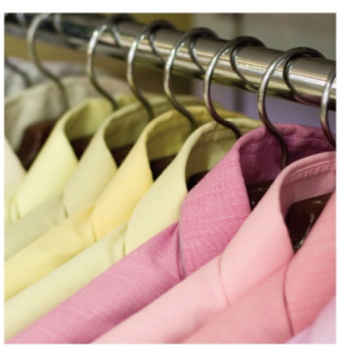
SOUTHERN CALIFORNIA
ASSOCIATION of GOVERNMENTS

Comprehensive Regional Goods Movement Plan and Implementation Strategy

Regional Rail Simulation Findings Technical Appendix

November 2011



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.

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1. 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, UP exercises trackage rights over lines owned by BNSF. There are also certain segments owned and controlled by Metrolink over which UP and BNSF exercise trackage rights. Both railroads operate over the Alameda Corridor to access the Ports of Los Angeles and Long Beach.

Through freight trains on both railroads may be classified as intermodal (trailers and containers on rail spine cars or well 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 double-stacked domestic container traffic), double-stacked domestic container trains, and double-stacked marine container trains.

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. Lines owned and operated by Metrolink that do not host through freight train movements also are not shown. An overview of through freight train operations and terminals in this network for each freight railroad is provided as follows.

Figure 1: Main Rail Lines West of Colton

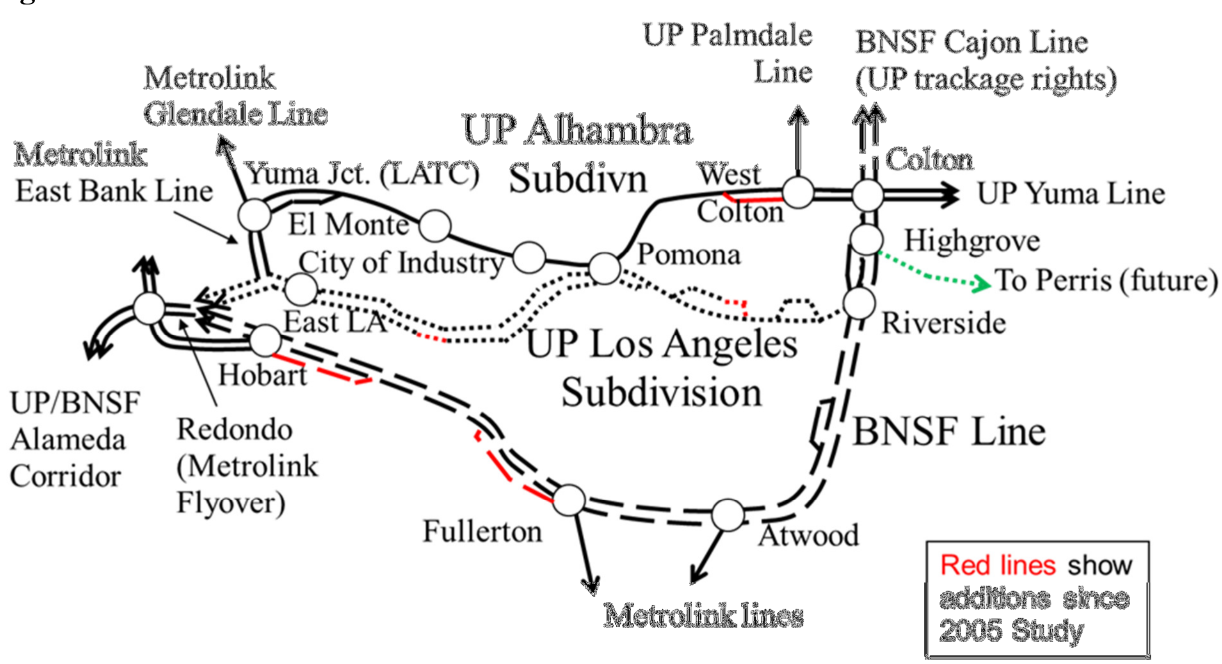
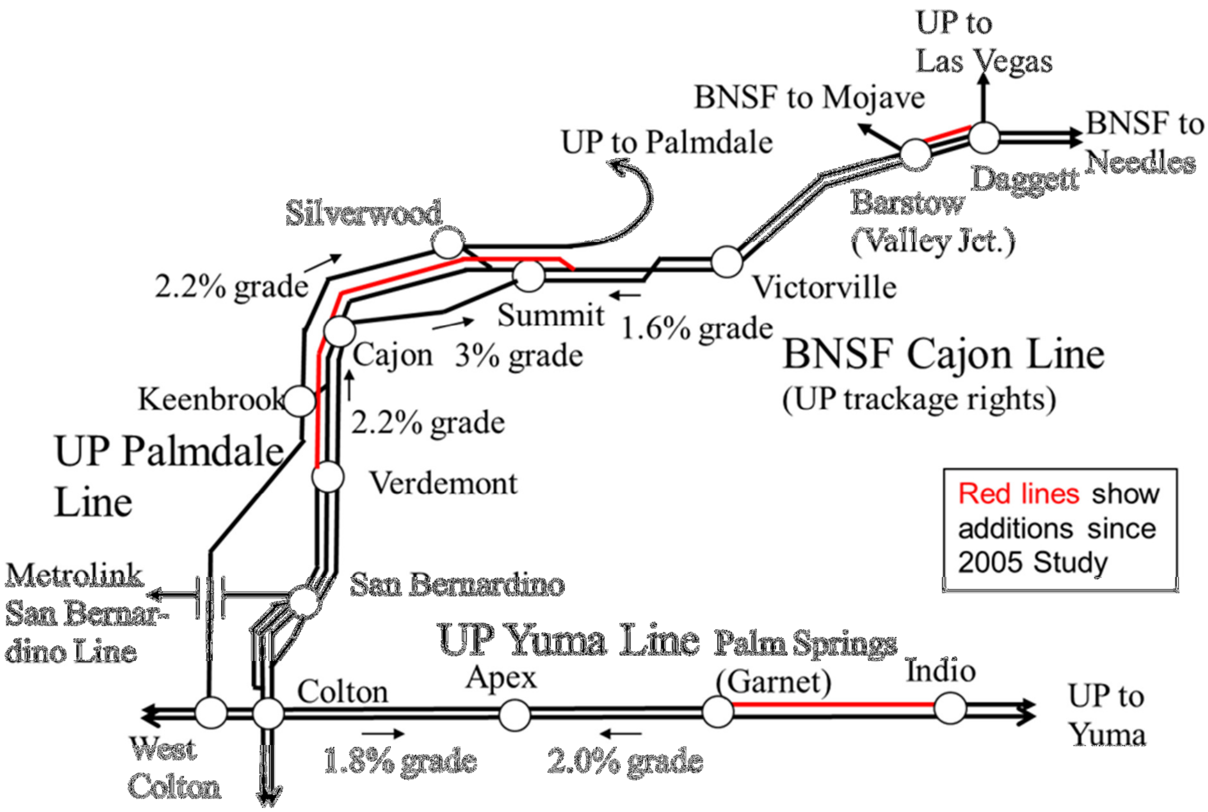


Figure 2: Main Rail Lines North and East of Colton



BNSF Overview

BNSF operates a single 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, where entry is made into the Alameda Corridor. This line comprises two crew districts, known as the BNSF Cajon Subdivision between Barstow and San Bernardino and the BNSF San Bernardino Subdivision between San Bernardino and Redondo. All BNSF through freight trains change crews at San Bernardino and Barstow.[1]

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 at Barstow. 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.

[1] One BNSF carload train per day in each direction originates/terminates at UP's West Colton classification yard. It does not change crews between Barstow and West Colton.

From Daggett (located just east of Barstow) westward to West Riverside, UP freight trains operating via Salt Lake City and Las Vegas operate over the BNSF Line under a long-standing trackage rights agreement. Some UP trains cross over to/from the UP Mojave Subdivision using connections installed at Silverwood or Keenbrook. Other UP trains 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 tracks ordinarily used by uphill trains. On a third 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 "distributed power" locomotive units (DPUs for short) on the back of the train or mid-train, as do some northbound carload trains. Southbound, loaded unit bulk trains, heavy carload trains and some marine container stack trains typically require DPUs. 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 has a terminal for unit auto trains in San Bernardino, although there is no traffic using the terminal at the time of this writing. 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 the west end of Hobart, passenger trains diverge onto passenger-only tracks that fly over the entrance to the Alameda Corridor at Redondo.

At Colton, BNSF and UP main lines cross at grade.[2] A connecting track in the southeast quadrant of the crossing allows UP trains to/from the UP Yuma Subdivision 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 BNSF Cajon Subdivision to connect to the UP Alhambra Subdivision 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 (Inland Empire-Orange County Line) points diverges from the BNSF line. This line is used by BNSF through freight trains to/from San Diego.

[2] At the time of this writing, a grade separation project is underway.

At Fullerton, another Metrolink-owned line to Orange County (Orange County Line) 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. An auto unloading terminal also is located in La Mirada. 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 and most domestic container 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 marine container 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. 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 points on the Central California Coast via trackage rights over Metrolink through Glendale, to Northern California and the Pacific Northwest points via the Mojave Subdivision, and to eastern points via the Yuma Subdivision or the BNSF Cajon Line. Long-distance carload freight trains to/from the BNSF Cajon Subdivision typically utilize the Mojave Subdivision as far as Keenbrook or Silverwood, then crossing over onto the BNSF Cajon Subdivision to exercise 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. As with BNSF, most UP carload and non-expedited intermodal trains crossing Cajon Pass utilize DPU.

Extending eastward from Colton Crossing is UP's Yuma Subdivision main line to Indio, 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 (just east of 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 DPU. Most westbound carload trains and many westbound intermodal trains also operate with DPU.

Extending north from West Colton is UP's Mojave Subdivision 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 (just past Silverwood). As remarked earlier, connections to the BNSF Cajon Subdivision exist at Keenbrook and Silverwood. Some carload trains on this line utilize DPU. In contrast to the heavy traffic volumes on the BNSF Line over Cajon Pass, traffic volumes on the UP Mojave Subdivision are light beyond Silverwood. UP intermodal trains between Los Angeles and the Pacific Northwest exit the Los Angeles Basin via trackage rights over Metrolink through Glendale, and unit oil and white bulk trains heading to the Southern California ports from Central California also normally use Metrolink's line through Glendale. This leaves only UP carload traffic to/from Northern California and the Pacific Northwest as the principal traffic on the Mojave Subdivision beyond Silverwood, forecast to remain at the current 6 trains per peak day in 2035. (This count excludes UP trains to/from Daggett that may be routed via this line as far north as Keenbrook or Silverwood.)

From Colton Crossing to the downtown Los Angeles area, UP has two main line routes. The Los Angeles Subdivision 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 Los Angeles Subdivision from West Riverside to a connection with Metrolink's East Bank Line at Soto Street Jct. near East Los Angeles and to a connection with the Alameda Corridor at Redondo. The Alhambra Subdivision extends westward from West Colton to Yuma Jct. (adjacent to the Los Angeles Transportation Center intermodal terminal) where connections with Metrolink's East Bank Line are made. The junction of the connecting track with the East Bank Line going southward is known as Pasadena Jct. The Metrolink San Bernardino Line is crossed at grade at this point. UP has trackage rights over the East Bank Line so that trains can operate off the Alhambra Subdivision southward to the Alameda Corridor at Redondo or to the East Los Angeles intermodal terminal, or northward through Glendale towards Northern California points via either the Coast or Valley Routes. The Los Angeles and Alhambra Subdivisions come alongside each other at Pomona, where connections allow trains to cross over from one route to the other.

Along the Alhambra Subdivision, small carload terminals are maintained at Kaiser (about 8 miles west of West Colton) and Aurant (about four miles west of Yuma Jct.). Another carload terminal at City of Industry is currently inactive. Some unit grain trains terminate at Kaiser. UP also operates a major intermodal terminal accessed from the Alhambra Subdivision at City of Industry. This terminal primarily receives and originates domestic container trains. A second major intermodal terminal on this line is LATC, located at the western end of the line (adjacent to Yuma Jct.). LATC originates and terminates primarily domestic container trains plus a few expedited intermodal trains. Trains to and from the vicinity of the Ports of Los Angeles and Long Beach can utilize the Metrolink East Bank Line to secure a route connection between the Alhambra Subdivision and the Alameda Corridor.

Coming from Glendale on the Metrolink tracks, there are unit oil trains that traverse the East Bank Line en route to the Alameda Corridor. Empty unit oil trains make a reverse movement.

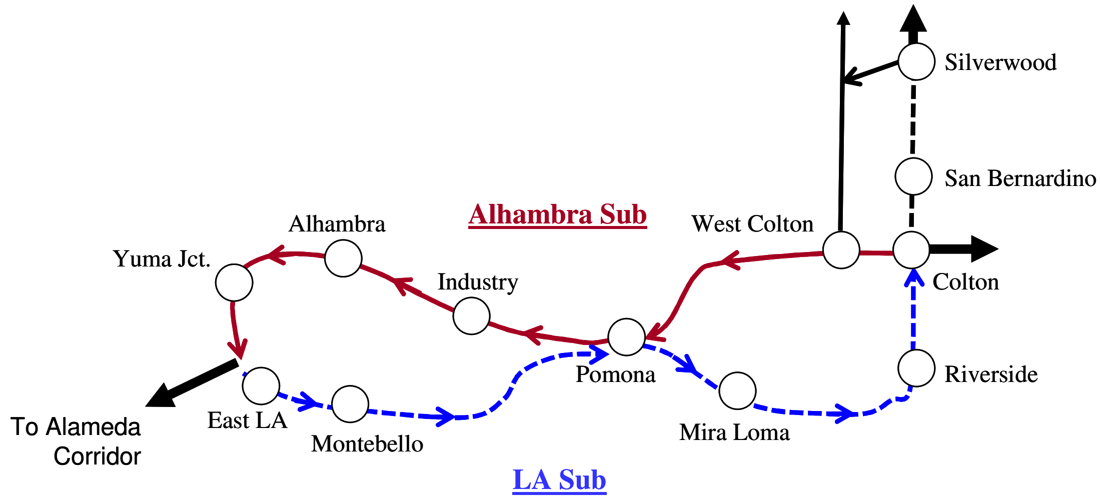
Along the Los Angeles Subdivision, the UP operates a terminal for unit auto trains at Mira Loma (about 13 miles east of Pomona). A small terminal for interchanging carload freight traffic to/from local operations is located at Montclair (about 3 miles east of Pomona). At East Los Angeles, UP operates a large intermodal terminal. Expedited UP intermodal trains and UP domestic container trains operate to and from this terminal. Carload trains also leave or enter the Los Angeles Subdivision main tracks at East Los Angeles.

At Soto St. Jct. (located just west of East Los Angeles), Metrolink trains from Riverside diverge onto 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 Los Angeles Subdivision terminates at Redondo, the start of the Alameda Corridor. Double-stacked marine container, carload, unit auto, unit oil and occasional unit bulk trains (coal or potash) enter/exit the Corridor at this point.

As will be discussed below, most of the UP Alhambra Subdivision and portions of the UP Los Angeles Subdivision are single-track. To minimize dispatching delays, UP utilizes these two lines as a sort of paired double track for many of its train movements (see Figure 3), 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. Westbound trains from Daggett typically exit the BNSF Cajon Subdivision at either Silverwood or Keenbrook, then follow the UP Mojave Subdivision to West Colton.[3] 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.

[3] An exception is a daily Barstow – West Colton carload train, and its returning counterpart. These trains conduct interchange between BNSF and UP and are staffed by BNSF crews. At present, these trains operate via Colton. Until about five years ago, they operated via the UP Mojave Subdivision Silverwood – West Colton, but the practice was discontinued when the BNSF found it lacked a stable supply of crews qualified to operate on the UP Mojave Subdivision.

Figure 3: UP Status Quo Routing



Track Configuration

In this section, current track configuration of the main line network is summarized.

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 BNSF 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 2-3 miles west of Fullerton and every 5-8 miles east and north of Fullerton for flexible routing of trains.

Starting a review of this trackage 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 Serapis (about 6 miles east of Hobart). Three main tracks resume at Valley View (6 miles west of Fullerton) and extend 6.8 miles to Fullerton Jct., where most Amtrak and Metrolink trains diverge. A third main track between Serapis and Valley View is currently under construction, but the completion of the full project is delayed pending award of grade separation funds.

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 Los Angeles Subdivision trains enter the BNSF Line on trackage rights), a third main track resumes and extends 4.5 miles to Highgrove. A branch line to Perris diverges here; Metrolink has plans to develop commuter service to Perris. From Highgrove to a point known as CP 29 located 0.3 miles north of Colton Crossing (3.2 miles), there are two main tracks. Single-track connections to Union Pacific tracks at West Riverside and Colton Crossing are at-grade junctions.

From CP 29 to Rana, there are three main tracks (0.7 miles), and from Rana to San Bernardino, there are four main tracks (2.2 miles). 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 Martinez (just beyond Cajon Summit, 25.5 miles), there are three main tracks, collapsing to two main tracks at Martinez. A connecting track between the UP Mojave Subdivision and the BNSF Cajon Subdivision is installed at Keenbrook, located about a half mile north of the Devore Road crossing of the BNSF Cajon Subdivision and the UP Mojave Subdivision. Another UP connecting track enters the BNSF Cajon Subdivision at Silverwood, one half mile before Cajon Summit is reached.

At Cajon station, 18.6 miles from San Bernardino, one of the three main tracks diverges to take a shorter, steeper route to Summit than the other two. Operation is normally left-handed in order to take advantage of more favorable grades. Mains 1 and 2, the usual northbound tracks, have a 2.2% gradient to Summit, while Main 3 has a 3% gradient Cajon – Summit. The route followed by Main 1 and Main 2 is almost 2 miles longer than the route followed by Main 3. The Silverwood connecting track with the UP Mojave Subdivision connects only to Mains 1 and 2.

In deference to the steep and dangerous grade on Main 3, BNSF has instituted a policy of spacing southbound trains leaving Summit on Main 3 by at least 30 minutes. This spacing requirement does not apply to westbound trains routed via Mains 1 or 2 on the BNSF Cajon Subdivision nor to UP trains using the Silverwood connecting track.

From Summit north about 1.5 miles to Martinez, there also is a third main track.

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 Los Angeles Subdivision 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 Los Angeles Subdivision has two main tracks over the entire stretch from Redondo to Roselawn (near Pomona), a distance of 28.9 miles. At that point it narrows to single track for 0.3 miles to Oak, where two-main-track operation resumes for the next 2.2 miles to WO Tower.

A complicated at-grade junction with the UP Alhambra Subdivision is located in the vicinity of Pomona. As noted above, 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 Subdivision whereby eastbound trains on the Los Angeles Subdivision can cross over to continue eastward on the Alhambra Subdivision. Westbound movements on the UP Alhambra Subdivision also can use this connection to cross over and continue westward on the UP Los Angeles Subdivision.

There are universal crossovers between the north main track of the UP Los Angeles Subdivision and the UP Alhambra Subdivision 0.4 miles east of Oak (named Hamilton station on the UP Alhambra Subdivision), 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 WO Tower.

The Los Angeles Subdivision continues as a single track line for 5.4 miles from WO Tower 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 Subdivision 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 Subdivision has two main tracks extending from connections with Metrolink's 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. CTC 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, the first starting 1.7 miles east of Bassett), 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 Los Angeles Subdivision), North Montclair (3 miles from Hamilton - Reservoir), North Ontario (3 miles from North Montclair), Guasti (4 miles from North Ontario), and South Fontana (4.6 miles from Guasti).[4] At Sierra (1.9 miles from South Fontana, at the approach to West Colton Yard) to Colton Crossing, the line has two main tracks. UP has indicated that their long-range plan is to add a second main track to the Alhambra Subdivision westward from Sierra to Pomona.

The UP Mojave Subdivision is single-track CTC with controlled passing sidings over the 28 miles from West Colton to the Silverwood connection to the BNSF Cajon Subdivision. Passing tracks are located at Slover (1.7 miles from West Colton), Dike (10 miles from Slover), and Canyon (11 miles from Dike). 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 4.6 miles north of the north switch of Canyon siding.

[4] A local carload and unit grain traffic support yard is located at Kaiser, 2.8 miles east of Guasti siding, but switches are not remotely controlled and Kaiser Yard is not normally used to allow a through train movement to pass an opposing one.

The UP Yuma Subdivision has two main tracks from Colton Crossing eastward 72.2 miles to Indio. From Loma Linda (2.6 miles east of Colton Crossing) to Beaumont (23.1 miles east of Colton Crossing), the line climbs a 1.8% grade, cresting the summit at Apex (1.7 miles east of Beaumont), then descending 23.5 miles of 2.0% grade on the east side to Garnet. The Palm Springs passenger station is located at Garnet. The remaining 23.4 miles from Garnet to Indio is single track, with grades opposing westward trains ranging up to 1.1%. For heavy carload trains and for non-expedited intermodal trains, DPU operation is typical.

Metrolink Trackage

The Metrolink East Bank Line is used by UP trains operating via the Alameda Corridor and the Alhambra Subdivision. It also is used by unit oil trains from the Central California Coast to a refinery near the Port of Los Angeles. It also can be used by trains terminating or originating at East Los Angeles that are routed via the Alhambra Subdivision. A single-track connection with the Corridor at Redondo crosses the Los Angeles River and joins the two main tracks of the East Bank Line at Ninth Street. (Metrolink commuter trains from Riverside diverge from the UP Los Angeles Subdivision at Soto St. Jct. and proceed onto the two-main-track East Bank Line. It is 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 Subdivision 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 Subdivision. There is an at-grade crossing with the Metrolink San Bernardino Line at Pasadena Jct.

2. Train Counts and Train Lengths in 2010

Passenger rail traffic follows pre-specified schedules. Published Amtrak and Metrolink schedules are reflected in the 2010 peak-day train counts provided below.

Freight train movements vary by day of week, and, to a lesser extent, by time of year. For the purposes of planning track capacity, it was decided to simulate train operations occurring on a *peak day* of rail traffic, generally computed as a factor of 1.16 times the average daily train movements, i.e., a peak day experiences 16% more through train movements than an average day. This corresponds approximately to the 90th percentile of the statistical distribution of daily freight train movements.

Actual records of train movements (with train identities) passing Norwalk, CA (between Hobart and Fullerton) and passing Summit, CA (between San Bernardino and Barstow) for the two-week period July 8 through July 21, 2010 were received from BNSF. From these data, statistics on the average number of trains per day for various types of trains were developed for train movements over BNSF line segments. Peak-day statistics were established by scaling these figures by the 1.16 factor. In addition, actual records for this same period in July, 2010, of UP train movements (with train identities) utilizing BNSF trackage rights between West Riverside and Colton, as well as counts of UP trains (without train identities) traversing the Colton Crossing of BNSF also were received from BNSF. From these data as well as from other inputs, the author deduced average numbers of UP trains of various types per day over UP line segments in the study area. Again, peak-day statistics were established by scaling these figures by the 1.16 factor.

Companion studies to this one assess the vehicular delays at grade crossings in the study area. For the convenience of these studies, the author tallied 2010 train counts by line segment. Tables 1 through 7 provide the 2010 peak-day average train counts for BNSF line segments in this study. In these tables, the train frequencies shown are the aggregate of train movements in both directions, except for certain UP trains between West Riverside and Colton that operate eastbound only, as indicated.

A brief explanation of the types of trains is as follows. There are three types of *intermodal* freight trains shown, i.e., trains hauling truck trailers or containers that can be mounted on a truck chassis and drayed from point of loading to the origin rail terminal and drayed from the destination rail terminal to the point of unloading. *Marine container trains* are double-stacked container trains hauling marine containers in 20-, 40- and 45-foot lengths. *Domestic container trains* are double-stacked container trains hauling domestic containers predominantly in 53-foot lengths. *Z trains* are premium-service intermodal trains (AKA expedited intermodal trains) hauling a mix of trailers (not stacked) and double-stacked domestic containers. *Unit auto trains* are solid trains of enclosed, multi-level cars hauling trucks or automobiles. *Unit bulk trains* are solid trains of hopper cars hauling commodities such as coal, soda ash, grain, or ballast. *Carload through trains* are trains hauling mixed consists of single-car shipments in box cars, tank cars, gondolas, hopper cars, etc., moving long distances between classification terminals. *Carload local trains* are short freight trains hauling mixed consists on their way to spot and pull cars at customer docks. *Light engines* are strings of locomotive units making a repositioning move without hauling any freight cars. *Amtrak long-distance trains* include the Chicago – Los Angeles *Southwest Chief* and the New Orleans – Los Angeles *Sunset Limited*. *Amtrak regional trains* are the Los Angeles – San Diego *Pacific Surfliner* trains. *Metrolink* trains are the regional local passenger service trains, including services Los Angeles – Fullerton – Orange County, Los Angeles – Fullerton – Riverside, Orange County – Atwood – Riverside, Los Angeles – Montebello – Pomona – Riverside, and Riverside – San Bernardino.

Table 1: 2010 Train Counts for the BNSF Hobart – Fullerton Line Segment

Train Type	Avg. Trains Per Day	Avg. Trains Per Peak Day
Marine container stack trains	12.1	14.0
Domestic container stack trains	9.0	10.4
Z trains (trailers and containers)	9.6	11.1
Unit bulk trains	1.2	1.4
Unit auto trains	0	0
Carload through trains	3.3	4.0
Carload locals and light engines	3.7	4.3
Subtotal, Freight trains	**38.9**	**45.3**
Amtrak long distance trains	2	2
Amtrak regional trains	22.70	24
Metrolink LA - Orange County trains	19	19
Metrolink LA – Riverside trains	9	9
Subtotal, Passenger trains	**52.7**	**54.0**
Grand total	**91.6**	**99.3**

Table 2: 2010 Train Counts for the BNSF Fullerton – Atwood Line

Train Type	Avg. Trains Per Day	Avg. Trains Per Peak Day
Marine container stack trains	12.1	14.0
Domestic container stack trains	9.0	10.4
Z trains (trailers and containers)	9.6	11.1
Unit bulk trains	1.2	1.4
Unit auto trains	0	0
Carload through trains	3.3	4.0
Carload locals and light engines	3.7	4.3
Subtotal, Freight trains	**38.9**	**45.3**
Amtrak long distance trains	2	2
Metrolink LA – Riverside trains	9	9
Subtotal, Passenger trains	**11**	**11**
Grand total	**49.9**	**56.3**

Table 3: 2010 Train Counts for the BNSF Atwood – West Riverside Line Segment

Train Type	Avg. Trains Per Day	Avg. Trains Per Peak Day
Marine container stack trains	12.1	14.0
Domestic container stack trains	9.0	10.4
Z trains (trailers and containers)	9.6	11.1
Unit bulk trains	1.8	2.1
Unit auto trains	0.8	0.9
Carload through trains	5.0	6.0
Carload locals and light engines	3.7	4.3
Subtotal, Freight trains	**42.0**	**48.9**
Amtrak long distance trains	2	2
Metrolink Orange County-Riverside trains	14	14
Metrolink LA – Riverside trains	9	9
Subtotal, Passenger trains	**25**	**25**
Grand total	**67.0**	**74.9**

Table 4: 2010 Train Counts for the BNSF West Riverside – Colton Line Segment

Train Type	Avg. Trains Per Day	Avg. Trains Per Peak Day
Marine container stack trains	12.1	14.0
Domestic container stack trains	9.0	10.4
Z trains (trailers and containers)	9.6	11.1
Unit bulk trains	1.8	2.1
Unit auto trains	0.8	0.9
Carload through trains	5.0	6.0
Carload locals and light engines	3.7	4.3
UP Z trains (EB)	1.6	1.8
UP marine container stack trains (EB)	8.7	10.1
UP domestic container stack trains (EB)	1.7	2.0
UP unit auto trains	3.7	4.3
Subtotal, Freight trains	**57.7**	**67.1**
Amtrak long distance trains	2	2
Metrolink Riverside – San Bernardino trains	8	8
Subtotal, Passenger trains	**10**	**10**
Grand total	**67.7**	**77.1**

Table 5: 2010 Train Counts for the BNSF Colton – San Bernardino Line Segment

Train Type	Avg. Trains Per Day	Avg. Trains Per Peak Day
Marine container stack trains	12.1	14.0
Domestic container stack trains	9.0	10.4
Z trains (trailers and containers)	9.6	11.1
Unit bulk trains	1.8	2.1
Unit auto trains	0.8	0.9
Carload through trains	5.0	6.0
Carload locals and light engines	3.7	4.3
UP Z trains (EB)	0.3	0.4
UP marine container stack trains (EB)	2.6	3.0
UP domestic container stack trains (EB)	0.2	0.2
Subtotal, Freight trains	**45.1**	**52.4**
Amtrak long distance trains	2	2
Metrolink Riverside – San Bernardino trains	8	8
Subtotal, Passenger trains	**10**	**10**
Grand total	**55.1**	**62.4**

Table 6: 2010 Train Counts for the BNSF Cajon Subdivision San Bernardino – Silverwood and the UP Mojave Subdivision West Colton - Silverwood

Train Type	Avg. Trains Per Day	Avg. Trains Per Peak Day
BNSF Carload	10.0	11.6
BNSF Unit bulk	3.0	3.5
BNSF Unit auto	1.6	1.9
BNSF Locals and light engines	2.1	2.4
BNSF Marine stack intermodal	17.7	20.5
BNSF Domestic stack intermodal	9.3	10.8
BNSF Z train intermodal	15.0	17.4
UP Carload	15.1	16.0
UP Z train intermodal	0.6	0.7
UP Marine stack intermodal	5.1	5.9
UP Domestic stack intermodal	0.4	0.5
UP Unit auto	0.7	0.8
UP Unit bulk	1.3	1.5
Subtotal, Freight Trains	**81.9**	**93.4**
Amtrak Southwest Chief	2	2
Subtotal, Passenger Trains	**2**	**2**
Total	**83.9**	**95.4**

Table 7: 2010 Train Counts for the BNSF Cajon Subdivision Silverwood - Barstow

Train Type	**Avg. Trains Per Day**	**Avg. Trains Per Peak Day**
BNSF Carload	10.0	11.6
BNSF Unit bulk	3.0	3.5
BNSF Unit auto	1.6	1.9
BNSF Locals and light engines	2.1	2.4
BNSF Marine stack intermodal	17.7	20.5
BNSF Domestic stack intermodal	9.3	10.8
BNSF Z train intermodal	15.0	17.4
UP Carload	9.1	10.0
UP Z train intermodal	0.6	0.7
UP Marine stack intermodal	5.1	5.9
UP Domestic stack intermodal	0.4	0.5
UP Unit auto	0.7	0.8
UP Unit bulk	1.3	1.5
Subtotal, Freight Trains	**75.9**	**87.4**
Amtrak Southwest Chief	2	2
Subtotal, Passenger Trains	**2**	**2**
Total	**77.9**	**89.4**

Table 8 presents the 2010 peak-day average train counts by train type for UP trains and passenger trains operating on UP tracks. As before, the train frequencies shown represent the aggregate frequencies of trains moving in both directions, for each train type. The Amtrak *Sunset Limited* count is only one because it operates tri-weekly in each direction.

Assumptions concerning train lengths are required for all train types to perform the grade crossing analyses in the companion studies. The assumptions shown in Table 9 concerning train lengths are judgments of the author based on field observation in the LA Basin, train lengths used in previous studies, and discussions with rail managers.

Except for intermodal trains, these lengths are consistent with those used in the 2005 Study. In the case of intermodal trains, there has been considerable evolution in the technology and traffic mix, and this evolution is on-going. In the 2005 Study, intermodal trains were assumed to be a mixture of 6,000 and 8,000 foot trains. Since that time, both BNSF and UP have completed substantial stretches of second main track on their transcontinental routes, and the use of distributed power units (DPU) has expanded. These changes have enabled the railroads to run longer trains. Ten-thousand-foot intermodal trains are now in regular operation, there are occasional twelve-thousand-foot intermodal trains, and there have been successful tests of intermodal trains in excess of eighteen thousand feet in length. At present, most of the port on-dock rail terminals cannot build or receive long trains, so the shift to longer trains is happening more quickly for domestic container trains than for marine container trains. Premium-service intermodal trains (AKA Z trains), which must achieve faster schedules, also are evolving to longer train lengths somewhat more slowly than are domestic container trains.

Table 8: 2010 UP Train Counts

Origin – Destination Pair	Train type	Avg. trains per day	Trains per peak day
East LA - Barstow	Z Train	0.60	0.70
C of I - Barstow	Domestic stack	0.40	0.46
Alameda Corridor - Barstow	Marine stack	5.10	5.92
West Colton - Barstow	Carload	3.10	4.00
West Colton - Bakersfield	Carload	6.00	6.00
Mira Loma - Barstow	Unit auto	0.70	0.81
Alameda Corridor - Barstow	Unit coal	0.43	0.50
Barstow - Kaiser	Unit grain	0.14	0.17
Barstow - West Colton	Unit ethanol	0.43	0.50
Barstow - West Colton	Unit ballast	0.29	0.33
LATC - Indio	Domestic stack	2.28	2.66
C of I - Indio	Domestic stack	2.57	2.98
East LA - Indio	Domestic stack	0.57	0.66
Alameda Corridor - Indio	Marine stack	12.30	14.27
East LA - Indio	Z Train	2.57	2.98
Mira Loma - Indio	Unit auto	3.70	4.29
West Colton - Indio	Carload	14.48	16.80
West Colton - C of I	Carload	1.71	2.00
West Colton - Glendale Line	Carload	3.43	4.00
West Colton - J Yard	Carload	1.71	2.00
West Colton - Alameda Corridor	Carload	1.71	2.00
West Colton - Montclair - Mira Loma	Carload	1.71	2.00
West Colton - Kaiser	Carload	1.71	2.00
Mira Loma - Alameda Corridor	Unit auto	1.71	2.00
Glendale Line - Alameda Corridor	Unit Oil	1.71	2.00
West Colton - Silverwood - Palmdale	Carload	5.20	6.00
LA - Yuma Jct. - Indio	Amtrak	1	1
LA - Soto St. Jct. – Riverside	Metrolink	12	12
Subtotal, Freight Trains LA – Colton		**44.9**	**51.2**
Subtotal, Freight Trains Colton - Indio		**38.5**	**44.6**
Subtotal, Freight Trains Colton - Silverwood		**23.2**	**25.4**
Subtotal, Passenger Trains		**13**	**13**

Table 9: Assumed Train Lengths in 2010

Train Type	Length in feet (including locomotives)
Marine container train	30% 6,000, 40% 8,000, 30% 10,000
Domestic container train	10% 6,000, 50% 8,000, 40% 10,000
Z trains (trailers and containers)	34% 6,000, 66% 8,000
Unit auto train	6,000
Unit bulk train	5,000
Carload through train	6,500
Carload locals and light engines	600
Amtrak long-distance train	1,000
Amtrak regional and Metrolink trains	500

3. Train Counts and Train Lengths in 2035

For the development of a 2035 rail traffic scenario, one question that arises concerns how much increase in passenger service frequencies there will be. Neither Amtrak nor the State of California has proposed any increase in Southern California Amtrak services in the near future. Metrolink has published goals for service frequencies it would like to provide in 2010, 2015, 2020, 2025, 2030 and 2035. However, it is uncertain if funding to provide such services can be secured. The consultant was directed that for the purposes of this study, the 2035 level of passenger train operations reflect the 2010 Amtrak service levels (i.e., no growth is assumed in Amtrak services). Additionally, based on a decision made by SCAG in consultation with the SCRRA, Metrolink's projections for growth in their services were adjusted to proposed 2020 service levels for 2035. The Metrolink trains to be introduced in the future were assumed by the author to follow the same percentage allocation to peak-morning, mid-day, peak-evening, and night hours as is reflected in 2010 schedules. Table 10 summarizes the passenger train services included in the capacity analysis. As may be seen, even scaling Metrolink back to its desired 2020 service levels, the number of Metrolink passenger trains is increasing from 58 to 131 per day, i.e., a 126% increase.

Table 10: 2035 Passenger Service Levels Assumed in Track Capacity Analysis

Train type	**2010 (actual)**	**2035 (projected)**
Amtrak		
Southwest Chief (long-distance LA – Chicago via BNSF)	2	2
Sunset Limited (long-distance LA – New Orleans via UP)	1	1
Surfliners (regional LA – San Diego)	24	24
Metrolink		
LA – Orange County	19	31
LA – Fullerton – Riverside	9	0
LA – Fullerton – Riverside – Highgrove - Perris	0	20
Orange County – Atwood – Riverside	14	20
Riverside – San Bernardino (continuation of Orange County – Riverside trains)	8	20
LA – Pomona – Riverside	12	20

Table 11 compares 2010 peak-day train counts to forecasted 2035 train counts for non-intermodal freight trains. The counts displayed include both directions of traffic. On the BNSF, a modest allowance for growth in carload traffic has been made on most routes. An allowance also has been made for modest growth in unit bulk traffic. A somewhat larger allowance has been made for growth of unit auto traffic. At present, BNSF does not participate in auto traffic to/from Southern California except to/from San Diego, as UP successfully outbid BNSF for all other auto traffic in the region. However, that could change when contracts come up for bid again, and so an allowance has been made for BNSF to participate in this traffic in 2035.

Table 11: Forecasted 2035 Non-intermodal Freight Train Movements

Railroad	Train Type	2010 Peak Day	2035 Peak Day
BNSF	Barstow – Alameda Corridor Carload	2.3	3
BNSF	Barstow – Hobart Carload	1.5	4
BNSF	Barstow – Atwood – San Diego Carload	2	3
BNSF	Barstow – San Bernardino – Irwindale Carload	2	2
BNSF	Barstow – West Colton (UP) Carload	2	2
BNSF	Barstow – Alameda Corridor Unit Bulk	1.4	2
BNSF	Barstow – Atwood – San Diego Unit Bulk	0.7	3
BNSF	Barstow – Alameda Corridor Unit Auto	0	2
BNSF	Barstow – Hobart Unit Auto	0	2
BNSF	Barstow – Atwood – San Diego Unit Auto	0.9	3
BNSF	Barstow – San Bernardino Unit Auto	0	2
UP	Indio – West Colton Carload	16.8	23
UP	Daggett – West Colton Carload	4	9
UP	Palmdale – West Colton Carload	6	6
UP	West Colton – Kaiser Carload	2	2
UP	West Colton – Pomona – Montclair Carload	2	2
UP	West Colton – City of Industry – Anaheim Carload	2	2
UP	West Colton – Alhambra – J Yard Carload	2	2
UP	West Colton – Glendale Line Carload	4	5
UP	West Colton – East Los Angeles Carload	2	2
UP	West Colton – Alameda Corridor Carload	2	3
UP	Daggett – West Colton/Kaiser Unit Bulk	1.2	0
UP	Daggett – Alameda Corridor Unit Bulk	0.6	8
UP	Glendale Line – Alameda Corridor Unit Oil	2	6
UP	Daggett – Riverside – Mira Loma Unit Auto	0.9	0
UP	Indio – Riverside – Mira Loma Unit Auto	4.3	7
UP	Indio – Alameda Corridor Unit Auto	2	2

On the UP, significant allowances have been made for growth in long-distance carload traffic West Colton – Indio and West Colton – Daggett; however, the existing retinue of Hauler trains operating west of the West Colton classification yard is assumed to be adequate to handle future traffic levels. A significant allowance also has been made for growth in unit bulk traffic, reflecting growing opportunities for export coal and other bulk commodities.

In terms of the percentage of total length of trains passing over grade crossings between, for example, West Riverside and Colton, intermodal trains account for about 81.6% in 2010. Moreover, since 2000 intermodal traffic has experienced by far the greatest growth among all types of rail freight traffic in and out of the Los Angeles Basin. This preponderance of intermodal trains is not expected to wane. Thus, in developing forecasts for 2035 train movements, the most important element is the forecast of intermodal train movements.

The starting point for developing intermodal train movement forecasts is the 2035 forecast issued by the Ports of Los Angeles and Long Beach. In their most recently issued forecast, the ports are projecting 43.14 million TEUs (twenty-foot equivalent units) in 2035, counting both inbound and outbound containers. To translate this annual figure into a peak-day figure, first, a monthly peaking factor of 1.092 is assumed (i.e., the peak month is 9.2% higher than an average month). Combined with the previously-posited 1.16 peak-day factor, this results in a peak-day volume of 150,127.2 TEUs passing through the ports.

Traditionally, the ports have projected a 40% share for inland point intermodal (IPI) movement of marine boxes (i.e., marine container trains), but in recent years this share has been slipping. For example, for the first 11 months of 2010, the ratio of eastbound rail-hauled marine container volume to total inbound port volume (both expressed in TEUs) was 34.9% (35.6% excluding inbound empties).[5] For the year 2006, statistics reported by the Intermodal Association of North America show that rail movements of marine containers in and out of Southern California were nearly exactly in balance. The author believes this balance is still in effect at present. Thus, the multiplier on total port volume that determines the TEU volume of rail movement of marine containers in and out of Southern California is recently in the range 35-36%. In Leachman [2010],[6] it is estimated that in 2006 only 23% of total containerized imports at San Pedro Bay from Asia were destined to a local region defined to include Southern California, Southern Nevada and Utah, all of Arizona and New Mexico, and a portion of Colorado. Considering market share losses of the San Pedro Bay ports since that time, perhaps the local share has risen to 24 or 25%. Using 36% as the rail-borne-marine-container multiplier, this leaves 39-41% for imports ultimately consumed out-of-region that are not moving in marine containers, i.e., these imports are trans-loaded to domestic vehicles before movement to other regions. In Leachman [2010], it is estimated that about 36-37% out of this 40% moves east of the Rockies in domestic container trains originating in Southern California, with the remaining 3-4% moving to Northern California and the Pacific Northwest. Thus in 2011 the volume of imports trans-loaded to

[5] These percentages are computed based on data supplied by the Alameda Transportation Corridor Authority, the Ports of Los Angeles and Long Beach, and the Intermodal Association of North America.

[6] Leachman, Robert C., *Final Report, Port and Modal Elasticity Study – Phase II*, prepared for the Southern California Association of Governments, Sept. 2010. Report may be downloaded from the SCAG web site, http://www.scag.ca.gov/goodsmove/elasticitystudyphase2.htm.

domestic containers and leaving the region on trains was comparable or slightly higher than the volume leaving the region intact in marine containers on trains.

The author believes the trend of declining market share for marine container trains will continue, for several reasons. First, large nation-wide importers practice trans-loading whereas regional and smaller importers generally do not, and the large importers are gaining market share. Leachman [2005][7] estimates that in 2003, the share of total imports from Asia to the Continental USA accounted for by large nation-wide importers was 30%. Leachman [2010] estimates that in 2007, this share had climbed to 40%. Second, as the values of Asian currencies rise relative to the American dollar, and as interest rates rise, there is more incentive for importers to restructure supply chains so as to reduce total system inventory. The scheme of trans-loading to domestic containers offers the opportunity to re-allocate inbound supply to regional demands much later in time than if destinations are committed before booking vessel passage. Trans-loading thereby achieves a much better match-up of supply to demand. Moreover, if in addition to a cross-dock, an import warehouse in the Los Angeles Basin is maintained, imported goods can be inventoried until it is known with more certainty where they will be demanded first. Leachman [2005] estimates that nation-wide importers practicing such inventory management schemes and trans-loading their imported cargoes to domestic containers and trailers achieve more than a 20% reduction in their total supply-chain inventory. Third, certain importers import a mixture of "weight freight" (i.e., cargoes that reach weight limits before cubic capacity of the container is reached) and "cube freight" (i.e., cargoes that reach cubic capacity before the weight limit is reached) from different origins. By unloading these cargoes and blending them when trans-loading to domestic containers, significant shipping economies can be achieved. Fourth, there is increasing competition from other ports such as Prince Rupert for the marine container train traffic, whereas such ports cannot provide competition for trans-loaded cargoes. And fifth, the expansion of the Panama Canal scheduled for completion in 2014 may result in an increasing share of Asian imports discharged from vessels at Gulf and East Coast ports. Leachman [2010] shows that IPI cargoes are much more sensitive to such diversion than are trans-loaded cargoes.

In this study it is assumed that the 2035 multiplier on total San Pedro Bay container volumes that determines total rail movement of marine containers (in TEUs) will be 30%, i.e., about 5 points less than it is at present. It is assumed that the 2035 multiplier on total San Pedro Bay container volumes that determines east-west volume (again expressed in TEUs) on domestic container trains is 35%.

The third category of intermodal traffic is accounted for by expedited intermodal trains, i.e., so-called Z trains. This train type at present consists of a mix of trailers and domestic containers. The domestic containers riding eastbound Z trains predominantly carry trans-loaded and re-sold imports. At present, some of the traffic loaded in domestic containers and all of the traffic loaded in trailers riding such trains pays a premium rate to receive premium service. The trailer volume is almost entirely less-than-trailer-load (LTL) traffic tendered to carriers such as Yellow Freight, ABF, and Roadway, or small-package shipments tendered to United Parcel Service. Some of the eastbound LTL and package express traffic are imports that have been re-sold. But some portion

[7] Leachman, Robert C. *Final Report, Port and Modal Elasticity Study*, prepared for the Southern California Association of Governments, Sept. 2005. Report may be downloaded from the SCAG web site, http://www.scag.ca.gov/goodsmove/pdf/FinalElasticityReport0905rev1105.pdf.

is true domestic freight. So unlike the eastbound marine container trains, which carry no domestic freight, and the eastbound domestic container trains, which carry very little truly domestic freight, the Z trains may handle a more significant amount of domestic freight (mostly package express). Notwithstanding this fact, in this study the volume of future Z train traffic is assumed to be indexed to the total port volume. It is assumed that a multiplier of 10% on total 2035 port volume determines total 2035 Z train traffic (expressed in TEUs).

The author believes the trend of operating longer intermodal trains will continue out to 2035 and beyond. The railroads are continuing to add more second main track to their transcontinental lines; it seems likely that BNSF Los Angeles – Chicago will be completely double-tracked well before 2035, and the UP Los Angeles – El Paso also will be completely double-tracked well before 2035. Refueling terminals and intermodal terminals are being modified to accommodate 12,000-foot trains operated with DPU. Table 12 shows the 2035 train length assumptions used in this study.

Table 12: Assumed Train Lengths in 2035

Train Type	Length in feet (including locomotives)
Marine container train	30% 8,000, 40% 10,000, 30% 12,000
Domestic container train	66% 10,000, 34% 12,000
Z trains (all containers)	30% 6,000, 40% 8,000, 30% 10,000
Unit auto train	6,000
Unit bulk train	5,000
Carload through train	6,500
Carload locals and light engines	600
Amtrak long-distance train	1,000
Amtrak regional and Metrolink trains	500

Another important trend is the decline in the use of trailers in rail intermodal service. At present, only UPS and the LTL carriers remain as trailer customers; all others have moved to domestic containers. The railroads are raising their rates for premium service, in light of the fact that trailers consume two slots (i.e., they cannot be stacked). UPS has already converted some of its rail traffic to domestic containers, as have certain LTL carriers. In this study, it is assumed that the use of trailers in rail intermodal service to/from Southern California will be discontinued before 2035, and Z trains will haul only containers (as indicated in Table 12).

Comparing to the data in Table 9, it may be seen that length assumptions for all non-intermodal trains are unchanged from the 2010 length assumptions. Lengths of intermodal trains, however, are assumed to grow. Domestic container train lengths are longest. While some 12,000-foot marine container trains are assumed, the marine container trains are assumed to be distributed over shorter lengths than the domestic stack train lengths, reflecting the constraints of port terminals.[8] Lengths of Z trains also are assumed to be distributed over shorter lengths than domestic container trains, owing to their need to achieve faster schedules, but nonetheless longer than the 2010 lengths.

These assumptions posit a major step up in train lengths from the assumptions of previous studies. Considering the importance of these assumptions, comment was requested from network executives of BNSF and UP. BNSF found the assumptions to be "a very reasonable forecast." UP declined to comment.

The next step to translate port volumes into intermodal train counts is to identify the TEU capacity of each train type. The relevant factors for determining these capacities are displayed in Table 13. These factors result in the train counts per peak day in 2035 displayed in Table 14.

Despite the relatively aggressive assumptions for increased train lengths, and the assumption of shifting all trailer freight into domestic containers, the 2035 forecast results in 157 east-west intermodal trains per peak day operating in the Los Angeles Basin. Note the sharp increase in the carrying capacity of Z trains afforded by the replacement of trailer service with domestic container service.

The next step in the development of the forecasts is to allocate these train movements to railroads and to intermodal terminals on each railroad. It is assumed herein that UP and BNSF will have equal market shares of marine container and domestic container train traffic, but that the shares of Z train traffic (premium rate, priority service) will be 75% BNSF and 25% UP. These shares are roughly consistent with current shares. In Table 15, an allocation of these trains to terminals is proposed. Table 16 tallies the consequent lifts required at the various terminals.

As may be seen, the 2035 forecasts require a substantial increase in terminal capacities. In terms of lifts per year, on-dock rail capacity will need to rise by about 180%. In the 2035 scenario, it is assumed herein that 100% of import (eastbound) marine box volume (30% of total port TEUs) is entrained at on-dock terminals. Westbound, it is assumed that 27.1% of the marine boxes would contain domestic backhauls,[9] and these domestic-load backhauls are de-trained at ICTF and the proposed BNSF SCIG terminal, with all the rest of the westbound marine boxes (export loads and empties) de-trained at on-dock terminals. These assumptions comprise a maximum allocation of marine container lifts to on-dock terminals, consistent with port policies to discourage handling domestic freight within the ports. Except for handling domestic backhauls in marine containers, it is assumed that in 2035 the ICTF, the proposed BNSF SCIG and all other intermodal terminals in the Los Angeles Basin would exclusively handle domestic equipment.

[8] It should be noted that, on occasion, both railroads are operating marine container trains in excess of 12,000 feet in length, assembling or disassembling such trains outside of the on-dock terminals and moving smaller train lengths in and out of the on-dock terminals.

[9] 24.8% is the author's best estimate of the domestic backhaul rate for rail-borne marine containers inbound to Southern California based on review of ACTA data for the period January through November, 2010 and IANA data for calendar 2009 received in private communications.

Table 13: Factors for Determining TEU Capacities of Intermodal Trains

Train Type	Car Length (feet)	Wells Per Car	TEUs Per Slot	Cars Per Train	TEUs Per Train
12,000-ft marine container	265	5 40-foot	1.76	45	792
10,000-ft marine container	265	5 40-foot	1.76	37	651.2
8,000-ft marine container	265	5 40-foot	1.76	30	528
12,000-ft domestic container	203	3 53-foot	2.61	59	923
10,000-ft domestic container	203	3 53-foot	2.61	49	766.6
8,000-ft domestic container	203	3 53-foot	2.61	39	610
10,000-ft trailer train	270	5 53-foot	1.30	37	482.4
8,000-ft trailer train	270	5 53-foot	1.30	29	378.1
6,000-ft trailer train	270	5 53-foot	1.30	22	286.8
10,000-ft Z train in 2035	203	3 53-foot	2.61	49	766.6
8,000-ft Z train in 2035	203	3 53-foot	2.61	39	610
6,000-ft Z train in 2035	203	3 53-foot	2.61	29	453.7

Notes: Train lengths are assumed to exclude locomotives. Container trains have two slots per well, i.e., containers may be double-stacked. Trailers are carried on spine cars and cannot be stacked, i.e., only one trailer per well. In computing the TEUs per slot, a utilization of 0.88 is assumed for all slots. The TEUs per slot for marine container trains are therefore 2*0.88 = 1.76. Domestic containers and trailers have 4,000 cubic feet of capacity, whereas high-cube 40-foot marine containers have 2,700 feet cubic feet of capacity. It is assumed that cargoes handled in domestic containers are all cube freight, i.e., the cubic capacity of the boxes is fully utilized. The TEUs per slot for domestic container trains are therefore (4,000/2,700)*2*0.88 = 2.61 and half that for trailer trains. Z trains in 2035 are assumed to consist 100% of 53-foot domestic container well cars and haulage of trailers is assumed to be eliminated.

Table 14: Forecasted Count of Intermodal Trains by Type on a Peak Day in 2035

Train Type	Trains Per Peak Day
12,000-ft marine container	21
10,000-ft marine container	28
8,000-ft marine container	21
12,000-ft domestic container	40
10,000-ft domestic container	21
10,000-ft Z train	8
8,000-ft Z train	10
6,000-ft Z train	8
Total intermodal trains	**157**

The Ports of Los Angeles and Long Beach have set forth plans that their on-dock rail capacity will be expanded to accommodate 12.94 million TEUs in 2030.[10] According to statistics collected by the Intermodal Association of North America, the mix of marine containers handled by California railroads in 2009 was 15.23% 20-foot containers, 78.51% 40-foot containers, and 6.26% 45-foot containers.[11] For these percentages, 12.94 million TEUs in 2030 translate into 6.94 million lifts in 2030, i.e., about 1.2 million lifts surplus to the maximum allocation of marine container lifts set forth in Table 16 below. The proposed expansion of ICTF would raise its capacity to 1.9 million TEUs per year.[12] Translating this into lifts using the IANA factors, ICTF after the proposed expansion would accommodate 1.02 million lifts per year. The proposed SCIG would have a capacity of 1.8 million TEUs per year.[14] Translating this TEU capacity into lifts using the IANA figures, SCIG could achieve 0.97 million lifts per year. That is, ICTF and SCIG collectively could process about 2 million lifts per year, i.e., about 1.4 million lifts short of the amount they would need to handle as in Table 16. Given the surplus capacity at on-dock terminals, this suggests that with either processing of 1.2 million domestic backhauls or 1.2 million domestic containers at on-dock terminals (or a combination thereof), and given a productivity improvement at ICTF and SCIG of about 200,000 lifts per year (i.e., about 9.5%), there would be sufficient capacity at near-dock (ICTF and SCIG) and on-dock terminals to meet the forecasted 2035 lifts at on-dock and near-dock terminals.

To secure a 50% share of the non-premium intermodal traffic in 2035, UP will have to scramble with respect to domestic terminal capacity. UP has the land to make a major expansion of its City of Industry intermodal terminal[13], but its East Los Angeles and LATC facilities are hemmed in by urban development. Even allowing for a 160% expansion of City of Industry throughput, on the order of 60% capacity gains at East Los Angeles and LATC seem to be required. With 24x7 operation and full staffing, such gains may be conceivable, although they likely would pose a great challenge. Whether adequate parking/container storage space exists or not is unclear.

[10] The Ports of Los Angeles and Long Beach, *San Pedro Bay Ports Rail Study Update*, Dec. 2006.
[11] Private communication.
[12] The Ports of Los Angeles and Long Beach, *San Pedro Bay Ports Rail Study Update*, Dec., 2006.
[13] At present, the City of Industry intermodal facility occupies about 90 acres. About 52 acres are available for expansion towards Marne siding. More acreage for intermodal usage is possible if the hump and bowl tracks of the carload switching facility are removed.

Nonetheless, it is assumed in this study that UP, through a combination of productivity improvements and terminal expansions, will achieve the terminal capacities set forth in Table 16.

Assuming SCIG is approved, and assuming it and on-dock terminals can be as productive as indicated above, then BNSF would be in relatively good shape with respect to intermodal terminal capacity in 2035. Only 7-10% productivity gains would be required at Hobart, San Bernardino and SCIG. However, if SCIG is not approved, BNSF will face a serious challenge as well.

The final step in development of intermodal train forecasts is to assign UP trains to routes. UP has two transcontinental routes from Southern California. The Sunset Route passes through Colton and Indio en route to El Paso, TX, where lines to Kansas City and Texas split. The Overland Route utilizes trackage rights on the BNSF from the Colton vicinity to Daggett (just east of Barstow) en route to Salt Lake City, UT and ultimately Chicago. In Inland Empire Mainline Rail Study (2005), the percentage allocation was roughly $2/3^{rds}$ via Indio and $1/3^{rd}$ via Daggett. But as UP has completed more and more second main track on the Sunset Route, the percentage routed via Daggett has dropped. The assumed allocation of 2035 UP intermodal trains to routes is displayed in Table 22. As may be seen, about an 84% allocation of UP intermodal trains to the Sunset Route is now assumed.

A summary of the projected 2035 peak-day BNSF intermodal trains by route is provided in Table 23.

Tables 10, 11, 17 and 18 delineate the through freight train movements simulated in this study. In support of related studies of grade crossing impacts in 2035, tallies of trains counts by BNSF line segment are provided in Tables 19 through 25.

Table 15: Allocation of Intermodal Trains to Intermodal Terminals in 2035

Train Type	Total Count	UP Count	BNSF Count	UP[14] On-Dock	BNSF[8] On-Dock	UP[8] ICTF	BNSF[8] SCIG	BNSF Hobart	UP East LA	UP LATC	UP COI	BNSF SBD
Marine stack 12K	21	10.5	10.5	10.5	10.5	0	0	0	0	0	0	0
Marine stack 10K	28	14	14	14	14	0	0	0	0	0	0	0
Marine stack 8K	21	10.5	10.5	10.5	10.5	0	0	0	0	0	0	0
Domestic stack 12K	40	20	20	0	0	12	12	5	4	0	4	3
Domestic stack 10K	21	10.5	10.5	0	0	4.5	4.5	3	1	4	1	3
Z train 10K	8	2	6	0	0	0	0	6	1	0	1	0
Z train 8K	10	2.5	7.5	0	0	0	0	5.5	1.5	0	1	2
Z train 6K	8	2	6	0	0	0	0	6	1	1	0	0
Totals	157	72	85	35	35	16.5	16.5	25.5	8.5	5	7	8

Note: "SBD" refers to the BNSF's San Bernardino intermodal facility.

Table 16: Comparison of 2007 Actual Lifts and 2035 Required Lifts by Terminal

	On-Dock	UP ICTF	BNSF SCIG	BNSF Hobart	UP East LA	UP LATC	UP COI	BNSF SBD
Required lifts per peak day in 2035	19,977	5,880	5,880	4,997	1,777	1,227	1,733	2,096
Required lifts per year in 2035	5,741,000	1,690,000	1,690,000	1,501,000	563,000	300,000	498,000	537,000
Actual lifts per year in 2007	2,003,000	710,000	NA	1,374,000	359,000	186,000	192,000	500,000
Proposed expansions (done before 2035)	6,944,000	1,088,000	966,000					

Notes: Figures expressing lifts per year are rounded to the nearest thousand. The BNSF Southern California International Gateway (SCIG) is a proposed terminal, not yet approved. "LATC" is short for the Los Angeles Transportation Center, "COI" is short for City of Industry and "SBD" is short for San Bernardino. Considering the mix of 20-foot containers handled on marine container trains, 1.143 lifts per loaded slot are assumed for marine container trains. 88% of slots are assumed to be loaded for all train types at all terminals. It is assumed in this analysis that 27.1% of westbound marine containers in 2035 contain domestic backhauls, and all of these backhauls are de-trained at ICTF and SCIG. All other westbound marine containers contain export loads or are empty and are assumed to be de-trained at on-dock terminals

[14] UP and BNSF on-dock and ICTF/SCIG train counts are before re-allocations discussed in the text in consideration of surplus terminal capacity in the ports and shortage of terminal capacity at ICTF and SCIG. Only total intermodal train counts for each railroad to/from the Alameda Corridor are used in this study, so such re-allocations have no impact on the analysis of track capacity.

Table 17: Assumed 2035 UP Intermodal Trains by Route

Train Type	Trains Per Peak Day	Via Indio	Via Daggett
Alameda Corridor 12K Marine Stack	10.5	10.5	0
Alameda Corridor 10K Marine Stack	14	11.2	2.8
Alameda Corridor 8K Marine Stack	10.5	6.3	4.2
Alameda Corridor 12K Domestic Stack	12	12	0
Alameda Corridor 10K Domestic Stack	4.5	3.6	0.9
East Los Angeles 12K Domestic Stack	4	4	0
East Los Angeles 10K Z Train	1	0	1
East Los Angeles 8K Z Train	1	1	0
East Los Angeles 6K Z Train	1.5	1.5	0
LATC 10K Domestic Stack	4	4	0
LATC 6K Z Train	1	1	0
COI 12K Domestic Stack	4	2.86	1.14
COI 10K Domestic Stack	1	1	0
COI 10K Z Train	1	1	0
COI 8K Z Train	1	0.64	0.36
Totals	**72**	**60.6**	**11.4**

Table 18: Assumed 2035 BNSF Intermodal Trains by Route

Train Type	Trains Per Peak Day
Alameda Corridor 12K Marine Stack	10.5
Alameda Corridor 10K Marine Stack	14
Alameda Corridor 8K Marine Stack	10.5
Alameda Corridor 12K Domestic Stack	12
Alameda Corridor 10K Domestic Stack	4.5
Hobart 12K Domestic Stack	5
Hobart 10K Domestic Stack	3
Hobart 10K Z Train	6
Hobart 8K Z Train	5.5
Hobart 6K Z Train	6
San Bernardino 12K Domestic Stack	3
San Bernardino 10K Domestic Stack	3
San Bernardino 8K Z Train	2
Total	**85**

Table 19: 2035 Train Counts for the BNSF Hobart – Fullerton Line Segment

Train Type	Avg. Trains Per Peak Day
12,000-ft marine container stack trains	10.5
10,000-ft marine container stack trains	14
8,000-ft marine container stack trains	10.5
12,000-ft domestic container stack trains	17
10,000-ft domestic container stack trains	7.5
10,000-ft Z trains	6
8,000-ft Z trains	5.5
6,000-ft Z trains	6
Unit bulk trains	2
Unit auto trains	4
Carload through trains	7
Subtotal, Freight trains	**90**
Amtrak long distance trains	2
Amtrak regional trains	24
Metrolink LA - Orange County trains	31
Metrolink LA – Riverside trains	20
Subtotal, Passenger trains	**77**
Grand total	**167**

Table 20: 2035 Train Counts for the BNSF Fullerton – Atwood Line Segment

Train Type	Avg. Trains Per Peak Day
12,000-ft marine container stack trains	10.5
10,000-ft marine container stack trains	14
8,000-ft marine container stack trains	10.5
12,000-ft domestic container stack trains	17
10,000-ft domestic container stack trains	7.5
10,000-ft Z trains	6
8,000-ft Z trains	5.5
6,000-ft Z trains	6
Unit bulk trains	2
Unit auto trains	4
Carload through trains	7
Subtotal, Freight trains	**90**
Amtrak long distance trains	2
Metrolink LA – Riverside trains	20
Subtotal, Passenger trains	**22**
Grand total	**112**

Table 21: 2035 Train Counts for the BNSF Atwood – West Riverside Line Segment

Train Type	**Avg. Trains Per Peak Day**
12,000-ft marine container stack trains	10.5
10,000-ft marine container stack trains	14
8,000-ft marine container stack trains	10.5
12,000-ft domestic container stack trains	17
10,000-ft domestic container stack trains	7.5
10,000-ft Z trains	6
8,000-ft Z trains	5.5
6,000-ft Z trains	6
Unit bulk trains	5
Unit auto trains	7
Carload through trains	10
Subtotal, Freight trains	**99**
Amtrak long distance trains	2
Metrolink Orange County – Riverside trains	20
Metrolink LA – Riverside – Perris trains	20
Subtotal, Passenger trains	**42**
Grand total	**141**

Table 22: 2035 Train Counts for the BNSF West Riverside – Colton Line Segment

Train Type	Avg. Trains Per Peak Day
12,000-ft marine container stack trains	10.5
10,000-ft marine container stack trains	14
8,000-ft marine container stack trains	10.5
12,000-ft domestic container stack trains	17
10,000-ft domestic container stack trains	7.5
10,000-ft Z trains	6
8,000-ft Z trains	5.5
6,000-ft Z trains	6
Unit bulk trains	5
Unit auto trains	7
Carload through trains	10
UP Mira Loma unit auto trains	7
UP East LA & Alameda Corridor unit auto	1 (EB only)
UP 6,000-ft Z Trains	1 (EB only)
UP 8,000-ft Z Trains	1.25 (EB only)
UP 10,000-ft Z Trains	1 (EB only)
UP 10,000-ft domestic container stack trains	5.25 (EB only)
UP 12,000-ft domestic container stack trains	10 (EB only)
UP 8,000-ft marine container stack trains	5.25 (EB only)
UP 10,000-ft marine container stack trains	7 (EB only)
UP 12,000-ft marine container stack trains	5.25 (EB only)
UP unit bulk trains	4 (EB only)
Subtotal, Freight trains	**147**
Amtrak long distance trains	2
Metrolink Riverside – San Bernardino trains	20
Metrolink Riverside – Perris trains	20
Subtotal, Passenger trains	**42**
Grand total	**189**

Note: Under Alternatives to the Status Quo routing of trains, the Eastbound-only UP trains are diverted to the Alhambra Subdivision, reducing the total freight trains to 106 per peak day.

Table 23: 2035 Train Counts for the BNSF Colton – San Bernardino Line Segment

Train Type	Avg. Trains Per Peak Day
BNSF 12,000-ft marine stack trains	10.5
BNSF 10,000-ft marine stack trains	14
BNSF 8,000-ft marine stack trains	10.5
BNSF 12,000-ft domestic stack trains	20
BNSF 10,000-ft domestic stack trains	10.5
BNSF 10,000-ft Z trains	6
BNSF 8,000-ft Z trains	7.5
BNSF 6,000-ft Z trains	6
BNSF unit bulk trains	5
BNSF unit auto trains	7
BNSF carload trains	12
UP 6,000-ft Z trains (EB)	0.5
UP 8,000-ft Z trains (EB)	0.2
UP 10,000-ft Z trains (EB)	0
UP 10,000-ft domestic stack trains (EB)	0.95
UP 12,000-ft domestic stack trains (EB)	0.6
UP 8,000-ft marine stack trains (EB)	2.1
UP 10,000-ft marine stack trains (EB)	1.4
UP 12,000-ft marine stack trains (EB)	0
UP unit bulk trains (EB)	4
Subtotal, Freight trains	**118.7**
Amtrak Southwest Chief	2
Metrolink Riverside - San Bernardino	20
Subtotal, Passenger trains	**22**
Total	**140.7**

Note: Under Alternatives to the Status Quo routing of trains, the Eastbound-only UP trains are diverted to the UP's Mojave Subdivision, reducing the total freight trains to 109 per peak day.

Table 24: 2035 Train Counts for the BNSF Cajon Subdivision San Bernardino – Silverwood and the UP Mojave Subdivision West Colton – Silverwood

Train Type	Avg. Trains Per Peak Day
BNSF 12,000-ft marine stack trains	10.5
BNSF 10,000-ft marine stack trains	14
BNSF 8,000-ft marine stack trains	10.5
BNSF 12,000-ft domestic stack trains	20
BNSF 10,000-ft domestic stack trains	10.5
BNSF 10,000-ft Z trains	6
BNSF 8,000-ft Z trains	7.5
BNSF 6,000-ft Z trains	6
BNSF unit bulk trains	5
BNSF unit auto trains	9
BNSF carload trains (except West Colton - Barstow)	12
BNSF West Colton - Barstow carload trains	2
UP 12,000-ft marine stack trains	0
UP 10,000-ft marine stack trains	2.8
UP 8,000-ft marine stack trains	4.2
UP 12,000-ft domestic stack trains	1.1
UP 10,000-ft domestic stack trains	1.9
UP 10,000-ft Z trains	0
UP 8,000-ft Z trains	0.4
UP 6,000-ft Z trains	1
UP unit bulk trains	8
UP carload trains (except Mojave Subdivision carload)	9
UP Mojave Subdivision carload trains	6
Subtotal, Freight trains	**147.4**
Amtrak Southwest Chief	2
Subtotal, Passenger trains	**2**
Total	**149.4**

Table 25: 2035 Train Counts for the BNSF Cajon Subdivision Silverwood – Barstow

Train Type	**Avg. Trains Per Peak Day**
BNSF 12,000-ft marine stack trains	10.5
BNSF 10,000-ft marine stack trains	14
BNSF 8,000-ft marine stack trains	10.5
BNSF 12,000-ft domestic stack trains	20
BNSF 10,000-ft domestic stack trains	10.5
BNSF 10,000-ft Z trains	6
BNSF 8,000-ft Z trains	7.5
BNSF 6,000-ft Z trains	6
BNSF unit bulk trains	5
BNSF unit auto trains	9
BNSF carload trains (except West Colton - Barstow)	12
BNSF West Colton - Barstow carload trains	2
UP 12,000-ft marine stack trains	0
UP 10,000-ft marine stack trains	2.8
UP 8,000-ft marine stack trains	4.2
UP 12,000-ft domestic stack trains	1.1
UP 10,000-ft domestic stack trains	1.9
UP 10,000-ft Z trains	0
UP 8,000-ft Z trains	0.4
UP 6,000-ft Z trains	1
UP unit bulk trains	8
UP carload trains	9
Subtotal, Freight trains	**141.4**
Amtrak Southwest Chief	2
Subtotal, Passenger trains	**2**
Total	**143.4**

Table 26 lists the 2035 counts of UP freight train movements in the study area. Because of the routing flexibility, specific counts for the Los Angeles Subdivision and the Alhambra Subdivision are not shown, nor are specific counts for the UP Mojave Subdivision and the BNSF Cajon Subdivision. To the counts listed in Table 26, one must add the 20 Metrolink Los Angeles – Pomona – Riverside commuter trains per day plus the one (tri-weekly) Amtrak *Sunset Limited* on the Los Angeles – Indio run. Table 27 provides a listing of the trains traversing the UP Yuma Subdivision between Colton Crossing and Indio.

Table 26: 2035 UP Train Counts

Origin-Destination Pair	Train Type	Avg. Trains Per Peak Day
LATC - Indio	6,000-ft Z trains	1
LATC - Indio	10,000-ft Domestic container	4
East LA - Indio	8,000-ft Z trains	1.5
East LA - Indio	10,000-ft Z trains	1
East LA - Indio	10,000-ft Domestic container	4
East LA - Daggett	6,000-ft Z trains	1
East LA - Daggett	10,000-ft Domestic container	1
Alameda Corridor - Indio	8,000-ft Marine container	6.3
Alameda Corridor - Indio	10,000-ft Marine container	11.2
Alameda Corridor - Indio	12,000-ft Marine container	10.5
Alameda Corridor - Indio	10,000-ft Domestic container	3.6
Alameda Corridor - Indio	12,000-ft Domestic container	12
Alameda Corridor - Daggett	8,000-ft Marine container	4.2
Alameda Corridor - Daggett	10,000-ft Marine container	2.8
Alameda Corridor - Daggett	10,000-ft Domestic container	0.9
City of Industry - Indio	8,000-ft Z trains	0.6
City of Industry - Indio	10,000-ft Z trains	1
City of Industry - Indio	10,000-ft Domestic container	1
City of Industry - Indio	12,000-ft Domestic container	2.9
City of Industry - Daggett	8,000-ft Z trains	0.4
City of Industry - Daggett	12,000-ft Domestic container	1.1
Alameda Corridor – Indio	Unit auto	1
East LA – Indio	Unit auto	1
Mira Loma – Indio Unit Auto	Unit auto	7
Alameda Corridor – Daggett	Unit bulk	8
Alameda Corridor – Glendale Line	Unit oil	6
Mead (Alameda Corr.) – W. Colton	Carload	3
J Yard - Aurant - West Colton	Carload	2
East LA – West Colton	Carload	4
Montclair - Pomona - West Colton	Carload	2
Glendale Line – West Colton	Carload	5
City of Industry – West Colton	Carload	2
Fontana – West Colton	Carload	2
West Colton – Mojave Subdivision	Carload	6
West Colton – Indio	Carload	23
West Colton – Daggett	Carload	9
Subtotal, LA – Pomona		**98**
Subtotal, Pomona – W. Colton/W. Riverside		**109**
Subtotal, Colton - Indio		**92.6**

Table 27: 2035 Train Counts for the UP Colton – Indio Line Segment

Train Type	**Avg. Trains Per Peak Day**
12,000-ft marine container stack trains	10.5
10,000-ft marine container stack trains	11.2
8,000-ft marine container stack trains	6.3
12,000-ft domestic container stack trains	18.9
10,000-ft domestic container stack trains	8.6
10,000-ft Z trains	2
8,000-ft Z trains	2.1
6,000-ft Z trains	1
Unit auto trains	9
Carload trains	23
Subtotal, Freight trains	**92.6**
Amtrak long distance trains	1
Subtotal, Passenger trains	**1**
Grand total	**92.6**

4. Routing Alternatives

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 as well as 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 passenger and through freight train operations on the same line poses significant 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 (Figure 4) are identical east of Pomona: They concentrate UP through train movements via the Alhambra Subdivision and the Mojave Subdivision, 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. 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. Compared to the Status Quo, they reduce the total through train counts in 2035 through downtown Riverside and downtown San Bernardino by 41 and 10, respectively. See Table 28.

The four alternatives to the Status Quo differ only in terms of 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.

Figure 4: Status Quo Routing

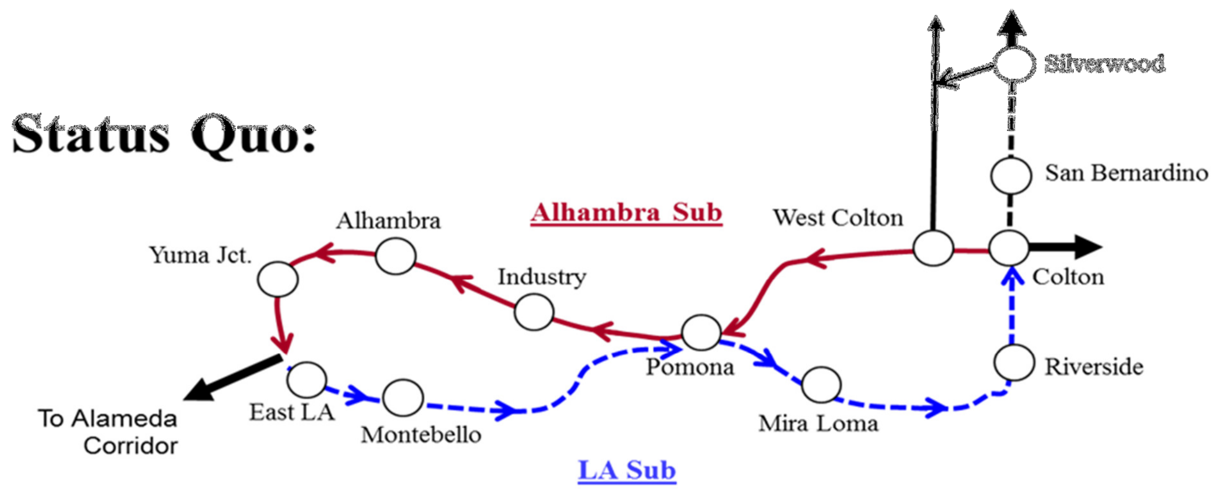


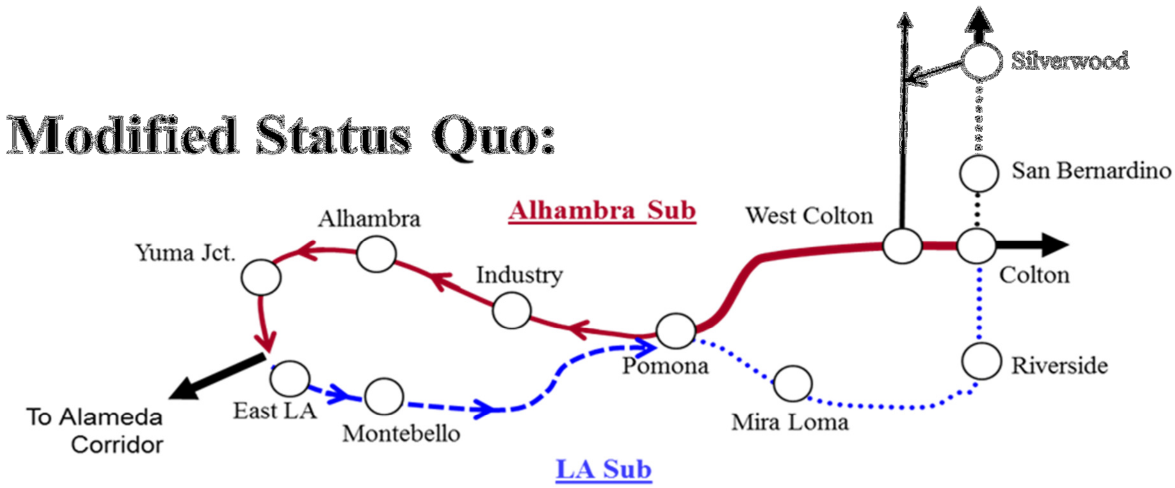
Table 28: Forecasted Peak-Day Through Freight Train Counts in Riverside and San Bernardino

	Riverside	**San Bernardino**
Routing Alternative	**2035**	**2035**
Status Quo	147	119
Alternatives to Status Quo	106	109
Reduction from Alternatives	**41**	**10**

The alternatives to Status Quo are summarized as follows:

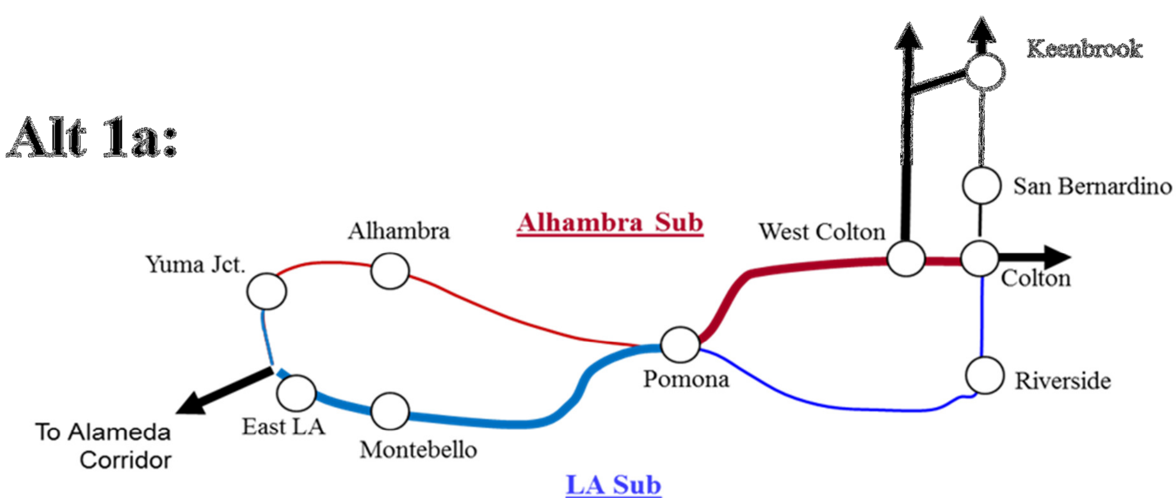
- *Modified Status Quo*: Operations west of Pomona are the same as in the Status Quo, i.e., most UP trains follow a one-way loop westbound on the Alhambra Subdivision and eastbound on the Los Angeles Subdivision. East of Pomona, only the Mira Loma auto trains and a carload local freight normally operate via the Los Angeles Subdivision. Freight trains to/from Daggett operate via the Mojave Subdivision. (Figure 5).

Figure 5: Modified Status Quo Routing



- *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 6). 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 6: Alternative 1a Routing

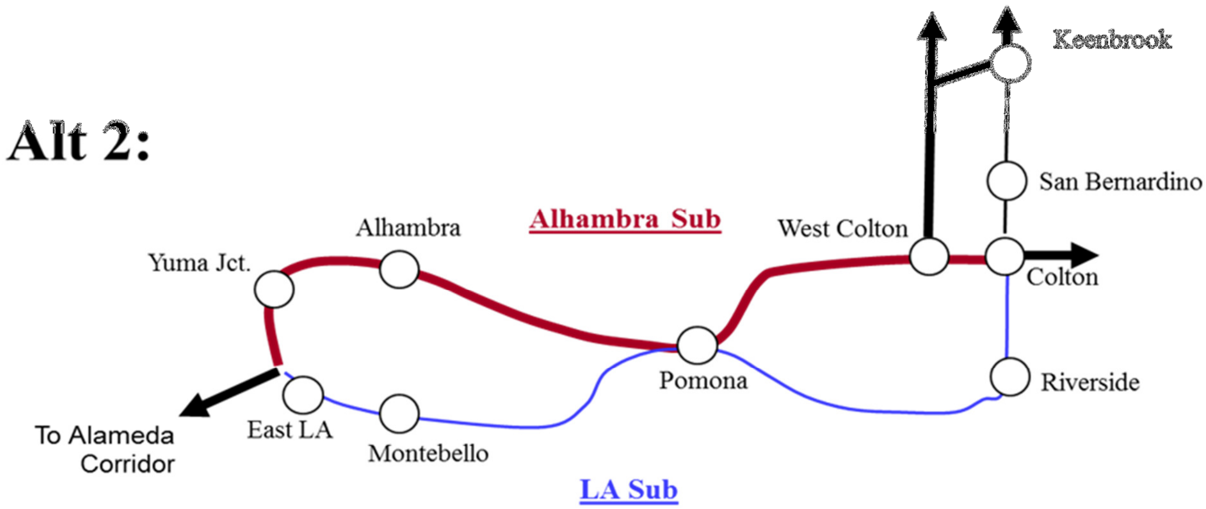


- *Alternative 1b:* Similar to Alternative 1a, but with the additional feature that Metrolink Riverside – Pomona – Los Angeles trains are re-routed via the UP Alhambra Subdivision west of Pomona (blue line, Figure 7). The station stop at City of Industry would be re-sited on the Alhambra Subdivision, 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 CSU-Northridge. 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 disjoint, thereby sharply reducing liability risks.

Figure 7: Alternative 1b Routing

- *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 8). 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 8: Alternative 2 Routing



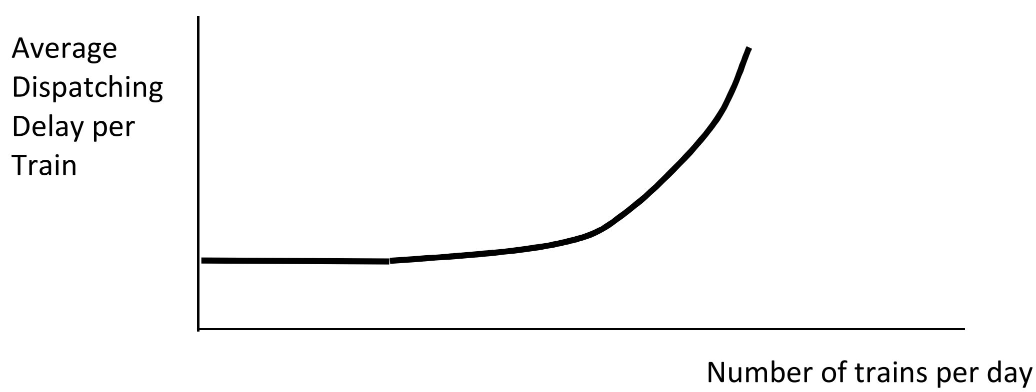
The rationale for formulating and analyzing these four alternatives is as follows. It is clear that future UP freight traffic needs to be concentrated on the UP Alhambra Line west of Pomona, in order to avoid the congestion on the Riverside – Colton Crossing segment that would result from overlaying 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 Los Angeles Subdivision, while Alternative 2 tests concentration of UP freight traffic on the UP Alhambra Subdivision. Alternative 1b tests the additional feature of re-routing Metrolink trains onto the Alhambra Subdivision (west of Pomona) and away from heavy UP freight traffic.

5. Train Dispatching Simulations

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 9 illustrates the general trade-off between transit time and traffic level. The trade-off is worse, i.e., the transit times rise more sharply with increasing volume, 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 to handle the rising freight and passenger volumes. The general analytical strategy taken in this study is to compare Year 2035 dispatching simulations to simulations of the Year 2000 Base Case and take note of the simulated average dispatching delays for BNSF trains, UP trains, Amtrak trains and Metrolink trains. If delays are above Year 2000 levels for any operator, we devise promising track capacity improvements and incorporate them into the 2035 simulations to determine the reduction afforded in dispatching delays. This process continues until a program of track capacity improvements that provides simulated average dispatching delays close to Year 2000 levels for all operators is achieved. In this way, we plan track capacity just sufficient to enable a quality of rail service comparable to that achieved in the Year 2000 Base Case.

Figure 9: Rail Line Capacity: The Trade-Off between Train Volume and Delay



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 Arena© Simulation Language.[15] 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.

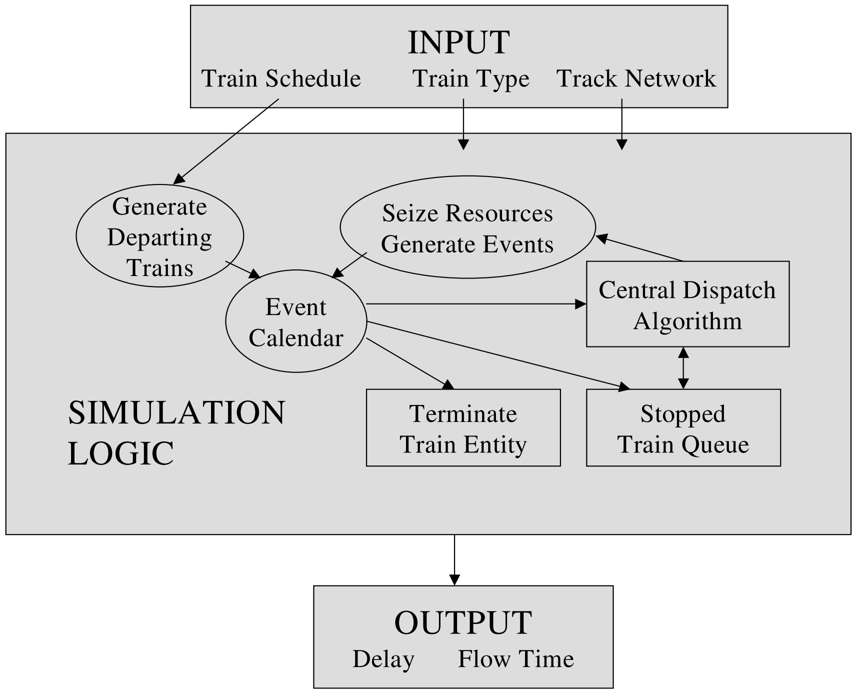
Simulation statistics are compiled for 100 consecutive peak-days (which effectively "stress-tests" the improvements). Freight train departure times are randomized, while passenger train departure times are fixed. The model incorporates assumptions about train lengths and tonnages, acceleration and deceleration 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.[16]

Figure 10 provides a simplified overview of the rail dispatch model. Data-file inputs to the model include Train Schedule, Train Type, and Track Network. The Train Schedule for an origin station generates Departing Train Entities and is stored in the Event Calendar. The 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.

[15] Kelton, W. David, Randall Sadowski and Nancy Swets, 2010. *Simulation with Arena.* Fifth Edition, McGraw-Hill, Inc., New York.

[16] 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 10: 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, 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. The 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 removed from the system. When the simulation finishes, the primary outputs are the average delay and average 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 simulations including all main line rail movements in the study area were completed by Leachman and Associates in previous phases of this study.[17] For convenience, statistics on simulated Year 2000 transit times and dispatching delays are included in this report.

[17] Southern California Association of Governments, *Los Angeles – Inland Empire Railroad Main Line Advanced Planning Study,* October, 2002, and Leachman, Robert C., *Inland Empire Main Line Rail Study,* prepared for Southern California Association of Governments,,June, 2005. Dr. Leachman authored the capacity analysis in the 2002 report.

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.[18] A brief summary of that validation is provided here.

A data set of 25 actual BNSF 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 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 inLos Angeles – Inland Empire Railroad Main Line Advanced Planning Study (2002).[19] 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.

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[18] 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.

[19]Southern California Association of Governments, *Los Angeles – Inland Empire Railroad Main Line Advanced Planning Study,* October, 2002. Dr. Leachman authored the capacity analysis in this report.

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 29. 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 29: 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.

6. Simulation Results

Three simulation models were developed to cover all main rail lines in the study area. One model encompasses all rail main lines from the Redondo connections to the Alameda Corridor to and including Colton Crossing. A second model incorporates lines north of West Colton and Colton Crossing to Barstow. A third model treats the UP Yuma Subdivision from Colton Crossing to Indio.[20] Multiple simulation runs were made with each model, testing the Year 2035 train counts on various trackage configurations and comparing the results to results of runs made in previous studies with Year 2000 trackage and train counts. For reasons of space, statistics on the results of all runs are not reported; in most cases, only the statistics for then run in which dispatching delays were brought down to Year 2000 levels are reported below. The results are discussed separately for each of the three simulation models.

Los Angeles – Colton Crossing

The Status Quo routing of trains was analyzed first. At the outset, the Los Angeles – Colton simulation model was run with a trackage configuration reflecting current conditions plus improvements in progress or announced, as follows:

- BNSF: Three main tracks completed Hobart – Fullerton, trackage as-is Fullerton – West Riverside, trackage as-is West Riverside – Highgrove, three main tracks completed Highgrove – Colton Crossing, Colton Crossing separated with flying-junction connections
- UP Los Angeles Subdivision: As is
- UP Alhambra Subdivision: Two main tracks completed West Colton – Pomona, rest as-is

Simulations of projected 2035 traffic levels following the Status Quo routings over this trackage configuration resulted in excessive and unstable delays. It was evident that more trackage is required. So another simulation run was made with trackage expanded as follows:

- BNSF: Four main tracks Hobart – Fullerton, three main tracks Fullerton – West Riverside, full flying junction at West Riverside, four main tracks West Riverside – Colton Crossing, Colton Crossing separated with flying-junction connections
- UP Los Angeles Subdivision: As is
- UP Alhambra Subdivision: Two main tracks completed West Colton – Pomona and Pomona – City of Industry, full flying junction at Rancho (West Colton), rest as-is

[20] Leachman & Associates LLC also has a simulation model of the Alameda Corridor, but that model was not used in this study.

For this configuration, the dispatching delays were comparable with Year 2000 delays, as documented in Table 30. Shown in the table are both average dispatching delays and average transit times. 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. As may be seen, delays for most train types are less than Year 2000 delays, except delays for BNSF trains, which averaged an additional two minutes. Note that the increment in transit time for BNSF trains is much more than the increment in delay, reflecting the lowering of freight train speed limits on the line and the much heavier and longer trains that are run.

It should be noted that it is very difficult or impossible to totally match Year 2000 dispatching delays on the BNSF Line under Year 2035 traffic levels, even for a four-track railroad Hobart – Fullerton and West Riverside – Colton. An additional two minutes per BNSF train (on average) is as close as could be achieved.

Next, the Modified Status Quo alternative was assessed. The trackage configuration reflecting current conditions plus improvements underway or announced was tested in a simulation. Delays were not nearly as bad as for the Status Quo routing of trains, but still significantly more than the Year 2000 delays. So another simulation run was made with trackage expanded as follows:

- BNSF: Four main tracks Hobart – Fullerton, three main tracks Fullerton – Colton Crossing, Colton Crossing separated with no flying junction connections
- UP Los Angeles Subdivision: As is
- UP Alhambra Subdivision: Two main tracks completed West Colton – Pomona and Pomona – City of Industry, full flying junction at Rancho (West Colton), rest as-is

For this configuration, the dispatching delays compared favorably with Year 2000 delays, as shown in Table 31.

Next, Alternative 1a was assessed. Again, iterative simulations were required to identify appropriate trackage. The trackage configuration yielding dispatching delays comparable to the Year 2000 delays is as follows:

- BNSF: Four main tracks Hobart – Fullerton, three main tracks Fullerton – Colton Crossing, Colton Crossing separated with no flying junction connections
- UP Los Angeles Subdivision: Three main tracks East Los Angeles – Pomona, with Metrolink fly-over at Pomona. As-is east of Pomona.
- UP Alhambra Subdivision: Two main tracks completed West Colton – Pomona and Pomona – City of Industry, full flying junction at Rancho (West Colton), rest as-is.

Table 32 documents the dispatching delays for this alternative. As may be seen, dispatching delays compare favorably to Year 2000 delays.

Next, Alternative 1b was assessed. Again, iterative simulations were required to identify appropriate trackage. The trackage configuration yielding dispatching delays comparable to the Year 2000 delays is summarized as follows:

Table 30: Simulation Results, Los Angeles – Colton Crossing,Status Quo Routing

		Average Delay (mins)				Average Transit Time (mins)			
Year[21]	**Trackage Configuration**	**BNSF**	**UP**	**Metrolink**	**Amtrak**	**BNSF**	**UP**	**Metrolink**	**Amtrak**
2000	Year 2000 trackage	32.7	31.2	11.5	14.1	124.6	117.5	57.6	49.0
2035	BNSF: 4 main tracks Hobart – Fullerton, three main tracks Fullerton – West Riverside, full flying junction at West Riverside, 4 main tracks West Riverside – Colton Crossing, Colton Crossing separated with flying-junction connections UP Los Angeles Subdivision: 2 main tracks Redondo – W. Riverside UP Alhambra Subdivision: 2 main tracks completed West Colton – Pomona and Pomona – City of Industry, full flying junction at Rancho (West Colton), rest as-is	36.1	24.4	12.6	8.6	136.7	114.2	61.9	45.8

[21] "Year" in Tables 35 through 42 refers to the level of rail traffic simulated, i.e., Year 2000 means the Year 2000 train counts were input to the simulation and Year 2035 means the Year 2035 train counts were input to the simulation.

Table 31: Simulation Results, Los Angeles – Colton Crossing, Modified Status Quo Routing

		Average Delay (mins)				Average Transit Time (mins)			
Year	**Trackage Configuration**	**BNSF**	**UP**	**Metrolink**	**Amtrak**	**BNSF**	**UP**	**Metrolink**	**Amtrak**
2000	Year 2000 trackage	32.7	31.2	11.5	14.1	124.6	117.5	57.6	49.0
2035	BNSF: 4 main tracks Hobart – Fullerton, three main tracks Fullerton – Colton Crossing, Colton Crossing separated with flying-junction connections UP Los Angeles Subdivision: Three main tracks Pomona – East LA, flying jct. at Pomona, rest as-is UP Alhambra Subdivision: 2 main tracks completed West Colton – Pomona and Pomona – City of Industry, full flying junction at Rancho (West Colton), rest as-is	26.6	16.1	9.2	7.5	127.2	105.3	58.6	44.7

Table 32: Simulation Results, Los Angeles – Colton Crossing, Alternative 1a Routing

		Average Delay (mins)				Average Transit Time (mins)			
Year	**Trackage Configuration**	**BNSF**	**UP**	**Metrolink**	**Amtrak**	**BNSF**	**UP**	**Metrolink**	**Amtrak**
2000	Year 2000 trackage	32.7	31.2	11.5	14.1	124.6	117.5	57.6	49.0
2035	BNSF: 4 main tracks Hobart – Fullerton, three main tracks Fullerton – Colton Crossing, Colton Crossing separated with flying-junction connections UP Los Angeles Subdivision: As is UP Alhambra Subdivision: 2 main tracks completed West Colton – Pomona and Pomona – City of Industry, full flying junction at Rancho (West Colton), rest as-is	28.6	18.5	11.9	7.4	129.3	101.3	61.3	44.5

- BNSF: Four main tracks Hobart – Fullerton, three main tracks Fullerton – Colton Crossing, Colton Crossing separated with no flying junction connections
- UP Los Angeles Subdivision: As-is East Los Angeles – Pomona, with Metrolink fly-over at Pomona. As-is east of Pomona.
- UP Alhambra Subdivision: Two main tracks completed West Colton – Pomona and Pomona – City of Industry, full flying junction at Rancho (West Colton), rest as-is

Table 33 documents the dispatching delays for this alternative. As may be seen, dispatching delays compare favorably to Year 2000 delays.

Finally, Alternative 2 was assessed. Again, iterative simulations were required to identify appropriate trackage. The trackage configuration yielding dispatching delays comparable to the Year 2000 delays is as follows:

- BNSF: Four main tracks Hobart – Fullerton, three main tracks Fullerton – Colton Crossing, Colton Crossing separated with no flying junction connections
- UP Los Angeles Subdivision: As-is East Los Angeles – Pomona, with Metrolink fly-over at Pomona. As-is east of Pomona.
- UP Alhambra Subdivision: Two main tracks completed West Colton – Pomona and Pomona – City of Industry, full flying junction at Rancho (West Colton), rest as-is

Table 34 documents the dispatching delays for this alternative. As may be seen, dispatching delays compare favorably to Year 2000 delays.

UP Yuma Subdivision

Results for the UP Yuma Line are presented in Table 35. 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 2000 and in 2035.

As may be seen, the existing two-main-track-CTC configuration accommodates the projected 2035 traffic levels with delays and transit times well below the Year 2000 figures. No further improvements are required on this line segment.

BNSF Cajon Subdivision and UP Mojave Subdivision

Results from simulating the rail main lines over Cajon Pass are presented in Tables 36 and 37. 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 Mojave Subdivision 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 both Year 2000 and Year 2035, so these Metrolink operations are not at issue.

Table 33: Simulation Results, Los Angeles – Colton Crossing, Alternative 1b Routing

		Average Delay (mins)				Average Transit Time (mins)			
Year	**Trackage Configuration**	**BNSF**	**UP**	**Metrolink**	**Amtrak**	**BNSF**	**UP**	**Metrolink**	**Amtrak**
2000	Year 2000 trackage	32.7	31.2	11.5	14.1	124.6	117.5	57.6	49.0
2035	BNSF: 4 main tracks Hobart – Fullerton, three main tracks Fullerton – Colton Crossing, Colton Crossing separated with flying-junction connections UP Los Angeles Subdivision: Flying jct. at Pomona, rest as-is UP Alhambra Subdivision: 2 main tracks completed West Colton – Pomona and Pomona – City of Industry, full flying junction at Rancho (West Colton), rest as-is	27.0	12.7	9.9	7.1	129.3	101.3	59.6	44.3

Table 34: Simulation Results, Los Angeles – Colton Crossing, Alternative 2 Routing

		Average Delay (mins)				Average Transit Time (mins)			
Year	**Trackage Configuration**	**BNSF**	**UP**	**Metrolink**	**Amtrak**	**BNSF**	**UP**	**Metrolink**	**Amtrak**
2000	Year 2000 trackage	32.7	31.2	11.5	14.1	124.6	117.5	57.6	49.0
2035	BNSF: 4 main tracks Hobart – Fullerton, three main tracks Fullerton – Colton Crossing, Colton Crossing separated with flying-junction connections UP Los Angeles Subdivision: as-is UP Alhambra Subdivision: 2 main tracks West Colton – Pasadena Jct., full flying junction at Rancho (West Colton), fly-over at Pasadena Jct. East Bank Line: 3 main tracks, 2 main tracks on connection to Redondo	27.0	20.3	9.0	8.2	127.7	108.6	59.1	45.5

Table 35: Simulation Results, Colton Crossing - Indio

		Average Dispatching Delay (minutes)		Average Transit Time (minutes)	
Year	**Trackage Configuration**	**UP**	**Amtrak**	**UP**	**Amtrak**
2000	Year 2000 trackage: Two main tracks Colton – Fingal, Single track CTC Fingal – West Indio, Double track West Indio - Indio	48.4	35.3	193.3	132.3
2035	Two main tracks, Colton - Indio	27.9	27.3	182.2	126.0

Table 36: Simulation Results,West Colton – Hiland, UP Mojavi Subdivision and Colton – Barstow, BNSF Cajon Subdivision, Status Quo Alternative (Case of No Cooperation)

		Average Delay (mins)				Average Transit Time (mins)			
Year	**Trackage Configuration**	**BNSF**	**UP**	**UP Mojave Sub trains**	**Amtrak**	**BNSF**	**UP**	**UP Mojave Sub trains**	**Amtrak**
2000	Year 2000 trackage	35.4	29.4	3.3	71.6	219.1	201.6	89.7	200.5
2035	**UP:** As is **BNSF:** As is	71.9	64.8	15.3	85.0	271.6	229.2	103.1	216.9
2035	**UP:** As is **BNSF:** 3 main tracks Martinez – Barstow, rest as is	69.0	57.5	16.3	75.9	268.6	218.6	104.2	207.8
2035	**UP:** 2 main tracks W. Colton – Keenbrook, rest as is **BNSF:** 3 main tracks Martinez – Barstow, rest as is	57.4	62.1	36.0	63.7	256.7	224.2	123.9	195.6
2035	**UP:** 2 main tracks W. Colton – Keenbrook, rest as is **BNSF:** As is Colton – Keenbrook, 4 tracks Keenbrook – Mojave Narrows, 3 tracks Mojave Narrows - Barstow	34.7	30.5	28.4	49.6	235.4	195.8	121.3	181.5

Table 37: Simulation Results, West Colton – Hiland on the UP Mojave Subdivision and Colton – Barstow on the BNSF Cajon Subdivision, Case of Cooperative Sharing of Main Tracks Keenbrook (Devore Road) - Silverwood

		Average Delay (mins)				Average Transit Time (mins)			
Year	**Trackage Configuration**	**BNSF**	**UP**	**UP Mojave Sub trains**	**Amtrak**	**BNSF**	**UP**	**UP Mojave Sub trains**	**Amtrak**
2000	Year 2000 trackage	35.4	29.4	3.3	71.6	219.1	201.6	89.7	200.5
2035	**UP:** 2 tracks W. Colton – Keenbrook, 1 track Keenbrook – Silverwood **BNSF:** As is Colton – Keenbrook, 3 tracks integrated with UP track Keenbrook – Silverwood, 4 tracks Silverwood – Martinez, 3 tracks Martinez - Barstow	36.2	33.5	41.3	45	235.5	199.0	129.2	176.9
2035	**UP:** 2 tracks W. Colton – Keenbrook, universal crossovers at Keenbrook (Devore Road), 1 track integrated with BNSF track Keenbrook – Silverwood **BNSF:** As is Colton – Keenbrook, 3 tracks integrated with UP track Keenbrook – Silverwood, 4 tracks Silverwood – Mojave Narrows, 3 tracks Mojave Narrows - Barstow	29.5	29.5	30.2	44.6	230.1	185.5	123.1	176.5

Two routing alternatives were simulated for lines north of Colton and West Colton. Under the Status Quo alternative, usage of tracks is as at present, i.e., UP Daggett trains may use the BNSF Cajon Subdivision, entering or exiting the BNSF tracks at Daggett on the north and at Silverwood, Keenbrook, Colton or West Riverside on the south. BNSF Barstow trains may not use the UP Mojave Subdivision.

The first trackage configuration assessed under Status Quo was the as-is configuration. This includes three main tracks on the BNSF Cajon Subdivision between San Bernardino and Martinez. As may be seen in Table 36, Year 2035 delays compare very unfavorably to Year 2000 delays. Next, the BNSF Cajon Subdivision was expanded to three main tracks Martinez to Barstow. This reduced delays, but not nearly enough. Next, the UP Mojave Subdivision was expanded to two main tracks between Rancho (West Colton) and the Keenbrook connection with the BNSF Cajon Subdivision. Again, this reduced delays, but still not enough. So in a fourth iteration (not shown), the BNSF Cajon Subdivision was expanded to four main tracks from the Silverwood connection over Cajon Summit and down to the start of the 1.6% southbound grade at the mouth of the Mojave Narrows (MP 38.0, at the Frost crossovers). Delays were reduced, but still not enough. So in a fifth and final iteration (shown as the last row in the table), a fourth main track was added to the BNSF Cajon Subdivision from the Keenbrook connection to Summit, utilizing the shorter 3% alignment between Cajon station and Summit, with four main tracks continuing down the north side of the Pass to the Mojave Narrows. Average delays by carrier (UP, BNSF, Amtrak) for this fifth trackage configuration are comparable with, or favorable to, Year 2000 delays.

Note the columns marked “UP Mojave Sub trains” in Table 36. These statistics exclude the UP Daggett trains (which may utilize the UP Mojave Subdivision for a portion of their runs), i.e., they only include the six carload trains per day operating via Palmdale to/from Northern California and the Pacific Northwest. As more UP Daggett trains are shifted off the BNSF Cajon Subdivision to fill up the UP Mojave Subdivision line, delays to the Mojave Subdivision carload trains are growing. However, delays to the UP Daggett trains are dropping, and so overall average delays to UP trains are comparable for the final trackage configuration.

The alternative to Status Quo involves cooperative sharing of the UP Mojave Subdivision between universal crossovers near Devore Road (Keenbrook) and the Silverwood connection, whereby both UP Daggett trains and BNSF trains could utilize the UP Mojave Subdivision between those points. In effect, the UP Mojave Subdivision between Keenbrook and Silverwod would become a fourth main track for the BNSF Cajon Subdivision (while still accommodating the UP Mojave Subdivision carload trains). Table 37 displays the simulated dispatching delays. A trackage configuration was tested with only three main tracks on the north side of Cajon Pass, but simulated dispatching delays were slightly higher than the Year 2000 delays. So another simulation was made including a fourth main track from Silverwood to Mojave Narrows. For this trackage configuration, delays were comparable to or compared favorably with Year 2000 delays.

Again, delays to UP Mojave Subdivision carload trains are higher, but overall average delays to UP freight trains are not, reflecting much-improved performance of the Daggett trains. In particular, despite the transition to much longer trains, the average transit time of UP freight trains in this territory drops by 15 minutes, compared to Year 2000, and it drops by 10 minutes compared to the Year 2035 Status Quo alternative.

7. Summary of Track Capacity Improvements

Improvements Required West and South of Colton Crossing

Table 38 summarizes the track capacity improvements required on the BNSF Line west and south of Colton Crossing. (Increments in track capacity are highlighted in bold type.) As may be seen, by 2035 the BNSF must become a four-main-track railroad Hobart – Fullerton Jct., and a three-main-track railroad Fullerton Jct. – West Riverside. The Alternatives to the Status Quo (i.e., Modified Status Quo, Alternative 1a, Alternative 1b, and Alternative 2) save construction of a flying junction at West Riverside, and they save construction of a fourth main track West Riverside – Colton Crossing.

Table 38: Summary of Required Track Capacity on BNSF Line, South and West of Colton Crossing

(Figures express required numbers of main tracks.)

Line Segment	Existing in 2010	Status Quo 2035	Alternatives 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, level connections**

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

Table 39 summarizes the track capacity improvements required under the Status Quo on the UP Lines west of Colton Crossing. As shown in the table, the UP Los Angeles Subdivision must be expanded to 2 main tracks over its entire extent. The UP Alhambra Subdivision must be expanded to 2 main tracks from Pomona west to the City of Intermodal intermodal facility. Flying junctions are required at West Riverside and Rancho (West Colton).

Table 39: Summary of Required Track Capacity on UP Line, West of Colton Crossing – Status Quo Alternative

(Figures express required numbers of main tracks.)

Line Segment	Existing in 2010	2035
UP Los Angeles Subdivision		
West Riverside MP 56.7 – Streeter MP 55.5	1	**2**
Streeter MP 55.5 – Arlington MP 52.6	2	2
Arlington MP 52.6 – Limonite MP 49.9	1	**2**
Limonite MP 49.9 – Bon View MP 38.4	2	2
Bon View MP 38.4 – WO Tower MP 33.0	1	**2**
WO Tower MP 33.0 – Oak MP 30.8	2	2
Oak MP 30.8 – Roselawn MP 30.5	1	**2**
Roselawn MP 30.5 – Weeds (East LA) MP 3.8	2	2
Weeds (East LA) MP 3.8 – Soto St. Jct. MP 2.1	3	3
Soto St. Jct. MP 2.1 – CP East Redondo MP 1.6	2	2
UP Alhambra Subdivision		
Colton Crossing MP 538.7 – Rancho MP 538.5	2	2
Rancho Jct. with Mojave Subdivision MP 538.5 at West Colton	Partial flying	**Full flying**
Rancho (West Colton) MP 538.5 – Sierra MP 532.4	2	2
Sierra MP 532.4 – Reservior MP 515.1	1	**2**
Reservoir MP 515.1 – Hamilton MP 513.7	2	2
Pomona route connections (Reservior – WO Tower – Oak – Hamilton)	At-grade crossovers	At-grade crossovers
Hamilton MP 513.7 – City of Industry MP 502.7	1	**2**
City of Industry MP 502.7 – Alhambra MP 488.3	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	1	1

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

Four routing alternatives to the Status Quo were investigated west of Colton Crossing, identified as Modified Status Quo, Alternatives 1(a), 1(b) and 2. As explained in section 4 of this Appendix, all three of these alternatives are identical east of Pomona. They minimize UP through freight trains over the UP Los Angeles Subdivision 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 40 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 Subdivision from West Colton to Pomona. In common with the Status Quo alternative, by 2035 they require a full flying junction of the UP Alhambra and Mojave Subdivisions at Rancho. However, in contrast to Status Quo, the alternatives make no improvements to the Los Angeles Subdivision between Pomona and Riverside.

Table 40: 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	**2035**
UP Los Angeles Subdivision		
West Riverside MP 56.7 – Streeter MP 55.5	1	1
Streeter MP 55.5 – Arlington MP 52.6	2	2
Arlington MP 52.6 – Limonite MP 49.9	1	1
Limonite MP 49.9 – Bon View MP 38.4	2	2
Bon View MP 38.4 – WO Tower MP 33.0	1	1
UP Alhambra Subdivision		
Colton Crossing MP 538.7 – Rancho MP 538.5	2	2
Rancho Jct. with Mojave Subdivision MP 538.5 at West Colton	Partial flying	**Full flying**
Rancho (West Colton) MP 538.5 – Sierra MP 532.4	2	2
Sierra MP 532.4 – Reservior MP 515.1	1	**2**
Reservoir MP 515.1 – Hamilton MP 513.7	2	2
Pomona route connections (Reservior – WO Tower – Oak – Hamilton)	At-grade crossovers	**Metrolink 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.

Note that Alternative 2 does not require a fly-over for Metrolink at Pomona, but the other alternatives to Status Quo require a fly-over to accommodate the heavy UP freight flows shifting between the Alhambra and Los Angeles Subdivisions.

Because these three alternatives route UP freight traffic differently west of Pomona, their improvement plans are different between Pomona and downtown Los Angeles. Table 41 summarizes these improvements. As may be seen, in 2035, like Status Quo, the Alternatives to Status Quo require two main tracks between Pomona and City of Industry to accommodate heavy intermodal traffic to/from that terminal. The Modified Status Quo Alternative is the same as Status Quo west of Pomona, with two main tracks on the Los Angeles Subdivision and one main track on the Alhambra Subdivision west of City of Industry. Alternative 1a requires triple tracking of the UP Los Angeles Subdivision west of Pomona. Alternative 2 requires double-tracking of the UP Alhambra Subdivision 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 similar to Modified Status Quo in terms of track capacity, with two tracks on the UP Los Angeles Subdivsion and one track on the UP Alhambra Subdivision west of City of Industry, but in addition it requires the Metrolink fly-over at Pomona (as noted above).

Table 41: Summary of Required Track Capacity on UP Lines West of Pomona for Alternatives to Status Quo Routing

(Figures express required numbers of main tracks.)

		2035			
	Existing in 2010	**Mod Status Quo**	**Alt 1a**	**Alt 1b**	**Alt 2**
Los Angeles Subdivision					
WO Tower MP 33.0 – Oak MP 30.8	2	2	2	2	2
Oak MP 30.8 – Roselawn MP 30.5	1	**2**	**3**	**2**	1
Roselawn MP 30.5 – Weeds (East LA) MP 3.8	2	2	**3**	2	2
Weeds MP 3.8 – Soto St. Jct. MP 2.1	3	3	3	3	3
Soto St. Jct. MP 2.1 – CP East Redondo MP 1.6	2	2	3	3	2
Alhambra Subdivision					
Pomona route connections (Reservior – WO Tower – Oak – Hamilton)	At-grade cross-overs	At-grade cross-overs	**Metrolink fly-over**	**Metrolink fly-over**	At-grade cross-overs
Hamilton MP 513.7 – City of Industry MP 502.7	1	**2**	**2**	**2**	**2**
City of Industry MP 502.7 – Alhambra MP 488.3	1	1	1	1	**2**
Alhambra MP 488.3 – Yuma Jct. MP 482.8	2	2	2	2	**2**
Yuma Jct. MP 482.8 – Pasadena Jct. MP 482.3	1	1	1	1	**2**
Metrolink crossing at Pasadena Jct.	At grade	At grade	At grade	At grade	**Fly-over**
Pasadena Jct. MP 482.3 – Ninth St. Jct. MP 484.9	2	2	2	2	**3**
Ninth St. MP 484.9 – CP East Redondo	1	1	1	1	**2**

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

Improvements Required East and North of Colton Crossing

Given the recent completion of two main tracks to Indio on the UP Yuma Subdivsion, no further improvements are required eastward from Colton Crossing to Indio. North from Colton Crossing is a different story. Table 42 summarizes track capacity improvements required north of Colton Crossing and north of West Colton.

On the UP Mojave Subdivision, two main tracks are required in 2035 between Rancho and connection to the BNSF Cajon Subdivision at Keenbrook.

Under the alternatives to the Status Quo, all UP Daggett through freight trains are routed via the UP Mojave Subdivision to connections with the BNSF at Keenbrook or Silverwood. Moreover, it is proposed under these alternatives that the Mojave Subdivision becomes integrated with the BNSF Cajon Subdivision, whereby the UP Mojave Subdivision line can be utilized by BNSF trains between route connections at Devore Road (Keenbrook) and Silverwood, just as UP Daggett trains can use the BNSF tracks.

On the BNSF Line, the 2035 traffic volumes can be accommodated on the existing three main tracks Colton Crossing – Keenbrook, assuming the parallel UP Mojave Subdivision is equipped with two main tracks. To match Year 2000 dispatching delays under Status Quo, a fourth main train is required Keenbrook – Silverwood – Martinez – Mojave Narrows. A third main track is required from the Mojave Narrows to Barstow.

Considering the BNSF Cajon Line and the UP Mojave Subdivision collectively, there already exist four main tracks up the south side of Cajon Pass, three 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 42). As noted above, under this scheme, all UP Daggett trains are normally routed via the UP Mojave Subdivision between West Colton and Devore Road (Keenbrook).

Table 42: Summary of Required Track Capacity North of Colton Crossing and West Colton

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

		Status Quo	**Alternatives**
	Existing in 2010	**2035**	**2035**
UP Mojave Subdivision			
West Colton – Keenbrook (Devore Road)	1	**2**	**2**
Keenbrook - Silverwood	1	1	**1 integrated with BNSF**
BNSF Cajon Subdivision			
Colton Crossing	At-grade	**Grade-separated, with flying jct. connections**	**Grade-separated, level connections**
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 conn.	One conn.	**Univ. conns.**
Devore Road – Cajon	3	**4**	**3 + use of UP Mojave Sub**
Cajon – Silverwood	Two 2.2%, one 3%	**Two 2.2%, two 3%**	**Two 2.2%, one 3% + use of UP Mojave Sub**
Silverwood connection	One conn.	One conn.	One conn.
Silverwood – Martinez	Three 2.2%	**Four 2.2%**	**Four 2.2%**
Martinez – Mojave Narrows	Two 1.6%	**Four 1.6%**	**Four 1.6%**
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.

8. 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 2010 unit costs were developed by applying an inflation factor to Year 2001 unit costs for new railroad construction.[22] 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.[23] That 2010/2001 factor is 1.40983. This figure is equivalent to a 3.89% compound annual growth rate. Table 43 summarizes the unit cost assumptions for 2010.

Table 43: Unit Cost Assumptions

(All figures in 2010 dollars)

Item	**Cost per track-mile**
For new main-line track:	
Roadbed	$196,200
Drainage	$42,300
Track	$1,043,300
Signals	$1,409,800
Utility relocation	$704,900
Right of way, east and north of Colton	$166,800
Right of way, west of Colton	$3,528,100
Subtotals:	
Cost per track-mile, east and north of Colton	$3,563,400
Cost per track-mile, west of Colton	$6,924,700
Exceptional items	**Unit cost**
Bridges	$70,492 per track-foot
Power-switch crossovers	$528,700 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

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

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

As may be seen, basic main-line costs amount to about $3.6 million per mile east and north of Colton and $6.9 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. These costs do not include any enhancements or additions for environmental mitigation or mitigation of impacts on vehicular traffic, i.e., they are cost estimates for solely the track capacity aspect of improvements.

Separated Crossings

Colton Crossing (all alternatives in 2035) - $116.9 million. Assumes UP Yuma Subdivision is elevated over existing BNSF tracks. UP Yuma Subdivision would have 1% approach grades in both directions. Costs for a third main track CP29 to Colton Crossing are included. Costs for a connection of the UP Yuma Subdivision (towards West Colton yard) with the BNSF Line (towards San Bernardino) passing under the UP Yuma Subdivision are included. Costs for a flying-junction connection of the UP Yuma Subdivision (towards Indio) to the BNSF Line (towards Riverside) are not included in this figure but are separately tabulated under Flying Junctions below.

Pasadena Jct. Metrolink Fly-over (Alternative 2 in 2035) - $51.9 million.

Flying Junctions

West Colton (Rancho) Full Flying Junction of UP Mojave and Alhambra Subdivisions and yard approaches (all alternatives in 2035) - $77.9 million.

Pomona Metrolink Fly-over and route connections (Alternatives 1a and 1b in 2035) - $51.9 million.

Colton Crossing Flying Junction connection of UP Yuma Subdivision (towards Indio) to BNSF Line (towards Riverside) (Status Quo alternative in 2035) - $26 million (as an add-on to the Colton Crossing separation)

West Riverside Flying Junction connection of UP Los Angeles Subdivision to BNSF Line (Status Quo alternative in 2035) - $64.9 million.

(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 Cajon Subdivision, Cajon to Summit (one added 3% track for the Status Quo alternative in 2035) - $51.9 million. Numerous deep cuts and high fills are required on this segment.

BNSF Cajon Subdivision, Keenbrook to Cajon (1 added 2.2% track for the Status Quo alternative in 2035) - $51.9 million. Several deep cuts and high fills are required on this segment.

BNSF Cajon Subdivision, Frost to Victorville (through Mojave Narrows) (1 added track for all alternatives in 2035) - $51.9 million. Excavating the high canyon wall along the Mojave River is required to accommodate a third main track.

UP Los Angles Subdivision, Streeter – West Riverside (Status Quo alternative in 2035) - $32.5 million. Excavation of the side of a large hill in West Riverside is required, involving the protection or property-taking 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 Subdivision. This necessitates a new station at City of Industry to replace the current station situated on the UP Los Angeles Subdivision. 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 included in cost estimates. (However, should this alternative be adopted, Metrolink may choose to route its trains west of El Monte via its Los Angeles Subdivision and thereby serve California State University, Los Angeles . To be conservative, costs for an additional Metrolink station are included in this study. The costs for each of these new stations, including property acquisition and construction, were estimated in 2004 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	Approximately $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	Approximately $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.

To these 2004 cost estimates, the Army Corps of Engineers inflation factors for the years 2005, 2006, 2007, 2008, 2009 and 2010 are applied. The aggregate factor is 1.298338. This inflation factor results in Year 2010 cost estimates of $24.7 million for the City of Industry re-located station and $9.3 million for the new Alhambra station.

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 44 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 Subdivsion.

Table 44: Summary of Estimated Rail Infrastructure Costs by Line Segment

(millions of 2010 dollars)

Line Segment	**2035**
UP Yuma Subdivision	
Rancho (West Colton) – Indio (excluding Colton Xing), all alternatives	$0
UP Mojave Subdivision	
Devore Road – West Colton (including Rancho flying jct.), all alternatives	$286.8
Silverwood – Devore Road, all alternatives	$0.0
BNSF Line	
Barstow – Silverwood, all alternatives	$438.0
Silverwood – Keenbrook, Status Quo	$245.7
Summit – Keenbrook, Alternatives to Status Quo	$0.5
Keenbrook – Colton CP 29	$0
Colton CP 29 – West Riverside (including Colton Xing), Status Quo	$418.0
Colton CP 29 – West Riverside (including Colton Xing), Alternatives to Status Quo	$199.7
West Riverside – Redondo, all alternatives	$732.3
UP Alhambra Subdivision	
West Colton – Pomona, all alternatives	$207.8
Pomona route connections, all alternatives except 1a and 1b	$2.1
Pomona route connections, Alternatives 1a and 1b	$54.0
Pomona – City of Industry, all alternatives	$79.0
City of Industry – Yuma Jct. – Redondo, Alternative 1b	$34.0
City of Industry – Yuma Jct. – Redondo, Alternative 2	$231.0
City of Industry – Yuma Jct. – Redondo, all alternatives except Alternatives 1b and 2	$0.0
UP Los Angeles Subdivision	
West Riverside – Pomona, Status Quo	$208.5
West Riverside – Pomona, alternatives to Status Quo	$0.0
Pomona – Redondo, Status Quo, Modified Status Quo and Alternative 2	$0.0
Pomona – Redondo, Alternative 1a	$400.0
Pomona – Redondo, Alternative 1b	$0.0

Total Costs by Alternative

Table 45 summarizes the total capital costs by routing alternative.

Table 45: Estimated Rail Infrastructure Costs by Routing Alternative
(billions of 2010 dollars)

Alternative	Total East and North of Colton Xing	Total Colton Xing and West	Total Capital Cost	Total less improvements already fully funded
Status Quo	$0.970	$1.648	$2.618	$2.379
Modified Status Quo	$0.725	$1.221	$1.946	$1.707
1a	$0.725	$1.673	$2.398	$2.159
1b	$0.725	$1.307	$2.032	$1.793
2	$0.725	$1.458	$2.183	$1.944

As may be seen, the total costs of the alternatives range between $2.0 and $2.6 billion dollars to raise Year 2000 track capacity to accommodate Year 2035 traffic levels. Accounting for track capacity improvements already completed or fully funded in Year 2010 (discussed below), this range is reduced to $1.7 to $2.4 billion. Modified Status Quo is least costly at $1.95 billion, about $85 million less than Alternative 1b, $450 million less Alternative 1a, $240 million less than Alternative 2, and $670 million less than the Status Quo.

The capital costs listed in the second and third columns of the table start with the Year 2010 track configuration as a base. As of mid-2010, the following improvements to that configuration were fully funded and under construction. (For purposes of comparison, the cost figures for the improvements listed below were developed using the cost estimation methodology in this study and are not the actually projected expenditure amounts.)

- Third main track on BNSF Line, Serapis MP 151.1 – Valley View MP 158.7, funded by Caltrans: $121.8 million (under construction). Improvement required for all alternatives in 2035. Completion of this project is delayed pending award of street crossing grade separation funds.
- Colton Crossing separation, funded jointly by the State of California, Federal Government TIGER funds, and the BNSF and UP railroads: $116.9 million. Improvement required for all alternatives in 2035. The funded project lifts the UP Yuma Subdivision main tracks but it does not include a flying junction connection between the UP Yuma Subdivision towards Indio and the BNSF San Bernardino Subdivision towards Riverside.
- Total for capacity improvements already funded: $238.7 million.

The $239 million in funded capacity improvements to date represents about 12.2% of the required capital outlays to raise capacity under the Modified Status Quo Alternative to accommodate Year 2035 traffic levels. The remaining projects would require outlays of about $68.3 million per year (expressed in 2010 dollars).