains passing by. We term this index the *train-weighted population exposure*. In the table, Alternatives 1(a) and 1(b) are not shown separately in the table, as the routings of freight trains under these two alternatives are identical.

Table 49
Population Exposure to Main-Line Freight Train Operations
(figures express millions of population multiplied by
peak-day through freight train movements passing within 0.5 miles)

Scenario	UP Lines	BNSF Lines	Total
2000 Status Quo	**14.70**	**19.03**	**33.73**
2025 Alternatives 1(a), 1(b)	**48.51**	**52.87**	**101.38**
2025 Alternative 2	**52.84**	**52.87**	**105.70**
2025 Status Quo	**48.70**	**57.56**	**106.26**

Regardless of routing alternative, from 2000 to 2025 the total population exposure to heavy freight train operations in the greater Los Angeles Basin is roughly tripling, due to an approximate doubling of train traffic juxtaposed on the population growth. Alternative 1 reduces population exposure to heavy freight train operations by about 5% compared to the Status Quo. Population exposure for Alternative 2 is about the same as for the Status Quo.

Note that Alternatives 1 and 2 achieve substantial reductions in population exposure on BNSF Lines. This comes from taking UP freight trains out of downtown San Bernardino and downtown Riverside and re-routing along the more sparsely-populated Palmdale and Alhambra Lines. Alternative 2 suffers an offsetting increase on the UP Lines, reflecting a higher population west of Pomona along the Alhambra Line than along the San Gabriel Line.

Population Access to Passenger Train Operations

For passenger trains, we take an opposite view of the exposure metric. Proximity of population to passenger routes is considered a good thing, because people residing close to the tracks ought to be more inclined to commute and travel via rail rather than private

automobile. Moreover, the more frequent the passenger service, the more likely the population will use it.[26] A metric similarly computed for passenger trains is termed the *train-weighted population access index*. Table 50 summarizes the total population access to passenger train movements in 2025. The figures in the table express total 2030 population (in millions) living within 0.5 miles of trackside, multiplied by the number of weekday 2025 passenger trains passing by.

As may be seen, train-weighted population access to passenger services in the greater Los Angeles Basin will be growing by almost a factor of four over the period 2000 to 2025. Alternatives 1(a), 2 and the Status Quo have identical scores because routings of passenger trains among these alternatives are identical. Alternative 1(b) shifts Metrolink Riverside – Pomona – Los Angeles trains to operate via the Alhambra Line west of Pomona in lieu of the San Gabriel Line. In so doing, it increases Basin-wide population access to passenger services by about 5%.

Table 50
Population Access to Passenger Train Operations
(figures express millions of population multiplied by weekday passenger train movements passing within 0.5 miles)

Scenario	UP Lines	BNSF Lines	Total
2000 Status Quo	**2.95**	**5.93**	**8.88**
2025 Alternative 1(b)	**14.92**	**21.53**	**36.45**
2025 Alternative 1(a), 2	**13.31**	**21.53**	**34.83**
2025 Status Quo	**13.31**	**21.53**	**34.83**

Summary of Ranking

Table 51 summarizes the evaluation. Figures are expressed as percentage improvements over the Status Quo Alternative.

Table 51
Ranking of Routing Alternatives
(Figures express percentage improvement in Year 2025 over Status Quo Alternative)

Alternative	Capital Cost	Emissions	Population Exposure To Freight Trains	Population Access To Passenger Trains
1(a)	1.1%	19.2%	4.6%	0.0%
1(b)	13.1%	18.8%	4.6%	4.7%
2	3.4%	18.0%	0.1%	0.0%

In the dimensions of cost, population exposure to freight trains and population access to passenger trains, Alternative 1(b) ranks best. In the emissions dimension, Alternative 1(a)

[26] We leave aside consideration of other factors that may influence ridership, such as income levels.

ranks best, but Alternative 1(b) contributes only about 0.6% more emissions. Compared to the Status Quo, Alternative 1(b) offers about 13% less capital cost, about 19% less emissions, about 5% less population exposure to main-line freight train operations, and about 5% more population access to passenger train operations.

12. Comments from Stakeholders

The preliminary findings of this study were presented to Metrolink and BNSF in Los Angeles on April 25, 2005. (BNSF serves as a strategic partner to Metrolink in planning track capacity for joint passenger and freight operations between Hobart and Colton Crossing.) Generally, improvements planned on BNSF Lines by Metrolink and by this study were in agreement. The only exceptions were at Colton Crossing. Metrolink and BNSF are projecting that a grade separation of Colton Crossing will be required by 2010 (whereas this study finds it unnecessary for the 2010 traffic levels but required for the 2025 traffic levels). Metrolink and BNSF also were planning for a flying junction connection with the UP Yuma Line in 2010 (not required in this study's Status Quo Alternative for 2010, but required in this study's Status Quo Alternative for 2025). As of the date of that meeting, Metrolink and BNSF had not analyzed 2025 traffic levels.

Given this concern, the consulting retrieved the simulation results for Colton Crossing. These results are summarized as follows:

Scenario/Train Type	**Fraction of Trains Stopped**	**Average Delay (minutes)** (including trains not delayed)
2000 Base Case		
UP trains across crossing	31.4%	1.7
BNSF trains across crossing	36.6%	3.1
2010 Status Quo		
UP trains across crossing	63.6%	6.5
BNSF trains across crossing	26.6%	2.0
2010 Alts. to Status Quo		
UP trains across crossing	64.1%	11.2
BNSF trains across crossing	30.1%	2.6

Note that the simulated stoppages of BNSF trains decline slightly in 2010. This is because the BNSF Line is planned to have three main tracks across Colton Crossing in 2010, but it had only two main tracks in the Year 2000 Base Case. Note also that delays at Colton Crossing in 2010 are higher for UP trains and slightly higher for BNSF trains under the Alternatives to the Status Quo than under the Status Quo. This is evidently because of congestion at West Colton backing up along the UP Line to Colton Crossing. (The junction with the UP Palmdale Line at West Colton is planned to remain as is in the 2010 scenarios but is planned become a full flying junction in the 2025 scenarios.)

The consultant's conclusion is that an at-grade crossing at Colton is feasible for the 2010 traffic levels assumed in this study, provided the BNSF Line is equipped with three main tracks. However, this configuration has little capacity to spare. With almost one third of BNSF trains getting stopped and almost two thirds of UP trains getting stopped at the

crossing, the 2010 traffic levels are close to the maximums that can be accommodated without grade separation. So the BNSF – Metrolink proposal to implement the separation in 2010 is not many years early compared to the time when the consultant believes it would be truly required.

A letter dated April 28, 2005 was received from Metrolink indicating that levels of passenger service in 2010 and 2025 different than assumed in this study are now being evaluated. These levels of service are as follows. (Figures include both Amtrak and Metrolink services. New Metrolink figures are cited first, assumptions of this study are second.)

Line Segment	**2010**	**2025**
BNSF Hobart – Fullerton	72 compared with 96	118 compared with 106
BNSF Atwood – Riverside	42 compared with 38	82 compared with 62
BNSF Riverside – Colton	24 compared with 24	40 compared with 36

Considering the time and budget limitations of this study, the consultant was unable to re-do the operational analysis for these new passenger train frequencies.

A second presentation of the preliminary findings was made to BNSF management in Fort Worth, TX on May 5, 2005. This time, the discussion was focused on track capacity improvements between San Bernardino and Barstow. BNSF's plans for 2010 call for three main tracks on their line between those points. This study plans for three main tracks Summit – Barstow, but it plans a fourth main track San Bernardino – Summit (Status Quo Alternative), and it plans three main tracks San Bernardino – Summit plus integration of the UP Palmdale Line with the BNSF Line between Devore Road and Silverwood and a fourth main track Silverwood – Summit (Alternatives to the Status Quo). As discussed in section 7 of this report, while the three-main-track configuration proposed by BNSF is indeed feasible, average freight train running times are predicted to be about 15 minutes longer than in the Year 2000 Base Case. The increased levels of improvements planned in this study are believed to be necessary to achieve Year 2000 transit times for the Year 2010 forecasts. As of the date of that meeting, BNSF had not analyzed 2025 traffic levels.

BNSF management also remarked that productivity improvements they are striving to achieve may temper train movement growth. They indicated that in 2004, BNSF intermodal unit volume (trailers and containers) to and from Southern California increased by about 14%, yet the number of intermodal trains operated increased by less than 4%.

A presentation of the preliminary findings was made to UP management in Omaha, NE on May 6, 2005. In general, UP management concurred with the planned improvements. UP indicated that a similar plan had been jointly presented by UP and BNSF two years ago to MTA, with copy to SCAG. (The consultant of this study has not seen that plan.) UP also indicated that their plans for accommodating 2010 traffic levels call for

increasing the percentage of UP train movements routed via the Alhambra Line between Colton and Pomona, and decreasing the percentage routed via the San Gabriel Line. This is consistent with the Alternatives to the Status Quo formulated in this study. Complete double-tracking of the San Gabriel Line between West Riverside and Pomona was seen by UP management as unrealistic, whereas double-tracking the Alhambra Line between West Colton and Pomona was more practical and part of their plan. UP management indicated that, in general, making capacity improvements in Southern California is much more difficult than elsewhere on their system, given the environmental reports and other requirements. As a result, no near-term track capacity improvements are planned by UP for the Los Angeles Basin, and their near-term capacity improvement projects are being undertaken elsewhere.

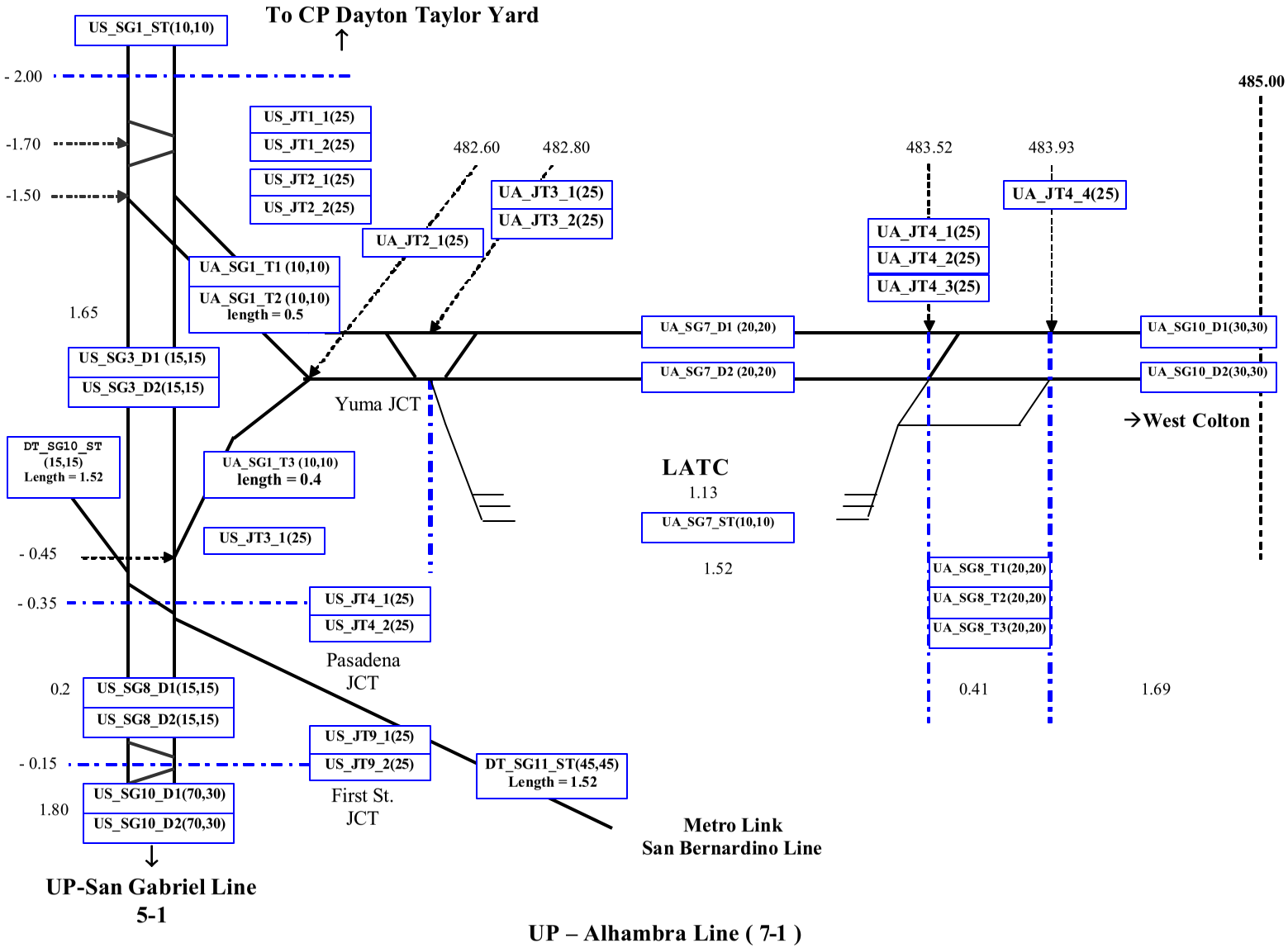
Appendix. Year 2000 Trackage Network

	XX_SGxx_S0 (a, b)	Single Track
	XX_SGxx_D1 (a, b) **XX_SGxx_D2 (a, b)**	Double Track
	XX_SGxx_T1 (a, b) **XX_SGxx_T2 (a, b)** **XX_SGxx_T3 (a, b)**	Triple Track
	XX_SGxx_ST (a, b)	Station
	XX_SGxx_BF (a, b)	Buffer
	XX_SGxx_DM)	Dummy segment with zero length
	XX_JTxx_xx(c)	Junction/ Switch

- ‘a’ : speed limit for passenger trains. (miles/hour)
  ‘b’ : speed limit for freight trains. (miles/hour)
  ‘c’ : speed limit for both passenger and freight trains. (miles/hour)

- ‘XX’ : has values ‘UA’, ’US’, ’BF’ or ‘DT’.
  ‘UA’ stands for the UP-Alhambra line.
  ‘US’ stands for the UP-San Gabriel line.
  ‘BF’ stands for the BNSF line.
  ‘DT’ stands for downtown line near Redondo Tower.

- ‘xx’: the track index number. Range 0-99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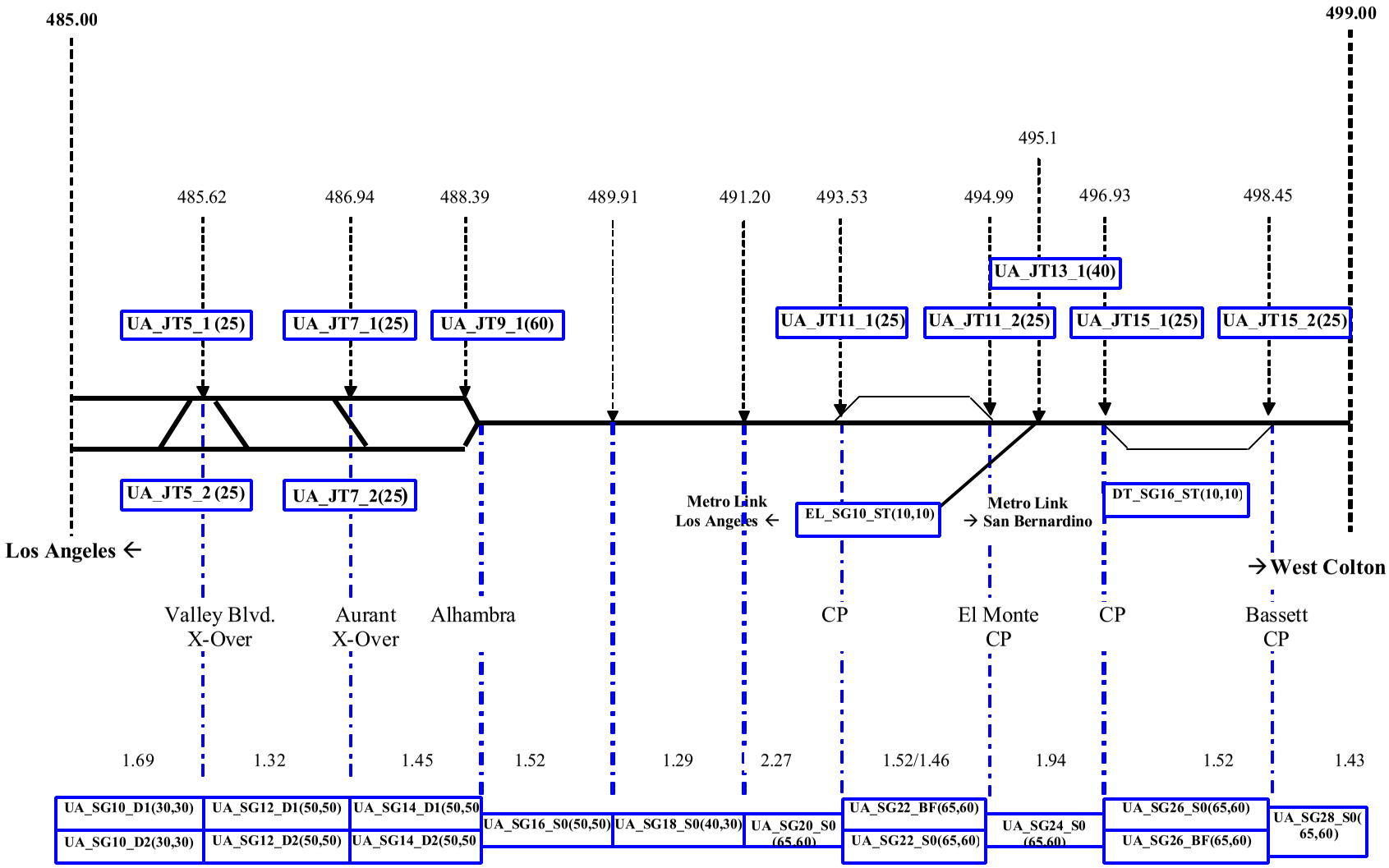
5-1
UP – Alhambra Line (7-1)



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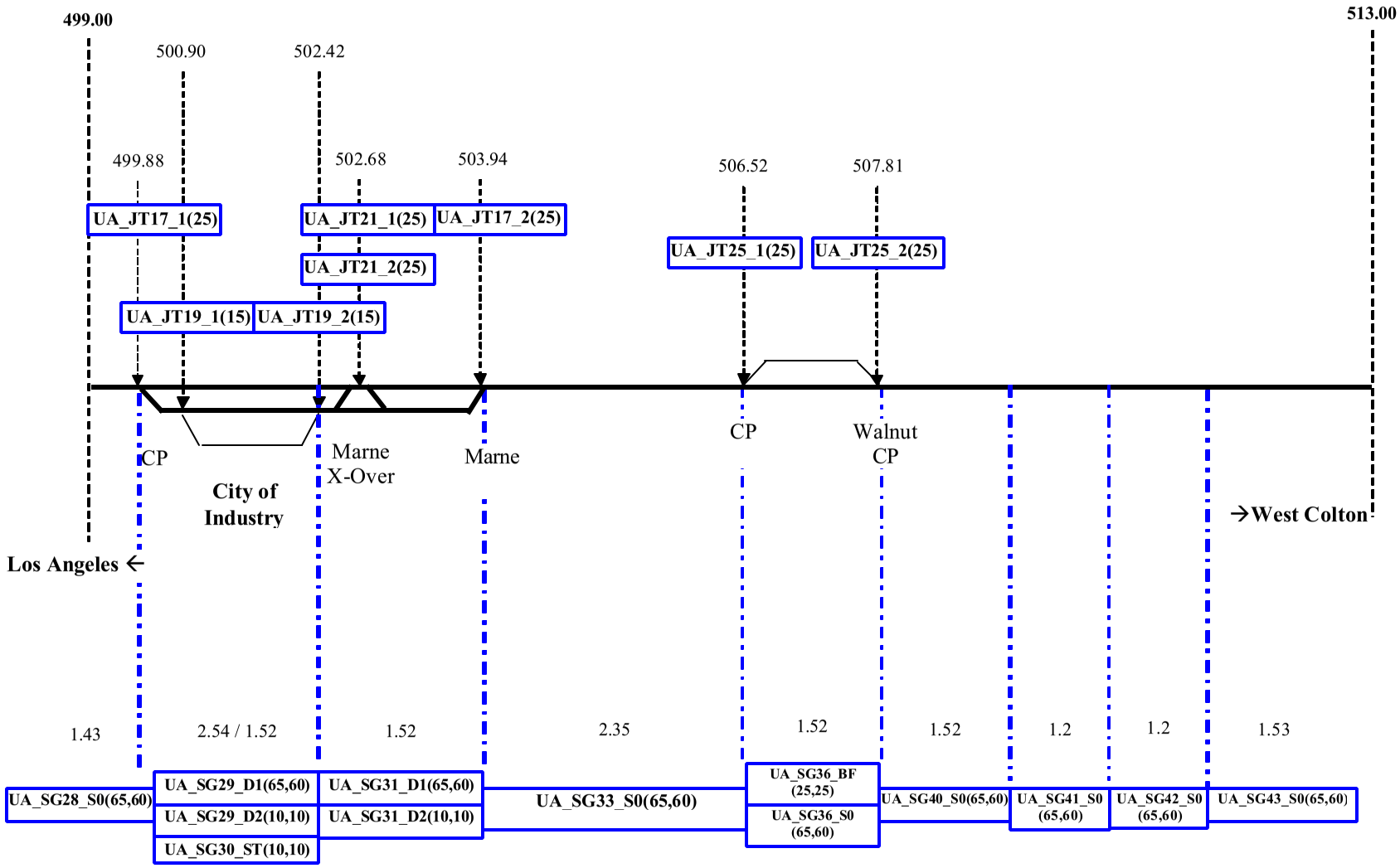

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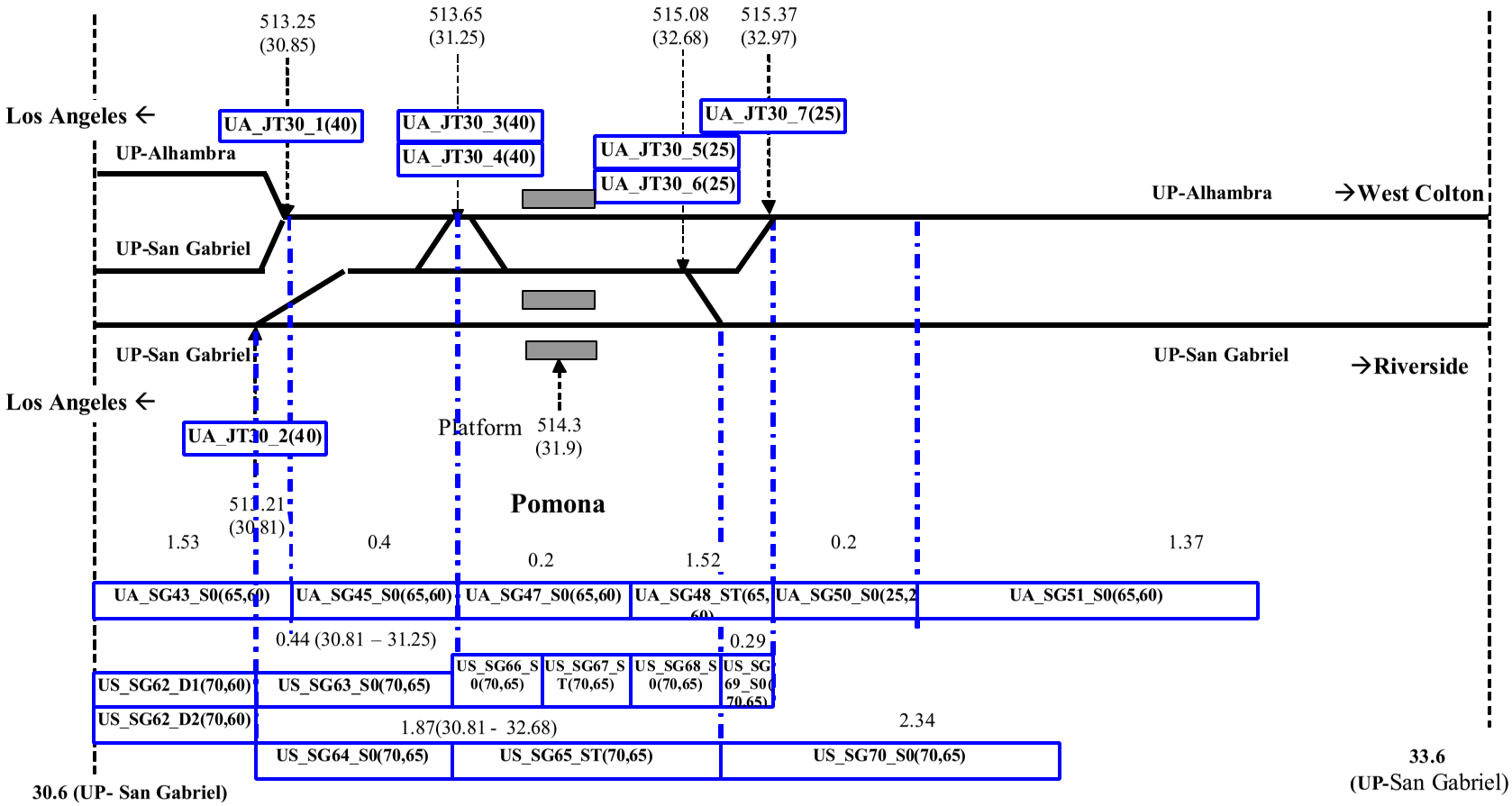

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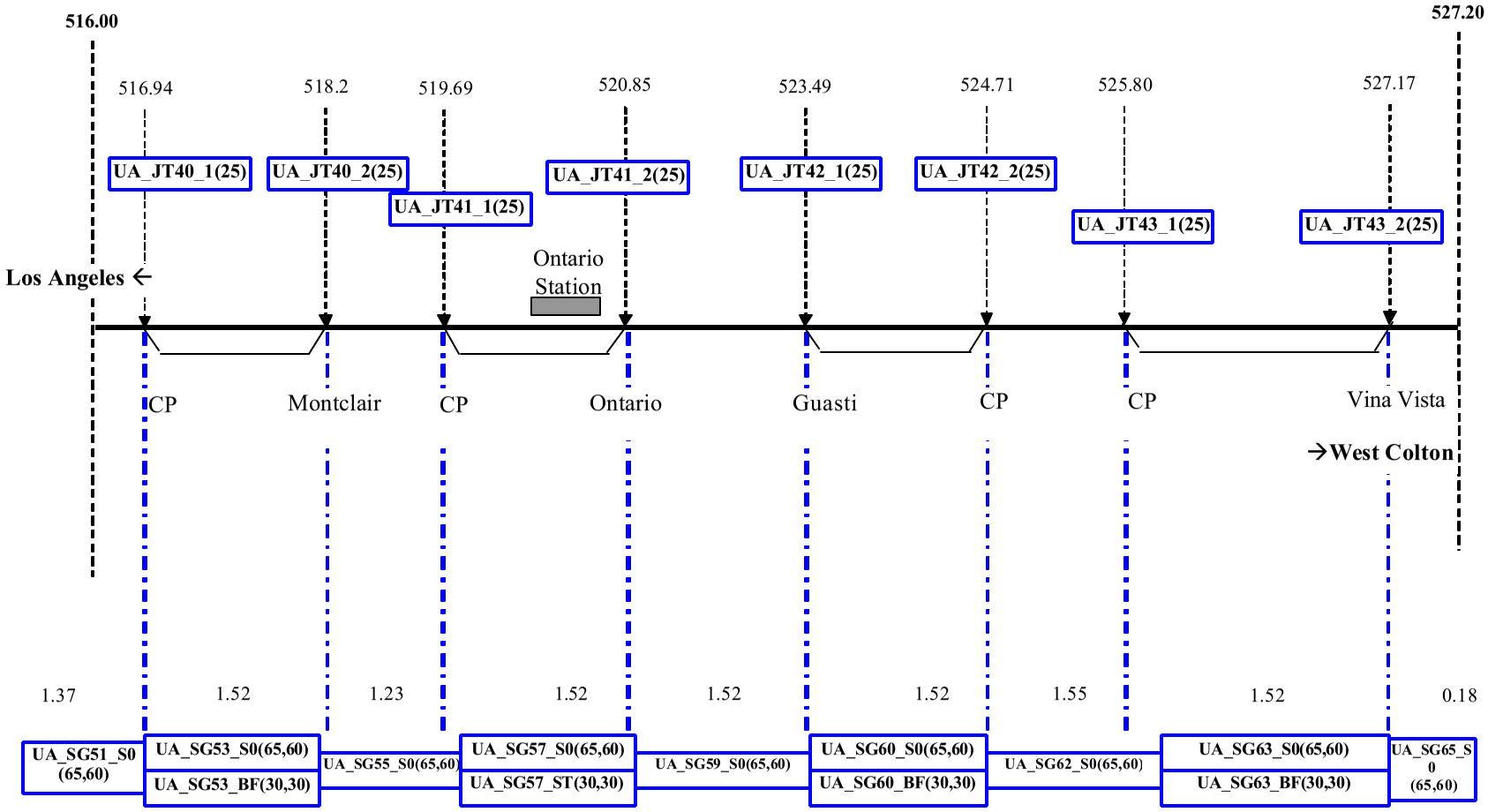

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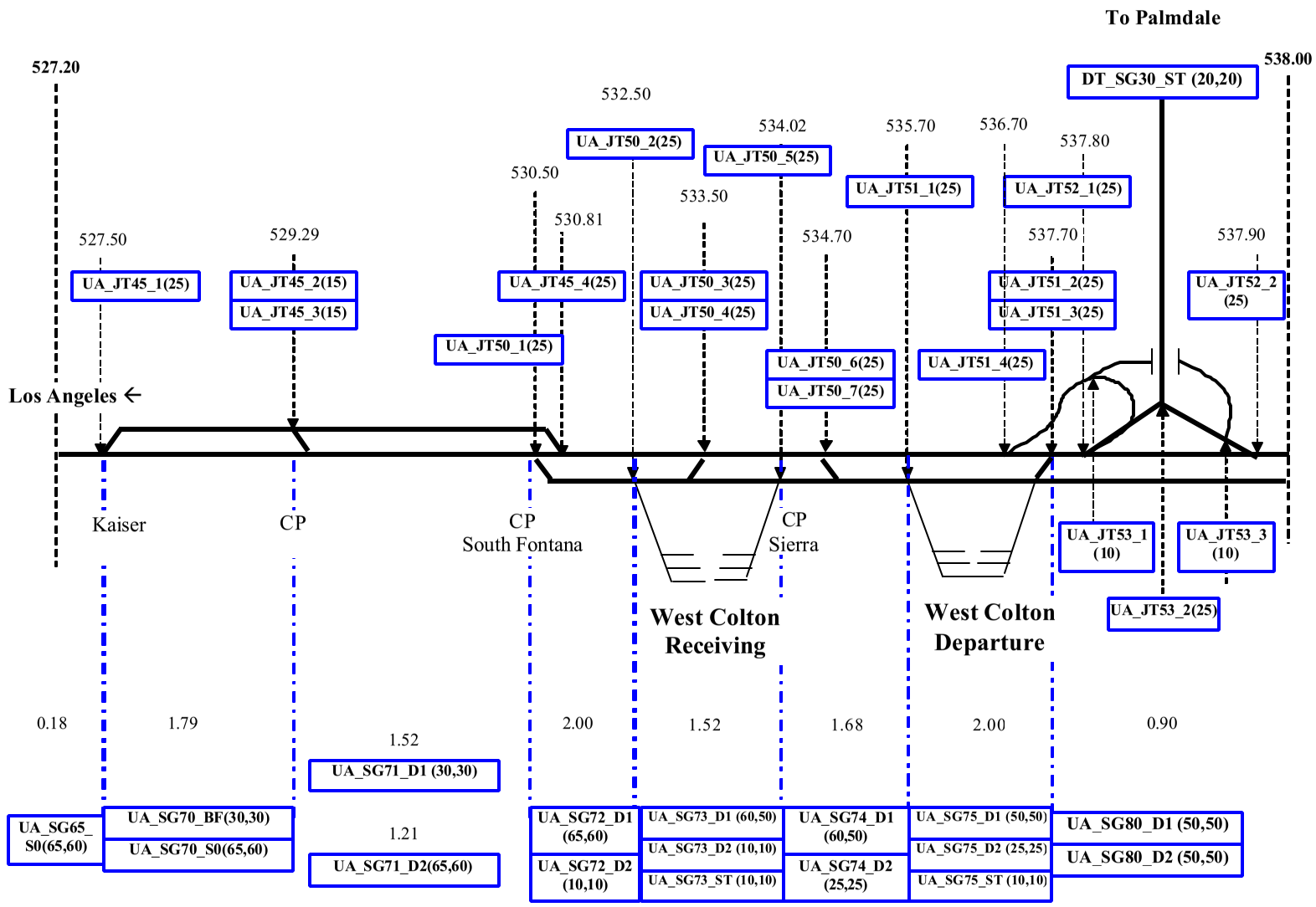

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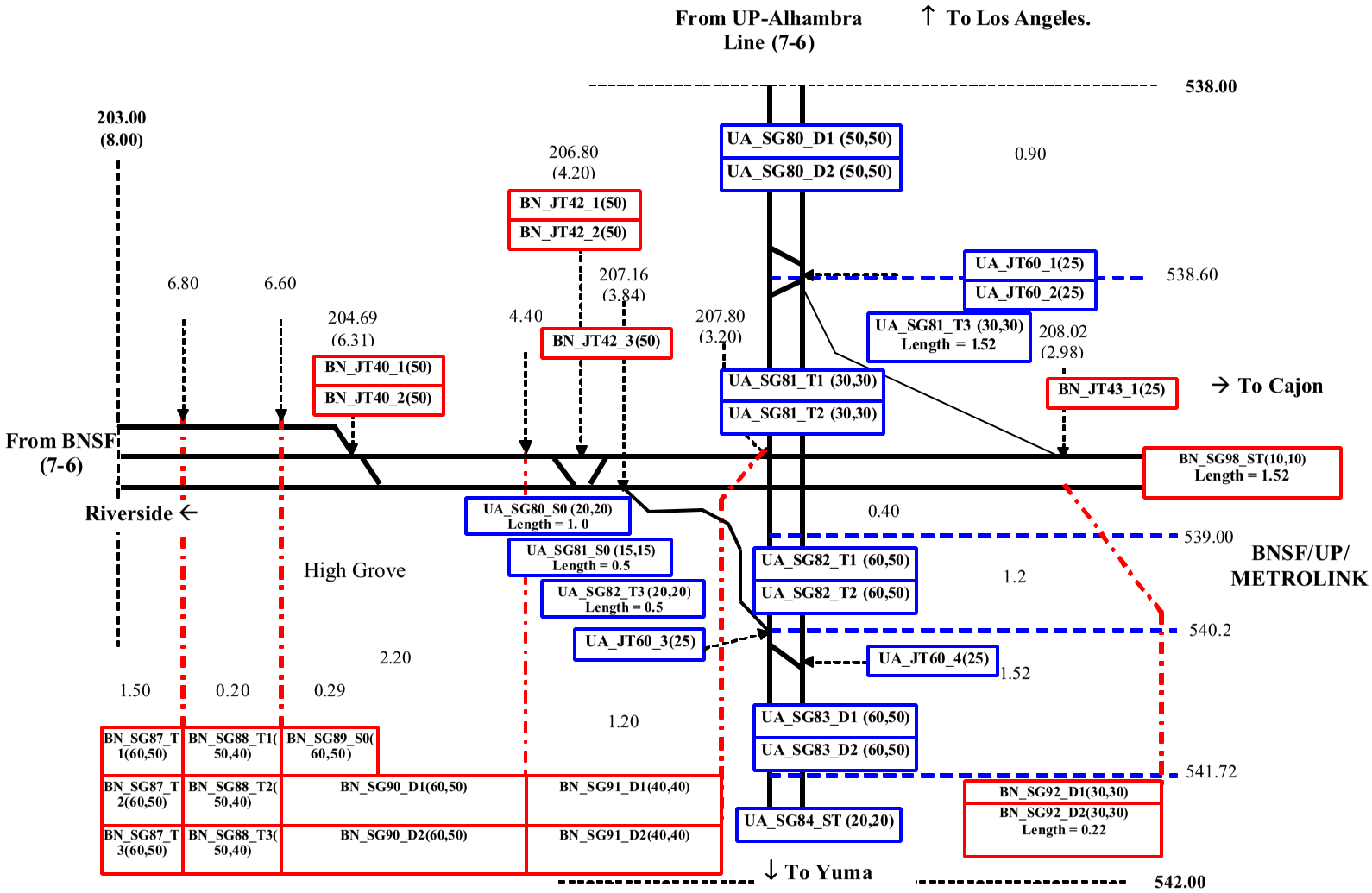

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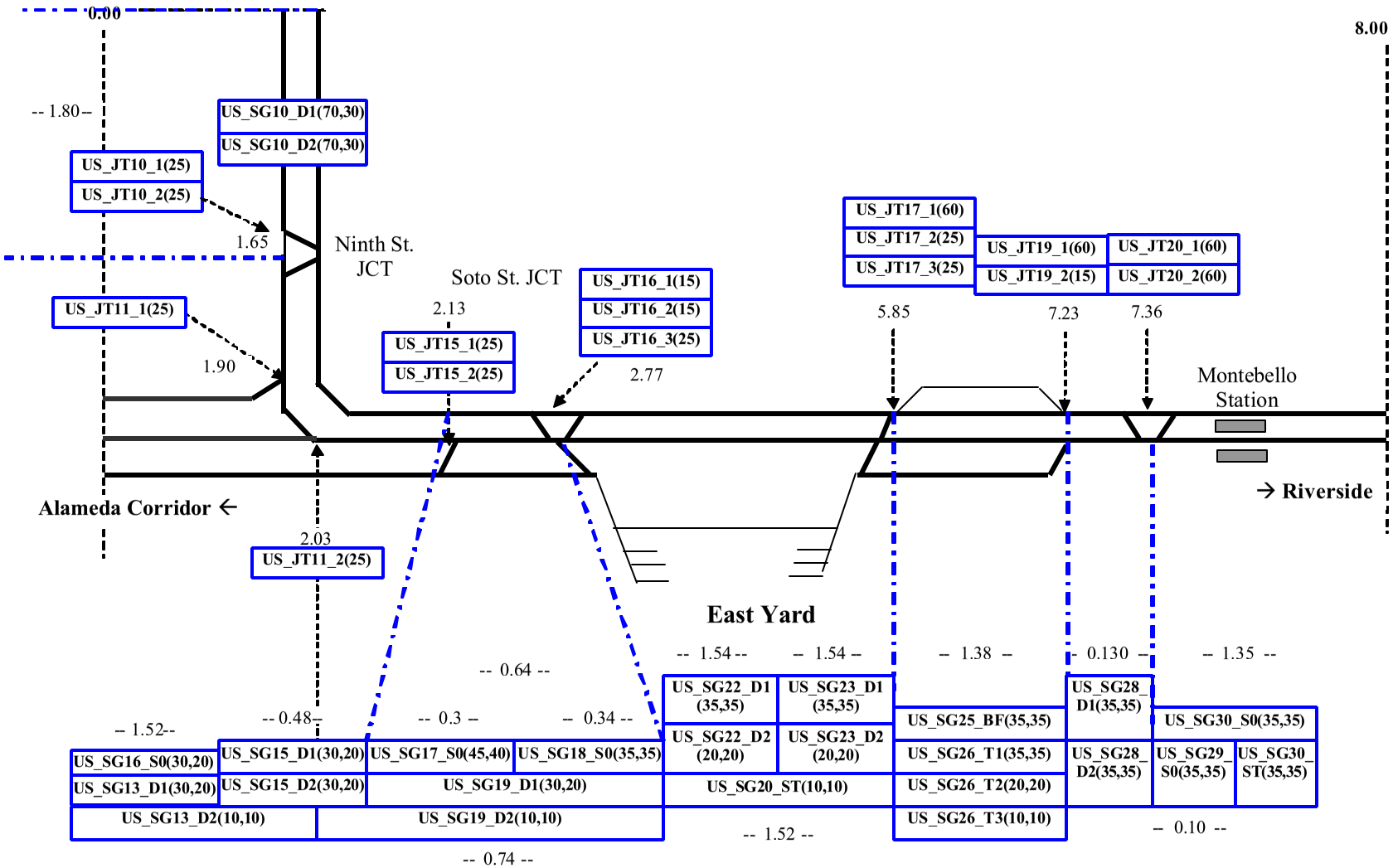
BNSF (7 -7)



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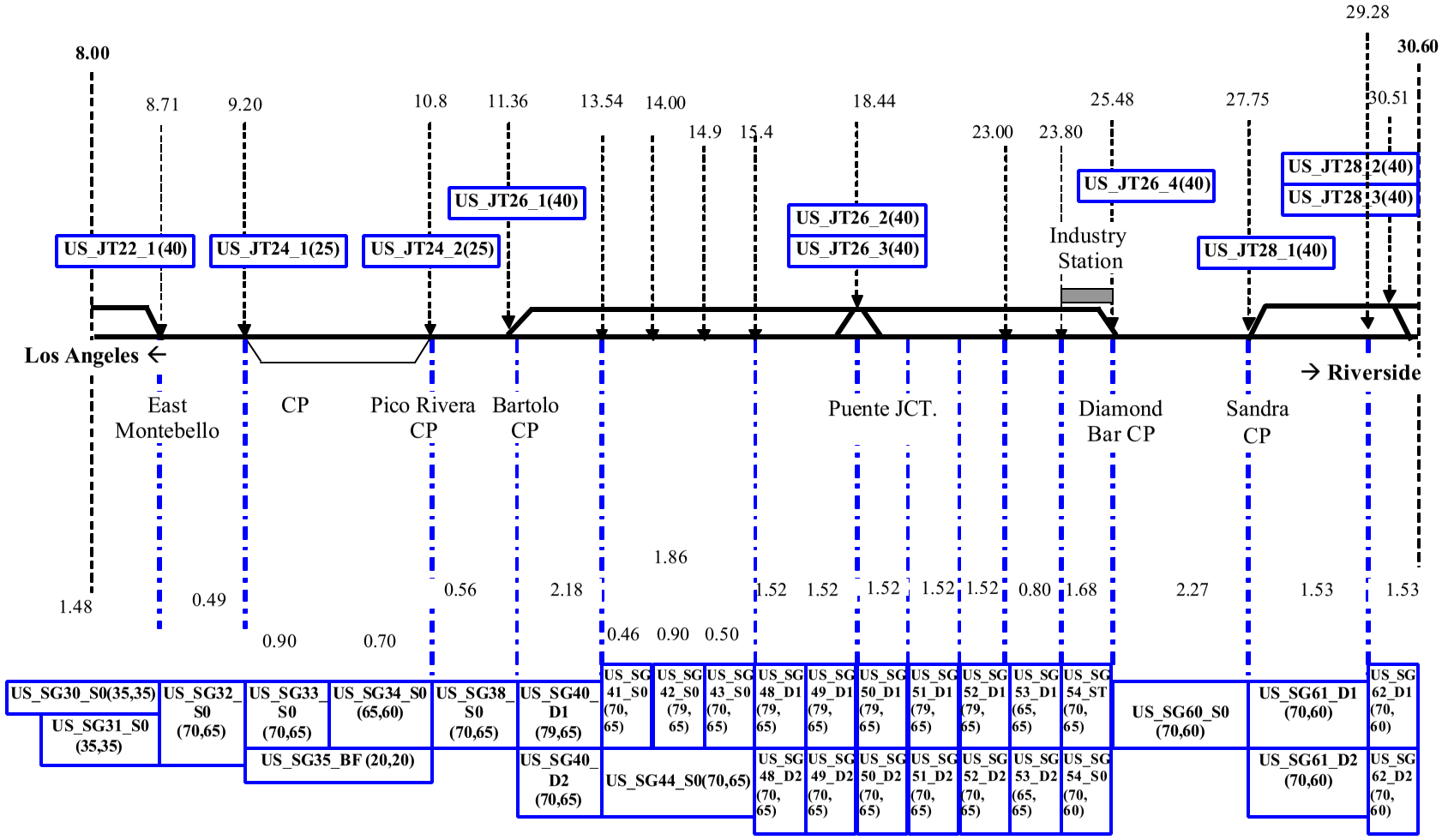

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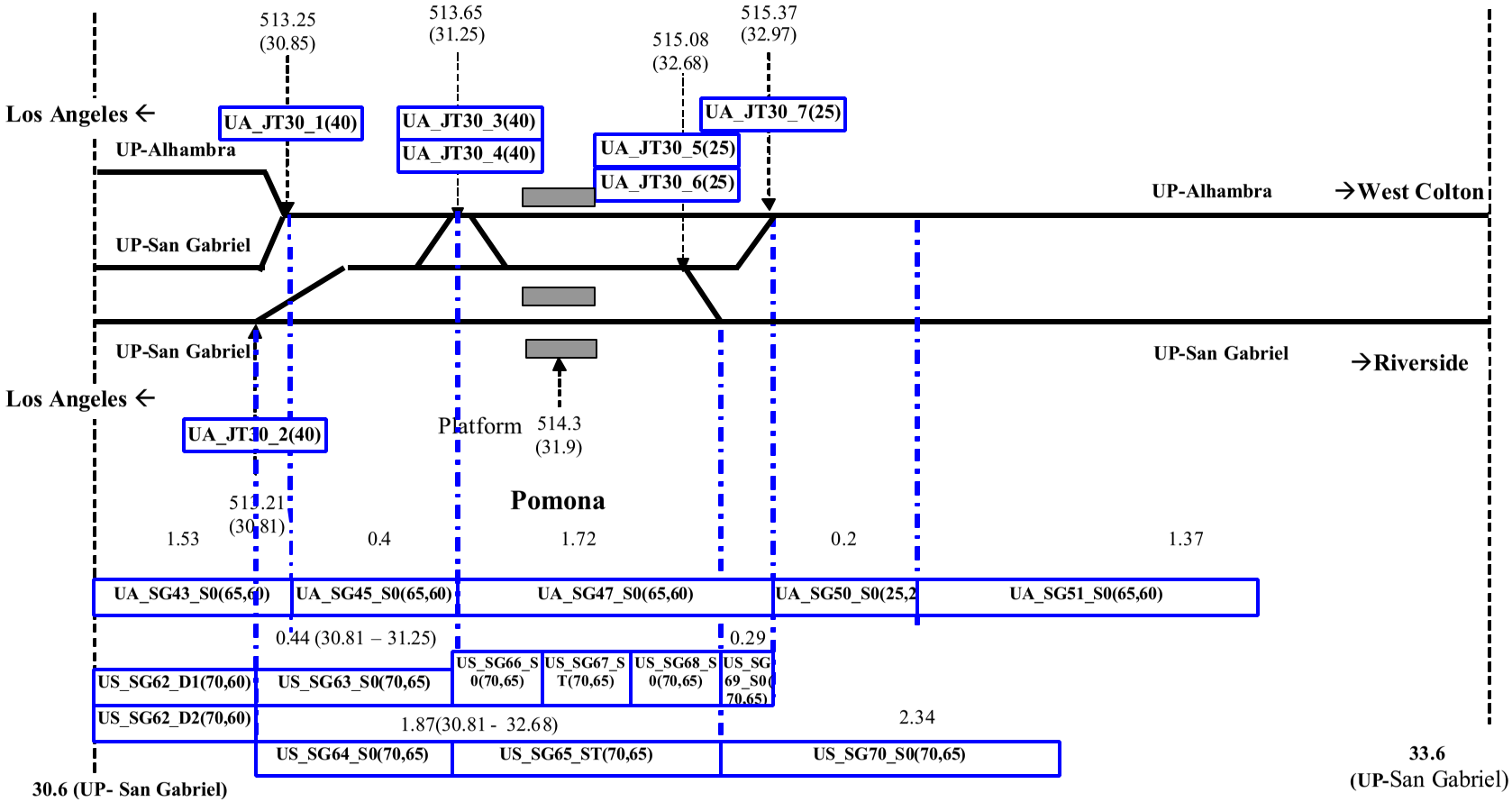

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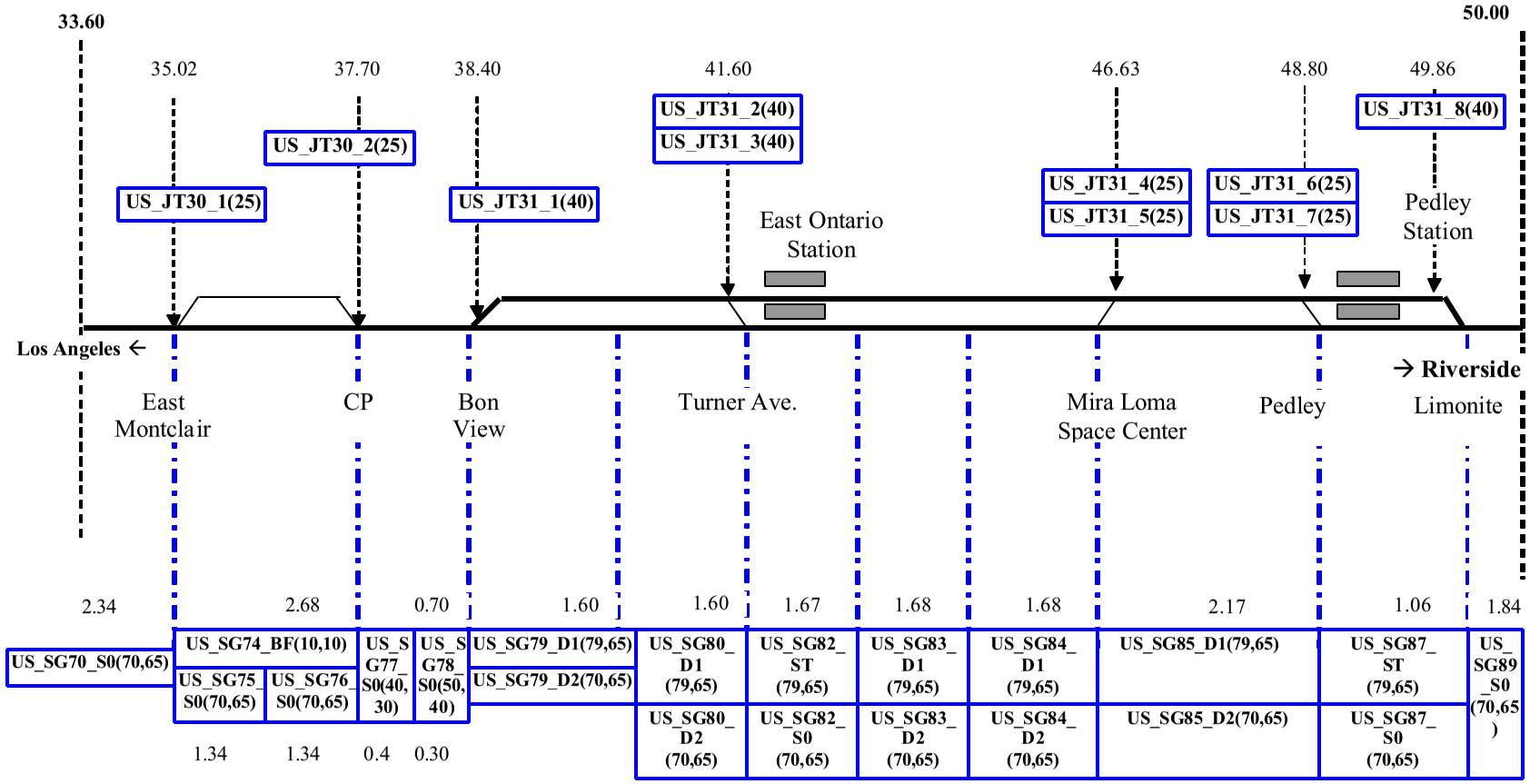
UP – Alhambra Line (7-4)



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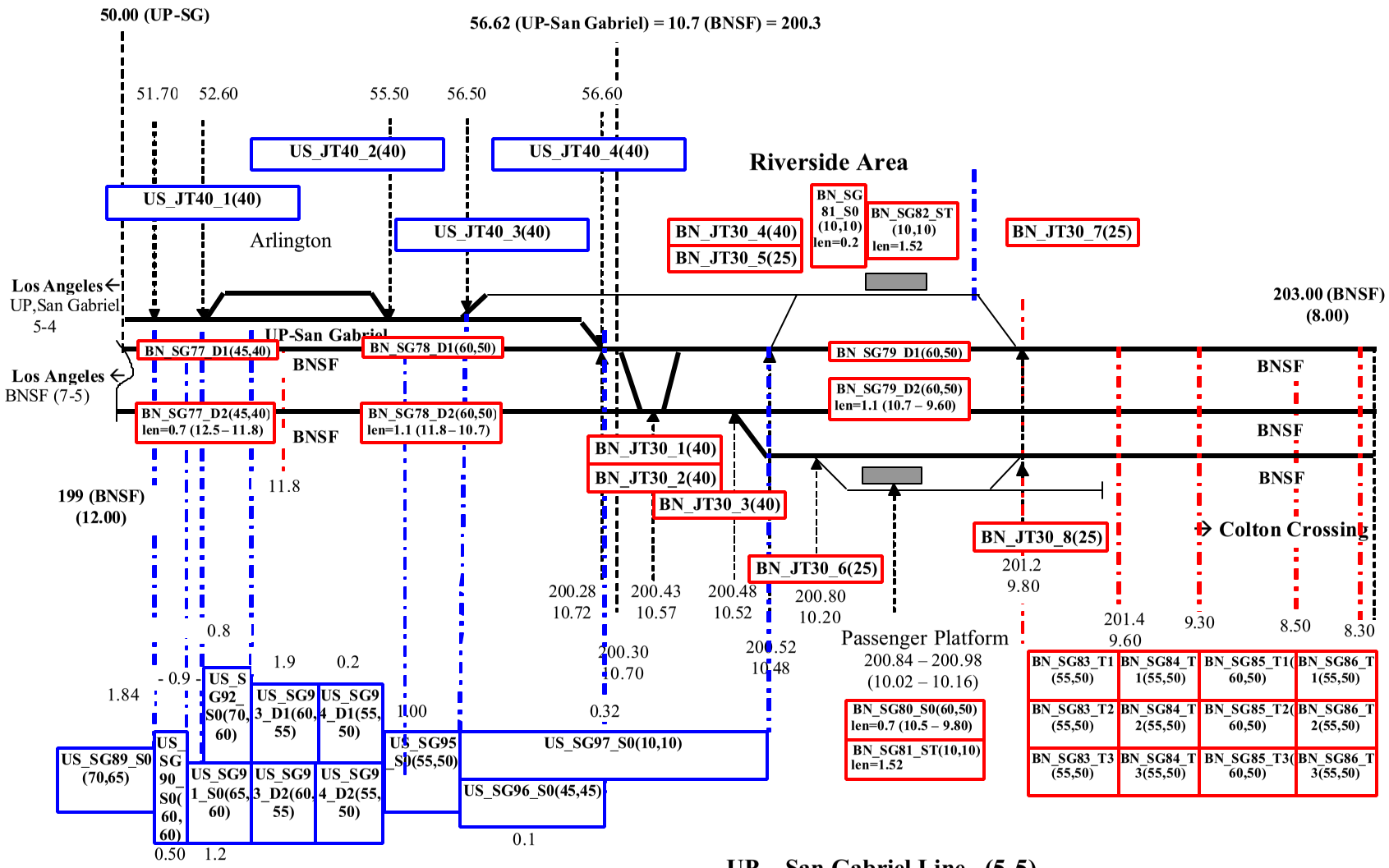
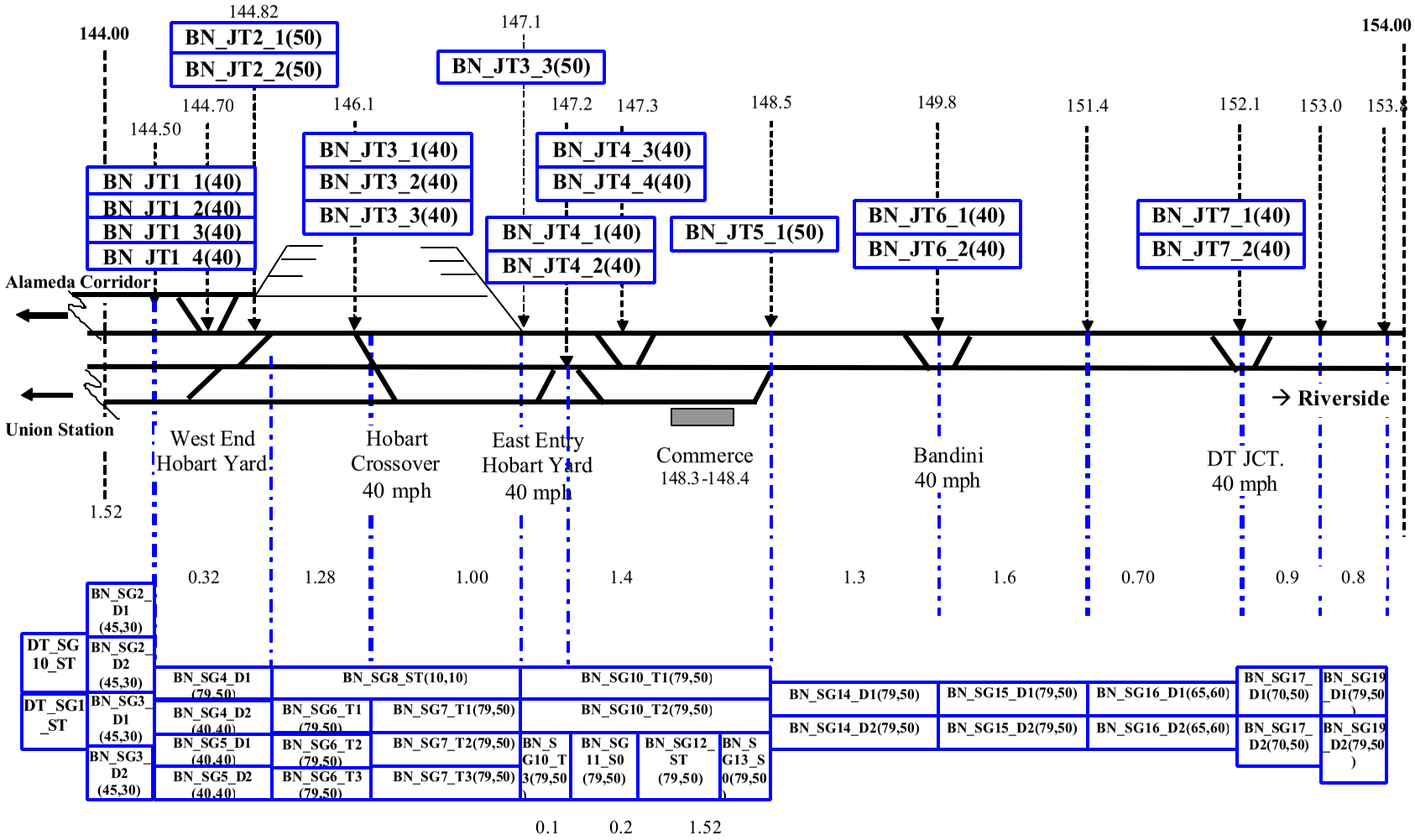


UP – San Gabriel Line (5-5)

BNSF (7-6)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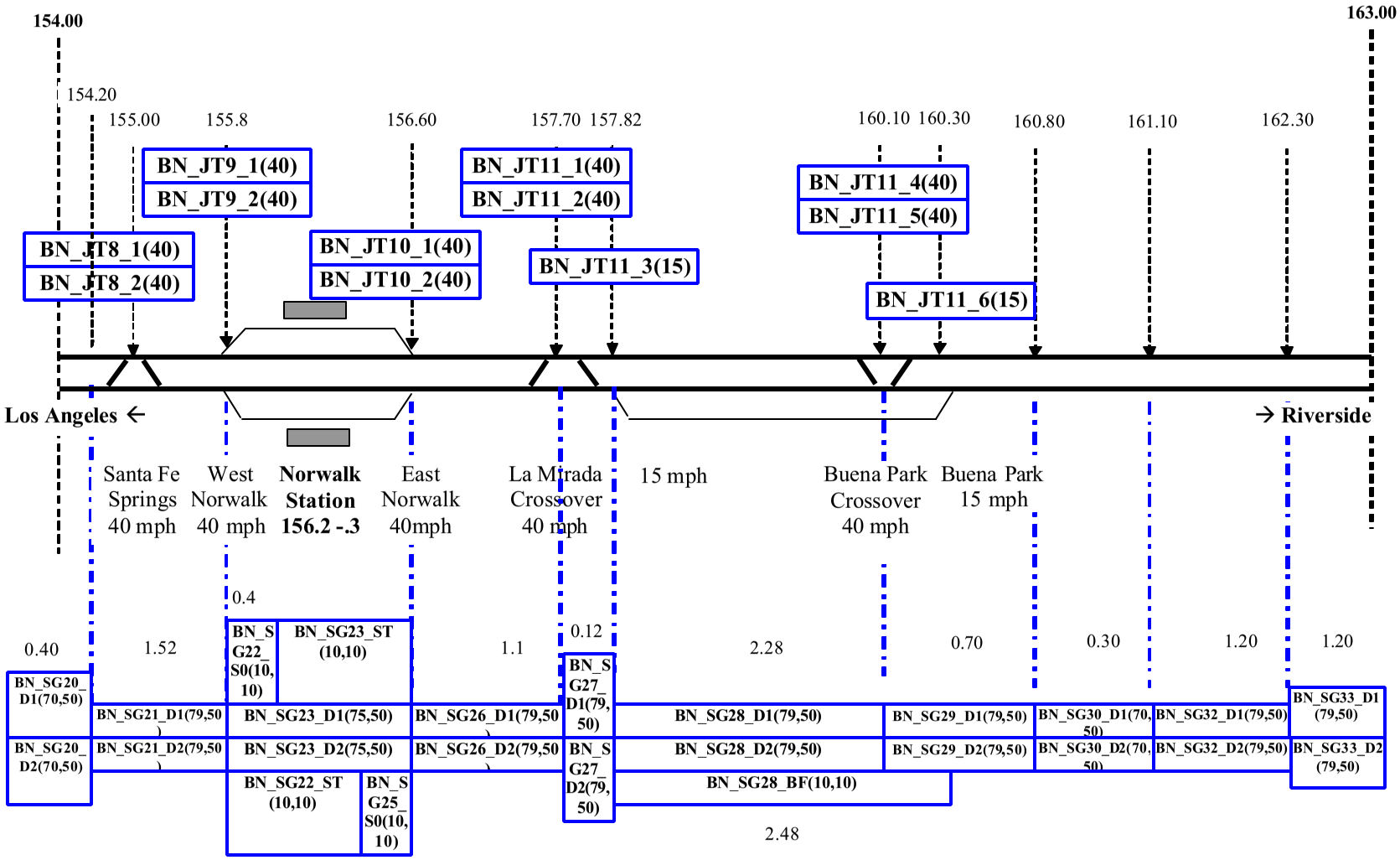
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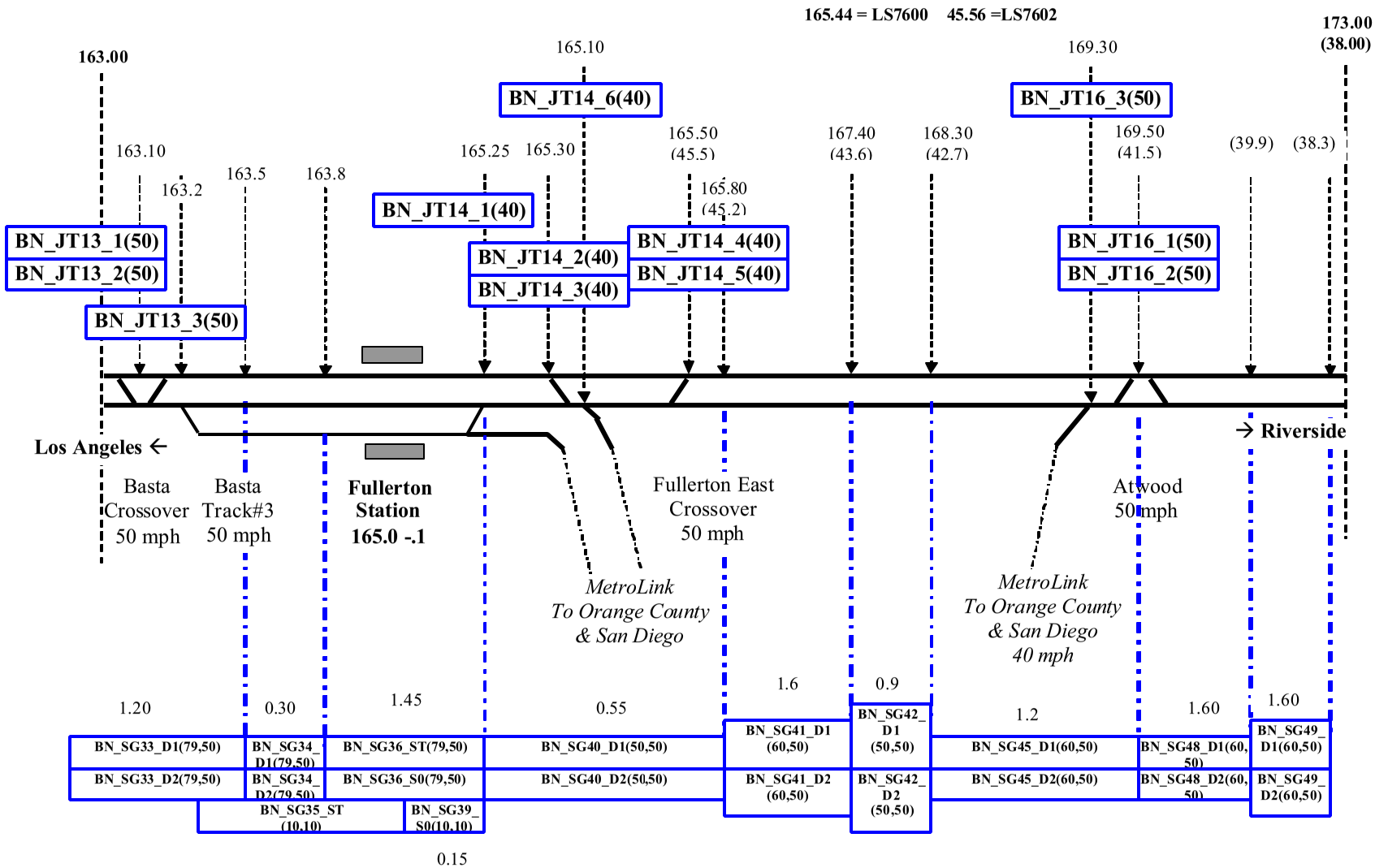
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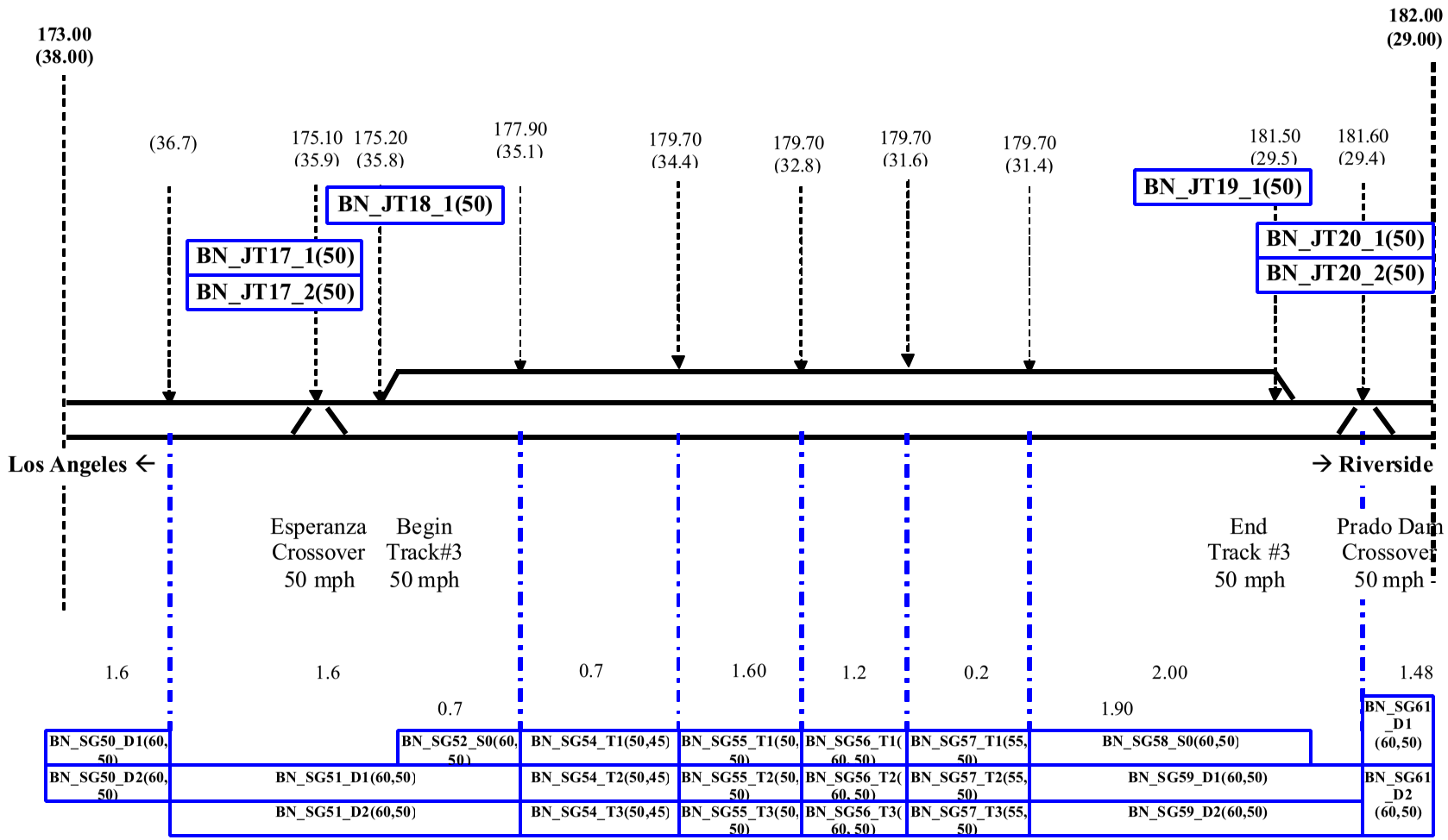
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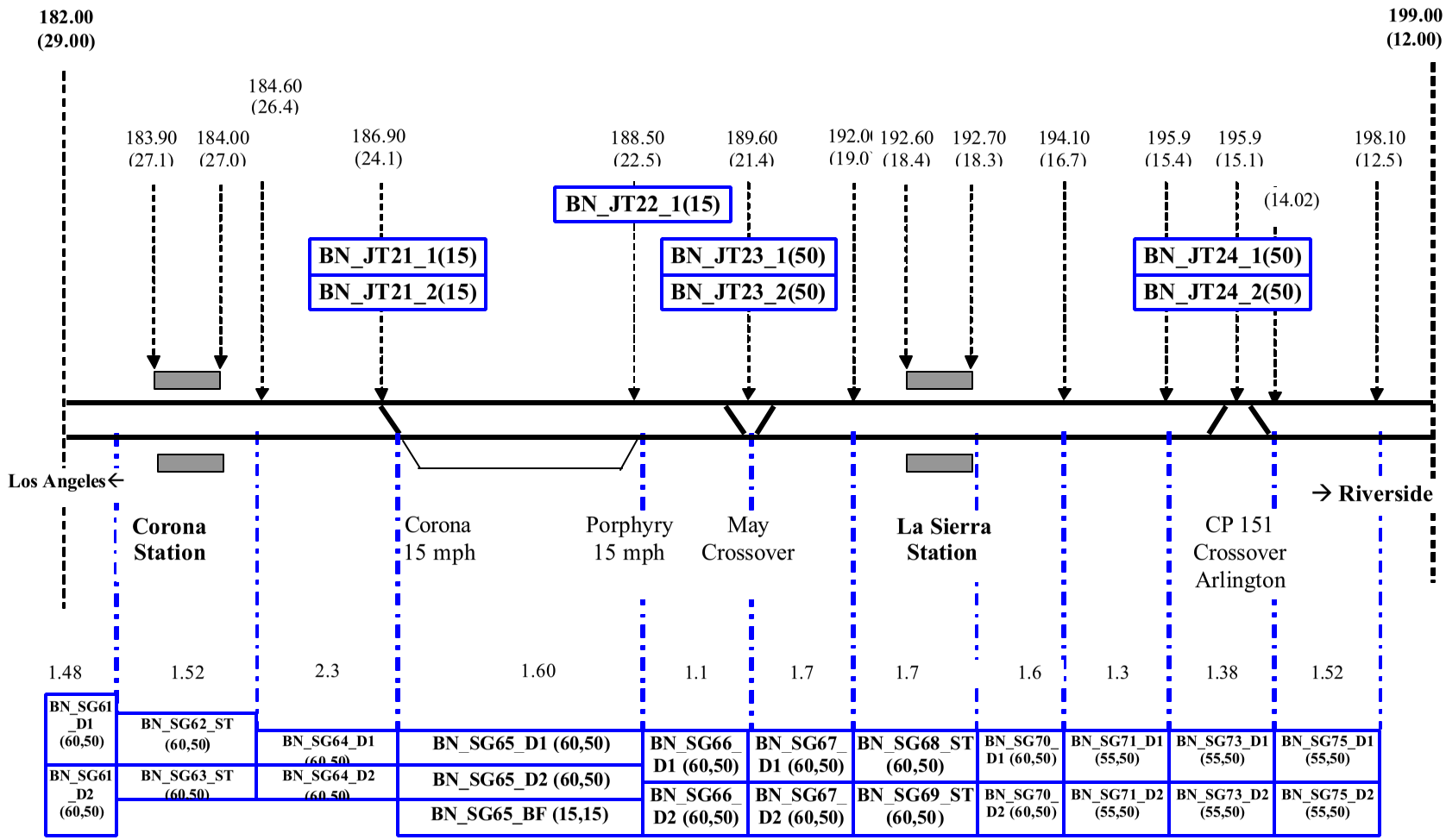
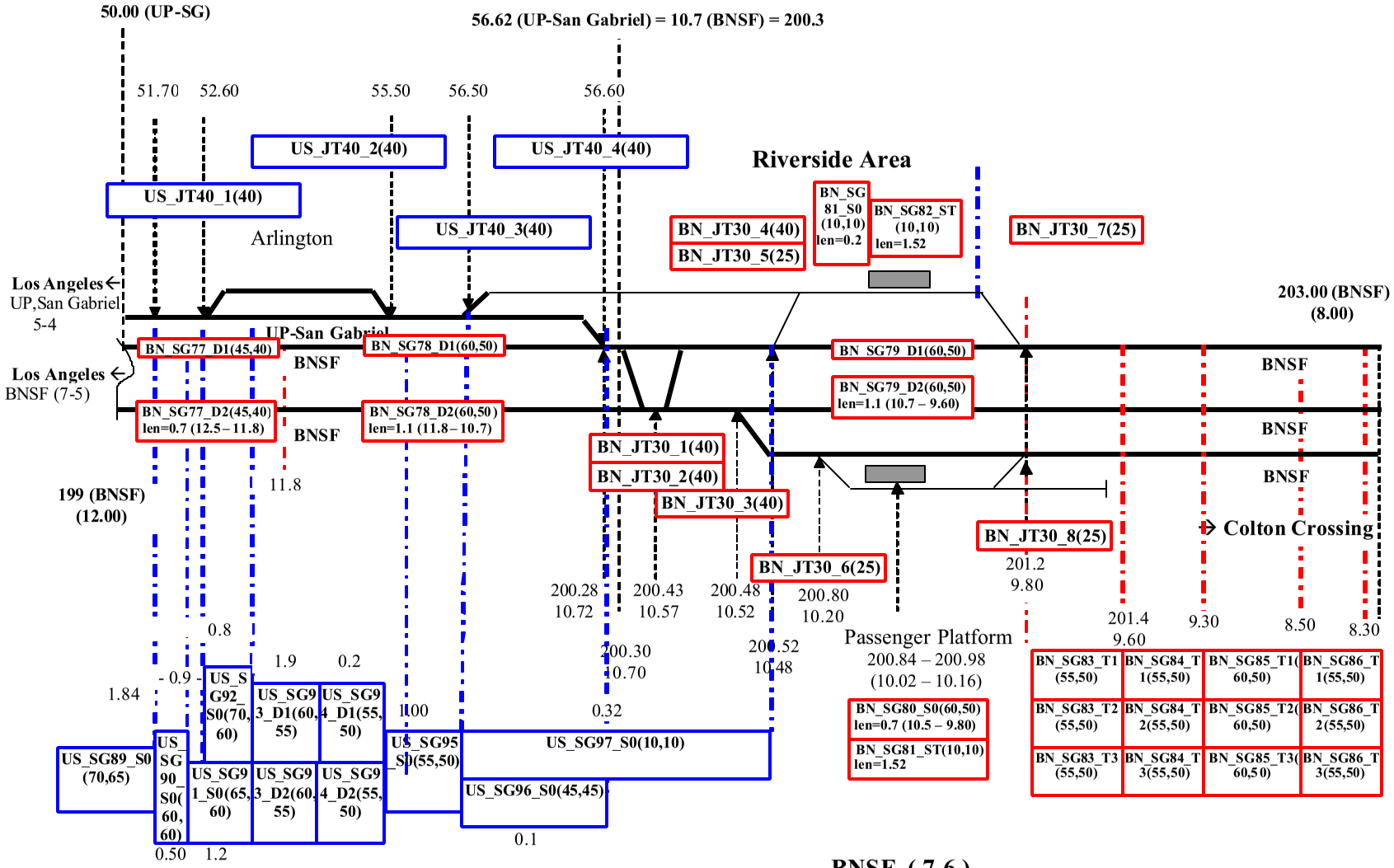
BN_SG54_T3(50,45)
BN_SG55_T1(50,50)
BN_SG55_T2(50,50)
BN_SG55_T3(50,50)
BN_SG56_T1(60,50)
BN_SG56_T2(60,50)
BN_SG56_T3(60,50)
BN_SG57_T1(55,50)
BN_SG57_T2(55,50)
BN_SG57_T3(55,50)
BN_SG58_S0(60,50)
BN_SG59_D1(60,50)
BN_SG59_D2(60,50)
BN_SG61_D1(60,50)
BN_SG61_D2(60,50)

BNSF (7-4)

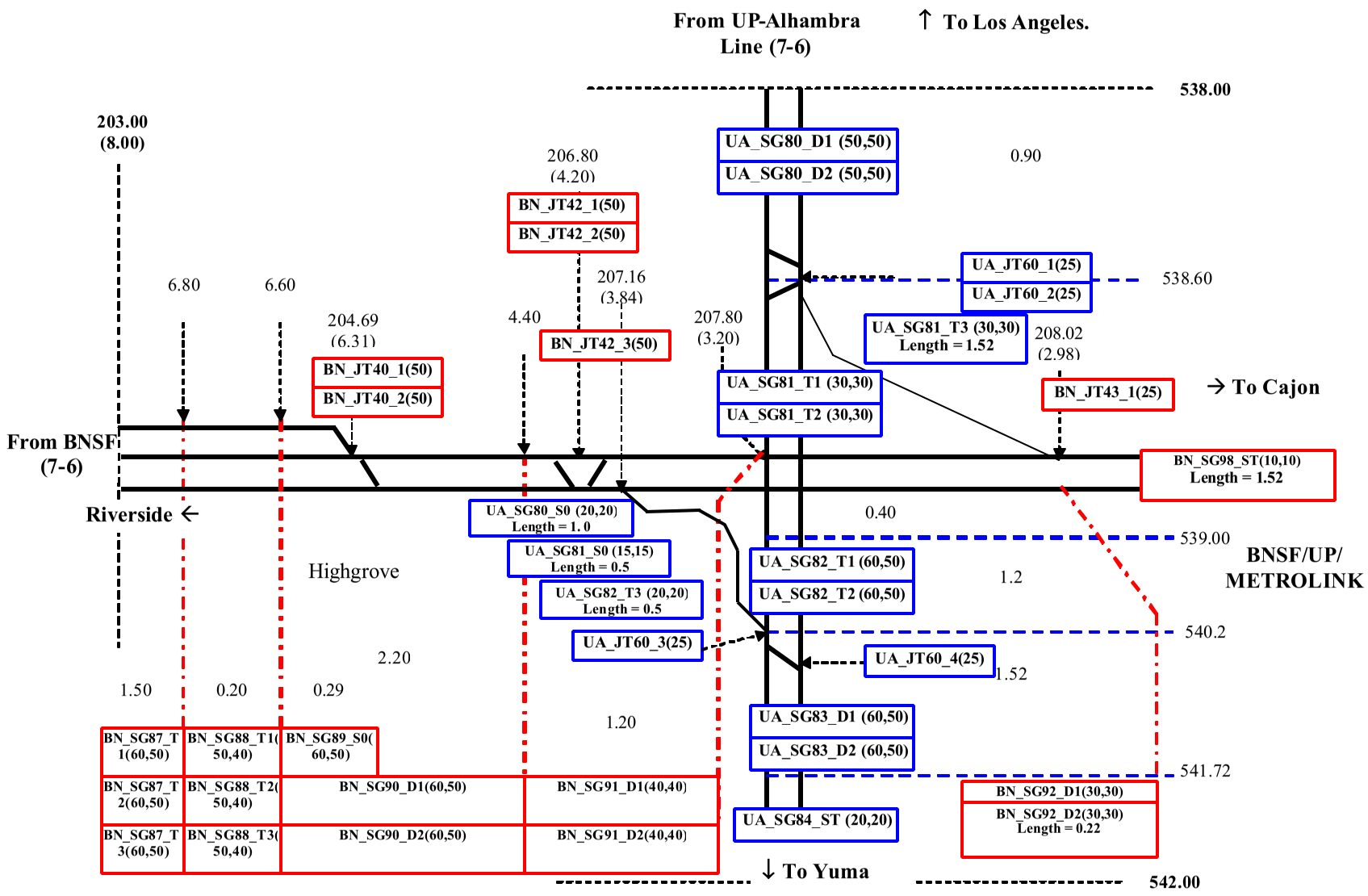

182.00
(29.00)
199.00
(12.00)
184.60
(26.4)
183.90
(27.1)
184.00
(27.0)
186.90
(24.1)
188.50
(22.5)
189.60
(21.4)
192.60
(18.4)
192.70
(18.3)
194.10
(16.7)
195.9
(15.4)
195.9
(15.1)
198.10
(12.5)
(14.02)
BN_JT22_1(15)
BN_JT21_1(15)
BN_JT21_2(15)
BN_JT23_1(50)
BN_JT23_2(50)
BN_JT24_1(50)
BN_JT24_2(50)
Los Angeles←
→ Riverside
Corona Station
Corona 15 mph
Porphyry 15 mph
May Crossover
La Sierra Station
CP 151 Crossover Arlington
1.48
1.52
2.3
1.60
1.1
1.7
1.7
1.6
1.3
1.38
1.52
BN_SG61_D1 (60,50)
BN_SG61_D2 (60,50)
BN_SG62_ST (60,50)
BN_SG63_ST (60,50)
BN_SG64_D1 (60,50)
BN_SG64_D2 (60,50)
BN_SG65_D1 (60,50)
BN_SG65_D2 (60,50)
BN_SG65_BF (15,15)
BN_SG66_D1 (60,50)
BN_SG66_D2 (60,50)
BN_SG67_D1 (60,50)
BN_SG67_D2 (60,50)
BN_SG68_ST (60,50)
BN_SG69_ST (60,50)
BN_SG70_D1 (60,50)
BN_SG70_D2 (60,50)
BN_SG71_D1 (55,50)
BN_SG71_D2 (55,50)
BN_SG73_D1 (55,50)
BN_SG73_D2 (55,50)
BN_SG75_D1 (55,50)
BN_SG75_D2 (55,50)

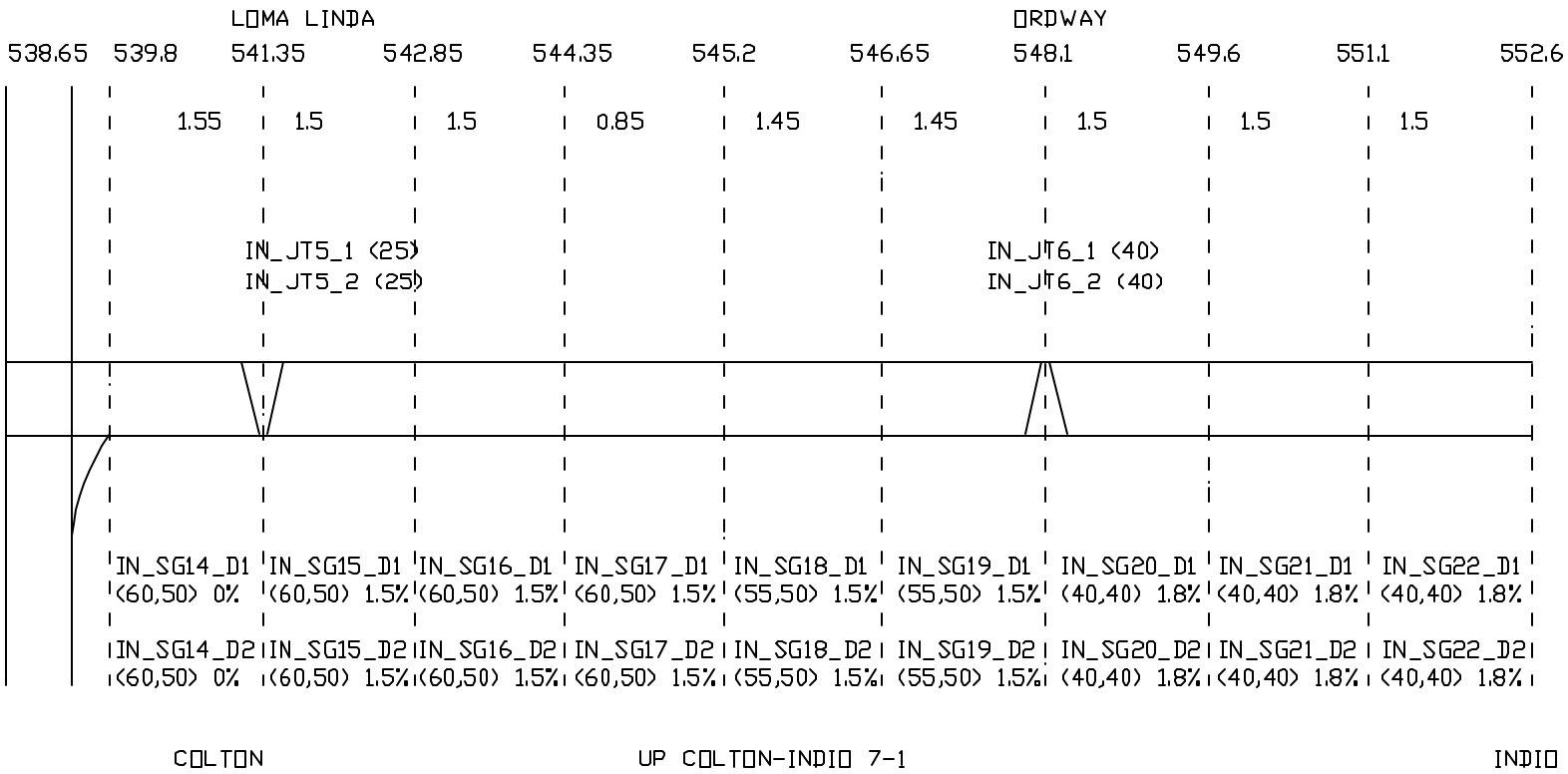
BNSF (7-5)

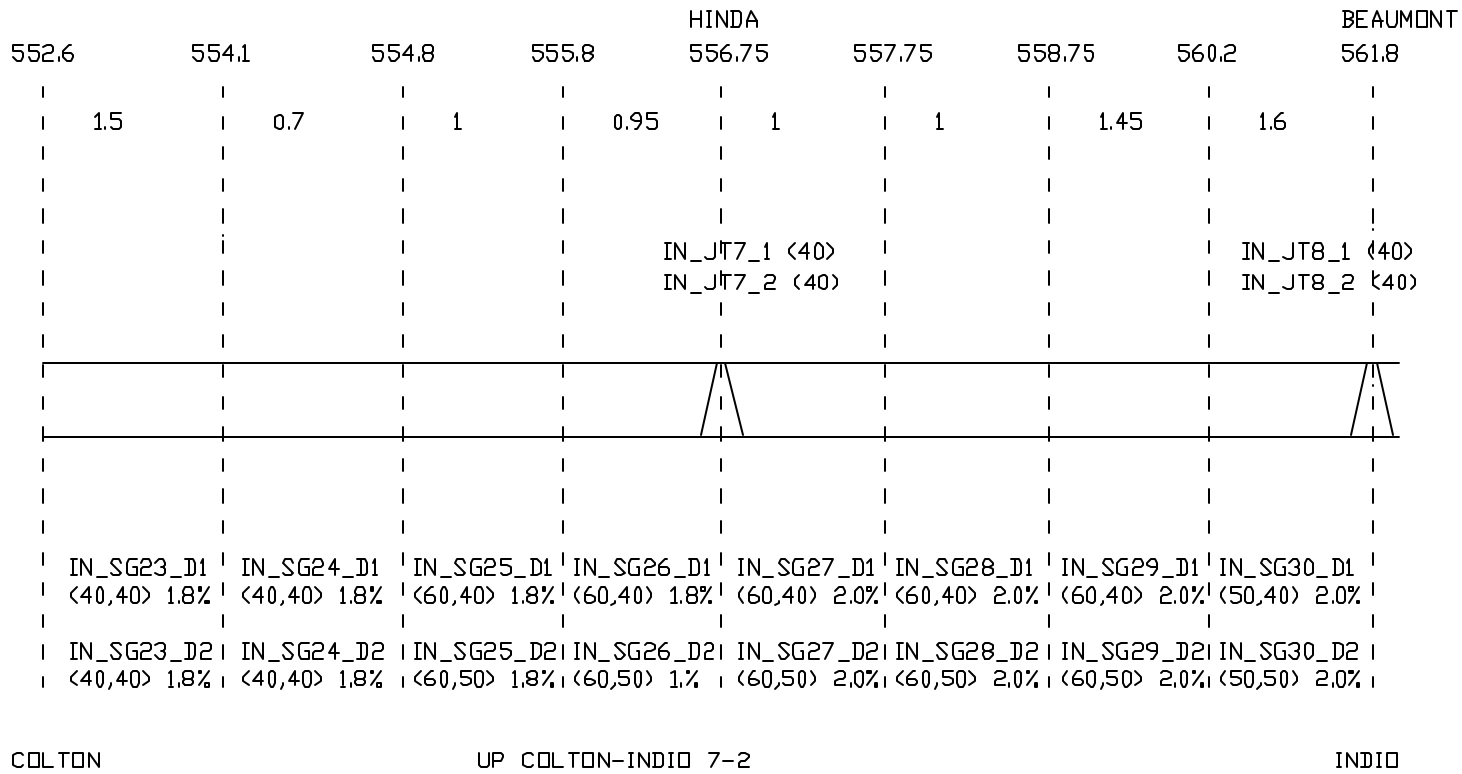


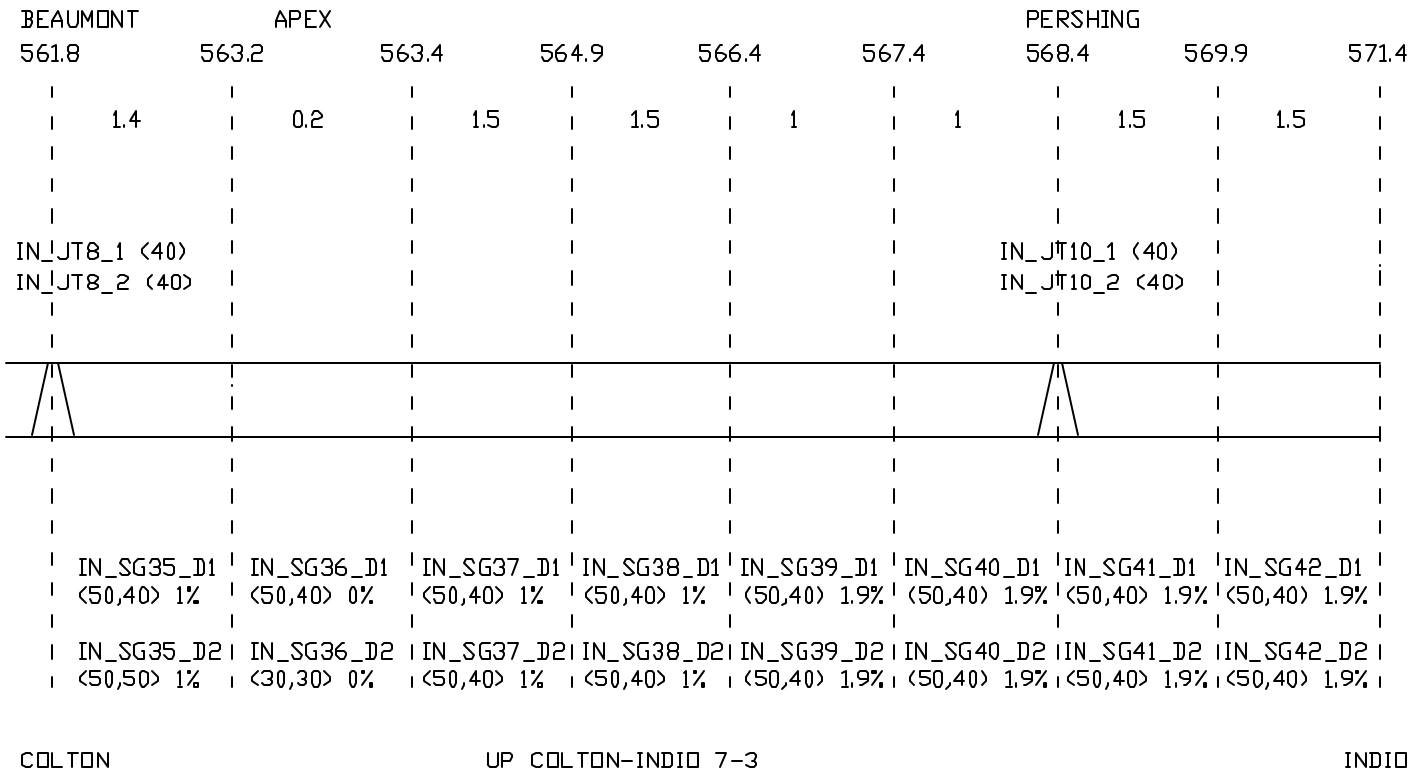
BNSF (7-6)

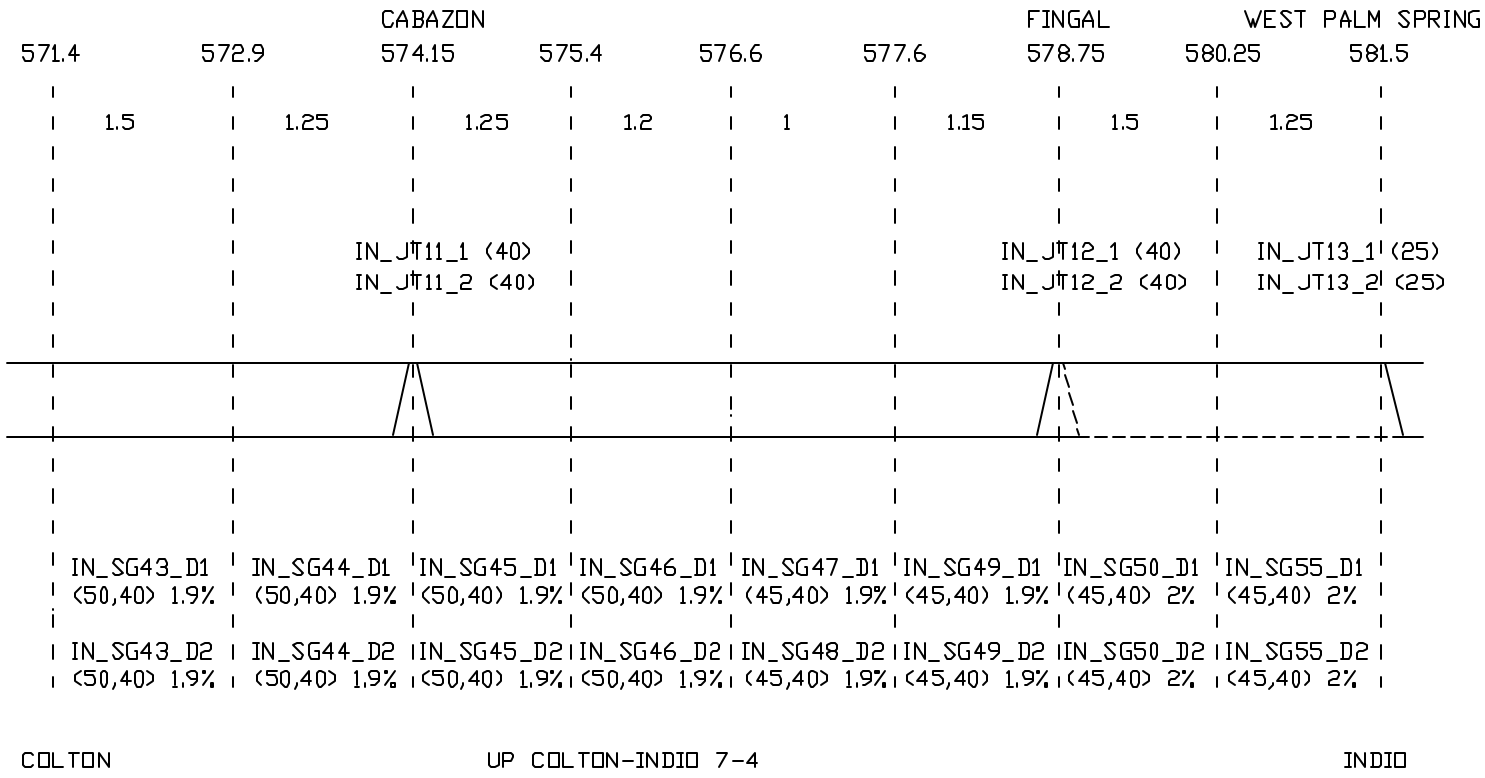
UP – San Gabriel Line (5-5)

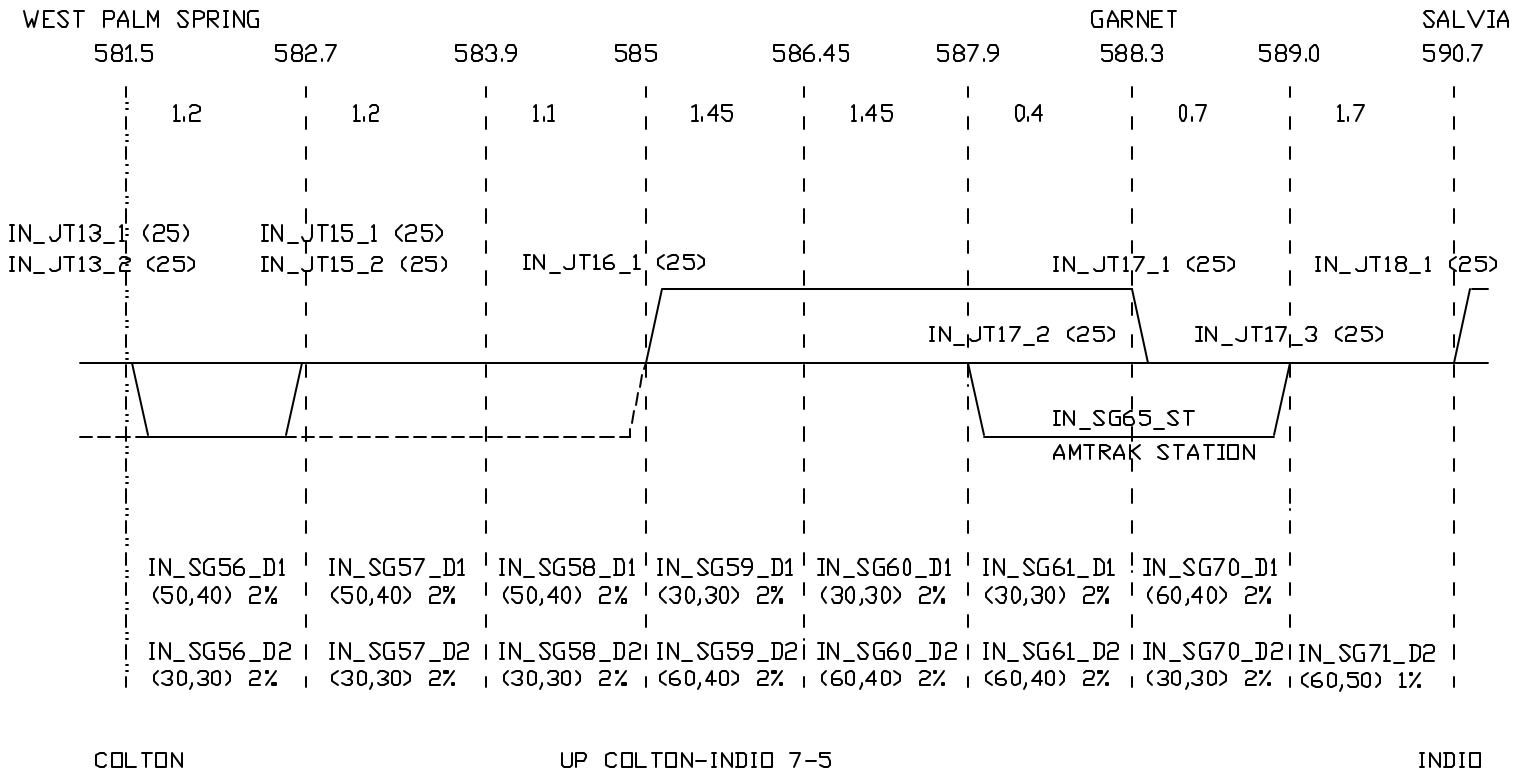

From UP-Alhambra Line (7-6)
↑ To Los Angeles.
538.00
203.00 (8.00)
206.80 (4.20)
UA_SG80_D1 (50,50)
UA_SG80_D2 (50,50)
0.90
BN_JT42_1(50)
BN_JT42_2(50)
UA_JT60_1(25)
UA_JT60_2(25)
538.60
6.80
6.60
207.16 (3.84)
204.69 (6.31)
4.40
207.80 (3.20)
UA_SG81_T3 (30,30) Length = 1.52
208.02 (2.98)
BN_JT42_3(50)
BN_JT40_1(50)
BN_JT40_2(50)
UA_SG81_T1 (30,30)
UA_SG81_T2 (30,30)
BN_JT43_1(25)
→ To Cajon
From BNSF (7-6)
BN_SG98_ST(10,10) Length = 1.52
Riverside ←
UA_SG80_S0 (20,20) Length = 1. 0
0.40
539.00
UA_SG81_S0 (15,15) Length = 0.5
Highgrove
UA_SG82_T1 (60,50)
UA_SG82_T2 (60,50)
1.2
BNSF/UP/ METROLINK
UA_SG82_T3 (20,20) Length = 0.5
540.2
UA_JT60_3(25)
UA_JT60_4(25)
2.20
1.52
1.50
0.20
0.29
1.20
UA_SG83_D1 (60,50)
UA_SG83_D2 (60,50)
BN_SG87_T1(60,50)
BN_SG88_T1(50,40)
BN_SG89_S0(60,50)
541.72
BN_SG87_T2(60,50)
BN_SG88_T2(50,40)
BN_SG90_D1(60,50)
BN_SG91_D1(40,40)
BN_SG92_D1(30,30)
BN_SG92_D2(30,30) Length = 0.22
UA_SG84_ST (20,20)
BN_SG87_T3(60,50)
BN_SG88_T3(50,40)
BN_SG90_D2(60,50)
BN_SG91_D2(40,40)
↓ To Yuma
542.00

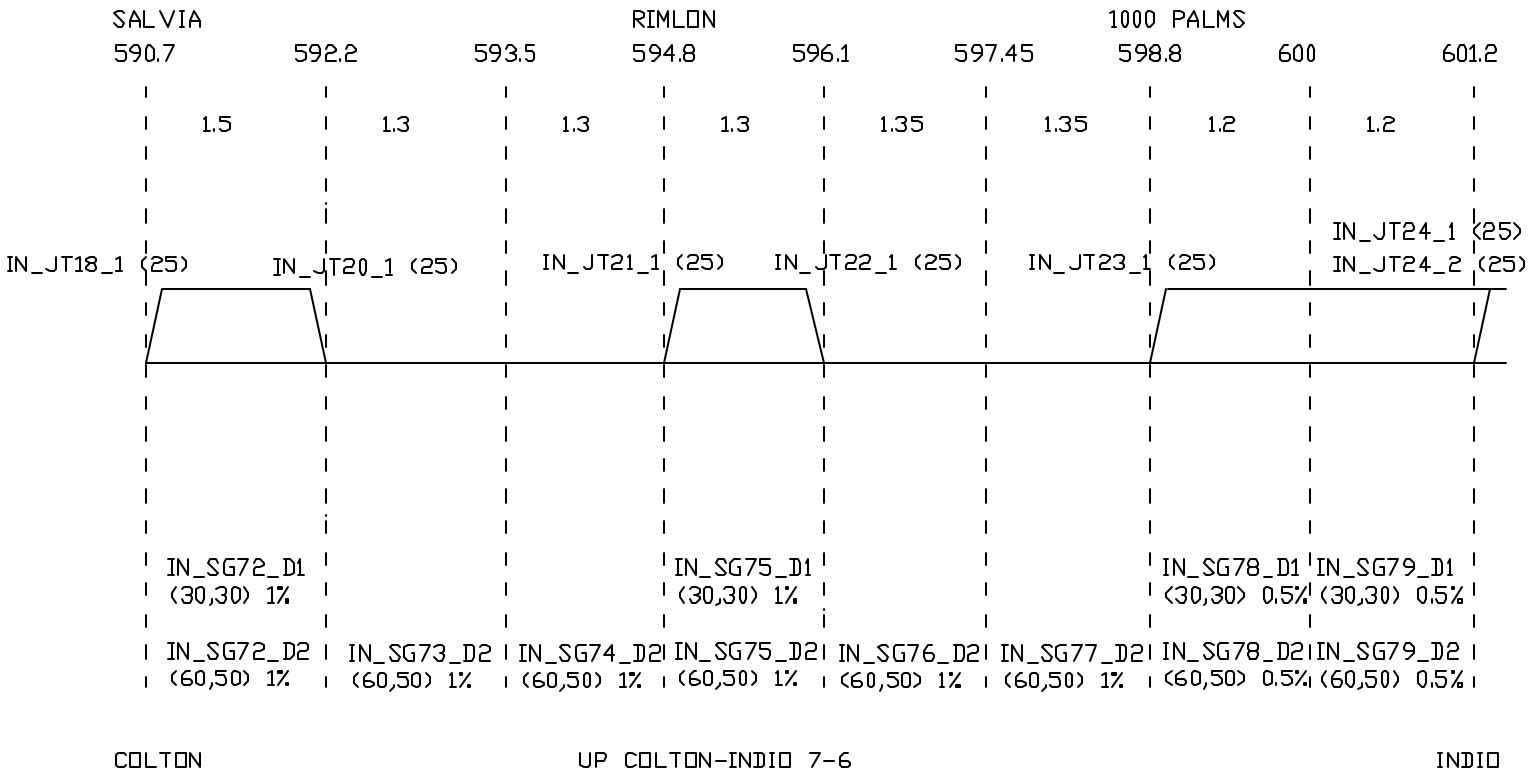

LOMA LINDA
ORDWAY
538.65
539.8
541.35
542.85
544.35
545.2
546.65
548.1
549.6
551.1
552.6
1.55
1.5
1.5
0.85
1.45
1.45
1.5
1.5
1.5
IN_JT5_1 (25)
IN_JT5_2 (25)
IN_JT6_1 (40)
IN_JT6_2 (40)
IN_SG14_D1 (60,50) 0%
IN_SG15_D1 (60,50) 1.5%
IN_SG16_D1 (60,50) 1.5%
IN_SG17_D1 (60,50) 1.5%
IN_SG18_D1 (55,50) 1.5%
IN_SG19_D1 (55,50) 1.5%
IN_SG20_D1 (40,40) 1.8%
IN_SG21_D1 (40,40) 1.8%
IN_SG22_D1 (40,40) 1.8%
IN_SG14_D2 (60,50) 0%
IN_SG15_D2 (60,50) 1.5%
IN_SG16_D2 (60,50) 1.5%
IN_SG17_D2 (60,50) 1.5%
IN_SG18_D2 (55,50) 1.5%
IN_SG19_D2 (55,50) 1.5%
IN_SG20_D2 (40,40) 1.8%
IN_SG21_D2 (40,40) 1.8%
IN_SG22_D2 (40,40) 1.8%
COLTON
UP COLTON-INDIO 7-1
INDIO

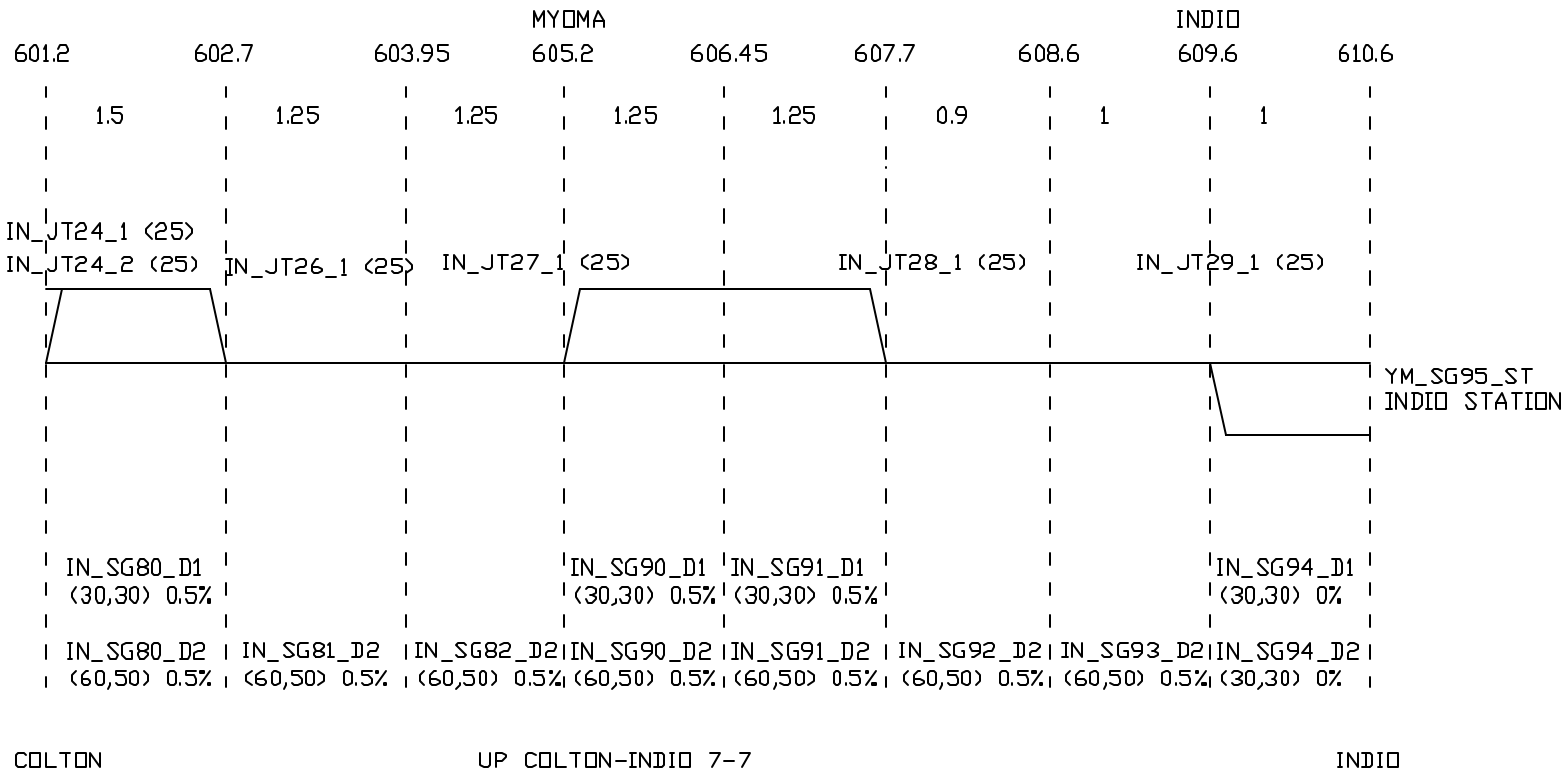

HINDA
BEAUMONT
552.6
554.1
554.8
555.8
556.75
557.75
558.75
560.2
561.8
1.5
0.7
1
0.95
1
1
1.45
1.6
IN_JT7_1 (40)
IN_JT7_2 (40)
IN_JT8_1 (40)
IN_JT8_2 (40)
IN_SG23_D1 (40,40) 1.8%
IN_SG24_D1 (40,40) 1.8%
IN_SG25_D1 (60,40) 1.8%
IN_SG26_D1 (60,40) 1.8%
IN_SG27_D1 (60,40) 2.0%
IN_SG28_D1 (60,40) 2.0%
IN_SG29_D1 (60,40) 2.0%
IN_SG30_D1 (50,40) 2.0%
IN_SG23_D2 (40,40) 1.8%
IN_SG24_D2 (40,40) 1.8%
IN_SG25_D2 (60,50) 1.8%
IN_SG26_D2 (60,50) 1.%
IN_SG27_D2 (60,50) 2.0%
IN_SG28_D2 (60,50) 2.0%
IN_SG29_D2 (60,50) 2.0%
IN_SG30_D2 (50,50) 2.0%
COLTON
UP COLTON-INDIO 7-2
INDIO

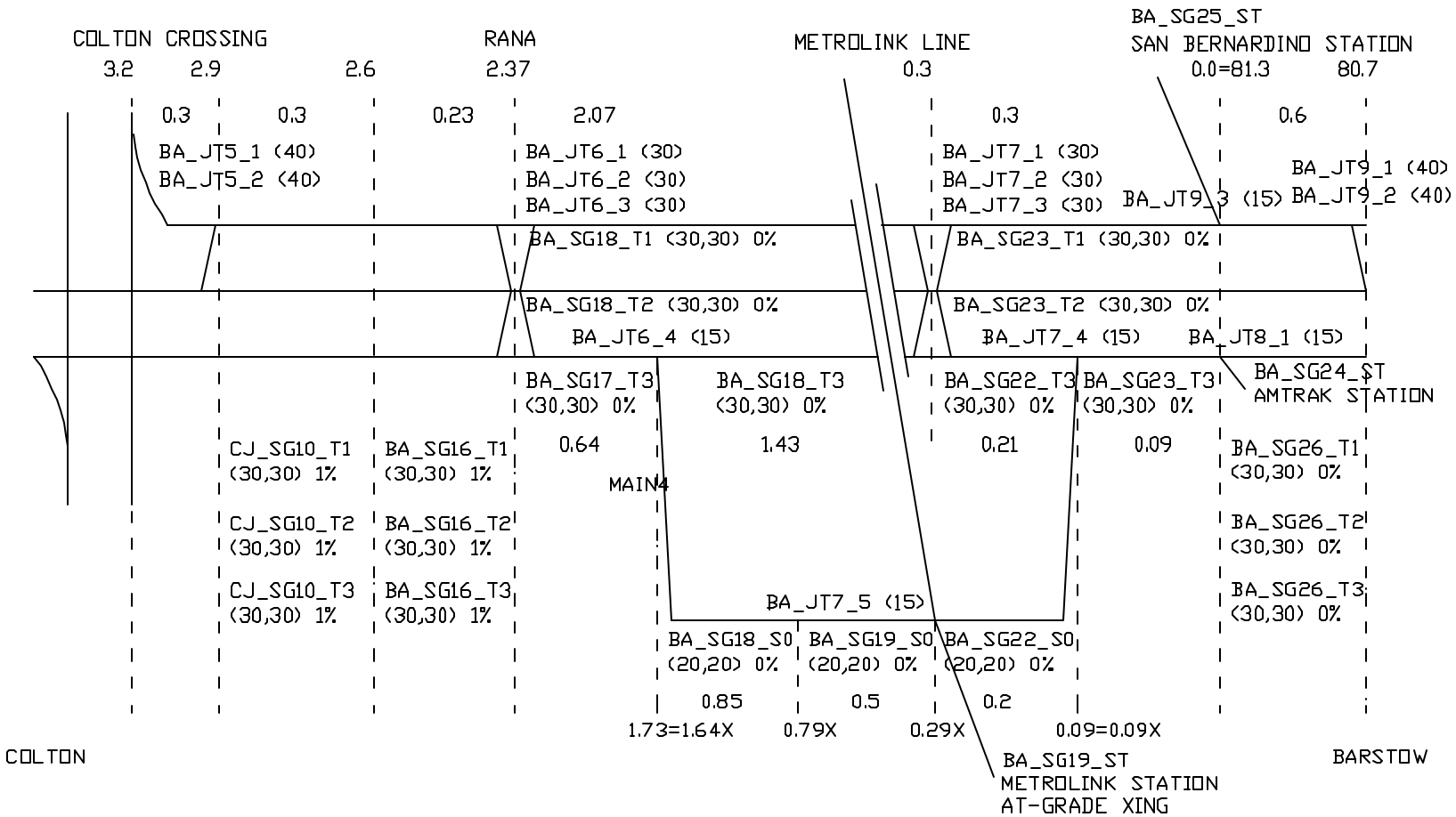

BEAUMONT
APEX
PERSHING
561.8
563.2
563.4
564.9
566.4
567.4
568.4
569.9
571.4
1.4
0.2
1.5
1.5
1
1
1.5
1.5
IN_JT8_1 (40)
IN_JT8_2 (40)
IN_JT10_1 (40)
IN_JT10_2 (40)
IN_SG35_D1 (50,40) 1%
IN_SG36_D1 (50,40) 0%
IN_SG37_D1 (50,40) 1%
IN_SG38_D1 (50,40) 1%
IN_SG39_D1 (50,40) 1.9%
IN_SG40_D1 (50,40) 1.9%
IN_SG41_D1 (50,40) 1.9%
IN_SG42_D1 (50,40) 1.9%
IN_SG35_D2 (50,50) 1%
IN_SG36_D2 (30,30) 0%
IN_SG37_D2 (50,40) 1%
IN_SG38_D2 (50,40) 1%
IN_SG39_D2 (50,40) 1.9%
IN_SG40_D2 (50,40) 1.9%
IN_SG41_D2 (50,40) 1.9%
IN_SG42_D2 (50,40) 1.9%
COLTON
UP COLTON-INDIO 7-3
INDIO


CABAZON
FINGAL
WEST PALM SPRING
571.4
572.9
574.15
575.4
576.6
577.6
578.75
580.25
581.5
1.5
1.25
1.25
1.2
1
1.15
1.5
1.25
IN_JT11_1 (40)
IN_JT11_2 (40)
IN_JT12_1 (40)
IN_JT12_2 (40)
IN_JT13_1 (25)
IN_JT13_2 (25)
IN_SG43_D1 (50,40) 1.9%
IN_SG44_D1 (50,40) 1.9%
IN_SG45_D1 (50,40) 1.9%
IN_SG46_D1 (50,40) 1.9%
IN_SG47_D1 (45,40) 1.9%
IN_SG49_D1 (45,40) 1.9%
IN_SG50_D1 (45,40) 2%
IN_SG55_D1 (45,40) 2%
IN_SG43_D2 (50,40) 1.9%
IN_SG44_D2 (50,40) 1.9%
IN_SG45_D2 (50,40) 1.9%
IN_SG46_D2 (50,40) 1.9%
IN_SG48_D2 (45,40) 1.9%
IN_SG49_D2 (45,40) 1.9%
IN_SG50_D2 (45,40) 2%
IN_SG55_D2 (45,40) 2%
COLTON
UP COLTON-INDIO 7-4
INDIO

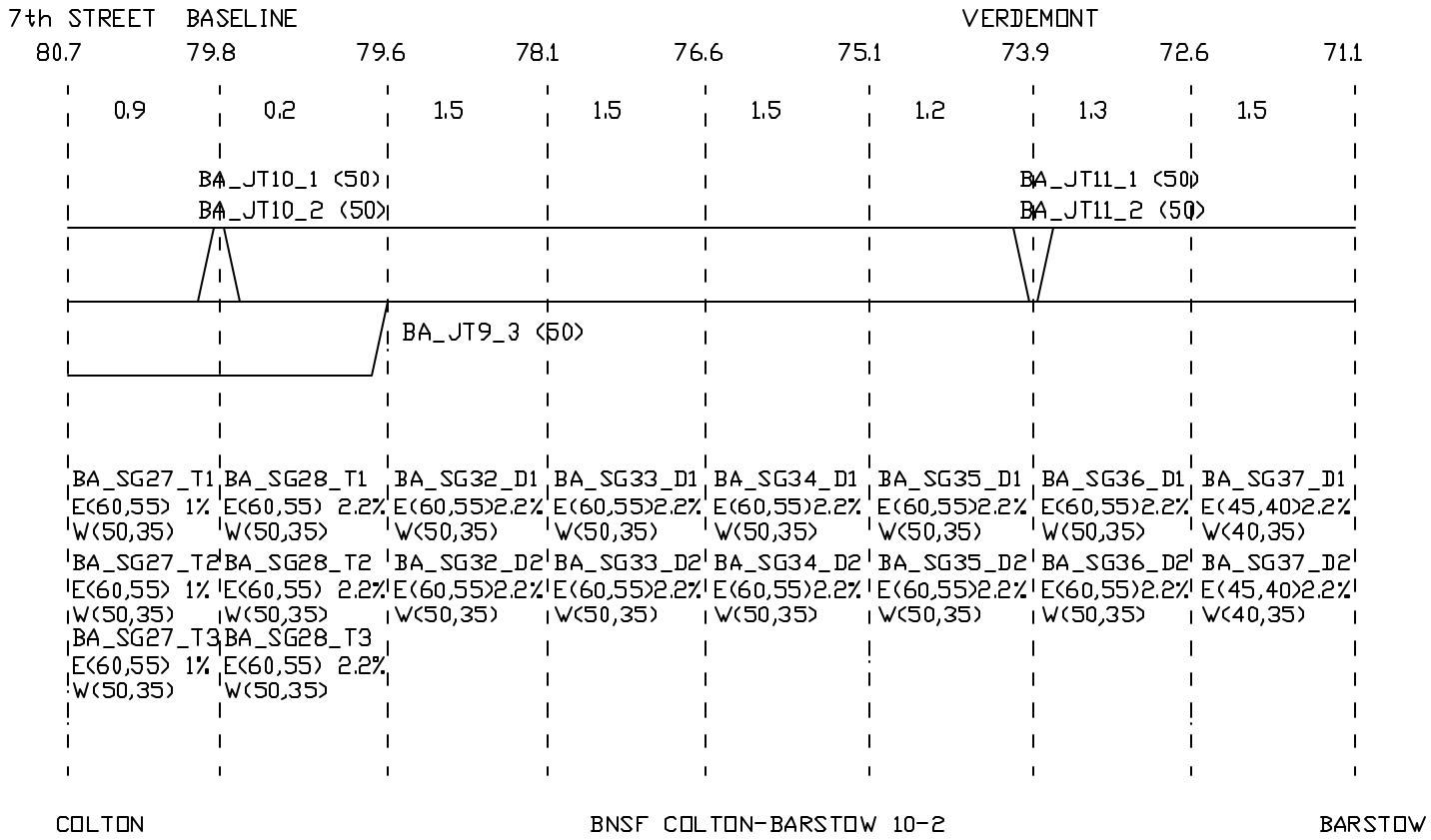

WEST PALM SPRING
GARNET
SALVIA
581.5
582.7
583.9
585
586.45
587.9
588.3
589.0
590.7
1.2
1.2
1.1
1.45
1.45
0.4
0.7
1.7
IN_JT13_1 (25)
IN_JT13_2 (25)
IN_JT15_1 (25)
IN_JT15_2 (25)
IN_JT16_1 (25)
IN_JT17_1 (25)
IN_JT18_1 (25)
IN_JT17_2 (25)
IN_JT17_3 (25)
IN_SG65_ST
AMTRAK STATION
IN_SG56_D1 (50,40) 2%
IN_SG57_D1 (50,40) 2%
IN_SG58_D1 (50,40) 2%
IN_SG59_D1 (30,30) 2%
IN_SG60_D1 (30,30) 2%
IN_SG61_D1 (30,30) 2%
IN_SG70_D1 (60,40) 2%
IN_SG56_D2 (30,30) 2%
IN_SG57_D2 (30,30) 2%
IN_SG58_D2 (30,30) 2%
IN_SG59_D2 (60,40) 2%
IN_SG60_D2 (60,40) 2%
IN_SG61_D2 (60,40) 2%
IN_SG70_D2 (30,30) 2%
IN_SG71_D2 (60,50) 1%
COLTON
UP COLTON-INDIO 7-5
INDIO

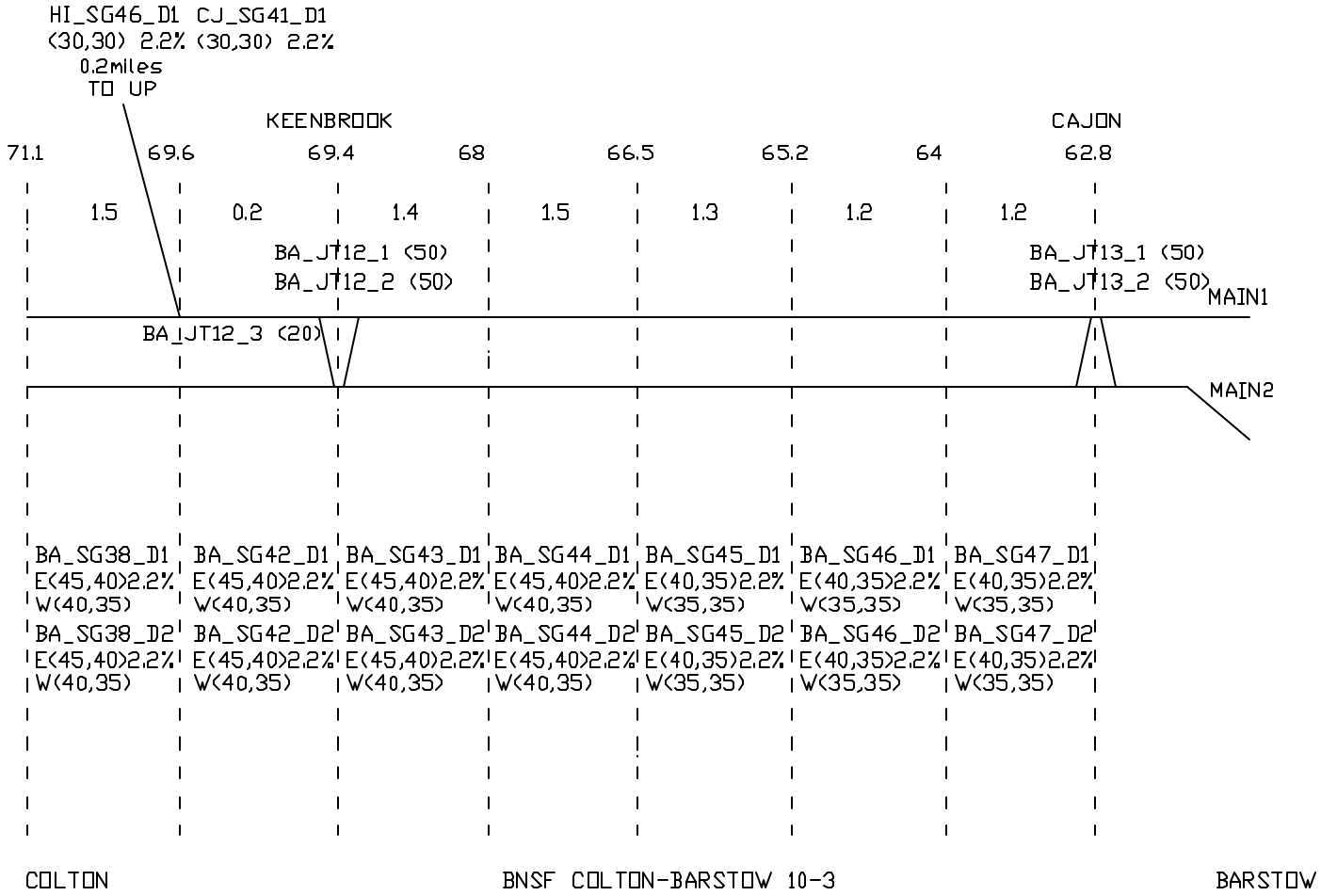

SALVIA
RIMLON
1000 PALMS
590.7
592.2
593.5
594.8
596.1
597.45
598.8
600
601.2
1.5
1.3
1.3
1.3
1.35
1.35
1.2
1.2
IN_JT18_1 (25)
IN_JT20_1 (25)
IN_JT21_1 (25)
IN_JT22_1 (25)
IN_JT23_1 (25)
IN_JT24_1 (25)
IN_JT24_2 (25)
IN_SG72_D1
(30,30) 1%
IN_SG75_D1
(30,30) 1%
IN_SG78_D1
(30,30) 0.5%
IN_SG79_D1
(30,30) 0.5%
IN_SG72_D2
(60,50) 1%
IN_SG73_D2
(60,50) 1%
IN_SG74_D2
(60,50) 1%
IN_SG75_D2
(60,50) 1%
IN_SG76_D2
(60,50) 1%
IN_SG77_D2
(60,50) 1%
IN_SG78_D2
(60,50) 0.5%
IN_SG79_D2
(60,50) 0.5%
COLTON
UP COLTON-INDIO 7-6
INDIO

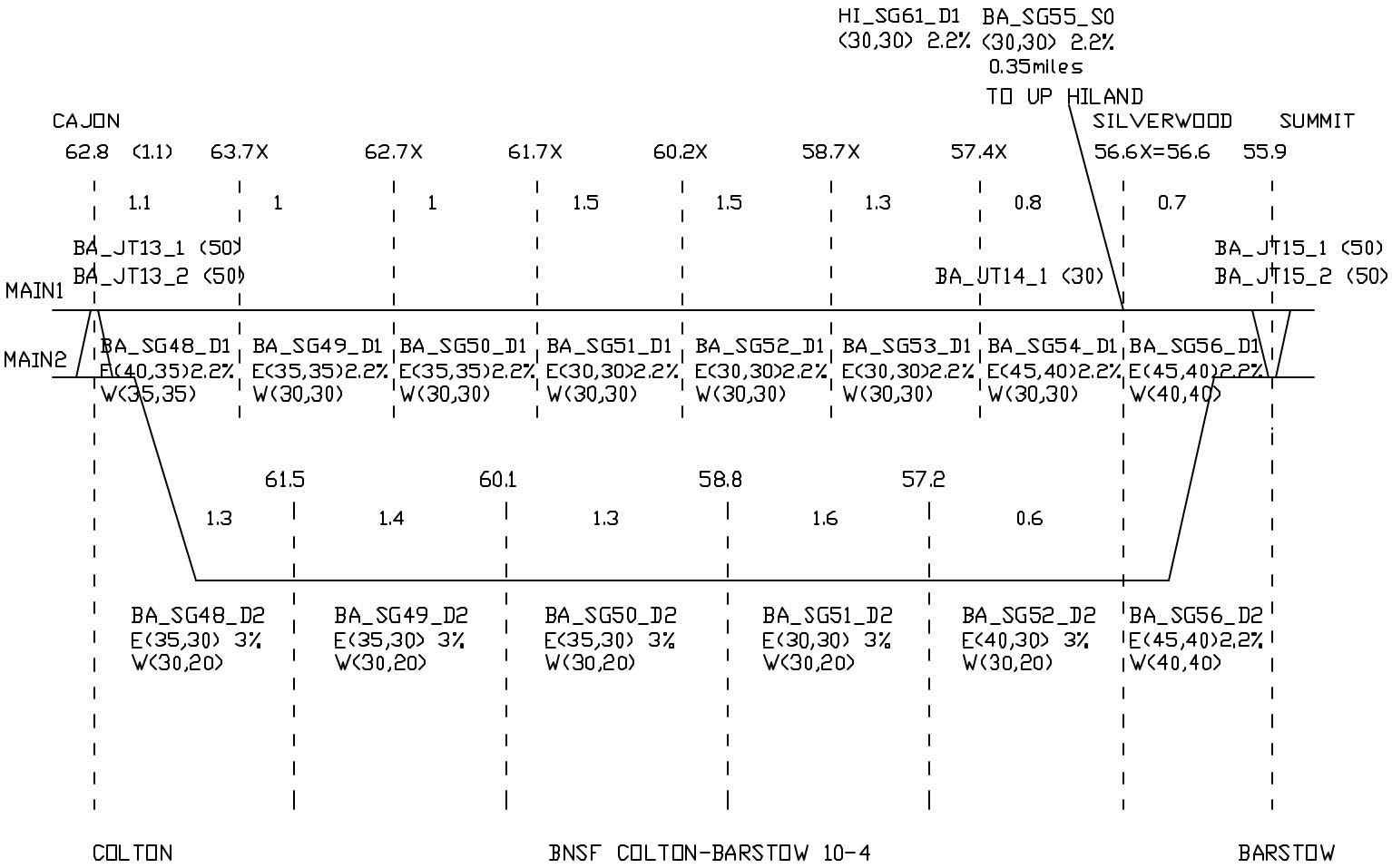

MYOMA
INDIO
601.2
602.7
603.95
605.2
606.45
607.7
608.6
609.6
610.6
1.5
1.25
1.25
1.25
1.25
0.9
1
1
IN_JT24_1 (25)
IN_JT24_2 (25)
IN_JT26_1 (25)
IN_JT27_1 (25)
IN_JT28_1 (25)
IN_JT29_1 (25)
YM_SG95_ST
INDIO STATION
IN_SG80_D1
(30,30) 0.5%
IN_SG90_D1
(30,30) 0.5%
IN_SG91_D1
(30,30) 0.5%
IN_SG94_D1
(30,30) 0%
IN_SG80_D2
(60,50) 0.5%
IN_SG81_D2
(60,50) 0.5%
IN_SG82_D2
(60,50) 0.5%
IN_SG90_D2
(60,50) 0.5%
IN_SG91_D2
(60,50) 0.5%
IN_SG92_D2
(60,50) 0.5%
IN_SG93_D2
(60,50) 0.5%
IN_SG94_D2
(30,30) 0%
COLTON
UP COLTON-INDIO 7-7
INDIO

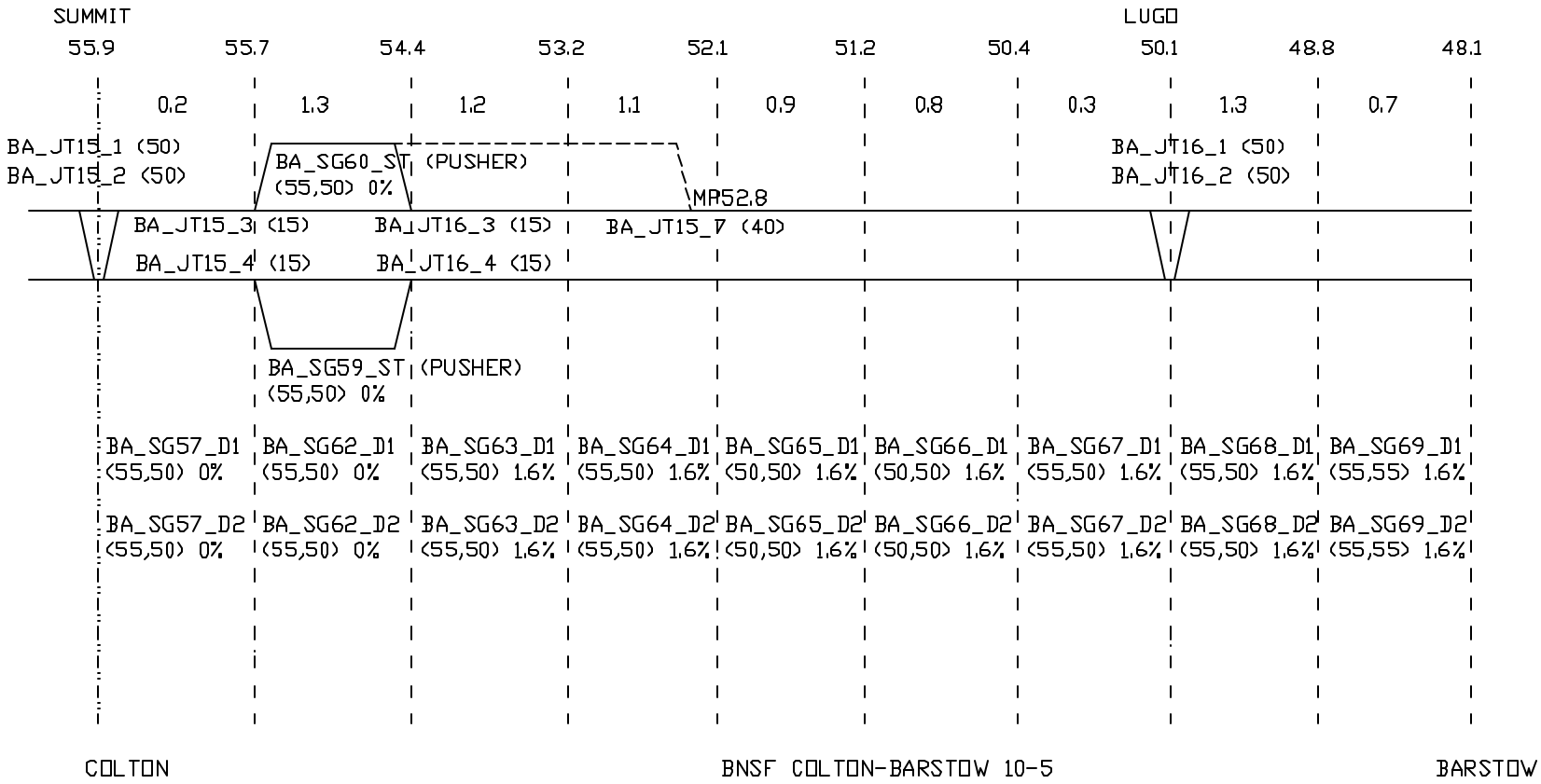


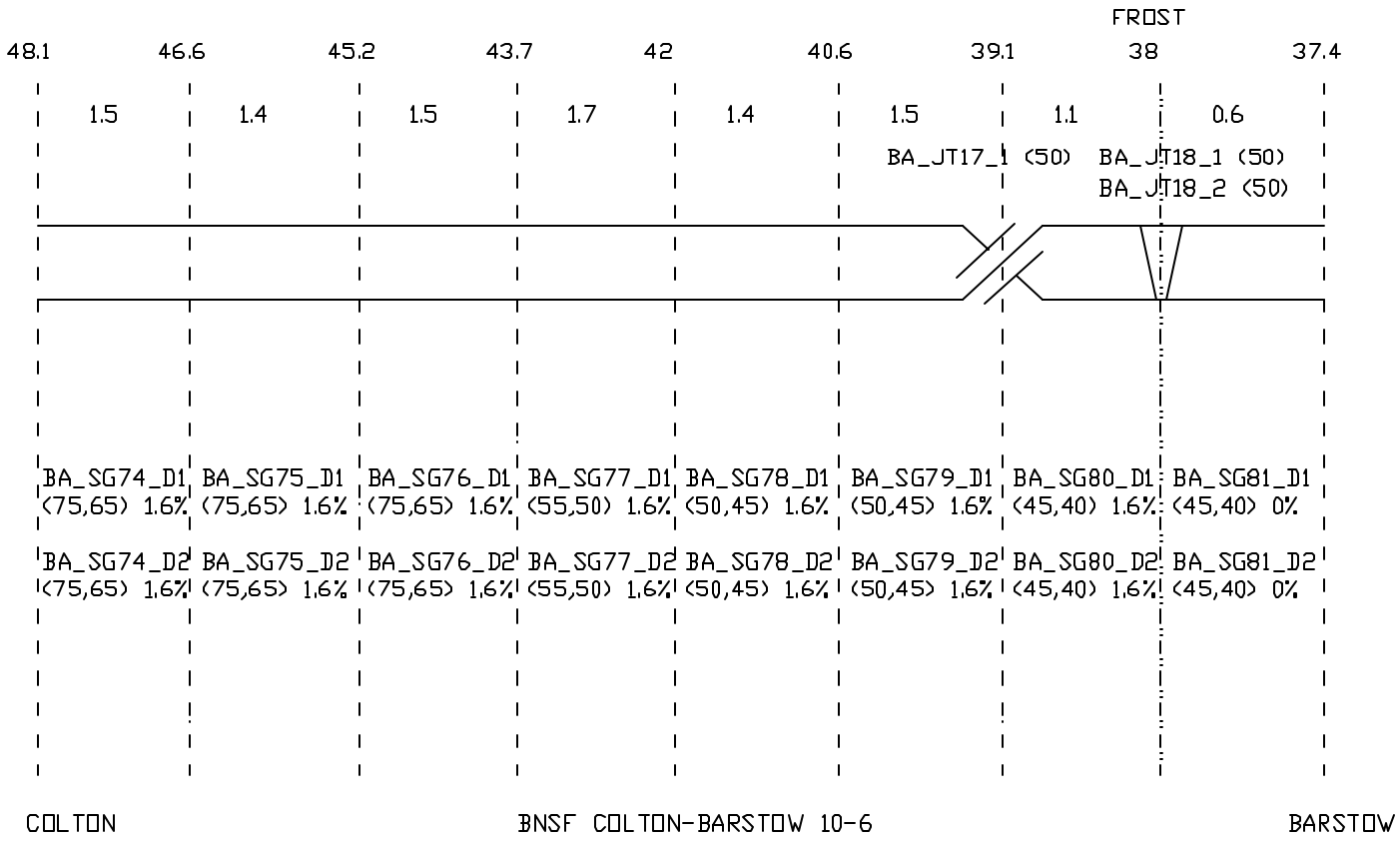
BNSF COLTON-BARSTOW 10-1

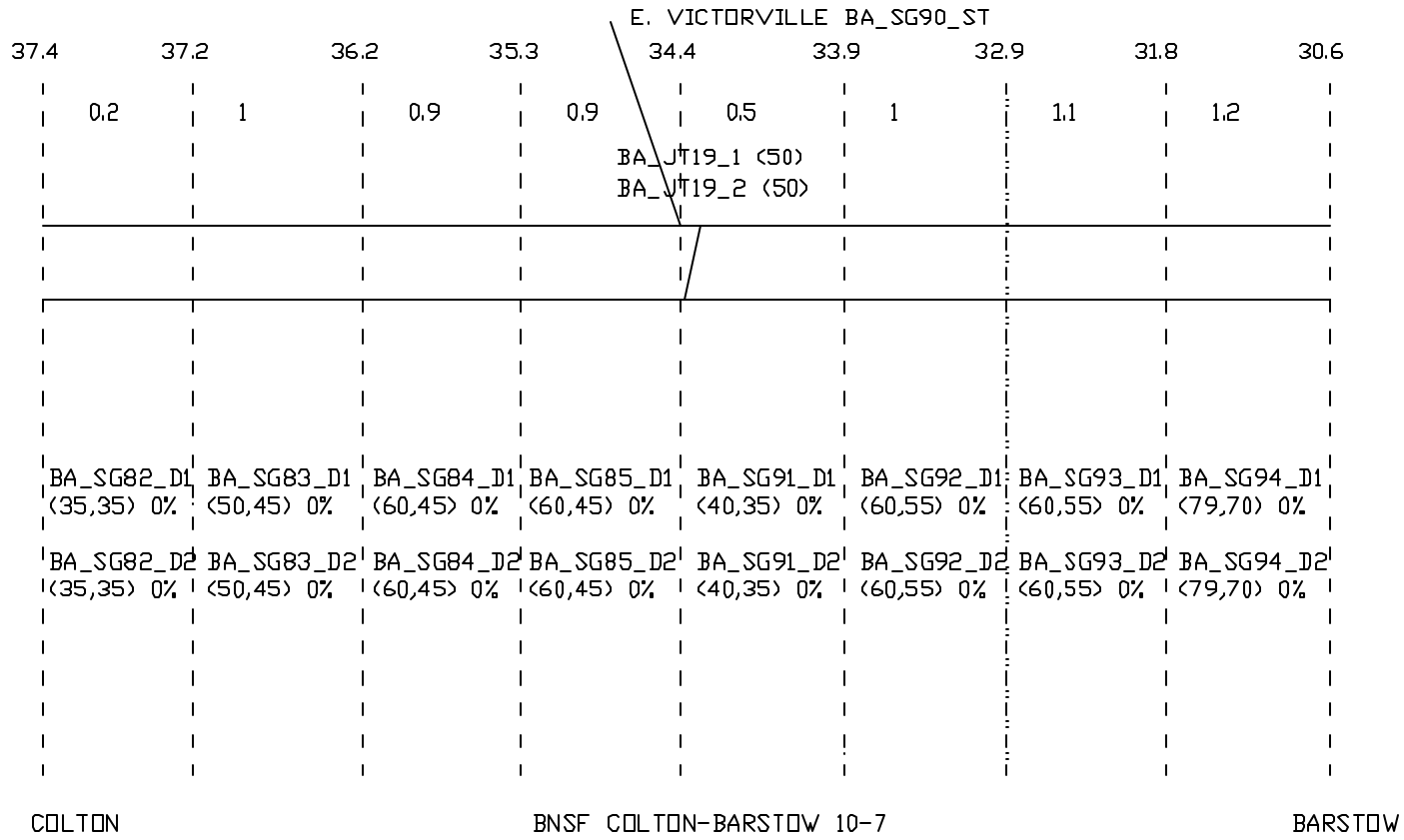

7th STREET
BASELINE
VERDEMONT
80.7
79.8
79.6
78.1
76.6
75.1
73.9
72.6
71.1
0.9
0.2
1.5
1.5
1.5
1.2
1.3
1.5
BA_JT10_1 (50)
BA_JT10_2 (50)
BA_JT11_1 (50)
BA_JT11_2 (50)
BA_JT9_3 (50)
BA_SG27_T1
E(60,55) 1%
W(50,35)
BA_SG27_T2
E(60,55) 1%
W(50,35)
BA_SG27_T3
E(60,55) 1%
W(50,35)
BA_SG28_T1
E(60,55) 2.2%
W(50,35)
BA_SG28_T2
E(60,55) 2.2%
W(50,35)
BA_SG28_T3
E(60,55) 2.2%
W(50,35)
BA_SG32_D1
E(60,55)2.2%
W(50,35)
BA_SG32_D2
E(60,55)2.2%
W(50,35)
BA_SG33_D1
E(60,55)2.2%
W(50,35)
BA_SG33_D2
E(60,55)2.2%
W(50,35)
BA_SG34_D1
E(60,55)2.2%
W(50,35)
BA_SG34_D2
E(60,55)2.2%
W(50,35)
BA_SG35_D1
E(60,55)2.2%
W(50,35)
BA_SG35_D2
E(60,55)2.2%
W(50,35)
BA_SG36_D1
E(60,55)2.2%
W(50,35)
BA_SG36_D2
E(60,55)2.2%
W(50,35)
BA_SG37_D1
E(45,40)2.2%
W(40,35)
BA_SG37_D2
E(45,40)2.2%
W(40,35)
COLTON
BNSF COLTON-BARSTOW 10-2
BARSTOW

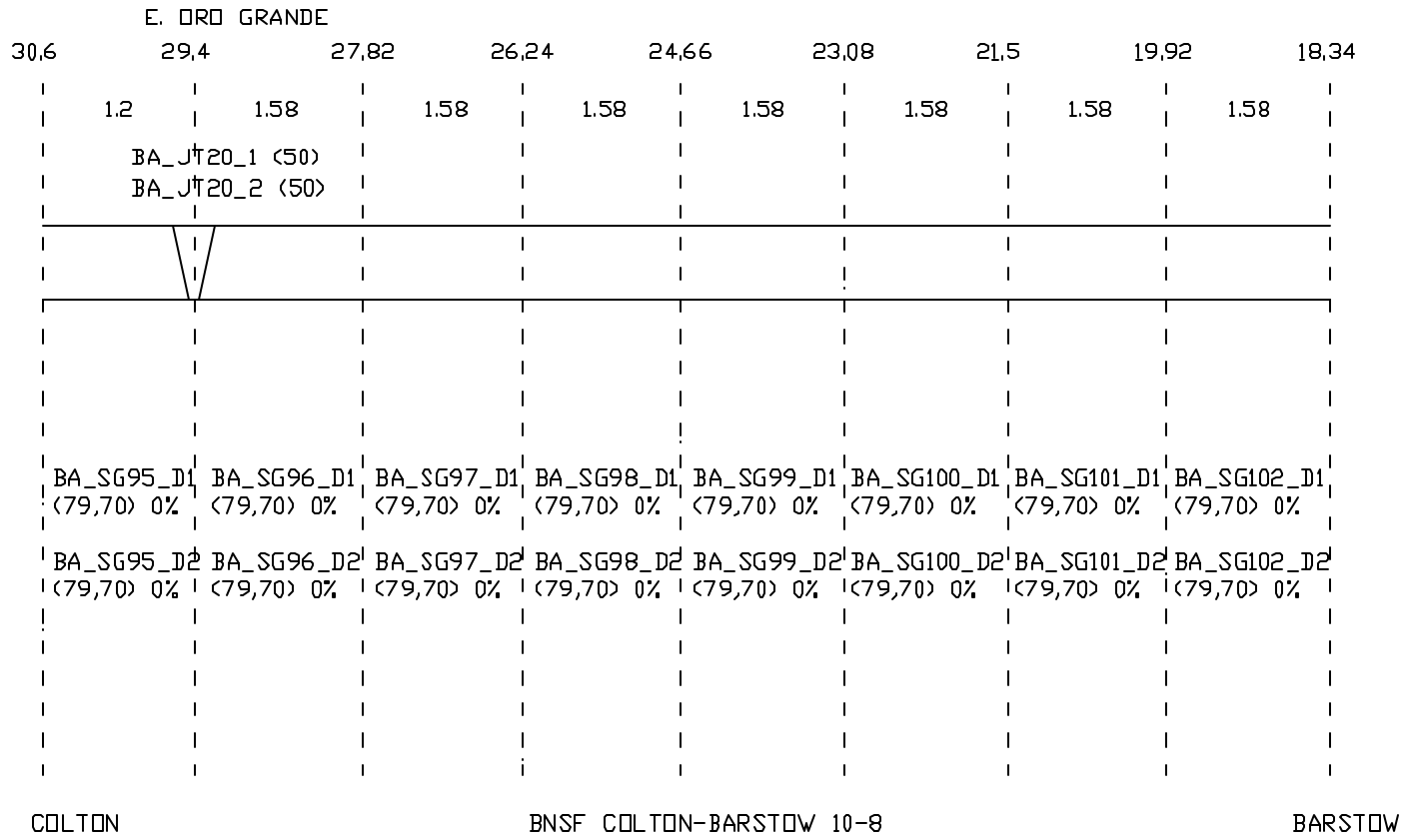

HI_SG46_D1 CJ_SG41_D1
(30,30) 2.2% (30,30) 2.2%
0.2miles
TO UP
KEENBROOK
CAJON
71.1
69.6
69.4
68
66.5
65.2
64
62.8
1.5
0.2
1.4
1.5
1.3
1.2
1.2
BA_JT12_1 (50)
BA_JT12_2 (50)
BA_JT13_1 (50)
BA_JT13_2 (50)
MAIN1
BA_JT12_3 (20)
MAIN2
BA_SG38_D1
E(45,40)2.2%
W(40,35)
BA_SG38_D2
E(45,40)2.2%
W(40,35)
BA_SG42_D1
E(45,40)2.2%
W(40,35)
BA_SG42_D2
E(45,40)2.2%
W(40,35)
BA_SG43_D1
E(45,40)2.2%
W(40,35)
BA_SG43_D2
E(45,40)2.2%
W(40,35)
BA_SG44_D1
E(45,40)2.2%
W(40,35)
BA_SG44_D2
E(45,40)2.2%
W(40,35)
BA_SG45_D1
E(40,35)2.2%
W(35,35)
BA_SG45_D2
E(40,35)2.2%
W(35,35)
BA_SG46_D1
E(40,35)2.2%
W(35,35)
BA_SG46_D2
E(40,35)2.2%
W(35,35)
BA_SG47_D1
E(40,35)2.2%
W(35,35)
BA_SG47_D2
E(40,35)2.2%
W(35,35)
COLTON
BNSF COLTON-BARSTOW 10-3
BARSTOW

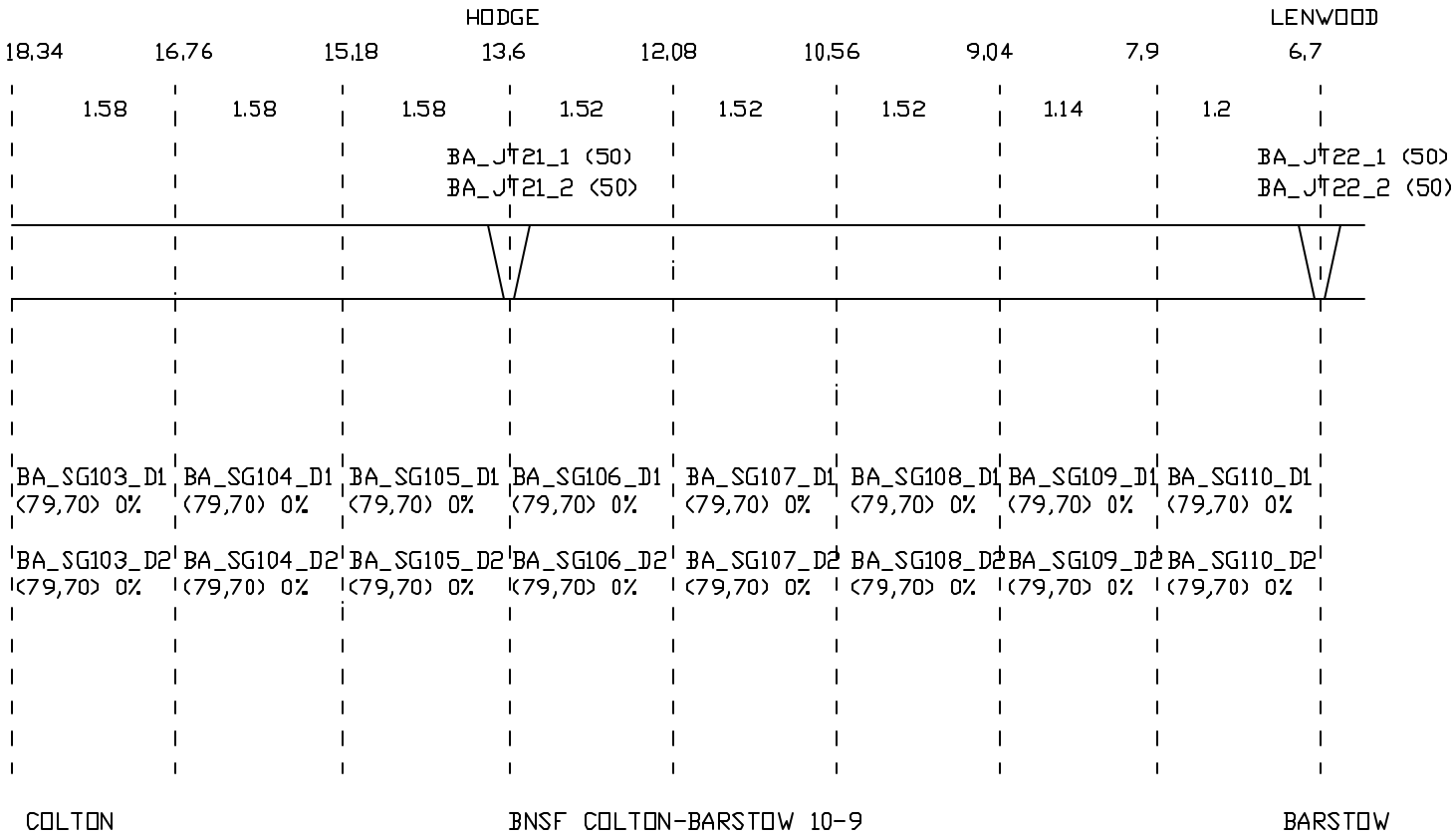

HI_SG61_D1
(30,30) 2.2%
BA_SG55_S0
(30,30) 2.2%
0.35miles
TO UP HILAND
CAJON
SILVERWOOD
SUMMIT
62.8 (1.1) 63.7X 62.7X 61.7X 60.2X 58.7X 57.4X 56.6X=56.6 55.9
1.1 1 1 1.5 1.5 1.3 0.8 0.7
BA_JT13_1 (50)
BA_JT13_2 (50)
BA_UT14_1 (30)
BA_JT15_1 (50)
BA_JT15_2 (50)
MAIN1
MAIN2
BA_SG48_D1
E(40,35)2.2%
W(35,35)
BA_SG49_D1
E(35,35)2.2%
W(30,30)
BA_SG50_D1
E(35,35)2.2%
W(30,30)
BA_SG51_D1
E(30,30)2.2%
W(30,30)
BA_SG52_D1
E(30,30)2.2%
W(30,30)
BA_SG53_D1
E(30,30)2.2%
W(30,30)
BA_SG54_D1
E(45,40)2.2%
W(30,30)
BA_SG56_D1
E(45,40)2.2%
W(40,40)
61.5 60.1 58.8 57.2
1.3 1.4 1.3 1.6 0.6
BA_SG48_D2
E(35,30) 3%
W(30,20)
BA_SG49_D2
E(35,30) 3%
W(30,20)
BA_SG50_D2
E(35,30) 3%
W(30,20)
BA_SG51_D2
E(30,30) 3%
W(30,20)
BA_SG52_D2
E(40,30) 3%
W(30,20)
BA_SG56_D2
E(45,40)2.2%
W(40,40)
COLTON
BNSF COLTON-BARSTOW 10-4
BARSTOW

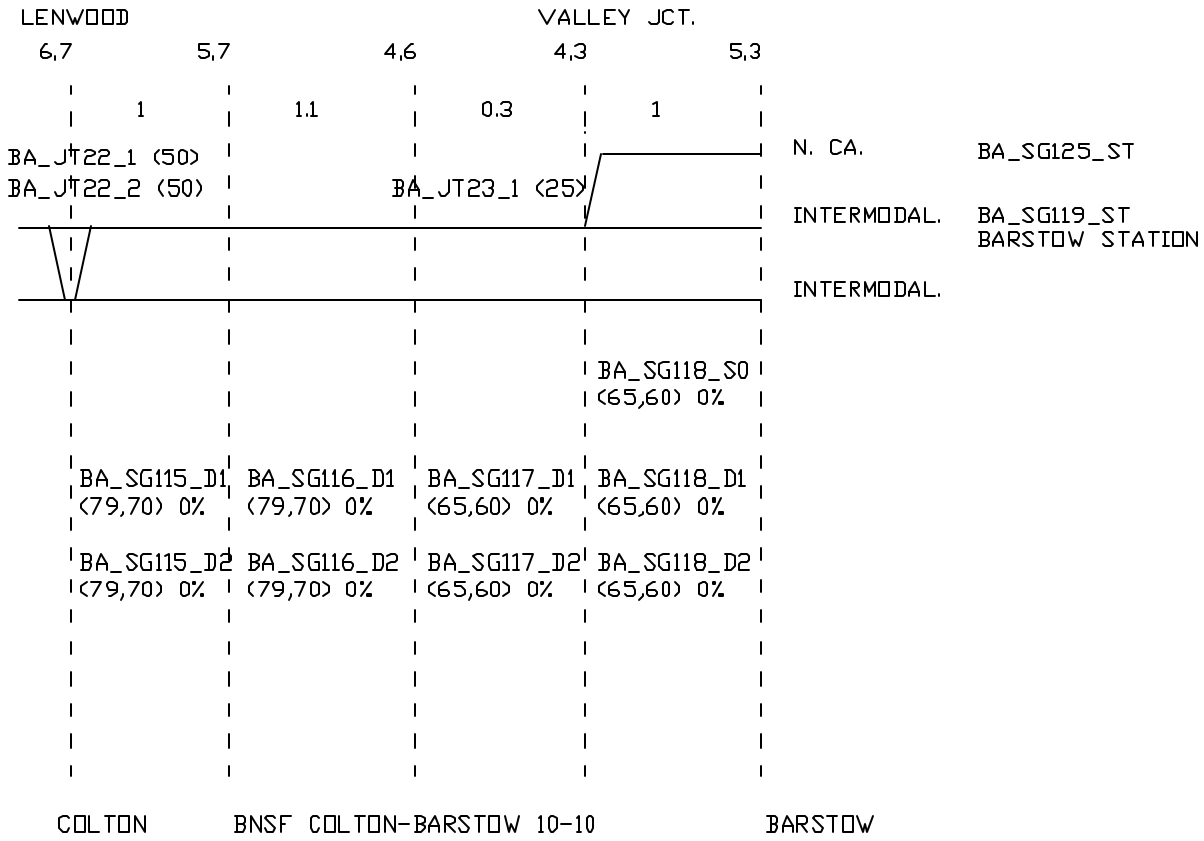

SUMMIT
LUGO
55.9
55.7
54.4
53.2
52.1
51.2
50.4
50.1
48.8
48.1
0.2
1.3
1.2
1.1
0.9
0.8
0.3
1.3
0.7
BA_JT15_1 (50)
BA_JT15_2 (50)
BA_SG60_ST (PUSHER)
(55,50) 0%
MP52.8
BA_JT16_1 (50)
BA_JT16_2 (50)
BA_JT15_3 (15)
BA_JT15_4 (15)
BA_JT16_3 (15)
BA_JT16_4 (15)
BA_JT15_7 (40)
BA_SG59_ST (PUSHER)
(55,50) 0%
BA_SG57_D1 (55,50) 0%
BA_SG62_D1 (55,50) 0%
BA_SG63_D1 (55,50) 1.6%
BA_SG64_D1 (55,50) 1.6%
BA_SG65_D1 (50,50) 1.6%
BA_SG66_D1 (50,50) 1.6%
BA_SG67_D1 (55,50) 1.6%
BA_SG68_D1 (55,50) 1.6%
BA_SG69_D1 (55,55) 1.6%
BA_SG57_D2 (55,50) 0%
BA_SG62_D2 (55,50) 0%
BA_SG63_D2 (55,50) 1.6%
BA_SG64_D2 (55,50) 1.6%
BA_SG65_D2 (50,50) 1.6%
BA_SG66_D2 (50,50) 1.6%
BA_SG67_D2 (55,50) 1.6%
BA_SG68_D2 (55,50) 1.6%
BA_SG69_D2 (55,55) 1.6%
COLTON
BNSF COLTON-BARSTOW 10-5
BARSTOW

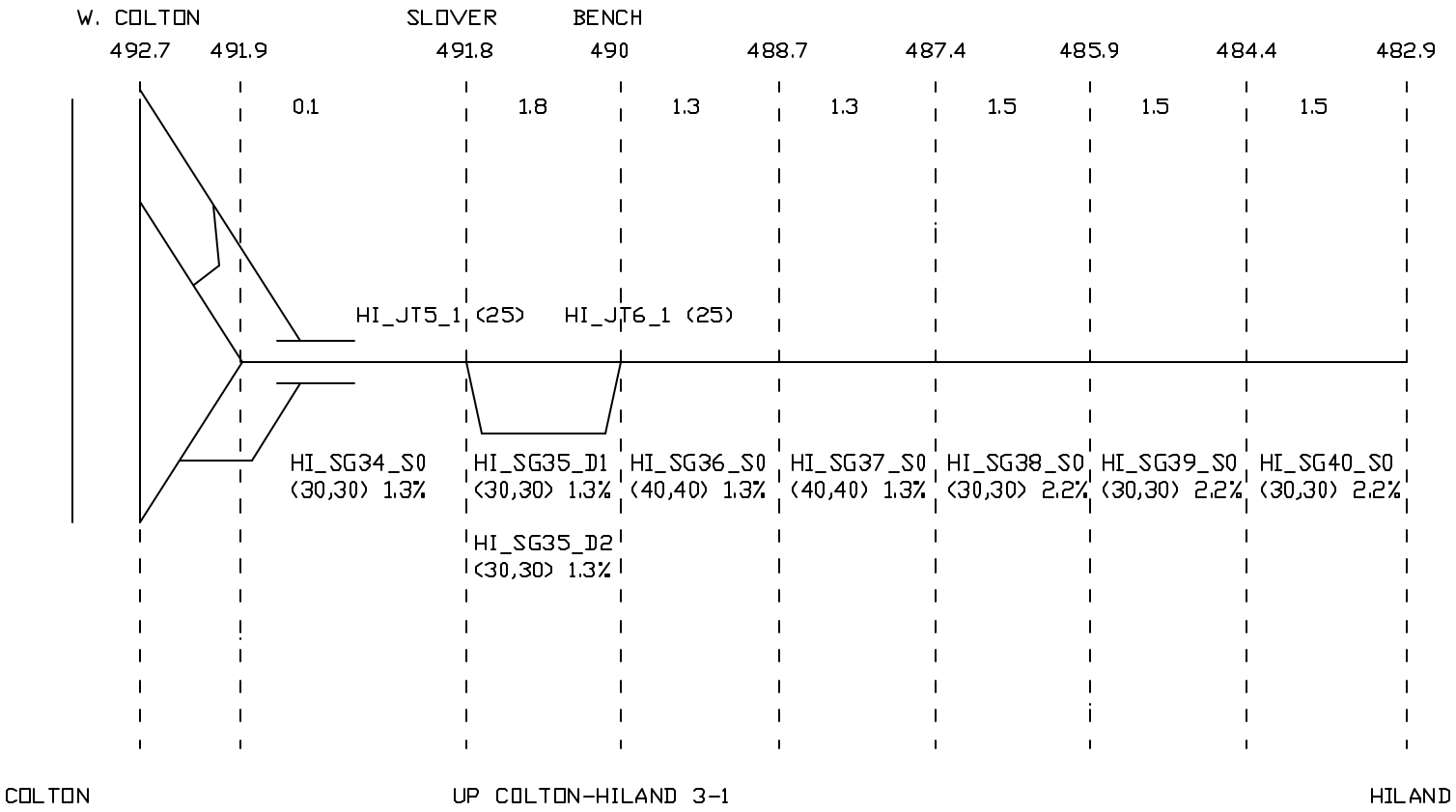

FROST
48.1
46.6
45.2
43.7
42
40.6
39.1
38
37.4
1.5
1.4
1.5
1.7
1.4
1.5
1.1
0.6
BA_JT17_1 (50)
BA_JT18_1 (50)
BA_JT18_2 (50)
BA_SG74_D1 (75,65) 1.6%
BA_SG75_D1 (75,65) 1.6%
BA_SG76_D1 (75,65) 1.6%
BA_SG77_D1 (55,50) 1.6%
BA_SG78_D1 (50,45) 1.6%
BA_SG79_D1 (50,45) 1.6%
BA_SG80_D1 (45,40) 1.6%
BA_SG81_D1 (45,40) 0%
BA_SG74_D2 (75,65) 1.6%
BA_SG75_D2 (75,65) 1.6%
BA_SG76_D2 (75,65) 1.6%
BA_SG77_D2 (55,50) 1.6%
BA_SG78_D2 (50,45) 1.6%
BA_SG79_D2 (50,45) 1.6%
BA_SG80_D2 (45,40) 1.6%
BA_SG81_D2 (45,40) 0%
COLTON
BNSF COLTON-BARSTOW 10-6
BARSTOW

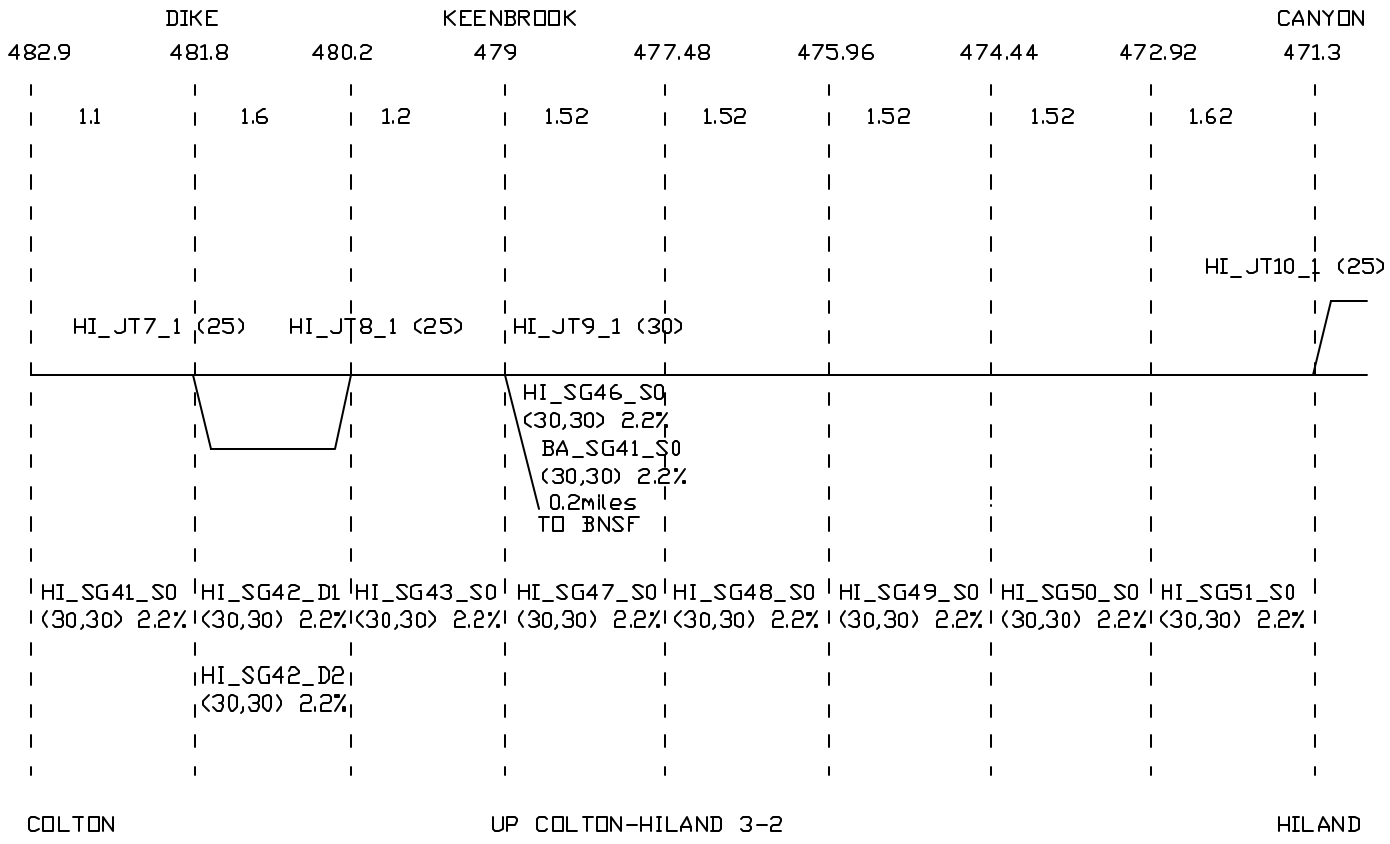

E. VICTORVILLE BA_SG90_ST
37.4
37.2
36.2
35.3
34.4
33.9
32.9
31.8
30.6
0.2
1
0.9
0.9
0.5
1
1.1
1.2
BA_JT19_1 (50)
BA_JT19_2 (50)
BA_SG82_D1 (35,35) 0%
BA_SG83_D1 (50,45) 0%
BA_SG84_D1 (60,45) 0%
BA_SG85_D1 (60,45) 0%
BA_SG91_D1 (40,35) 0%
BA_SG92_D1 (60,55) 0%
BA_SG93_D1 (60,55) 0%
BA_SG94_D1 (79,70) 0%
BA_SG82_D2 (35,35) 0%
BA_SG83_D2 (50,45) 0%
BA_SG84_D2 (60,45) 0%
BA_SG85_D2 (60,45) 0%
BA_SG91_D2 (40,35) 0%
BA_SG92_D2 (60,55) 0%
BA_SG93_D2 (60,55) 0%
BA_SG94_D2 (79,70) 0%
COLTON
BNSF COLTON-BARSTOW 10-7
BARSTOW

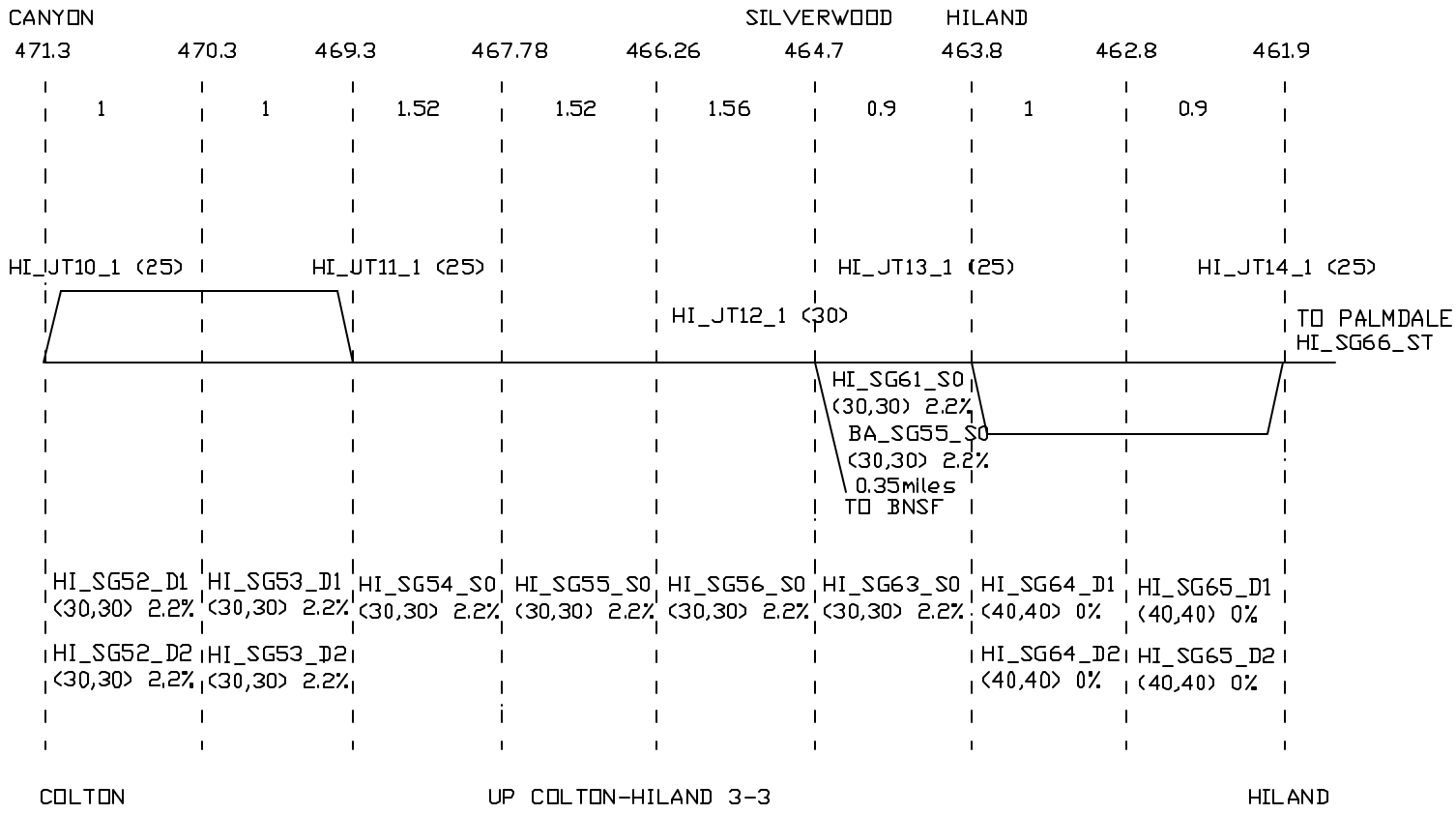

E. ORO GRANDE
30.6
29.4
27.82
26.24
24.66
23.08
21.5
19.92
18.34
1.2
1.58
1.58
1.58
1.58
1.58
1.58
1.58
BA_JT20_1 (50)
BA_JT20_2 (50)
BA_SG95_D1 (79,70) 0%
BA_SG96_D1 (79,70) 0%
BA_SG97_D1 (79,70) 0%
BA_SG98_D1 (79,70) 0%
BA_SG99_D1 (79,70) 0%
BA_SG100_D1 (79,70) 0%
BA_SG101_D1 (79,70) 0%
BA_SG102_D1 (79,70) 0%
BA_SG95_D2 (79,70) 0%
BA_SG96_D2 (79,70) 0%
BA_SG97_D2 (79,70) 0%
BA_SG98_D2 (79,70) 0%
BA_SG99_D2 (79,70) 0%
BA_SG100_D2 (79,70) 0%
BA_SG101_D2 (79,70) 0%
BA_SG102_D2 (79,70) 0%
COLTON
BNSF COLTON-BARSTOW 10-8
BARSTOW


HODGE
LENWOOD
18.34
16.76
15.18
13.6
12.08
10.56
9.04
7.9
6.7
1.58
1.58
1.58
1.52
1.52
1.52
1.14
1.2
BA_JT21_1 (50)
BA_JT21_2 (50)
BA_JT22_1 (50)
BA_JT22_2 (50)
BA_SG103_D1 (79,70) 0%
BA_SG104_D1 (79,70) 0%
BA_SG105_D1 (79,70) 0%
BA_SG106_D1 (79,70) 0%
BA_SG107_D1 (79,70) 0%
BA_SG108_D1 (79,70) 0%
BA_SG109_D1 (79,70) 0%
BA_SG110_D1 (79,70) 0%
BA_SG103_D2 (79,70) 0%
BA_SG104_D2 (79,70) 0%
BA_SG105_D2 (79,70) 0%
BA_SG106_D2 (79,70) 0%
BA_SG107_D2 (79,70) 0%
BA_SG108_D2 (79,70) 0%
BA_SG109_D2 (79,70) 0%
BA_SG110_D2 (79,70) 0%
COLTON
BNSF COLTON-BARSTOW 10-9
BARSTOW


LENWOOD
VALLEY JCT.
6,7
5,7
4,6
4,3
5,3
1
1.1
0.3
1
BA_JT22_1 (50)
BA_JT22_2 (50)
BA_JT23_1 (25)
N. CA.
BA_SG125_ST
INTERMODAL.
BA_SG119_ST
BARSTOW STATION
INTERMODAL.
BA_SG118_S0
(65,60) 0%
BA_SG115_D1
(79,70) 0%
BA_SG116_D1
(79,70) 0%
BA_SG117_D1
(65,60) 0%
BA_SG118_D1
(65,60) 0%
BA_SG115_D2
(79,70) 0%
BA_SG116_D2
(79,70) 0%
BA_SG117_D2
(65,60) 0%
BA_SG118_D2
(65,60) 0%
COLTON
BNSF COLTON-BARSTOW 10-10
BARSTOW


W. COLTON
SLOVER
BENCH
492.7
491.9
491.8
490
488.7
487.4
485.9
484.4
482.9
0.1
1.8
1.3
1.3
1.5
1.5
1.5
HI_JT5_1 (25)
HI_JT6_1 (25)
HI_SG34_S0
(30,30) 1.3%
HI_SG35_D1
(30,30) 1.3%
HI_SG35_D2
(30,30) 1.3%
HI_SG36_S0
(40,40) 1.3%
HI_SG37_S0
(40,40) 1.3%
HI_SG38_S0
(30,30) 2.2%
HI_SG39_S0
(30,30) 2.2%
HI_SG40_S0
(30,30) 2.2%
COLTON
UP COLTON-HILAND 3-1
HILAND


DIKE
KEENBROOK
CANYON
482.9
481.8
480.2
479
477.48
475.96
474.44
472.92
471.3
1.1
1.6
1.2
1.52
1.52
1.52
1.52
1.62
HI_JT10_1 (25)
HI_JT7_1 (25)
HI_JT8_1 (25)
HI_JT9_1 (30)
HI_SG46_S0
(30,30) 2.2%
BA_SG41_S0
(30,30) 2.2%
0.2miles
TO BNSF
HI_SG41_S0
(30,30) 2.2%
HI_SG42_D1
(30,30) 2.2%
HI_SG43_S0
(30,30) 2.2%
HI_SG47_S0
(30,30) 2.2%
HI_SG48_S0
(30,30) 2.2%
HI_SG49_S0
(30,30) 2.2%
HI_SG50_S0
(30,30) 2.2%
HI_SG51_S0
(30,30) 2.2%
HI_SG42_D2
(30,30) 2.2%
COLTON
UP COLTON-HILAND 3-2
HILAND


CANYON
SILVERWOOD
HILAND
471.3
470.3
469.3
467.78
466.26
464.7
463.8
462.8
461.9
1
1
1.52
1.52
1.56
0.9
1
0.9
HI_JT10_1 (25)
HI_JT11_1 (25)
HI_JT13_1 (25)
HI_JT14_1 (25)
HI_JT12_1 (30)
TO PALMDALE
HI_SG66_ST
HI_SG61_S0
(30,30) 2.2%
BA_SG55_S0
(30,30) 2.2%
0.35miles
TO BNSF
HI_SG52_D1
(30,30) 2.2%
HI_SG53_D1
(30,30) 2.2%
HI_SG54_S0
(30,30) 2.2%
HI_SG55_S0
(30,30) 2.2%
HI_SG56_S0
(30,30) 2.2%
HI_SG63_S0
(30,30) 2.2%
HI_SG64_D1
(40,40) 0%
HI_SG65_D1
(40,40) 0%
HI_SG52_D2
(30,30) 2.2%
HI_SG53_D2
(30,30) 2.2%
HI_SG64_D2
(40,40) 0%
HI_SG65_D2
(40,40) 0%
COLTON
UP COLTON-HILAND 3-3
HILAND

Appendix B. Peak-Day Train Counts

Table B-1. Peak-Day Train Counts on BNSF Lines, Year 2000 Base Case

	8,000 ft intermodal	6,000 ft intermodal	5,000 ft unit bulk	6,000 ft unit auto	6,500 ft carload	500 ft commuter passenger	1,000 ft intercity passenger	Total
Year 2000 Base Case								
Barstow - Summit	20.6	33	8.4	8	17.2	0	2	89.2
Summit - Devore Rd. (inclusive)								
via BNSF tracks	20.6	33	8.4	8	17.2	0	2	89.2
via UP Palmdale track	0	0	0	0	6.5	0	0	6.5
Devore Rd. - San Bernardino	20.6	33	8.4	8	17.2	0	2	89.2
San Bernardino - Colton Crossing								
via Mains 1,2 and 3	20.6	29	8.4	6	15.2	0	0	79.2
via Main 4	0	0	0	0	0	9	2	11
Colton Crossing – West Riverside	20.6	36.6	8.4	11.4	15.2	9	2	103.2
West Riverside - Atwood	11	29	3	6	8	15	2	74
Atwood - Fullerton	11	29	1	4	5	3	2	55
Fullerton Jct. - Hobart	11	29	1	4	5	44	2	96
Hobart - Redondo	11	11	1	2	2	44	2	73

Table B-2. Peak-Day Train Counts on BNSF Lines, Status Quo Routing Alternative

	8,000 ft intermodal	6,000 ft intermodal	5,000 ft unit bulk	6,000 ft unit auto	6,500 ft carload	500 ft commuter passenger	1,000 ft intercity passenger	Total
Year 2010 Status Quo								
Barstow – Summit	36.2	48	9.8	9.2	19.3	4	2	128.5
Summit – Devore Rd. (inclusive)								
via BNSF tracks	36.2	48	9.8	9.2	19.3	4	2	128.5
via UP Palmdale track	0	0	0	0	7.5	0	0	7.5
Devore Rd. – San Bernardino	36.2	48	9.8	9.2	19.3	4	2	128.5
San Bernardino - Colton Crossing								
via Mains 1,2 and 3	36.2	42.9	9.8	6.9	17.3	0	0	113.1
via Main 4	0	0	0	0	0	22	2	24
Colton Crossing – West Riverside	36.2	55.6	9.8	13.1	17.3	22	2	156
West Riverside - Atwood	19.9	42.9	3.5	6.9	9	36	2	120.2
Atwood - Fullerton	19.9	42.9	1.2	4.6	5.5	18	2	94.1
Fullerton Jct. - Hobart	19.9	42.9	1.2	4.6	5.5	74	2	150.1
Hobart - Redondo	19.9	19.9	1.2	2.3	2	74	2	121.3
Year 2025 Status Quo								
Barstow – Summit	62.7	70.4	11.3	11.8	21.7	6	2	185.9
Summit – Devore Rd. (inclusive)								
via BNSF tracks	62.7	70.4	11.3	11.8	21.7	6	2	185.9
via UP Palmdale track	0	0	0	0	8.8	0	0	8.8
Devore Rd. – San Bernardino	62.7	70.4	11.3	11.8	21.7	6	2	185.9
San Bernardino - Colton Crossing								
via Mains 1,2 and 3	62.7	64	11.3	8.1	19.7	0	0	165.8
via Main 4	0	0	0	0	0	34	2	36
Colton Crossing – West Riverside	62.7	85.1	11.3	15.4	19.7	34	2	230.2
West Riverside - Atwood	35.2	64	4	8.1	10	60	2	183.3
Atwood - Fullerton	35.2	64	1.3	5.4	6	32	2	145.9
Fullerton Jct. - Hobart	35.2	64	1.3	5.4	6	98	2	211.9
Hobart - Redondo	35.2	35.2	1.3	2.7	2	98	2	176.4

Table B-3. Peak-Day Train Counts on BNSF Lines, Routing Alternatives 1a, 1b and 2

	8,000 ft intermodal	6,000 ft intermodal	5,000 ft unit bulk	6,000 ft unit auto	6,500 ft carload	500 ft commuter passenger	1,000 ft intercity passenger	Total
Year 2010 Status Quo								
Barstow – Summit	36.2	48	9.8	9.2	19.3	4	2	128.5
Summit – Devore Rd. (inclusive)								
via BNSF tracks	24.1	32.0	6.5	6.1	17.9	2.7	1.3	90.7
via UP Palmdale track	12.1	16.0	3.3	3.1	8.9	1.3	0.7	45.3
Devore Rd. – San Bernardino	19.9	48	3.5	9.2	15.6	4	2	102.2
San Bernardino - Colton Crossing								
via Mains 1,2 and 3	19.9	42.9	3.5	6.9	13.6	0	0	86.8
via Main 4	0	0	0	0	0	22	2	24.0
Colton Crossing – West Riverside	19.9	42.9	3.5	11.5	13.6	22	2	115.4
West Riverside - Atwood	19.9	42.9	3.5	6.9	9	36	2	120.2
Atwood - Fullerton	19.9	42.9	1.2	4.6	5.5	18	2	94.1
Fullerton Jct. - Hobart	19.9	42.9	1.2	4.6	5.5	74	2	150.1
Hobart - Redondo	19.9	19.9	1.2	2.3	2	74	2	121.3
Year 2025 Status Quo								
Barstow – Summit	62.7	70.4	11.3	11.8	21.7	6	2	185.9
Summit – Devore Rd. (inclusive)								
via BNSF tracks	47.0	52.8	8.5	8.9	22.9	4.5	1.5	146.0
via UP Palmdale track	15.7	17.6	2.8	3.0	7.6	1.5	0.5	48.7
Devore Rd. – San Bernardino	35.2	70.4	4	11.8	17.4	6	2	146.8
San Bernardino - Colton Crossing								
via Mains 1,2 and 3	35.2	64	4	8.1	15.4	0	0	126.7
via Main 4	0	0	0	0	0	34	2	36.0
Colton Crossing – West Riverside	35.2	64	4	13.5	15.4	34	2	168.1
West Riverside - Atwood	35.2	64	4	8.1	10	60	2	183.3
Atwood - Fullerton	35.2	64	1.3	5.4	6	32	2	145.9
Fullerton Jct. - Hobart	35.2	64	1.3	5.4	6	98	2	211.9
Hobart - Redondo	35.2	35.2	1.3	2.7	2	98	2	176.4

Table B-4. Peak-Day Train Counts on UP Lines, Year 2000 Base Case

	8,000 ft intermodal	6,000 ft intermodal	5,000 ft unit bulk	6,000 ft unit auto	6,500 ft carload	500 ft commuter passenger	1,000 ft intercity passenger	Total
Year 2000 Base Case								
Devore Rd. - West Colton (Palmdale Line)	0	0	0	0	6.5	0	0	6.5
Indio - Garnet	0	21.6	0	5.4	15	0	2	44
Garnet - Colton Crossing	0	21.6	0	5.4	15	0	2	44
Colton Crossing - West Colton	0	14	0	0	15	0	2	31
West Colton – Pomona (Alhambra Line)	0	14	0	0	9.4	0	2	25.4
Pomona - City of Industry	0	14	0	0	9.4	0	2	25.4
City of Industry - El Monte	0	14	0	0	7.4	0	2	23.4
El Monte - Yuma Jct.	0	14	0	0	7.4	0	0	21.4
Yuma Jct. - Pasadena Jct.	0	10	0	0	4	0	0	14
Pasadena Jct. – Ninth Street	0	10	4.4	0	4	12	0	30.4
West Riverside - Mira Loma	9.6	7.6	5.4	5.4	7.2	12	0	47.2
Mira Loma - Pomona	9.6	7.6	5.4	1.4	7.2	12	0	43.2
Pomona - East Los Angeles (San Gabriel Line)	9.6	7.6	5.4	1.4	7.2	12	0	43.2
East Los Angeles – Ninth Street	7.6	5.6	5.4	0.6	0	12	0	31.2

Table B-5. Peak-Day Train Counts on UP Lines, Status Quo Routing Alternative in 2010

	8,000 ft intermodal	6,000 ft intermodal	5,000 ft unit bulk	6,000 ft unit auto	6,500 ft carload	500 ft commuter passenger	1,000 ft intercity passenger	Total
Year 2010 Status Quo								
Devore Rd. - West Colton (Palmdale Line)	0	0	0	0	6.5	0	0	6.5
Indio - Garnet	0	21.6	0	5.4	15	0	2	44
Garnet - Colton Crossing	0	21.6	0	5.4	15	0	2	44
Colton Crossing - West Colton	0	14	0	0	15	0	2	31
West Colton – Pomona (Alhambra Line)	0	14	0	0	9.4	0	2	25.4
Pomona - City of Industry (Alhambra Line)	0	14	0	0	9.4	0	2	25.4
City of Industry - El Monte	0	14	0	0	7.4	0	2	23.4
El Monte - Yuma Jct.	0	14	0	0	7.4	0	0	21.4
Yuma Jct. - Pasadena Jct.	0	10	0	0	4	0	0	14
Pasadena Jct. – Ninth Street	0	10	4.4	0	4	12	0	30.4
West Riverside - Mira Loma	9.6	7.6	5.4	5.4	7.2	12	0	47.2
Mira Loma - Pomona	9.6	7.6	5.4	1.4	7.2	12	0	43.2
Pomona - East Los Angeles (San Gabriel Line)	9.6	7.6	5.4	1.4	7.2	12	0	43.2
East Los Angeles – Ninth Street	7.6	5.6	5.4	0.6	0	12	0	31.2

Table B-6. Peak-Day Train Counts on UP Lines, Status Quo Routing Alternative in 2025

	8,000 ft intermodal	6,000 ft intermodal	5,000 ft unit bulk	6,000 ft unit auto	6,500 ft carload	500 ft commuter passenger	1,000 ft intercity passenger	Total
Year 2025 Status Quo								
Devore Rd. - West Colton (Palmdale Line)	0	0	0	0	8.8	0	0	8.8
Indio - Garnet	0	59.6	0	7.3	20.2	0	2	89.1
Garnet - Colton Crossing	0	59.6	0	7.3	20.2	6	2	95.1
Colton Crossing - West Colton	0	38.5	0	0	20.2	6	2	66.7
West Colton – Pomona (Alhambra Line)	0	38.5	0	0	10.6	6	2	57.1
Pomona - City of Industry (Alhambra Line)	0	38.5	0	0	10.6	6	2	57.1
City of Industry - El Monte	0	38.5	0	0	8.6	6	2	55.1
El Monte - Yuma Jct.	0	38.5	0	0	8.6	0	0	47.1
Yuma Jct. - Pasadena Jct.	0	32.1	0	0	4	0	0	36.1
Pasadena Jct. – Ninth Street	0	32.1	5.9	0	4	36	0	78
West Riverside - Mira Loma	27.5	21.1	7.3	7.3	9.7	36	0	108.9
Mira Loma - Pomona	27.5	21.1	7.3	1.9	9.7	36	0	103.5
Pomona - East Los Angeles (San Gabriel Line)	27.5	21.1	7.3	1.9	9.7	36	0	103.5
East Los Angeles – Ninth Street	24.3	17.9	7.3	0.8	0	36	0	86.3

Table B-7. Peak-Day Train Counts on UP Lines, Routing Alternative 1a in 2010

	8,000 ft intermodal	6,000 ft intermodal	5,000 ft unit bulk	6,000 ft unit auto	6,500 ft carload	500 ft commuter passenger	1,000 ft intercity passenger	Total
Year 2010 Alternative 1a								
Devore Rd. - West Colton (Palmdale Line)	16.3	0	6.3	0	11.2	0	0	33.8
Indio - Garnet	0	35.9	0	6.2	17.4	0	2	61.5
Garnet - Colton Crossing	0	35.9	0	6.2	17.4	2	2	63.5
Colton Crossing - West Colton	0	23.2	0	1.6	17.4	2	2	46.2
West Colton – Pomona (Alhambra Line)	16.3	35.9	6.3	1.6	13.6	2	2	77.7
Pomona - City of Industry (Alhambra Line)	0	5.1	0	0	5.9	2	2	15.0
City of Industry - El Monte	0	5.1	0	0	3.9	2	2	13.0
El Monte - Yuma Jct.	0	5.1	0	0	3.9	0	0	9.0
Yuma Jct. - Pasadena Jct.	0	0	0	0	0	0	0	0.0
Pasadena Jct. – Ninth Street	0	0	5.1	0	0	22	0	27.1
West Riverside - Mira Loma	0	0	0	4.6	4.6	22	0	31.2
Mira Loma - Pomona	0	0	0	0	4.6	22	0	26.6
Pomona - East Los Angeles (San Gabriel Line)	16.3	30.8	6.3	1.6	12.3	22	0	89.3
East Los Angeles – Ninth Street	13.7	28.2	6.3	0.7	4	22	0	74.9

Table B-8. Peak-Day Train Counts on UP Lines, Routing Alternative 1a in 2025

	8,000 ft intermodal	6,000 ft intermodal	5,000 ft unit bulk	6,000 ft unit auto	6,500 ft carload	500 ft commuter passenger	1,000 ft intercity passenger	Total
Year 2025 Alternative 1a								
Devore Rd. - West Colton (Palmdale Line)	27.5	0	7.3	0	13.1	0	0	47.9
Indio - Garnet	0	59.6	0	7.3	20.2	0	2	89.1
Garnet - Colton Crossing	0	59.6	0	7.3	20.2	6	2	95.1
Colton Crossing - West Colton	0	38.5	0	1.9	20.2	6	2	68.6
West Colton – Pomona (Alhambra Line)	27.5	59.6	7.3	1.9	14.9	6	2	119.2
Pomona - City of Industry (Alhambra Line)	0	6.4	0	0	6.6	6	2	21.0
City of Industry - El Monte	0	6.4	0	0	4.6	6	2	19.0
El Monte - Yuma Jct.	0	6.4	0	0	4.6	0	0	11.0
Yuma Jct. - Pasadena Jct.	0	0	0	0	0	0	0	0.0
Pasadena Jct. – Ninth Street	0	0	5.9	0	0	36	0	41.9
West Riverside - Mira Loma	0	0	0	5.4	5.4	36	0	46.8
Mira Loma - Pomona	0	0	0	0	5.4	36	0	41.4
Pomona - East Los Angeles (San Gabriel Line)	27.5	53.2	7.3	1.9	13.7	36	0	139.6
East Los Angeles – Ninth Street	24.3	50	7.3	0.8	4	36	0	122.4

Table B-9. Peak-Day Train Counts on UP Lines, Routing Alternative 1b in 2010

	8,000 ft intermodal	6,000 ft intermodal	5,000 ft unit bulk	6,000 ft unit auto	6,500 ft carload	500 ft commuter passenger	1,000 ft intercity passenger	Total
Year 2010 Alternative 1b								
Devore Rd. - West Colton (Palmdale Line)	16.3	0	6.3	0	11.2	0	0	33.8
Indio - Garnet	0	35.9	0	6.2	17.4	0	2	61.5
Garnet - Colton Crossing	0	35.9	0	6.2	17.4	2	2	63.5
Colton Crossing - West Colton	0	23.2	0	1.6	17.4	2	2	46.2
West Colton – Pomona (Alhambra Line)	16.3	35.9	6.3	1.6	13.6	2	2	77.7
Pomona - City of Industry (Alhambra Line)	0	5.1	0	0	5.9	24	2	37.0
City of Industry - El Monte	0	5.1	0	0	3.9	24	2	35.0
El Monte - Yuma Jct.	0	5.1	0	0	3.9	20	0	29.0
Yuma Jct. - Pasadena Jct.	0	0	0	0	0	0	0	0.0
Pasadena Jct. – Ninth Street	0	0	5.1	0	0	0	0	5.1
West Riverside - Mira Loma	0	0	0	4.6	4.6	22	0	31.2
Mira Loma - Pomona	0	0	0	0	4.6	22	0	26.6
Pomona - East Los Angeles (San Gabriel Line)	16.3	30.8	6.3	1.6	12.3	0	0	67.3
East Los Angeles – Ninth Street	13.7	28.2	6.3	0.7	4	0	0	52.9

Table B-10. Peak-Day Train Counts on UP Lines, Routing Alternative 1b in 2025

	8,000 ft intermodal	6,000 ft intermodal	5,000 ft unit bulk	6,000 ft unit auto	6,500 ft carload	500 ft commuter passenger	1,000 ft intercity passenger	Total
Year 2025 Alternative 1b								
Devore Rd. - West Colton (Palmdale Line)	27.5	0	7.3	0	13.1	0	0	47.9
Indio - Garnet	0	59.6	0	7.3	20.2	0	2	89.1
Garnet - Colton Crossing	0	59.6	0	7.3	20.2	6	2	95.1
Colton Crossing - West Colton	0	38.5	0	1.9	20.2	6	2	68.6
West Colton – Pomona (Alhambra Line)	27.5	59.6	7.3	1.9	14.9	6	2	119.2
Pomona - City of Industry (Alhambra Line)	0	6.4	0	0	6.6	42	2	57.0
City of Industry - El Monte	0	6.4	0	0	4.6	42	2	55.0
El Monte - Yuma Jct.	0	6.4	0	0	4.6	34	0	45.0
Yuma Jct. - Pasadena Jct.	0	0	0	0	0	0	0	0.0
Pasadena Jct. – Ninth Street	0	0	5.9	0	0	0	0	5.9
West Riverside - Mira Loma	0	0	0	5.4	5.4	36	0	46.8
Mira Loma - Pomona	0	0	0	0	5.4	36	0	41.4
Pomona - East Los Angeles (San Gabriel Line)	27.5	53.2	7.3	1.9	13.7	0	0	103.6
East Los Angeles – Ninth Street	24.3	50	7.3	0.8	4	0	0	86.4

Table B-11. Peak-Day Train Counts on UP Lines, Routing Alternative 2 in 2010

	8,000 ft intermodal	6,000 ft intermodal	5,000 ft unit bulk	6,000 ft unit auto	6,500 ft carload	500 ft commuter passenger	1,000 ft intercity passenger	Total
Year 2010 Alternative 2								
Devore Rd. - West Colton (Palmdale Line)	16.3	0	6.3	0	11.2	0	0	33.8
Indio - Garnet	0	35.9	0	6.2	17.4	0	2	61.5
Garnet - Colton Crossing	0	35.9	0	6.2	17.4	2	2	63.5
Colton Crossing - West Colton	0	23.2	0	1.6	17.4	2	2	46.2
West Colton – Pomona (Alhambra Line)	16.3	33.3	6.3	1.6	13.6	2	2	75.1
Pomona - City of Industry (Alhambra Line)	13.7	33.3	6.3	0.7	9.9	2	2	67.9
City of Industry - El Monte	13.7	33.3	6.3	0.7	7.9	2	2	65.9
El Monte - Yuma Jct.	13.7	33.3	6.3	0.7	7.9	0	0	61.9
Yuma Jct. - Pasadena Jct.	13.7	28.2	6.3	0.7	4	0	0	52.9
Pasadena Jct. – Ninth Street	13.7	28.2	11.4	0.7	4	22	0	80.0
West Riverside - Mira Loma	0	0	0	4.6	4.6	22	0	31.2
Mira Loma - Pomona	0	0	0	0	4.6	22	0	26.6
Pomona - East Los Angeles (San Gabriel Line)	2.6	2.6	0	0.9	8.3	22	0	36.4
East Los Angeles – Ninth Street	0	0	0	0	0	22	0	22.0

Table B-12. Peak-Day Train Counts on UP Lines, Routing Alternative 2 in 2025

	8,000 ft intermodal	6,000 ft intermodal	5,000 ft unit bulk	6,000 ft unit auto	6,500 ft carload	500 ft commuter passenger	1,000 ft intercity passenger	Total
Year 2025 Alternative 2								
Devore Rd. - West Colton (Palmdale Line)	27.5	0	7.3	0	13.1	0	0	47.9
Indio - Garnet	0	59.6	0	7.3	20.2	0	2	89.1
Garnet - Colton Crossing	0	59.6	0	7.3	20.2	6	2	95.1
Colton Crossing - West Colton	0	38.5	0	1.9	20.2	6	2	68.6
West Colton – Pomona (Alhambra Line)	27.5	59.6	7.3	1.9	14.9	6	2	119.2
Pomona - City of Industry (Alhambra Line)	24.3	56.4	7.3	0.8	10.6	6	2	107.4
City of Industry - El Monte	24.3	56.4	7.3	0.8	8.6	6	2	105.4
El Monte - Yuma Jct.	24.3	56.4	7.3	0.8	8.6	0	0	97.4
Yuma Jct. - Pasadena Jct.	24.3	50	7.3	0.8	4	0	0	86.4
Pasadena Jct. – Ninth Street	24.3	50	13.2	0.8	4	36	0	128.3
West Riverside - Mira Loma	0	0	0	5.4	5.4	36	0	46.8
Mira Loma - Pomona	0	0	0	0	5.4	36	0	41.4
Pomona - East Los Angeles (San Gabriel Line)	3.2	3.2	0	1.1	9.7	36	0	53.2
East Los Angeles – Ninth Street	0	0	0	0	0	36	0	36.0

Table B-13. Locomotive Consists for Various Types of Trains Assumed in Train Dispatching Simulations and Emissions Analysis

Train Type	Locomotive Consist
Long-distance passenger train (1,000ft)	2 4,000HP B-B locomotive units
Commuter passenger train (500ft)	1 4,000HP B-B locomotive unit
BNSF freight trains	
Alameda Corridor - Barstow Carload	3 4,400 HP C-C locomotive units, plus 2 3,000 HP C-C locomotive units as pusher San Bernardino - Victorville
Hobart - Barstow Carload	3 4,400 HP C-C locomotive units, plus 2 3,000 HP C-C locomotive units as pusher San Bernardino - Victorville
San Diego - Atwood - Barstow Carload	3 4,400 HP C-C locomotive units, plus 2 3,000 HP C-C locomotive units as pusher San Bernardino - Victorville
Fontana - San Bernardino - Barstow Carload	3 4,400 HP C-C locomotive units, plus 2 3,000 HP C-C locomotive units as pusher San Bernardino - Victorville
Alameda Corridor - Barstow Unit Bulk	4 4,400 HP C-C locomotive units, plus 2 3,000 HP C-C locomotive units as pusher San Bernardino - Victorville
San Diego - Atwood - Barstow Unit Bulk	4 4,400 HP C-C locomotive units, plus 2 3,000 HP C-C locomotive units as pusher San Bernardino - Victorville
Alameda Corridor - Barstow 8,000ft Intermodal	4 4,400 HP C-C locomotive units, plus 2 3,000 HP C-C locomotive units as pusher San Bernardino - Victorville
Alameda Corridor - Barstow 6,000ft Intermodal	4 4,400 HP C-C locomotive units
Hobart - Barstow 6,000ft Intermodal	4 4,400 HP C-C locomotive units
San Bernardino - Barstow 6,000ft Intermodal	4 4,400 HP C-C locomotive units
Alameda Corridor - Barstow Unit Auto	4 4,400 HP C-C locomotive units
Hobart - Barstow Unit Auto	4 4,400 HP C-C locomotive units
San Diego - Atwood - Barstow Unit Auto	4 4,400 HP C-C locomotive units
San Bernardino - Barstow Unit Auto	4 4,400 HP C-C locomotive units
UP freight trains	
LATC - Indio 6,000ft Intermodal	4 4,400 HP C-C locomotive units

East LA - Indio 6,000ft Intermodal	4 4,400 HP C-C locomotive units
Alameda Corridor - Indio 6,000ft Intermodal	4 4,400 HP C-C locomotive units
Alameda Corridor - Barstow 8,000ft Intermodal	4 4,400 HP C-C locomotive units, plus 2 3,000 HP C-C locomotive units as pusher San Bernardino - Victorville
East LA - Barstow 8,000ft Intermodal	4 4,400 HP C-C locomotive units, plus 2 3,000 HP C-C locomotive units as pusher San Bernardino - Victorville
Alameda Corridor - Indio Unit Auto	4 4,400 HP C-C locomotive units
East LA - Indio Unit Auto	4 4,400 HP C-C locomotive units
Mira Loma - Indio Unit Auto	4 4,400 HP C-C locomotive units
Alameda Corridor - Barstow Unit Bulk	4 4,400 HP C-C locomotive units, plus 2 3,000 HP C-C locomotive units as pusher San Bernardino - Victorville
Alameda Corridor - Glendale Line Unit Bulk	4 4,400 HP C-C locomotive units
Alameda Corridor - West Colton Carload	2 4,400 HP C-C locomotive units
East LA - Barstow Carload w/stop at Montclair	3 4,400 HP C-C locomotive units, plus 2 3,000 HP C-C locomotive units as pusher San Bernardino - Victorville
East LA - Barstow Carload non-stop	3 4,400 HP C-C locomotive units, plus 2 3,000 HP C-C locomotive units as pusher San Bernardino - Victorville
Glendale Line - West Colton Carload	2 4,400 HP C-C locomotive units
City of Industry - West Colton Carload	2 4,400 HP C-C locomotive units
West Colton - Palmdale Line Carload	3 4,400 HP C-C locomotive units, plus 2 3,000 HP C-C locomotive units as pusher San Bernardino - Victorville
West Colton - Indio Carload	3 4,400 HP C-C locomotive units, plus 2 3,000 HP C-C locomotive units as pusher Colton - Garnet