SOUTHERN CALIFORNIA
ASSOCIATION of GOVERNMENTS

Comprehensive Regional Goods Movement Plan and Implementation Strategy

Regional Rail Simulation Update Summary Report

November 2011

FREIGHTWORKS
SOUTHERN CALIFORNIA DELIVERS THE GOODS









This report was authored by Dr. Robert C. Leachman, Leachman & Associates LLC, under contract to Cambridge Systematics, Inc. for the Southern California Association of Governments as part of the Comprehensive Regional Goods Movement Plan and Implementation Strategy.

Funding: The preparation of this report was funded in part by grants from the United States Department of Transportation (DOT).

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Background and Introduction

In 2009, Southern California Association of Governments (SCAG) initiated the *Comprehensive Regional Goods Movement Plan and Implementation Strategy* to further define the regional goods movement system for the development of the 2012 Regional Transportation Plan. This initiative includes updates of regional train volume forecasts from *The Inland Empire Railroad Main Line Study,* authored by Dr. Leachman and issued by SCAG in 2005. The analysis examines railroad infrastructure needs to accommodate operations of both freight and passenger trains in Southern California between downtown Los Angeles on the west and Barstow and Indio on the east. Track capacity plans and capital cost estimates were developed to accommodate 2035 rail traffic forecasts. Several alternative routings for future freight and passenger train operations were assessed.

Since the 2005 study, important assumptions underlying that study have changed. There has been, and continues to be, considerable evolution in rail intermodal technology, significantly reducing the number of trains required to move a given annual cargo volume. Changes in import supply chains have accelerated this trend of increased application of more efficient rail intermodal technology. Second, the Ports of Los Angeles and Long Beach have scaled back their growth projections. Third, in light of governmental budgetary problems, projections of future Amtrak and Metrolink passenger services have been scaled back for analysis.

This updated regional rail forecast reflects the above mentioned changes. The scope of this updated study is as follows:

- Prepare forecasts of train movements in 2035 between downtown Los Angeles and Barstow – Indio over the Burlington Northern Santa Fe and Union Pacific main lines;
- Determine track capacity improvements required for the status quo routing of the forecasted 2035 train movements, and also for promising alternative future routings of those movements;
- Estimate capital costs for the improvements; and
- Assess the implications of future train routings and track capacity improvements.

The criterion for planning track capacity in this study is to maintain Year 2000 average dispatching delays under the 2035 traffic scenario. From iterative simulation experiments for several routing alternatives, required trackage configurations were identified meeting this criterion.

Summary of Mainline Rail Configuration

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. Also not shown are Metrolink main lines that do not host through rail freight operations.

Figure 1. Main Rail Lines West of Colton

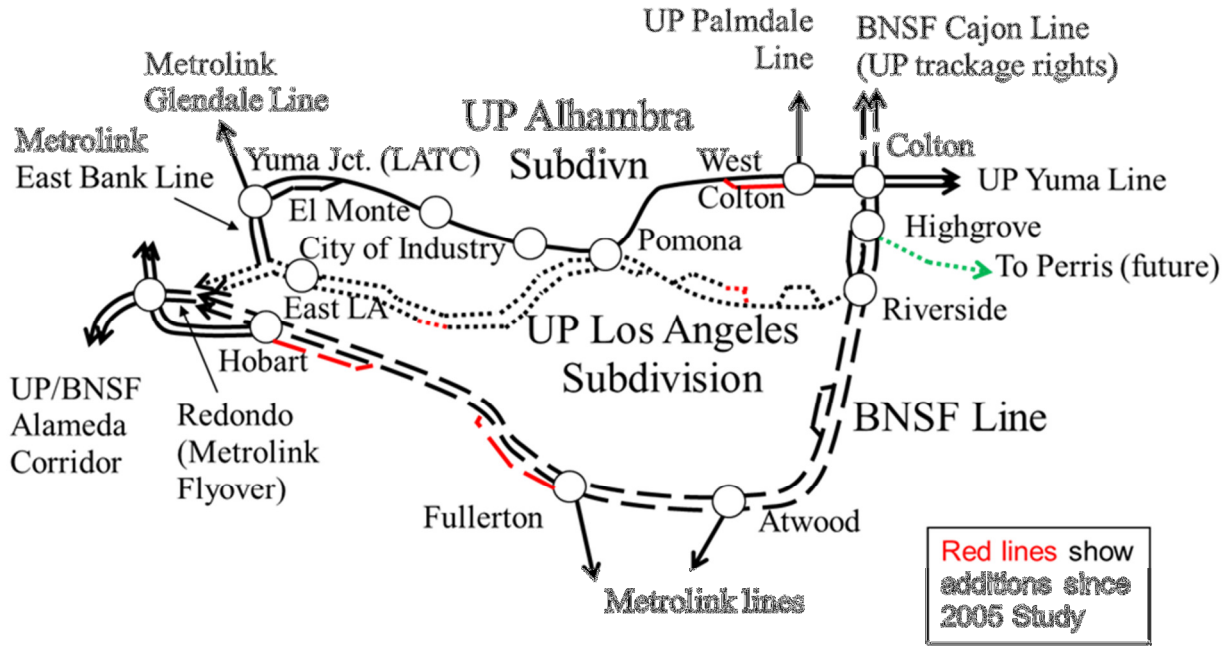
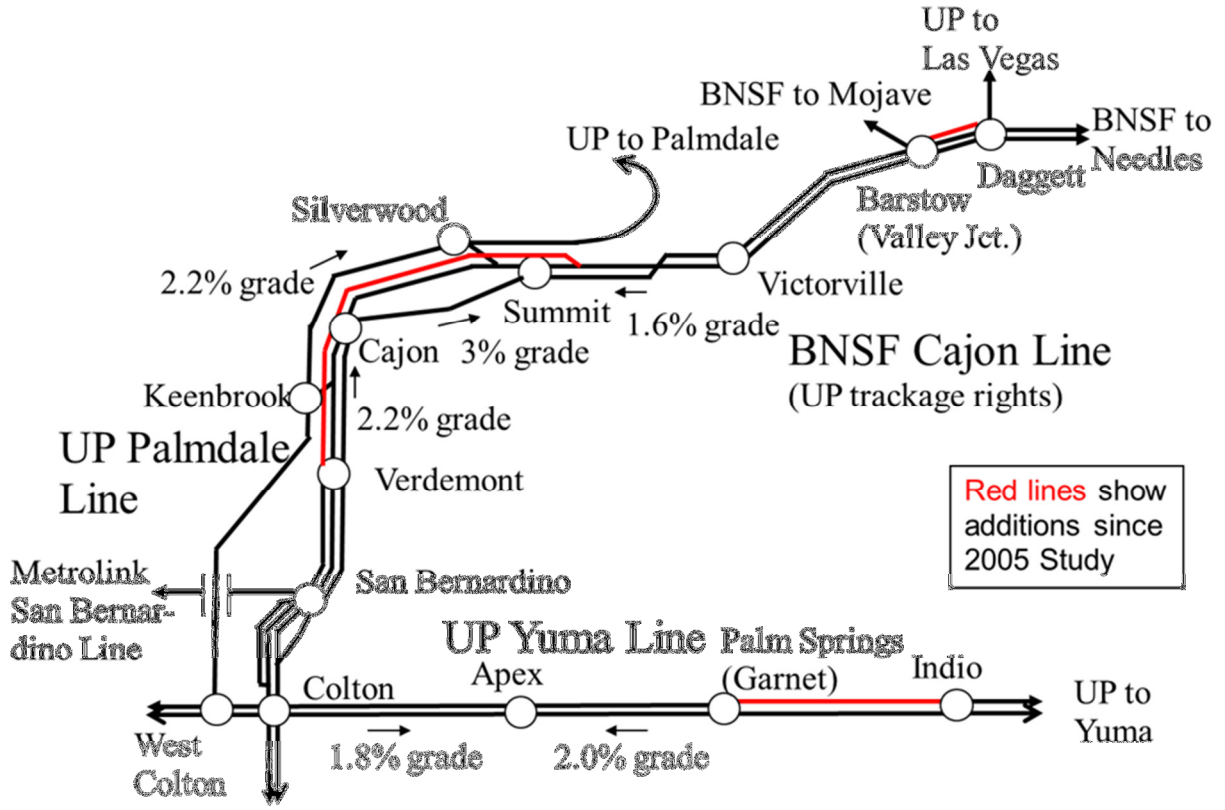


Figure 2. Main Rail Lines North and East of Colton



BNSF operates a single main line extending from connections to the Alameda Corridor at Redondo (near downtown Los Angeles) eastward and northward to Barstow. From Redondo to San Bernardino the line is designated as the BNSF San Bernardino Subdivision. From San Bernardino to Barstow, the line is designated as the BNSF Cajon Subdivision.

Intermodal terminals are operated by BNSF at Hobart (adjoining the City of Commerce) and San Bernardino. In addition, numerous trains hauling marine containers terminate or originate at on-dock terminals in the Ports of Los Angeles and Long Beach, accessed via the Alameda Corridor. UP trains utilize trackage rights over the BNSF Line from West Riverside to Daggett, just beyond Barstow. The entire BNSF line has at least two main tracks reverse-signaled under centralized traffic control (CTC), and there are significant stretches of three main tracks in various locales. Expansion of three-main-track territory is on-going. Most recently, a third main track was completed from San Bernardino to the summit of Cajon Pass. A third main track is currently under construction between Hobart and Fullerton.

Key Assumptions and Routing Alternatives

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 generally 16% higher than the average daily train movement count.

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. In 2010, the passenger train count has risen to 54, but the freight train count has dropped to 45 per peak day (albeit the amount of cargo handled is greater.) Those figures are forecast to rise to 77 passenger trains and 90 freight trains in 2035. Joint passenger-freight operations also are projected to be very heavy between West Riverside and Colton. Union Pacific contributes a significant amount of through freight train movements to this segment, exercising trackage rights on the BNSF line. In 2010, on a peak day there are 10 passenger trains and 67 freight trains traversing this segment. Juxtaposed with projected growth in freight traffic, Metrolink proposes to increase service frequencies and extend services which currently terminate at Riverside northward to Perris, turning off the BNSF main line at Highgrove. With no change in policies for routing Union Pacific through freight trains, it is projected that in 2035 there would be 42 passenger trains and 147 freight trains per peak day on the BNSF between West Riverside and Highgrove.

UP operates two main lines between downtown Los Angeles and Colton Crossing. In this report, these lines are designated as the UP Los Angeles Subdivision and the UP Alhambra Subdivision. These lines consist of a mixture of single-track and two-main-track territories operated under CTC. The UP Alhambra Subdivision is mostly single-track, while the UP Los Angeles

Subdivison is completely two-main-track west of Pomona and partially two-main-track east of Pomona.

Intermodal terminals operated by UP include East Los Angeles (at the west end of the UP Los Angeles Subdivision), Los Angeles Transportation Center (at the west end of the UP Alhambra Subdivision), City of Industry (midway on the UP Alhambra Subdivision), and the Intermodal Container Transfer Facility (ICTF, near the south end of the Alameda Corridor). In addition, some UP trains hauling marine containers originate or terminate at on-dock terminals within the Ports of Los Angeles and Long Beach. To connect the Alhambra Subdivision with the Alameda Corridor, UP utilizes trackage rights over Metrolink's East Bank Line between LATC and the east-side junction to the bridge crossing the Los Angeles River to Redondo, the station name for the entrance to the Alameda Corridor. A large carload freight classification yard is located at West Colton (at the east end of the Alhambra Subdivision). A large auto unloading terminal is located at Mira Loma (mid-way between Pomona and West Riverside on the Los Angeles Subdivision).

North from West Colton, UP operates the single-track-CTC Mojave Subdivision to Northern California and Pacific Northwest points. This line closely parallels the BNSF Cajon Subdivision as the two lines climb the south slope of Cajon Pass. Connections are afforded at Keenbrook and Silverwood to enable UP trains to enter/exit the main tracks of the BNSF Cajon Subdivision. Beyond Silverwood to Palmdale, the UP Mojave Subdivision is lightly trafficked.

In Year 2000, 94 freight trains and two Amtrak passenger trains per peak day crossed Cajon Pass, considering both the BNSF Cajon Subdivision and the UP Mojave Subdivision. In Year 2010 the train counts are almost the same, with 93 freight trains and two Amtrak passenger trains per peak day. In 2035, the peak-day figures for the Cajon Pass corridor are forecast to be 147 freight trains and 2 passenger trains.

East from Colton Crossing to Indio, UP operates its transcontinental Sunset Route main line, designated in this report as the UP Yuma Subdivision. The line now has two main tracks under CTC the entire distance to Indio. East of Indio, the Sunset Route still has stretches of single-track, but construction of a second main track is underway.

In Year 2000, UP operated 59 through freight trains per peak day collectively over the UP Los Angeles and UP Alhambra Subdivisions. This figure dropped to 51 trains in 2010 but is forecast to rise to 111 trains in 2035. On the Yuma Subdivision, UP operated 42 freight trains per peak day in Year 2000. That figure rose to 45 trains in 2010 and is projected to rise to 93 trains in 2035.

Passenger train movements over UP tracks in the study area are heaviest on the UP Los Angeles Subdivision. In Year 2000, there were 12 Metrolink trains per peak day over this line, continuing up the Metrolink East Bank Line almost to LATC before turning to cross the Los Angeles River into Los Angeles Union Station. This level of service continues in 2010, but is forecast to rise to 20 trains in 2035. In contrast, passenger movements over the UP Alhambra Subdivision and the UP Yuma Subdivision are very light. Only 2 trains per peak day traversed this line in Year 2000, dropping to one train per day in 2010 (because the Amtrak service was reduced to tri-weekly).

No increase in this Amtrak service is forecast for 2035. There are no regular passenger movements over the UP Mojave Subdivision.

Intermodal trains account for 157 out of the 266 freight train movements forecasted to traverse the foregoing rail main lines on a peak day in 2035. This compares to 70 intermodal trains on a peak day in 2010. Important assumptions underlying the development of forecasts for intermodal train movements in 2035 are as follows:

- UP and BNSF each will have 50% market shares of the marine container and domestic container service markets.
- UP will have a 25% market share and BNSF will have a 75% market share of the premium intermodal service market.
- By 2035, premium intermodal service will be conducted entirely using domestic containers, and trailer (van) service will be discontinued.
- The most recent forecast of total container traffic in Year 2035 issued by the Ports of Los Angeles and Long Beach calls for 43.14 million TEUs (twenty-foot equivalent units) to be handled through the ports.
- It is assumed that marine container trains will account for 30% of this volume, domestic container trains will account for 35% of this volume, and premium-service intermodal trains will account for 10% of this volume.[1]
- TEU volume during the peak month of containerized trade for the ports is 9.2% higher than containerized trade in the average month. Containerized volume on a peak day is 16% higher than on an average day in the peak month.
- Train lengths in 2035 are assumed as follows: Marine container trains will be 30% 8,000-ft trains, 40% 10,000-ft trains and 30% 12,000-ft trains. Domestic container trains will be 66% 12,000-ft trains and 34% 10,000-ft trains. Premium-service intermodal trains will be 30% 10,000-ft trains, 40% 8,000-ft trains, and 30% 6,000-ft trains.
- Slots in railroad double-stack well cars are assumed to be 88% full, both for marine container trains and domestic container trains. Well cars for marine containers accommodate up to 10 40-foot marine containers and are 265 feet long. Well cars for domestic containers accommodate up to 6 53-foot domestic containers and are 203 feet long.
- One domestic container holds 2.96 TEUs. (This is based on the 4,000 cubic-foot capacity of a 53-foot domestic container, versus a 2,700 cubic-foot capacity of a high-cube 40-foot marine container.)

Non-intermodal freight trains include unit auto trains, unit oil trains, unit bulk trains, through carload trains, local carload freight trains, and light engines. For each of the various types of non-intermodal freight trains, generally only modest growth is assumed, on the order of one-to-three trains per day per origin-destination pair. Exceptions include local carload freight trains (no growth assumed) at one extreme and unit bulk trains (collectively growing from 5 to 13 trains

[1] Unlike eastbound marine container trains and domestic container trains, eastbound premium-service intermodal trains haul a significant amount of goods not imported. However, it is assumed herein that premium service intermodal volume may be indexed to equal 10% of total port TEUs.

per peak day) at the other. In aggregate, the count of non-intermodal freight trains is projected to grow from the 74 trains per peak day in 2010 to 109 trains per peak day in 2035.

Passenger trains include Amtrak service and Metrolink service. No expansion of existing Amtrak services is assumed in this study. Existing services in the study area include 3 long distance trains per peak day and 24 regional trains (the Surfliners) per peak day. Metrolink services are assumed to rise to Metrolink's 2020 service plans, an increase from the current 58 trains per peak day in the study area to 111 trains per peak day in 2035.

Discrete-event computer simulations ("train dispatch simulations") of the forecasted 2035 railroad operations were carried out by the consultant for several routing alternatives. Given frequencies of various types of trains, characteristics of those trains, trackage configuration and track speeds as input, one hundred peak days of train operations were simulated and statistics on transit times and delays were compiled. As indicated above, the criterion for planning track capacity in this study is to maintain Year 2000 average dispatching delays under the 2035 traffic scenario. From iterative simulation experiments, required trackage configurations were identified meeting this criterion.

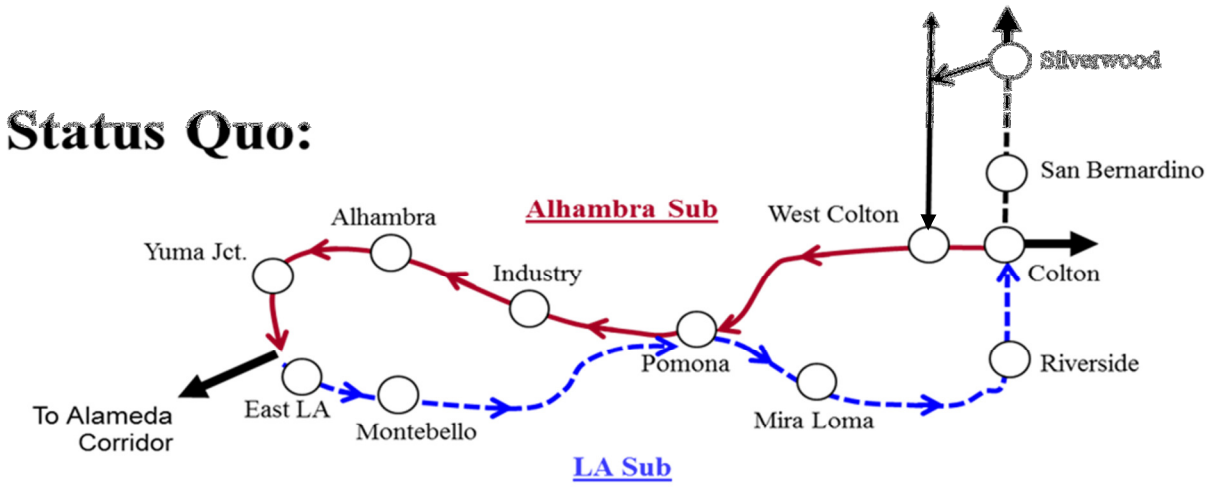
Designing a rail line to accommodate high frequencies of non-stop 40-50 MPH 6,000-12,000-foot freight trains jointly with high frequencies of 60-80 MPH 500-600-foot passenger trains making frequent stops to load and discharge passengers presents a tremendous engineering challenge, both from service reliability and safety viewpoints. For lines west and south of Colton Crossing, accommodating this disparity in speeds, lengths and intermediate stops dramatically escalates the scope and costs of required improvements compared to a scenario wherein all trains run at similar speeds, have similar lengths and do not make intermediate stops generating pedestrian traffic in the vicinity of the tracks. It is assumed in this study that all Metrolink station platforms are positioned on the same side of multiple main tracks, e.g., on the south and east sides of the tracks Hobart – Fullerton – Riverside and on the north side of the tracks Los Angeles – Pomona – Riverside. Were passenger trains required to cross back and forth across the multiple main tracks to make station stops, the capital improvement plans set forth here would be inadequate. Even the feasibility of accommodating the 2035 traffic levels is questionable in that case. Moreover, it is assumed herein that there would be pedestrian bridges and barriers preventing pedestrians from crossing the tracks in the vicinity of all stations, enabling through freight trains to proceed without delay on parallel tracks while station stops are made by passenger trains. Costs of such station access infrastructure are not included in the capital cost estimates for track capacity improvements assessed in this report.

As BNSF has only a single route, no routing alternatives were considered for BNSF freight trains. But in the case of UP, several alternatives have been conceived and assessed. The Status Quo alternative is as consistent as possible with current (2010) UP practice. Under Status Quo, the Alhambra and Los Angeles Subdivisions are used to some extent as a paired double track, with eastbound trains operating via the Los Angeles Subdivision from Redondo or East Los Angeles to West Riverside, thence via trackage rights over BNSF through Riverside up to Colton, and then turning east on to the UP Yuma Subdivision or continuing north on the BNSF Cajon Subdivision to Daggett, depending on if the UP train is routed via El Paso or via Salt Lake City on its way east (See Figure 3). Westbound trains from Daggett typically (but not always)

exit the BNSF Cajon Subdivision at either Silverwood or Keenbrook, then follow the UP Mojave Subdivision to West Colton. In that case, if destined further west, the UP train continues westward on the Alhambra Subdivision. Westbound trains from Daggett on the UP Yuma Subdivision typically proceed straight across Colton Crossing to West Colton. Again, if destined further west, the UP train continues westward on the Alhambra Subdivision.

Because of the locations of certain terminals, a significant number of UP trains must move against the current of traffic defined above. Auto trains terminating at Mira Loma must use trackage rights over BNSF Colton – West Riverside and then operate westbound over the Los Angeles Subdivision to Mira Loma. Empty auto trains from Mira Loma to the Ports of Los Angeles and Long Beach must operate westbound over the Los Angeles Subdivision from Mira Loma to Pomona. Eastbound intermodal trains originating at City of Industry must operate via the Alhambra Subdivision between City of Industry and Pomona. All carload trains originate or terminate at the West Colton classification terminal located on the Alhambra Subdivision. For these reasons, about 26% of UP through trains must operate against the current of traffic in the Status Quo alternative. Nonetheless, the 74% that can run with the current of traffic enables UP to minimize dispatching delays by pairing the tracks of the two Subdivisions.

Figure 3. Status Quo Routing



Four 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:

- Routing trains via the UP Los Angeles Subdivision 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. Moreover, double-tracking the remaining portions of the UP Los Angeles

Subdivision would be very costly, involving duplication of the lengthy Santa Ana River bridge and significant property-taking and earth removal in Riverside. Expansion of capacity of the UP Alhambra Subdivision between West Colton and Pomona is more practical and much less costly.

- The UP Mojave Subdivision is relatively underutilized, whereas the BNSF Line through Riverside, San Bernardino and over Cajon Pass is heavily utilized. Integrating the UP Mojave Subdivision 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 2035 traffic levels.

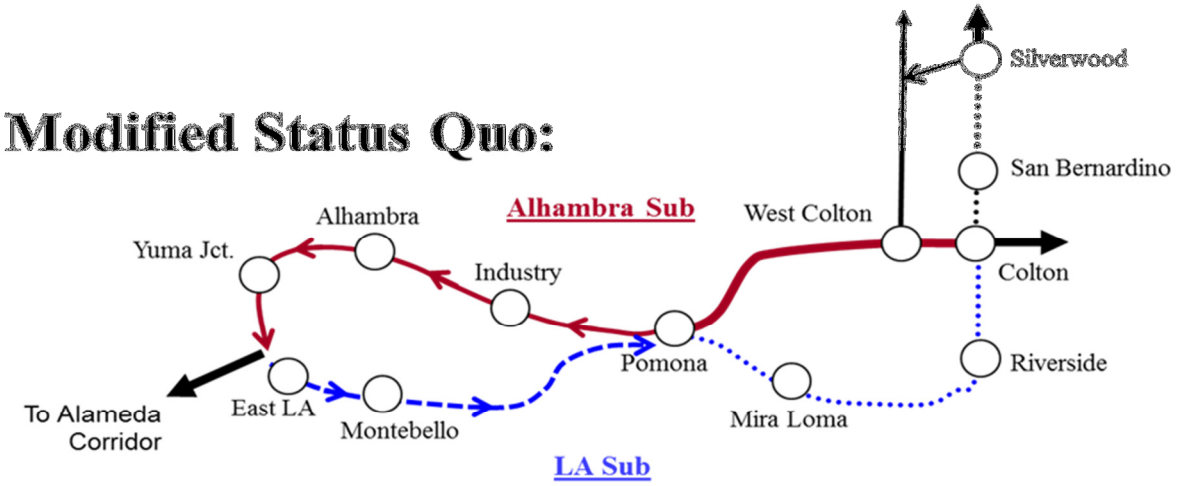
- Blending high levels of Metrolink and through freight train operations on the same line poses reliability and safety risks. Given the presence of two UP main lines, it is possible to allocate most UP freight and Metrolink passenger operations onto separate lines. In particular, Shifting UP trains operating between Cajon Pass and Pomona off the BNSF Line and the UP Los Angeles Subdivision and onto the UP Palmdale and UP Alhambra Subdivisions reduces conflicts between Metrolink commuter trains and UP freight operations.

All four alternatives to the Status Quo are identical east of Pomona: They concentrate UP through train movements via the Alhambra Subdivision and the Palmdale Line, leaving only the Mira Loma auto trains and a carload local freight to exercise trackage rights over the BNSF between Colton and West Riverside and utilize the Los Angeles Subdivision between West Riverside and Pomona. Compared to the Status Quo, the alternatives reduce the total through train counts in 2035 through downtown Riverside and downtown San Bernardino by 41 and 10, respectively. These four alternatives concentrate about 92% of UP through train movements via West Colton versus only 8% via the UP Los Angeles Subdivision through Riverside.

The four alternatives to the Status Quo differ only in the routing of UP through train movements west of Pomona. One alternative is the same as the Status Quo west of Pomona, one increases the concentration of Metrolink and Union Pacific operations on the same line, and two others significantly reduce the co-mingling of passenger and freight operations west of Pomona. The alternatives to Status Quo are summarized as follows:

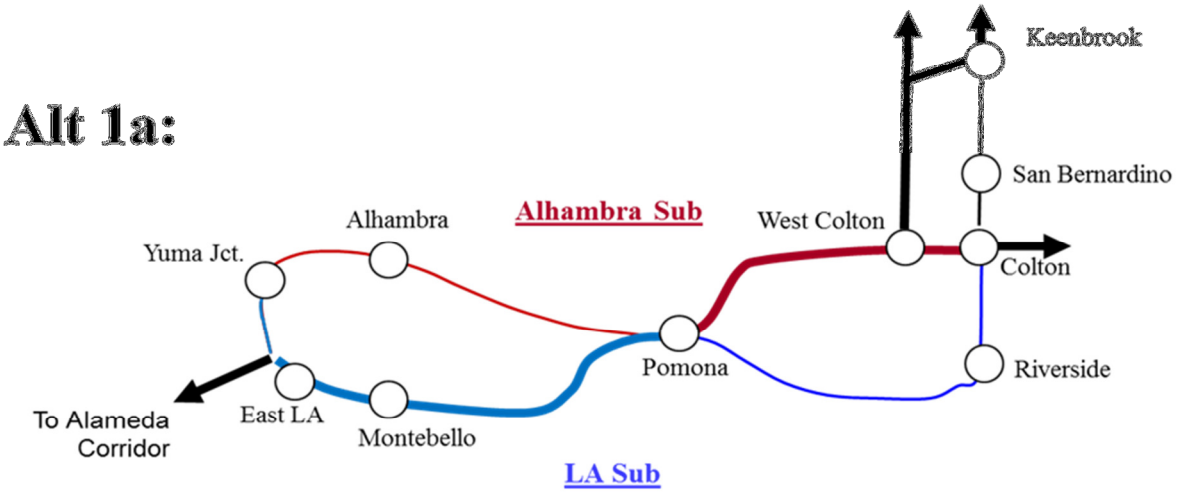
- *Modified Status Quo*: Operations pertaining to the direction of train flows west of Pomona are the same as in the Status Quo, i.e., most UP trains follow a one-way loop westbound on the Alhambra Subdivision and eastbound on the Los Angeles Subdivision. East of Pomona, only the Mira Loma auto trains and a carload local freight normally operate via the Los Angeles Subdivision. Freight trains to/from Daggett operate via the Palmdale Line. (Figure 4).

Figure 4. Modified Status Quo Routing Alternative



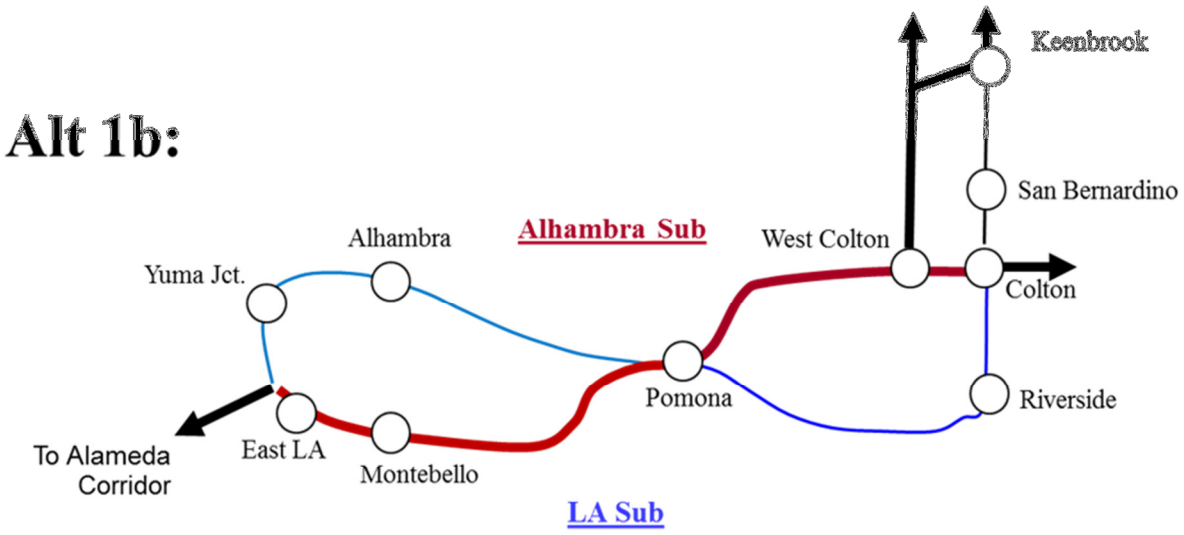
- *Alternative 1a:* Same as Modified Status Quo west of Pomona and north of Colton. West of Pomona, about 84% of UP through train movements between Pomona and downtown Los Angeles points are routed via the UP Los Angeles Subdivision (Figure 5). Only UP intermodal trains utilizing the City of Industry intermodal terminal, UP carload trains to/from the Metrolink Glendale Line, and UP carload freight trains making pick-ups or setouts between Pomona and Yuma Jct. on the Alhambra Subdivision are normally routed via the UP Alhambra Subdivision west of Pomona. A fly-over is implemented at Pomona to mitigate conflicts between Metrolink and UP freight trains. This alternative largely separates Metrolink and UP through freight operations east of Pomona, but concentrates them together on the Los Angeles Subdivision west of Pomona.

Figure 5. Routing Alternative 1a



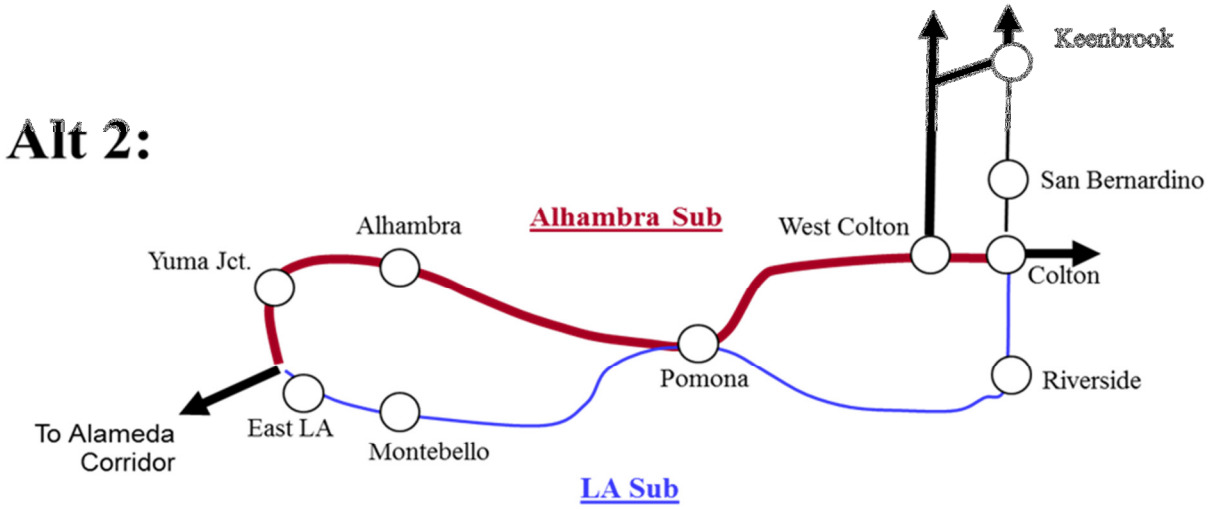
- *Alternative 1b:* Similar to Alternative 1a, but with the additional feature that Metrolink Riverside – Pomona – Los Angeles trains are re-routed via the UP Alhambra Subdivision west of Pomona (blue line, Figure 6). The station stop at City of Industry would be re-sited on the Alhambra Subdivision, and the station stop at Montebello would be closed (with passengers re-directed to the Commerce station on the BSNF Line). A new station stop at Alhambra could be introduced, or Metrolink could switch to/from its existing tracks at El Monte to serve California State University Los Angeles. In this alternative, the carload trains to/from the Metrolink Glendale Line are re-routed via the Los Angeles Subdivision and the East Bank Line, raising the percentage of UP through train movements between Pomona and downtown Los Angeles routes via the Los Angeles Subdivision to 89%. A fly-over is implemented at Pomona to mitigate conflicts between Metrolink and UP freight trains. Under this alternative, Metrolink operations and heavy UP through train movements are largely separated.

Figure 6. Routing Alternative 1b



- *Alternative 2:* Same as Modified Status Quo east of Pomona and north of Colton. West of Pomona, 100% of UP through train movements between Pomona and downtown Los Angeles points are routed via the UP Alhambra Subdivision (Figure 7). Metrolink operations continue via the UP Los Angeles Subdivision. Under this alternative, Metrolink operations and heavy UP through train movements are disjoint westward from Pomona as far as the Los Angeles River, but then they are concentrated together along the Metrolink East Bank Line (see Figure 1).

Figure 7. Routing Alternative 2



All four alternatives to the Status Quo have common trackage configurations on the BNSF Line, as well as east of Pomona on all UP Lines.

Findings: Track Capacity Improvement Needs

The 2035 required trackage configurations are summarized for the alternatives 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 Mojave Subdivision between Devore Road (south of Keenbrook) and Silverwood as if it were another BNSF main track. A new connection at Devore Road is required to enable this flexibility. This avoids the need to construct a costly new main track through the mountains between Devore Road and Silverwood. With or without this arrangement, a second main track on the UP Mojave Subdivision is required between West Colton and Devore Road, and a fourth main track on the BNSF is required from Silverwood to the south edge of the Mojave Narrows.
- By routing most UP Yuma Subdivision trains and all UP Daggett 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 in Alternatives 1a and 1b, and a Metrolink fly-over at Pasadena Jct. is required in Alternative 2.

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

	Existing	**Status Quo**	**Alternatives**
Line Segment	**in 2010**	**2035**	**2035**
BNSF Line			
Hobart – Serapis	3	**4**	**4**
Serapis – Valley View	2	**4**	**4**
Valley View – Fullerton Jct.	3	**4**	**4**
Fullerton Jct. – Atwood	2	**3**	**3**
Atwood – Esperanza	2	**3**	**3**
Esperanza – Prado Dam	3	3	3
Prado Dam – West Riverside	2	**3**	**3**
West Riverside jct. with UP	At grade	**Flying jct.**	At grade
West Riverside – Highgrove	3	**4**	3
Highgrove – Colton Crossing	2	**4**	**3**
Colton Crossing	At grade	**Separated, with flying jct. to UP**	**Separated**

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

In 2035, the existing two-main-track centralized traffic control (CTC) configuration of the UP Yuma Subdivision is adequate to maintain Year 2000 average dispatching delays, i.e., no further improvements are required on this segment (Table 2). On the Mojave Subdivision, a second main track is required from West Colton to the BNSF connection at Keenbrook (near Devore Road). In 2035, the BNSF Cajon Subdivision will require a minimum of three main tracks over the entire extent between Colton Crossing and Barstow (Table 2). To match Year 2000 dispatching delays, four main tracks are required on the steep mountain grades BNSF Cajon Subdivision between the UP Connection at Devore Road (Keenbrook) and the south end of the Mojave Narrows just south of Victorville (Table 2). Under the alternatives to the Status Quo, integration of the UP Mojave Subdivision with the BNSF Cajon Subdivision main tracks would avoid the costly construction of a new track climbing the south slope of Cajon Pass. This integration requires a new crossover near Devore Road to enable uphill trains on the BNSF Cajon Subdivision to access the Mojave Subdivision main track.

Under all alternatives, a full flying junction of the UP Mojave and Alhambra Subdivisions and approaches to West Colton Yard also is required, enabling trains operating via the Mojave Subdivision to enter and exit the Yard or join/diverge from the Alhambra Subdivision without fouling opposing movements on the Alhambra Subdivision main tracks (Table 3).

Between Colton Crossing and Pomona, the alternatives to the Status Quo concentrate UP trains on the UP Alhambra Subdivision. This requires a second main track between West Colton and Pomona (Table 3). On the other hand, the Status Quo requires a second main track both West Colton – Pomona on the Alhambra Subdivision and West Riverside – Pomona on the UP Los Angeles Subdivision (Table 3). In addition, in 2035, 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, as summarized in Tables 4 and 5. The Status Quo requires two main tracks on the UP Los Angeles Subdivision west of Pomona in 2010 and two main tracks on the Alhambra Subdivision west of Pomona in 2035 (Table 4). Alternative 1a, concentrating UP through freight operations on the UP Los Angeles Subdivision west of Pomona where they share right of way with Metrolink operations, requires three main tracks on that line by 2035 (Table 5). Alternative 1b, shifting Metrolink over to the Alhambra Subdivision west of Pomona, is able to meet transit time goals with two main tracks west of Pomona on the Los Angeles Subdivision in 2010 and no improvements to the Alhambra Subdivision 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 Subdivision west of Pomona and leaving Metrolink on the UP Los Angeles Subdivision, requires full double-tracking of the Alhambra Subdivision, double-tracking of the Los Angeles Subdivision 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 2. Summary of Required Track Capacity on Lines North and East of West Colton
(Figures express required numbers of main tracks. Percentages express track gradients.)

	Existing	**Status Quo**	**Alternatives**
Line Segment	**in 2010**	**2035**	**2035**
UP Yuma Subdivision			
Indio – Colton Crossing	2	2	2
Colton Crossing	At-grade	**Separated**	**Separated**
UP Mojave Subdivision			
West Colton – Devore Rd. (Keenbrook)	1	**2**	**2**
Devore Rd. (Keenbrook) – Silverwood	1	1	**1 integrated with BNSF**
BNSF Cajon Subdivision			
Colton Crossing – Rana	2	**3**	**3**
Rana – San Bernardino	4	4	4
San Bernardino – Verdemont	3	3	3
Verdemont – Devore Road	3	3	3
Devore Rd. (Keenbrook) connection	One-way conn.	One-way conn.	**Univ. conns.**
Devore Road – Cajon	3	**4**	3
Cajon – Silverwood	Two 2.2%, one 3%	**Two 2.2%, two 3%**	Two 2.2%, one 3%
Silverwood connection	One conn.	One conn.	One conn.
Silverwood - Martinez	Three 2.2%	**Four 2.2%**	**Four 2.2%**
Martinez – Mojave Narrows	2	**4**	**4**
Mojave Narrows – Barstow	2	**3**	**3**

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.)

	Existing	Status Quo	Alternatives
Line Segment	**in 2010**	**2035**	**2035**
UP Los Angeles Subdivision			
West Riverside – Streeter	1	**2**	1
Streeter - Arlington	2	2	2
Arlington - Limonite	1	**2**	1
Limonite – Bon View	2	2	2
Bon View - Pomona	1	**2**	1
UP Alhambra Subdivision			
Colton Crossing – Rancho (West Colton)	2	2	2
Jct. with Mojave Subdivision at Rancho (West Colton)	Partial flying	**Full flying**	**Full flying**
Rancho – Riverside Avenue	1	**2**	**2**
Riverside Avenue – South Fontana	2	2	2
South Fontana – Pomona	1	**2**	**2**
Pomona route connections	At-grade cross-overs	At-grade cross-overs	**Metro-link fly-over (except Alt. 2)**

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.

Table 4. Summary of Required Track Capacity on UP Lines West of Pomona for Status Quo and Modified Status Quo Alternatives

(Figures express required numbers of main tracks.)

Line Segment	Existing in 2010	2035
UP Los Angeles Subdivision		
Pomona – Redondo	2	2
UP Alhambra Subdivision		
Pomona – City of Industry	1	**2**
City of Industry - Alhambra	1	1
Alhambra – Yuma Jct.	2	2
Yuma Jct. – Pasadena Jct.	1	1
Metrolink crossing at Pasadena Jct.	At grade	At grade
Pasadena Jct. – Ninth St.	2	2
Ninth St. – Redondo connection	1	1

Table 5. Summary of Required Track Capacity on UP Lines West of Pomona for Alternatives 1a, 1b and 2

(Figures express required numbers of main tracks.)

	Existing in 2010	2035		
		Alt 1a	**Alt 1b**	**Alt 2**
Los Angeles Subdivision				
Pomona – Roselawn	1	**3**	2	**2**
Roselawn – Bartolo	2	**3**	2	2
Bartolo – Pico Rivera	1	**3**	2	**2**
Pico Rivera – Redondo	2	**3**	2	2
Alhambra Subdivision				
Pomona – City of Industry	1	**2**	**2**	**2**
City of Industry - Alhambra	1	1	1	**2**
Alhambra – Yuma Jct.	2	2	2	2
Yuma Jct. – Pasadena Jct.	1	1	1	**2**
Metrolink crossing at Pasadena Jct.	At grade	At grade	At grade	**Fly-over**
Pasadena Jct. – Ninth St. Jct.	2	2	2	**3**
Ninth St. Jct. – Redondo conn.	1	1	1	**2**

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

Estimated Capital Costs for Alternatives

A summary of estimated costs is provided below. These Year 2010 cost estimates were derived by applying an inflation factor to Year 2001 unit costs for new railroad construction.[2] The inflation factor that was applied was based on the US Army Corps of Engineers Indices for years 2001 through 2010 applicable to road, rail and bridge construction projects.[3] That 2010/2001 factor is 1.40983. This figure is equivalent to a 3.89% compound annual growth rate.

Total capital costs required to raise track capacity from current (Year 2010) configuration to configurations that accommodate Year 2035 traffic levels at the Year 2000 level of dispatching delays range from $1.95 billion to $2.62 billion among the alternatives. About $1.22 billion to $1.67 billion of these costs are expended west and south of Colton Crossing (including the crossing), while $0.73 billion to $0.97 billion are to be expended north of West Colton[4] and Colton Crossing, depending on the alternative.

While the Status Quo is the most costly alternative, the Modified Status Quo is least costly, about $672 million less than the Status Quo. About $245 million of this results from cooperation on Cajon Pass to integrate the UP Mojave Subdivision with the BNSF main lines between Devore

[2] Southern California Association of Governments, *Inland Empire Mainline Trade Corridor Cost Benefit Study, Order of Magnitude Cost for Railroad Infrastructure*, Draft Report Fall 2001.

[3] U.S. Army Corps of Engineers Cost Index, http://140.194.76.129/publications/eng-manuals/em1110-2-1304/entire.pdf .

[4] Costs for the full flying junction at Rancho (West Colton) are included in the expenditures for improvements to be made north of West Colton.

Road and Silverwood; the other $427 million results from shifting all UP through trains except the Mira Loma auto trains off the Los Angeles Subdivision between Pomona and West Riverside and off the BNSF between West Riverside and Colton.

Alternative 1b is the second cheapest, about $85 million more than the Modified Status Quo. It should be noted that Alternative 1b provides near total separation of heavy UP freight flows and Metrolink operations. The Modified Status Quo alternative separates Metrolink and heavy Union Pacific freight flows east of Pomona, but it still involves Metrolink sharing tracks with heavy Union Pacific freight flows west of Pomona.

Freight and Passenger Train Combined Operation

Joint accommodation of increased Metrolink service levels and increased freight traffic flows accounts for much of the capital expenses arising west and south of Colton Crossing. The author believes that considerable capital expense could be avoided if Metrolink service frequencies were not to increase, One way Metrolink could expand ridership without engendering these capital requirements would be to run longer trains, e.g., 10- or 12-car trains powered by a locomotive at either end in lieu of the current 5- or 6-car trains powered by a single locomotive. This would require longer station platforms than existing at some or most stations.

No alternatives have been explored in this study for separating heavy BNSF freight flows from the frequent Metrolink and Amtrak passenger train operations over BNSF tracks. While adequate track capacity can be planned for joint operations (and has been done so in this study), the potential risks associated with reliability and safety at 2035 traffic levels is substantial and should be taken into consideration. Moreover, by itself, the BNSF line would have little or no capability to accommodate continued growth beyond 2035. For planning horizons longer than 2035, or to achieve substantial reductions in risks on the BNSF line, the author recommends consideration be given to developing an exclusive freight corridor between East Los Angeles and Colton shared by BNSF and UP via the UP Los Angeles Subdivision west of Pomona and the UP Alhambra Subdivision east of Pomona

Rail Intermodal Terminal Capacity

While the focus of this report is rail main-line capacity, rail intermodal terminal capacity in year 2035 warrants attention. Moreover, assumptions about terminal growth underlie assumptions about intermodal train counts by line segment. Considering the evolution in intermodal technology and supply chain management practices, terminal capacity to handle domestic containers will be in short supply. On the other hand, given proposed port on-dock rail development plans, there will be a surplus of terminal capacity to handle marine boxes. Accordingly, the following changes should be considered::

- The proposed expansion of the Intermodal Container Transfer Facility (ICTF) and the proposed BNSF Southern California Intermodal Gateway (SCIG) are critical to meet 2035 intermodal traffic projections. However, in anticipation of continued growth in transloaded domestic cargo volume, these facilities will have to become predominantly domestic container terminals instead of marine container terminals before 2035.

- In 2035, on-dock and future near-dock rail terminals will need to perform on the order of 1.2 million domestic-backhaul marine-box lifts per year or alternatively 1.2 million domestic container lifts per year (or some combination thereof) in order to fully utilize their projected capacity.

- For Union Pacific to achieve a 50% market share of the non-premium domestic container traffic and a 25% share of the premium domestic intermodal market in 2035, it will have to accomplish major expansions and/or major productivity gains at its East Los Angeles, Los Angeles Transportation Center, City of Industry and ICTF intermodal terminals. UP has land to expand its City of Industry terminal, and an expansion of the ICTF has been proposed, but even assuming the ICTF expansion is completed and assuming a 160% increase in throughput at City of Industry, that would still leave a requirement for on the order of 60% increases in lifts per day to be achieved at East Los Angeles and LATC, and a 9.5% increase above the projected build-out capacity of 1.02 million lifts per year at an expanded ICTF.

- Assuming BNSF has a 75% share of the premium domestic intermodal market and a 50% share of the non-premium intermodal market in 2035, proposed port on-dock and near-dock terminals and SCIG are approved and built as planned, and SCIG transitions to become predominantly a domestic container terminal, BNSF will be in relatively better shape with respect to required terminal capacity. Only 7-9% productivity gains at Hobart and San Bernardino, plus a 9.5% increase above an assumed SCIG capacity of 0.97 million lifts per year, are required. However, if SCIG is not approved, then BNSF also will face a serious challenge finding adequate intermodal terminal capacity.

Conclusion and Discussion Points

- The Modified Status Quo alternative, featuring much-increased concentration of UP freight operations on its Alhambra Subdivision east of Pomona, is a more likely prospect for the 2035 routing of UP freight trains than the status quo routing, in which UP trains are more distributed among the Alhambra and Los Angeles Subdivisions east of Pomona.

    - It is estimated that such a change to the routing of UP trains would reduce the track capacity investments required to accommodate 2035 traffic levels by more than $425 million.

    - If any of the alternatives to the Status Quo are pursued, public investment to expand track capacity or to mitigate vehicular delays at grade crossings on the Los Angeles Subdivision east of Pomona would need to be reconsidered due to fewer number of trains traveling through the segment. Conversely, this routing alternative would increase the need to mitigate vehicular delays arising on the Alhambra Subdivision east of Pomona.

    - Further, with any of the alternatives to Status Quo, the need to expand track capacity to accommodate increased UP freight train movements over the BNSF San Bernardino Subdivision between Colton Crossing and West Riverside is

significantly reduced. In particular, a flying junction connection at Colton Crossing between the UP Yuma Subdivision (towards Indio) and the BNSF San Bernardino Subdivision (towards Riverside), a flying junction connection at West Riverside, and a fourth main track between West Riverside and Colton Crossing are expensive and may not be necessary with the likely routing of UP freight trains in 2035.

  - However, there will be heavy rail traffic on this BNSF line, and a third main track will be required throughout—highlighting the importance of investment in mitigating vehicular delays arising on the BNSF San Bernardino Subdivision between Riverside and San Bernardino.

- UP freight trains on its Salt Lake City route must utilize trackage rights over BNSF from Cajon Pass north to Daggett, a junction just beyond Barstow. At present, UP freight trains on this route are distributed between operation over UP's Mojave Subdivision north out of West Colton to connections with the BNSF at Keenbrook or Silverwood on the south side of Cajon Pass and operation over the BNSF line beginning at West Riverside or Colton. BNSF possesses no rights to use the UP's Mojave Subdivision. If such rights were granted to BNSF between Devore Road and Silverwood, and if UP's Mojave Subdivision were equipped with a second main track from West Colton to universal crossovers at Devore Road, the costs of track capacity improvements accommodating 2035 traffic levels would be reduced by an estimated 245 million dollars. Moreover, UP's average train transit times would be reduced by 10 minutes and BNSF's average train transit times would be reduced by 5 minutes compared to the times achievable when the status quo routing of trains is accommodated by the construction of a fourth BNSF main track from Devore Road to Summit.

- Considering track capacity projects already funded, the track capacity required to accommodate Year 2035 traffic levels with Year 2000 levels of dispatching delays under the Modified Status Quo routing alternative requires total expenditures at a rate of about $68.3 million per year (2010 dollars) from 2011 through 2035. This does not include the costs of environmental mitigation or mitigation of vehicular traffic delays.

  Alternative 1b, featuring increased concentration of UP freight trains on the Los Angeles Subdivision west of Pomona and re-routing of Metrolink's Los Angeles – Pomona – Riverside trains via the Alhambra Subdivision west of Pomona, is estimated to cost $85 million more than the Modified Status Quo alternative, in terms of required track capacity improvements. However, this alternative eliminates the need for grade separation projects between City of Industry and downtown Los Angeles along the Alhambra Subdivision, it achieves separation of freight train traffic and passenger train traffic, and it could potentially introduce new direct Metrolink services for origin – destination pairs such as Riverside – CSULA or Riverside – Alhambra. For planning horizons further out than 2035, track capacity on the BNSF line is a concern. Even with a four-track railroad Los Angeles – Fullerton, three tracks Fullerton – Keenbrook, four tracks Keenbrook – Mojave Narrows, and three tracks Mojave Narrows – Barstow, achievement of dispatching delays comparable to Year 2000 delays is barely possible. Moreover, Year 2035 operations

involve co-mingling high levels of freight and passenger operations, presenting significant risks. Should a planning horizon further out than 2035 be considered, or if it is desired to sharply reduce risks, consideration should be given to a bolder routing scheme, wherein BNSF and UP freight trains are concentrated to a significant extent on an exclusive freight corridor utilizing the UP Los Angeles Subdivision west of Pomona and the UP Alhambra Subdivision from Pomona to Colton Crossing

- While this report has focused on main line capacity needs, 2035 intermodal terminal capacity merits attention as well. An expanded ICTF, SCIG and an expanded City of Industry terminal will be needed. Additionally, significant improvements in lift productivity will be required.