Hybrid Rail Study

Appendix A: Rail Modeling Summary Report

May 3, 2018

San Bernardino County Transportation Authority

Mott MacDonald
1000 Wilshire Boulevard
Suite 400
Los Angeles CA 90017
United States of America

T +1 (818) 506 8088
mottmac.com

San Bernardino County
Transportation Authority
1170 W 3rd Street
San Bernardino CA 92410

Hybrid Rail Study

Appendix A: Rail Modeling Summary Report

May 3, 2018

Issue and revision record

Revision	Date	Originator	Checker	Approver	Description
V1	4/30/18	Rick Degman	JD Douglas	Eric Banghart	Internal Draft

Document reference: 309710 | A | 1

Information class: Standard

Contents

Tables

Figures

Acronyms and Abbreviations

BNSF	BNSF Railway
CMF	Central Maintenance Facility
IEMF	Inland Empire Maintenance Facility
OTP	On-Time Performance
CP	Control Point
HR	hybrid-rail
LAUS	Los Angeles Union Station
LHC	locomotive-hauled consist
MP	milepost
ONT	Ontario International Airport
RPRP	Redlands Passenger Rail Project
RTC	Rail Traffic Controller
SBL	Metrolink San Bernardino Line
SBTC	San Bernardino Transit Center
STS	service transfer station

1 Rail Operations Modeling

1.1 Purpose

Rail Operations Modeling is a computer simulation of railroad operations, infrastructure, and operating conditions used in the railway industry to help find solutions for operational and infrastructure challenges. Rail Traffic Controller (RTC) software, developed by Berkeley Simulation Software, is the standard simulation software utilized by every major railroad and most transit systems in North America, and was utilized for this study. RTC provides analysis to help validate that a particular project achieves the results intended.

For this study, RTC modeling was used to test various hybrid-rail and Metrolink service scenarios against existing infrastructure of the Metrolink San Gabriel Subdivision and planned infrastructure of the Redlands Passenger Rail Project (RPRP) corridor. The analysis helps determine how well the infrastructure would operationally support each scenario and what, if any, infrastructure improvements may be necessary to provide reliable operation.

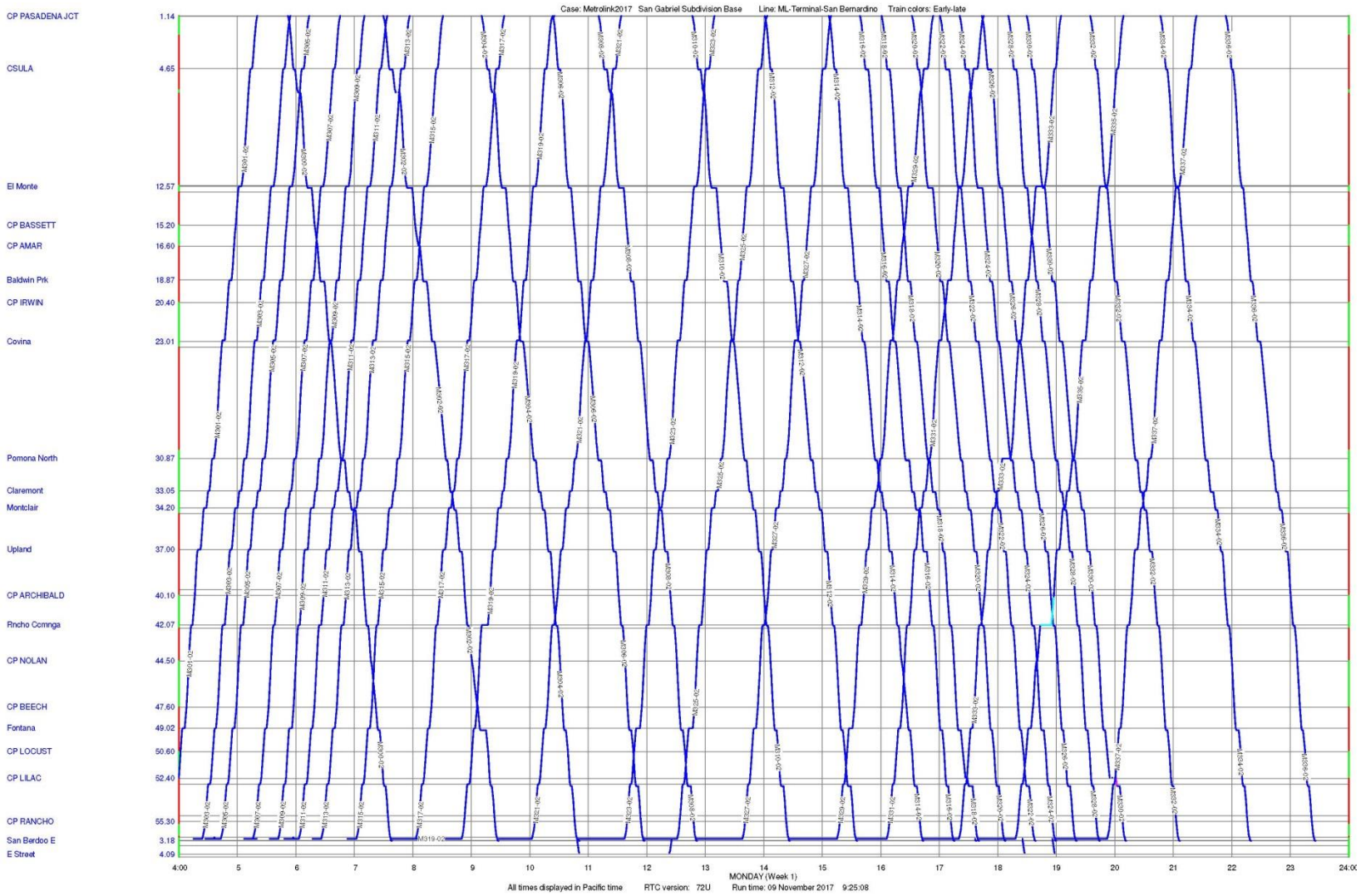
1.2 Stringline Charts: Key Rail Traffic Controller Modeling Output

Stringline charts indicate the location and timing of trains over a particular route segment. A stringline depicts the following information:

- The vertical axis represents the route locations by milepost (MP) and control point (CP) and/or station.
- The vertical bar represents the infrastructure location and type. A red section of the vertical bar indicates a route segment that consists of one single main track, and a green section consists of two main tracks, or one main track and a passing track.
- The horizontal axis represents the time of day.
- Trains are represented by lines on the graph, illustrating their location at a particular time of the day. The particular train number is shown along the line. The point where lines cross indicates where trains operating in opposite directions pass or “meet” each other.
- Stringline charts in this report portray one RTC model run and represent a “perfect” day of operation, with all trains operating on schedule.

As an example, a stringline chart depicting current Metrolink operations of the San Gabriel Division during a typical weekday is shown on Figure 1-1.

Figure 1-1. Stringline Chart for 2018 Metrolink San Bernardino Line Service



2 Phase 1A: Baseline Scenario, University of Redlands to Claremont

2.1 Scope

The purpose of this modeling phase is to utilize existing Metrolink San Gabriel Subdivision infrastructure and planned RPRP infrastructure to determine the route's ability to accommodate a combination of locomotive-hauled consists (LHC) and hybrid-rail consists (HR) between University of Redlands and Los Angeles Union Station (LAUS). Specifically, the modeling will help determine:

- If and how existing Metrolink peak LHC service can operate in "express" mode between LAUS and the San Bernardino Transit Center (SBTC), with HR providing "local" service connecting passengers at key stations with Metrolink Express Trains
- The feasibility of converting off-peak LHC service to HR operation, as long as HR equipment has sufficient capacity to accommodate existing Metrolink ridership levels

2.2 Locomotive-Hauled Consists Express Service with Hybrid-Rail Consists Local Service

2.2.1 Los Angeles to Covina Route Segment

In 2014, the *Metrolink San Bernardino Line* (SBL) *Infrastructure Improvement Strategic Study* (Metrolink 2014) was released. The report concluded that a key constraint to increasing peak service on the SBL is the single track operation between Pasadena Junction (MP 0.9) and CP Hondo (MP 12.5). This track segment severely restricts the Metrolink's ability to increase inbound AM or outbound PM peak service to and/or from LAUS without either rerouting or eliminating reverse-peak service or upgrading the infrastructure (a difficult proposition, as most of this segment resides in the center median of I-10). There is not enough capacity to add additional peak service frequencies on top of the existing Metrolink service schedule in this segment. For this reason, the addition of HR local service was not analyzed in this segment during this modeling phase.

2.2.2 Selection of a Westernmost Hybrid-Rail Station and Layover Track

Although a full analysis of the preferred location for the westernmost HR station on this route segment has not been completed, a hypothetical location needed to be selected for the purpose of this modeling phase. A primary requirement for the westernmost HR station stop is the need for a layover track to be constructed immediately west of station. This track would be used by HR train sets while changing operating ends and awaiting scheduled departure times, thereby minimizing the use of mainline capacity and improving operational flexibility.

A cursory look at right-of-way near the El Monte, Baldwin Park, and Covina stations did not show any vacant land suitable for this use. Directly west of the Pomona (North) station, however, there appears to be vacant property adjacent to the San Gabriel Subdivision that may allow for the construction of a layover track. A full analysis of the preferred location, including potential impacts to the Metro Gold Line extension to Montclair, is underway but has not been completed for inclusion in this modeling phase.

For the purposes of this modeling Phase 1A, the HR service will only operate between Pomona (North) (North) and University of Redlands.

2.2.3 Selection of Express and Local Schedule Times

On April 4, 2016, Metrolink initiated a major schedule change for the SBL, with the intent of providing a more reliable service by reducing the amount of late performing trains on the route. Since the schedule implementation, on-time performance and customer satisfaction for the route has improved considerably. As a result of the success of the schedule change, Metrolink expressed concerns that any change in the schedules resulting from implementation of local HR and express LHC trains could negatively impact the route's overall performance and such impacts should be avoided. Metrolink also expressed its opinion that headway times between trains be as long as necessary to ensure a minimal risk of delays from one late train "cascading" delays to following trains.

Upon reviewing the April 3, 2017, Metrolink Timetable, there are two gaps between consecutive trains in both the AM and PM peak service periods where a HR local train might be inserted successfully, allowing for an adjacent LHC train to be converted to an express. Figure 2-1 illustrates the gaps in the AM peak schedule.

Figure 2-1. AM Peak Schedule Headway Gaps

Metrolink Train No.	301	303	305	Gap	307	309	311	313	Gap	315
SBTC (estimated time)	3:47	4:19	4:38	**0:33**	5:11	5:37	5:57	6:21	**0:36**	6:57
L.A. Union Station	5:26	5:59	6:20		6:50	7:16	7:40	8:02		8:36

The longest headway gaps in the AM peak service are between Trains 305 and 307 (33 minutes) and 313 and 315 (36 minutes). Figure 2-2 illustrates the gaps in the PM peak schedule.

Figure 2-2. PM Peak Schedule Headway Gaps

Metrolink Train No.	314	316	318	Gap	320	Gap	322	324	326
L.A. Union Station	3:02	3:34	3:56	**0:29**	4:25	**0:31**	4:56	5:16	5:39
SBTC (estimated time)	4:44	5:16	5:48		6:13		6:44	7:05	7:26

The longest headway gaps in the PM peak service are between Trains 318 and 320 (29 minutes) and 320 and 322 (31 minutes). These peak period gaps provide the best opportunity to insert a local train without negatively impacting other existing Metrolink schedules and were, therefore, selected for further analysis.

In selecting the express service stops, Pomona (North) is the hypothetical service transfer station (STS) location and the westernmost stop for the HR local service, which automatically qualifies it as an express stop. As desired by Metrolink, all stops west of Pomona (North) would continue to be served by all trains. Rancho Cucamonga was selected as the other express stop because it was a stop for Metrolink's previous express service offering and supports some of the route's highest ridership. For modeling purposes, SBTC would be the easternmost stop, with the exception of one express round trip extending to downtown Redlands. All other stops between Pomona (North) and SBTC would be skipped by the express service and served by the local HR trains and the non-express Metrolink trains. Those stops include Claremont, Montclair, Upland, Fontana, Rialto, and San Bernardino (Santa Fe Station). It is estimated that elimination of those stops will reduce the overall express schedule time by approximately 12 to 30 minutes, depending on the recovery time inserted by Metrolink in the schedule. Adding an additional express station stop would have little or no impact on the rest of the daily schedule but would add 2 to 5 minutes running time to the express trains.

To facilitate a platform transfer of passengers between services, local trains would arrive at the STS 5 minutes before the express on the morning westbound schedules and depart 5 minutes after the express

trains on the afternoon eastbound schedules. Figure 2-3 shows the updated SBL schedules with four HR local and four LHC trains converted to express trains, stopping at SBTC, Rancho Cucamonga, and Pomona (North). The schedules also depict non-peak HR schedules intended to position the equipment for the peak local schedules.

Figure 2-3. San Bernardino Line Schedule with Local and Express Train Services

Metrolink Train No.	301	303	305	Local	307E	309	311	313	Local	315E	317	319	321	323	325	327	329	Local	331	Local	333	335	337
SBTC	3:47	4:19	4:38	5:01	5:19	5:37	5:57	6:21	6:46	7:06	7:58	8:45	9:57	11:32	12:26	1:33	3:10	3:31	4:01	4:12	5:15	6:21	7:51
Rancho Cucamonga	4:14	4:47	5:06	5:29	5:42	6:04	6:26	6:49	7:14	7:29	8:25	9:17	10:25	12:02	12:56	2:01	3:40	3:59	4:29	4:41	5:43	6:55	8:15
Pomona (North)	4:32	5:08	5:27	5:51	5:55	6:26	6:46	7:10	7:36	7:42	8:47	9:38	10:47	12:23	1:17	2:23	4:01	4:21	4:50	5:03	6:13	7:10	8:40
L.A. Union Station	5:26	5:59	6:20		6:45	7:16	7:40	8:02		8:32	9:39	10:30	11:39	1:15	2:08	3:14	5:00		5:53		7:10	8:11	9:31

Metrolink Train No.	Local	300	Local	302	304	306	308	310	312	314	316	318E	Local	320E	Local	322	324	326	328	330	332	334	336
L.A. Union Station		5:46		7:25	9:06	10:19	11:06	12:42	1:56	3:02	3:34	3:56		4:25		4:56	5:16	5:39	6:06	6:25	7:30	8:42	9:49
Pomona (North)	6:30	6:50	8:05	8:35	10:06	11:13	12:06	1:42	2:50	3:56	4:29	4:50	4:55	5:23	5:28	5:53	6:15	6:36	7:01	7:19	8:23	9:35	10:42
Rancho Cucamonga	6:54	7:14	8:29	8:57	10:28	11:35	12:28	2:04	3:12	4:18	4:54	5:03	5:17	5:36	5:50	6:15	6:37	6:58	7:23	7:41	8:45	9:57	11:04
SBTC	7:24	7:44	8:59	9:33	10:55	12:03	12:57	2:31	3:36	4:49	5:21	5:26	5:44	5:59	6:17	6:44	7:05	7:26	7:52	8:17	9:12	10:25	11:31

Figure 2-4 and Figure 2-5 depict the stringline charts for AM and PM peak periods. The local trains are shown in light blue lines and the express trains are in red. Positioning movements for the local HR train sets (eastbound to SBTC in the AM and westbound to Pomona (North) in the PM) are not included in the charts but would yield priority to peak Metrolink trains on single track segments.

Figure 2-4. Stringline Chart for AM Peak Service

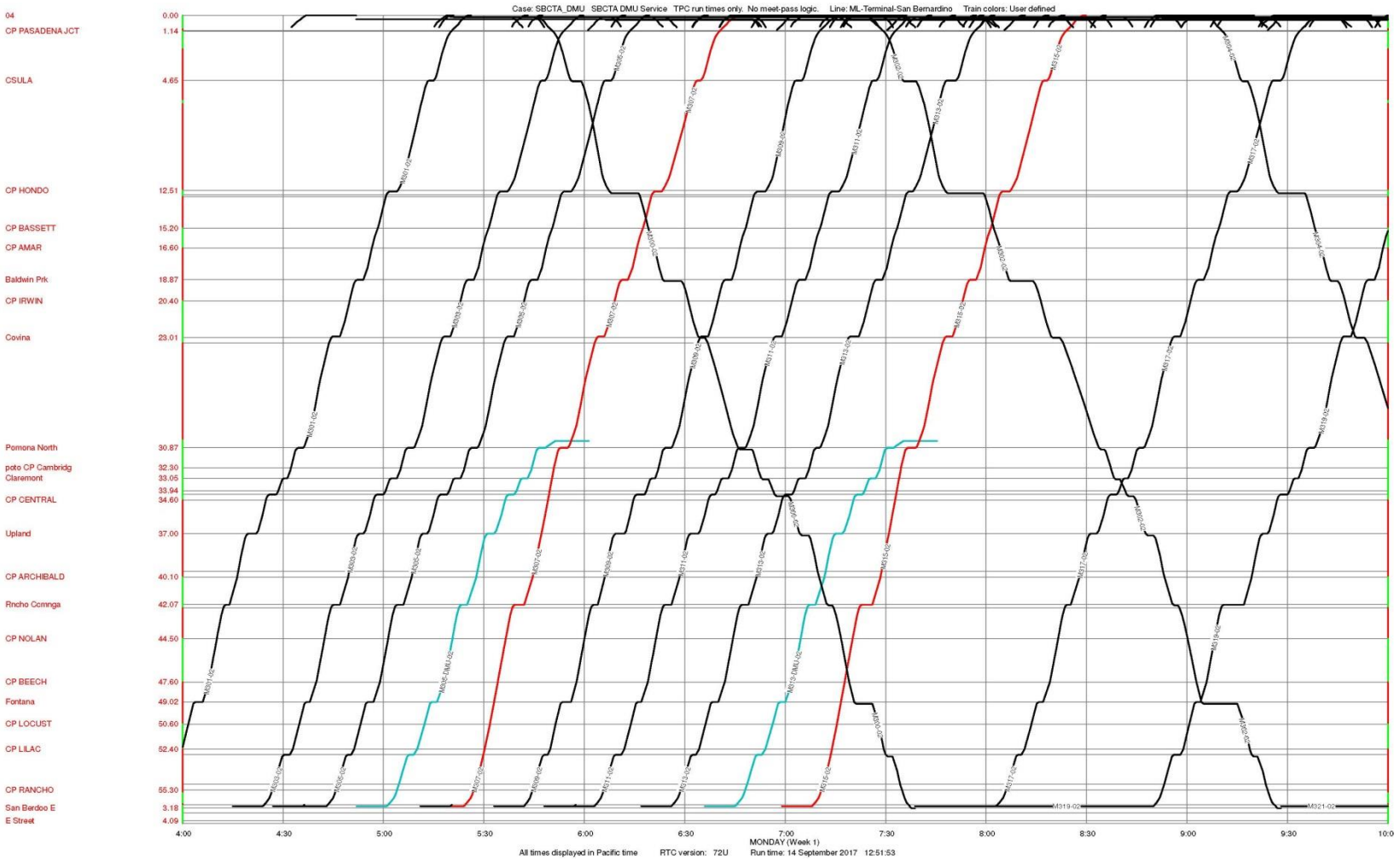
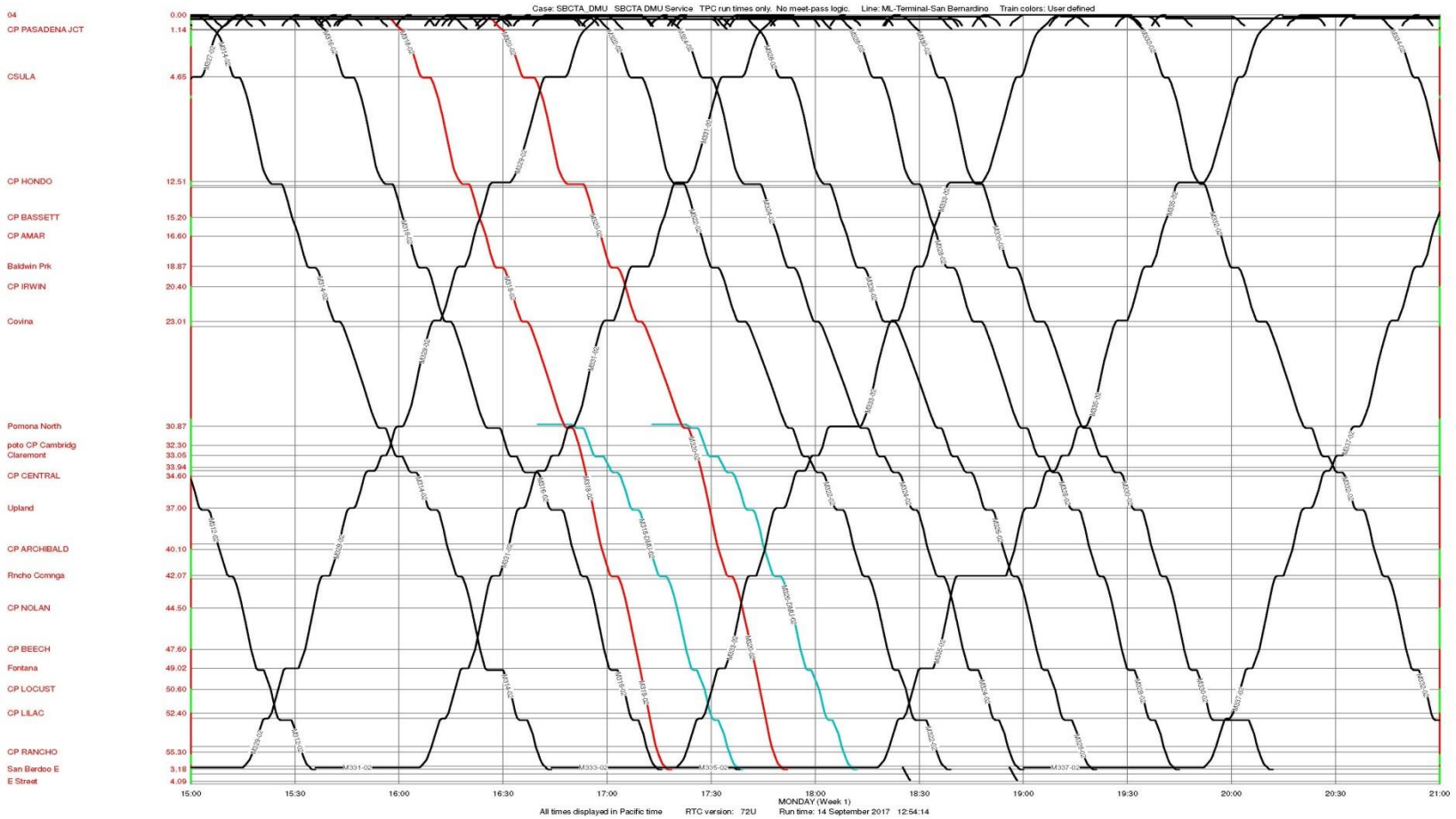


Figure 2-5. Stringline Chart for PM Peak Service



2.2.4 Summary

The insertion of two AM and two PM peak local trains using HR train sets, as well as the conversion of the following AM and PM peak LHC trains to express service, can be attained with relatively little impact on the rest of the SBL service. Pomona (North) was used as the hypothetical STS, but using another site, such as Montclair, would have little impact on the schedules. (It should be noted that the suitability of the Montclair station site to be a potential STS was not evaluated in this study.) A layover track, accessible from both main tracks and long enough to store two HR train sets, would need to be constructed west of the westernmost local station stop. Adding an additional express station stop would have little or no impact on the rest of the schedule but would add 2 to 5 minutes to the express train schedule.

2.3 Conversion of Low-Ridership Locomotive-Hauled Consists Trains to Hybrid-Rail Consists

To reduce operating costs for reverse peak and off-peak service, the project team investigated which existing LHC train schedules could be converted to HR service and how those changes would impact Metrolink LHC and HR equipment cycles and utilization.

2.3.1 Hybrid-Rail Train Set Configuration

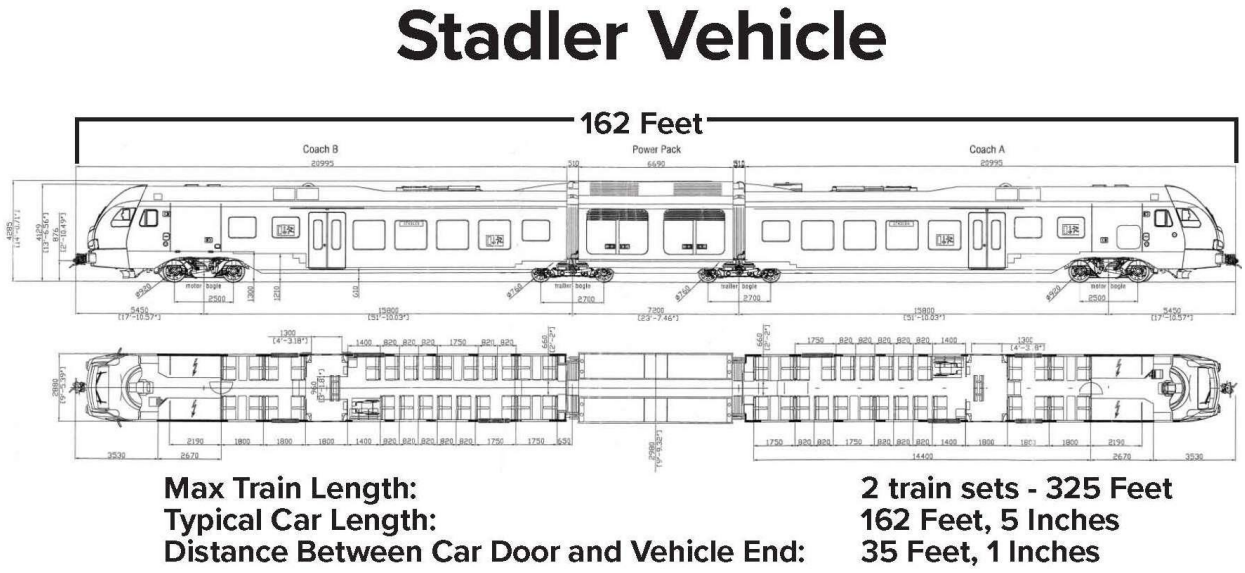
For the conversion to work, the ridership for a particular train must not exceed the capacity of the HR vehicle selected. Metrolink passengers generally travel longer distances than passengers using other rail modes and prefer a seat. If a seat is not available, passengers may elect to use alternate transportation forms. For this reason, the stakeholders agreed to look at converting only those trains with an average daily ridership of fewer than 200 passengers, which could be supported by either a two-train set or extended train set configuration.

San Bernardino County Transit Authority (SBCTA) provided the following train set information for the Arrow/RPRP service, which would be used for the HR service and are shown on Figure 2-6:

- A combination of two of these train sets would provide a 232 person seating capacity.
- Alternatively, the Stadler HR train set can also be modified to accommodate more passengers by adding passenger car sections between the cab sections and the power section. This train set may accommodate nearly as many passengers as two of the train sets shown on Figure 2-6 at a significantly lower capital cost.

Using the larger train set may impact interoperability of the train sets between the SBL and Arrow services, as the initial ridership estimates for the Arrow service do not envision the need for a vehicle with this much seating capacity.

Figure 2-6. Stadler Hybrid-Rail Vehicle



2.3.2 San Bernardino Line Ridership

Figure 2-7 shows the average daily ridership for the SBL for October 2016, which was the highest ridership month for the 12-month period ending July 31, 2017. The numbers indicate total ridership on each train, and the maximum passenger load of that train at any one time would be less. The trains in red have ridership below 200.

Figure 2-7. San Bernardino Line Average Daily Ridership

Westbound

Metrolink Train No.	301	303	305	307	309	311	313	315	317	319	321	323	325	327	329	331	333	335	337
Daily Ridership	258	268	306	563	418	525	532	568	304	181	187	180	80	129	130	104	95	76	91

Eastbound

Metrolink Train No.	300	302	304	306	308	310	312	314	316	318	320	322	324	326	328	330	332	334	336
Daily Ridership	67	75	100	128	110	172	257	363	323	320	428	627	484	447	300	254	286	176	106

As expected, the low-ridership trains were generally grouped in the following categories:

- AM reverse-peak eastbound trains
- Midday off-peak trains
- PM reverse-peak westbound trains
- Late evening off-peak trains

2.3.3 Metrolink Equipment Cycle Plan

Figure 2-8 displays the current equipment cycle plan for the SBL as of October 2016.

Figure 2-8. San Bernardino Line Equipment Cycles

Metrolink Train No.	301	303	305	307	309	311	313	315	317	319	321	323	325	327	329	331	333	335	337
Metrolink Cycle Number	11	13	14	17	15	19	16	37	20	11	17	34	40	16	37	14	19	12	37
Turns From	EMF	EMF	EMF	EMF	EMF	EMF	EMF	EMF	EMF	300	302	**802**	306	308	310	312	314	318	326
San Bernardino	**3:52**	**4:24**	**4:43**	**5:16**	**5:42**	**6:03**	**6:26**	**7:02**	**8:03**	**8:50**	**10:02**	**11:37**	**12:31**	**1:38**	**3:15**	**4:06**	**5:20**	**6:18**	**7:52**
L.A. Union Station	**5:26**	**5:59**	**6:20**	**6:50**	**7:16**	**7:40**	**8:02**	**8:36**	**9:39**	**10:30**	**11:39**	**1:15**	**2:08**	**3:14**	**5:00**	**5:53**	**7:10**	**8:14**	**9:29**
Turns to	300	**201**	**103**	302	304	**205**	**907**	310	320	316	322	**688**	**215**	328	326	330	332	334	336

Metrolink Train No.	300	302	304	306	308	310	312	314	316	318	320	322	324	326	328	330	332	334	336
Metrolink Cycle Number	11	17	15	40	16	37	14	19	11	12	20	17	36	37	16	14	19	12	37
Turns from	301	307	309	**900**	DH 907	315	112	**216**	319	**685**	317	321	**683**	329	327	331	333	335	337
L.A. Union Station	**5:46**	**7:25**	**9:06**	**10:19**	**11:06**	**12:42**	**1:56**	**3:02**	**3:34**	**3:56**	**4:25**	**4:56**	**5:16**	**5:39**	**6:06**	**6:25**	**7:30**	**8:42**	**9:49**
San Bernardino	**7:39**	**9:28**	**10:50**	**11:58**	**12:52**	**2:26**	**3:36**	**4:44**	**5:16**	**5:43**	**6:08**	**6:39**	**7:00**	**7:21**	**7:47**	**8:12**	**9:07**	**10:20**	**11:26**
Turns to	319	321	**815**	325	327	329	331	333	EMF	335	EMF	EMF	EMF	337	EMF	EMF	EMF	EMF	EMF

Metrolink's current equipment cycles reposition some train sets during peak periods to provide a second peak directional service, operate mid-day, then operate again during the PM peak. This improves Metrolink equipment utilization but creates issues when trying to operate HR train sets for low occupancy trains.

For example, Train 301 arrives at LAUS at 5:26 a.m. with an average of 258 passengers. The train set turns and departs for San Bernardino at 5:46 a.m. as Train 300, with 67 passengers. The train set then turns again and departs for LAUS at 8:50 a.m. as Train 319, with 181 passengers, then makes a final run back to San Bernardino at 3:34 p.m. as Train 316, with 323 passengers. This particular train set needs a large enough consist to support AM and PM peak trains but is also used for off-peak trains that require far less capacity. If HR train sets were used for Trains 300 and 319, it is possible Metrolink may have limited or no alternative use for the LHC train set during the day, and it may sit idle for part of that period.

Equipment sets used on the SBL are not exclusive to this route; some sets operate on other lines during the day. Any changes to the SBL equipment cycles will have some impact on Metrolink's system equipment cycle. Further analysis may be warranted to determine how the introduction of HR train sets on the SBL impacts overall Metrolink LHC equipment utilization and costs.

2.3.4 Locomotive-Hauled Consists and Hybrid-Rail Equipment Cycles

It is the intent of this modeling phase to convert as many LHC trainsets to HR trainsets as possible, without creating unnecessary equipment positioning moves.

There are 10 westbound and 8 eastbound trains in this category. Five of the 18 low-ridership train candidates originate at LAUS in the morning and 10 terminate at LAUS in the evening. Unless empty HR equipment is located to LAUS during the day, it is difficult to convert all 18 trains to HR equipment without some empty equipment positioning moves.

Based upon these and other factors, the methodology for creating the LHC/HR equipment cycles includes the following assumptions:

- Some HR trainsets will be stored at Central Maintenance Facility.
- Some HR trainsets will be stored at the Inland Empire Maintenance Facility.
- All LHC trainsets with average daily ridership above 200 will remain LHC.
- Because of the directional imbalance of low-ridership trains, the cycles will convert only 16 of the 18 trains to HR operation.
- The HR equipment cycles will include local trains, low-ridership trains, and the proposed Arrow service schedule between University of Redlands and SBTC.
- HR equipment is compatible with Arrow equipment and will be used interchangeably.
- All local and LHC trains converted to HR trainsets will operate to and from University of Redlands, with the exception of Metrolink Trains 334 and 336, which will terminate at SBTC. Some of these schedules will help maintain the desired peak and off-peak Arrow service headways.
- All Metrolink LHC equipment that is idled for part of the day will be available for alternate Metrolink use at LAUS.

Figure 2-9 depicts a hypothetical equipment cycle for SBL LHC and HR equipment. This scenario includes four HR local trains, four Metrolink express trains, and 16 LHC low-ridership trains converted to HR service.

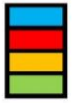
Eight sets of HR equipment and nine sets of LHC equipment are required to support this level of service. The utilization of the LHC trains drop considerably under this scenario, with seven sets making just one round trip between SBTC and LAUS.

Because Metrolink's equipment cycles switch some trainsets between lines during a typical day, it is unknown what impact the substitution of SBL HR for LHC equipment may have on the overall Metrolink equipment plan.

Figure 2-9. San Bernardino Line Equipment Cycles, Locomotive-Hauled Consists and Hybrid Rail Equipment

Consist Codes:

Locomotive-hauled local
Locomotive-hauled express
Hybrid-Rail local consist
Hybrid-Rail off-peak consist



Metrolink Train No.	301	303	305	Local	307E	309	311	313	Local	315E	317	319	321	323	325	327	329	Local	331	Local	333	335	337
Metrolink Cycle Number	11	13	14	HR 1	17	15	19	16	HR 2	37	20	HR 3	HR 2	HR 7	HR 5	HR 6	HR 1	HR 2	11	HR 8	13	HR 4	HR 3
Turns From	EMF	EMF	EMF	IEMF	EMF	EMF	EMF	EMF	Arrow	EMF	EMF	300	LOCAL	304	300	308	Arrow	310	312	Arrow	314	Arrow	Arrow
Redlands					4:58				6:25			8:21	9:36	11:11	12:05	**1:12**	**2:35**	**3:10**		**3:51**		**6:00**	**7:30**
SBTC	3:47	4:19	4:38	5:01	5:19	5:37	5:57	6:21	6:46	7:06	7:58	8:45	9:57	11:32	12:26	**1:33**	**3:10**	**3:31**	**4:01**	**4:12**	**5:15**	**6:21**	**7:51**
Pomona (North)	4:32	5:08	5:27	5:50	5:55	6:26	6:46	7:10	7:36	7:42	8:47	9:38	10:47	12:23	**1:17**	**2:23**	**4:01**	**4:20**	**4:50**	**5:01**	**6:13**	**7:10**	**8:40**
L.A. Union Station	5:26	5:59	6:20		6:45	7:16	7:40	8:02		8:32	9:39	10:30	11:39	**1:15**	**2:08**	**3:14**	**5:00**		**5:53**		**7:10**	**8:11**	**9:31**
Turns to	312	314	316	LOCAL	318	320	322	324		326	328	308	310	CMF	CMF	CMF	CMF	LOCAL		330	332	334	336

Metrolink Train No.	Local	300	Local	302	304	306	308	310	312	314	316	318E	Local	320E	Local	322	324	326	328	330	332	334	336
Metrolink Cycle Number	HR 1	HR 3	HR 2	HR 4	HR 5	HR 6	HR 3	HR 2	11	13	14	17	HR 2	15	HR 8	19	16	37	20	11	13	HR 4	HR 3
Turns from	LOCAL	CMF	LOCAL	CMF	CMF	CMF	319	321	301	303	305	307	LOCAL	309	LOCAL	311	313	315	317	331	333	335	337
L.A. Union Station		5:46		7:25	9:06	10:19	11:06	12:42	**1:56**	**3:02**	**3:34**	**3:56**		**4:25**		**4:56**	**5:16**	**5:39**	**6:06**	**6:25**	**7:30**	**8:42**	**9:49**
Pomona (North)	6:30	6:55	8:05	8:35	10:06	11:13	12:06	**1:42**	**2:50**	**3:56**	**4:29**	**4:50**	**4:55**	**5:23**	**5:28**	**5:52**	**6:15**	**6:36**	**7:01**	**7:19**	**8:23**	**9:35**	**10:42**
SBTC	7:14	7:44	8:49	9:26	10:55	12:03	12:57	**2:31**	**3:36**	**4:44**	**5:16**	**5:26**	**5:39**	**5:59**	**6:12**	**6:44**	**7:05**	**7:26**	**7:52**	**8:17**	**9:12**	**10:25**	**11:31**
Redlands	7:35	8:05	9:10	9:47	11:16	12:24	**1:18**	**2:52**					**6:00**		**6:33**	**7:09**							
Turns to	Arrow	319	321	Arrow	325	327	Arrow	LOCAL	331	333	EMF	EMF	Arrow	EMF	Arrow	EMF	EMF	EMF	EMF	EMF	EMF	IEMF	IEMF

16 of 18 low ridership trains converted to HR

4 new HR local trains created to support 4 LHC expresses

HR Sets- 10 round trips

8 sets

IEMF-LOCAL-LOCAL-ARROW-329-CMF — HR 1
ARROW-LOCAL-321-310-LOCAL-LOCAL-ARROW — HR 2
CMF-300-319-308-ARROW-337-336-IEMF — HR 3
CMF-302-ARROW-335-334-IEMF — HR 4
CMF-304-325-CMF — HR 5
CMF-306-327-CMF — HR 6
ARROW-323-CMF — HR 7
ARROW-LOCAL-LOCAL-ARROW — HR 8

Locomotive-Hauled Sets- 11 round trips

9 sets

EMF-301-312-331-330-EMF — 11
EMF-303-314-333-332-EMF — 13
EMF-305-316-EMF — 14
EMF-307-318-EMF — 17
EMF-309-320-EMF — 15
EMF-311-322-EMF — 19
EMF-313-324-EMF — 16
EMF-315-326-EMF — 37
EMF-317-328-EMF — 20

Figure 2-10 depicts the hypothetical equipment cycle for HR trainsets supporting both the SBL and Arrow services.

This equipment scenario assumes that HR trains can operate freely between the SBL and Redlands branch. The eight HR trainsets required to support services on the SBL also can support the Arrow service. If shared equipment and operations between the SBL and Arrow services is not feasible, eight HR trainsets would still be required for SBL service and two would be required for Arrow service (per the original Redlands Passenger Rail Program operating plan).

2.3.5 Summary

A total of 8 HR equipment sets can support 4 local HR trains, 16 SBL low-ridership trains, and the proposed Arrow service. If Arrow service needs to operate independently from SBL service, eight sets will still be required for SBL and two will be required for the Arrow service. Metrolink LHC equipment currently being used on the low-ridership trains may be idle during this period of time, unless Metrolink finds other uses for the equipment.

Figure 2-10. Hybrid-Rail Equipment Cycles, San Bernardino Line and Arrow Service

Origin Facility	TEMF			TEMF		CMF			CMF		CMF	CMF																	
	Arrow	Arrow	Arrow	Arrow	Local	M300	Arrow	Local	M302	Arrow	M304	M306	M308	Arrow	M310	Arrow	Arrow	Arrow	Arrow	Arrow	Arrow	Local	Local	Arrow	Arrow	Arrow	Arrow	M334	M336
LAUS	...	...	...	...	...	5:46	...	...	7:25	...	9:06	10:19	11:06	...	12:42	...	...	...	...	...	...	...	...	...	...	...	...	20:42	21:49
Pomona (North)	...	...	...	...	6:30	6:55	...	8:05	8:35	...	10:06	11:13	12:06	...	13:42	...	...	...	...	...	...	16:55	17:28	...	...	...	...	21:35	22:42
SBTC	5:00	6:00	6:30	7:00	7:14	7:44	8:30	8:49	9:26	10:00	10:55	12:03	12:57	14:00	14:31	15:00	15:30	16:00	16:30	17:00	17:30	17:39	18:12	19:00	20:00	21:00	22:00	22:25	23:31
University of Redlands	5:21	6:21	6:51	7:21	7:35	8:05	8:51	9:10	9:47	10:21	11:16	12:24	13:18	14:21	14:52	15:21	15:51	16:21	16:51	17:21	17:51	18:00	18:33	19:21	20:21	21:21	22:21	...	...
Destination Facility																											TEMF	TEMF	TEMF

Origin Facility	TEMF	TEMF																											
	Local	Arrow	Arrow	Local	Arrow	Arrow	Arrow	M319	Arrow	M321	Arrow	M323	M325	M327	Arrow	M329	Local	Local	Arrow	Arrow	Arrow	Arrow	M335	Arrow	Arrow	M337	Arrow	Arrow
University of Redlands	...	5:00	6:00	6:25	7:00	7:30	8:00	8:21	9:00	9:36	10:07	11:11	12:05	13:12	14:00	14:35	15:10	15:51	16:00	16:30	17:00	17:30	18:00	18:30	19:00	19:30	21:00	22:00
SBTC	5:01	5:21	6:21	6:46	7:21	7:51	8:21	8:45	9:21	9:57	10:28	11:32	12:26	13:33	14:21	14:56	15:21	16:12	16:21	16:51	17:21	17:51	18:21	18:51	19:21	19:51	21:21	22:21
Pomona (North)	5:50	...	...	7:36	...	...	...	9:38	...	10:47	...	12:23	13:17	14:23	...	16:01	16:24	17:15	...	...	...	...	...	...	...	...	...	...
LAUS	...	...	...	...	...	...	...	10:30	...	11:39	...	13:15	14:08	15:14	...	17:00	...	...	...	...	...	...	20:26	...	...	21:38	...	...
Destination Facility												CMF	CMF	CMF		CMF												TEMF

Hybrid-Rail equipment sets:

- Trainset 1
- Trainset 2
- Trainset 3
- Trainset 4
- Trainset 5
- Trainset 6
- Trainset 7
- Trainset 8

3 Phase 2A (i): Unconstrained HR Service, University of Redlands to Pomona (North) with Improvements

3.1 Scope

The purpose of this modeling phase is to determine infrastructure requirements to support various HR service frequencies between University of Redlands and Pomona (North). There are no Metrolink or BNSF trains included in this model, only HR service. For each service frequency examined, this phase will use the model of the Metrolink San Gabriel Subdivision from Phase 1A, with the RPRP Redlands branch added to the model. For each alternative, infrastructure improvements will be added, as needed, to the San Gabriel Subdivision infrastructure between SBTC and Pomona (North) and the Redlands branch between SBTC and University of Redlands to support each particular service frequency.

The process for the modeling each service frequency is for trains to initially meet on the planned passing track for RPRP and determine what additional infrastructure on the San Gabriel Subdivision would be required to support that particular service frequency.

HR service frequencies of 15, 20, and 30 minutes were analyzed.

3.2 Modeling Assumptions

For this modeling phase, the following assumptions were used:

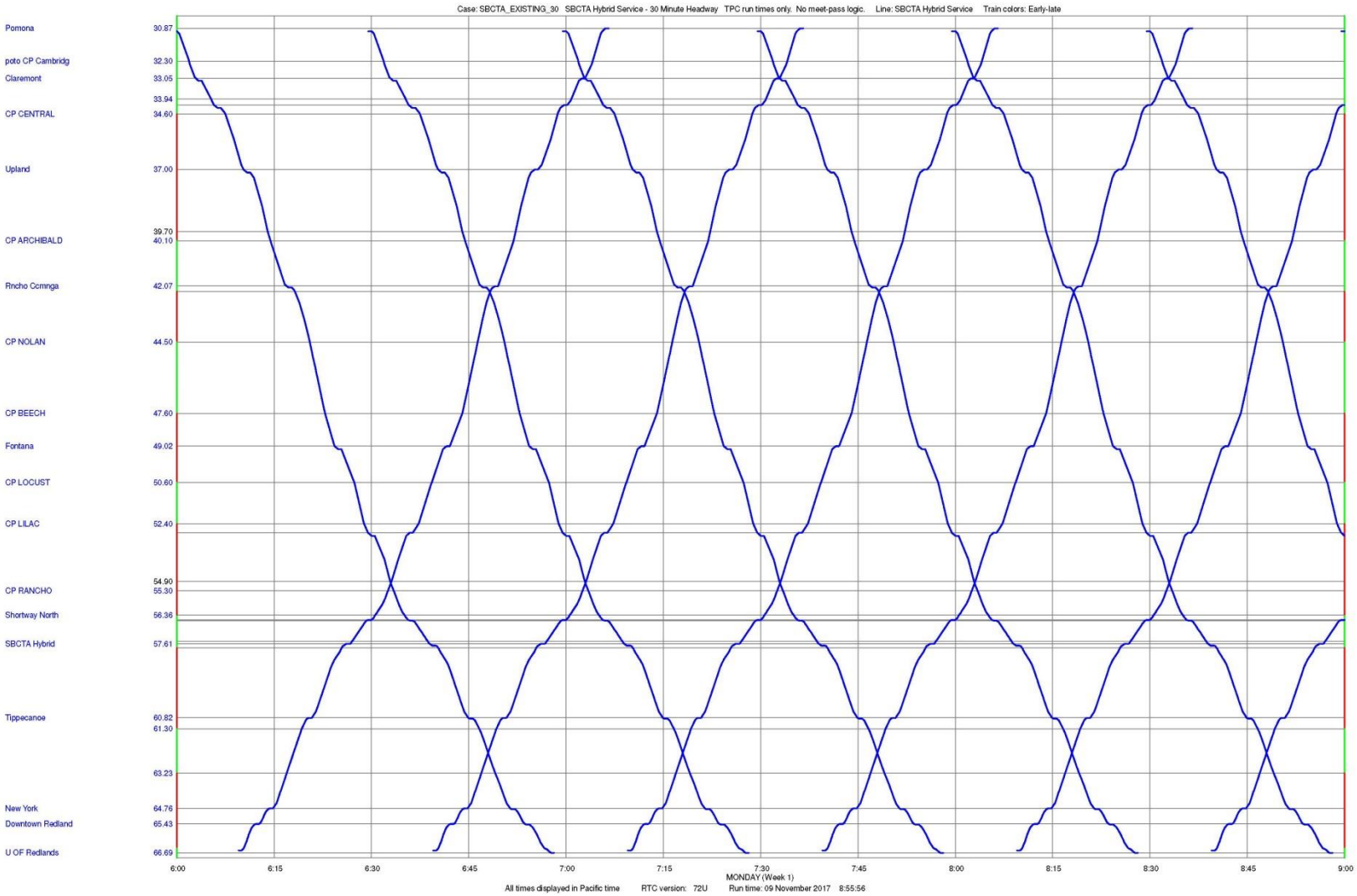
- No Metrolink or BNSF freight services are modeled.
- A hypothetical layover track, with access to both main tracks, is constructed in the model west of the Pomona (North) station.
- There is a maximum 50 miles per hour speed on Redlands branch.
- A single unit, three-section Stadler diesel multiple-unit rail car, similar to the Arrow equipment procurement order, is used in the simulation.
- 30-second dwell times at each station.

3.3 30-Minute Hybrid-Rail Service Frequencies

3.3.1 Existing Infrastructure

As described in Section 1.1, HR trains were slotted so the eastbound and westbound trains would meet on the planned passing siding on the RPRP Redlands branch. The stringline chart on Figure 3-1 indicates where the trains would meet with no meet-pass conflicts on the existing San Gabriel Subdivision and Redlands branch infrastructure.

Figure 3-1. Stringline Chart for 30-Minute Service Frequencies, Existing Infrastructure



With the trains programmed to meet at the Redlands branch passing track, meets on the San Gabriel Subdivision occur near the following locations:

- Directly west of CP Rancho (MP 55.0) in single track territory
- At the Rancho Cucamonga station (MP 42.0). This is on a double track section but very close to single track at CP Rochester (MP 42.4)
- At the Claremont Station (MP 33.1)

3.3.2 Proposed Infrastructure Improvements

For a train schedule to perform reliably on a daily basis, there needs to be sufficient double track to provide for expeditious meets when one of the trains is operating a few minutes late. This capability reduces the possibility of one late train causing opposing and following trains to run late, “cascading” delays onto the rest of the schedule.

For this service scenario to work, the trains will need a segment of double track near CP Rancho to meet. Extension of double track from CP Lilac to CP Rancho was recommended through the Metrolink San Bernardino Line (SBL) Infrastructure Improvement Strategic Study, and its construction would solve the meet issue at CP Rancho.

The other meet location at Rancho Cucamonga poses some challenges. If the westbound train meeting here is operating just a few minutes late, the eastbound train will have to wait west of CP Rochester on the double track until the westbound passes. Double tracking the 2.1-mile single track segment from CP Rochester to CP Nolan would alleviate this potential operational bottleneck. By connecting existing double track segments, it would also provide for a continuous double track segment between CP Archibald (MP 40.2) and CP Beech (MP 47.5), a total distance of 7.3 miles. In addition to supporting a reliable 30 minute HR service, it would also provide for greater operational flexibility for both Metrolink and BNSF trains.

The following infrastructure improvements are recommended to support the 30-minute service frequency scenario (Figure 3-2):

- Extend double track 2.9 miles from CP Lilac (MP 52.4) to CP Rancho (CP 55.3), creating 4.6 miles of continuous double track
- Extend double track 2.1 miles between CP Rochester (MP 42.4) and CP Nolan (MP 44.5), creating 7.3 miles of continuous double track

Figure 3-3 depicts the stringline chart for 30-minute service frequencies with the addition of double track segments between CP Rancho and CP Lilac and CP Rochester and CP Nolan.

Figure 3-2. Recommended Double Tracking Locations: Phase 2A (i) 30-Minute Hybrid Rail Service

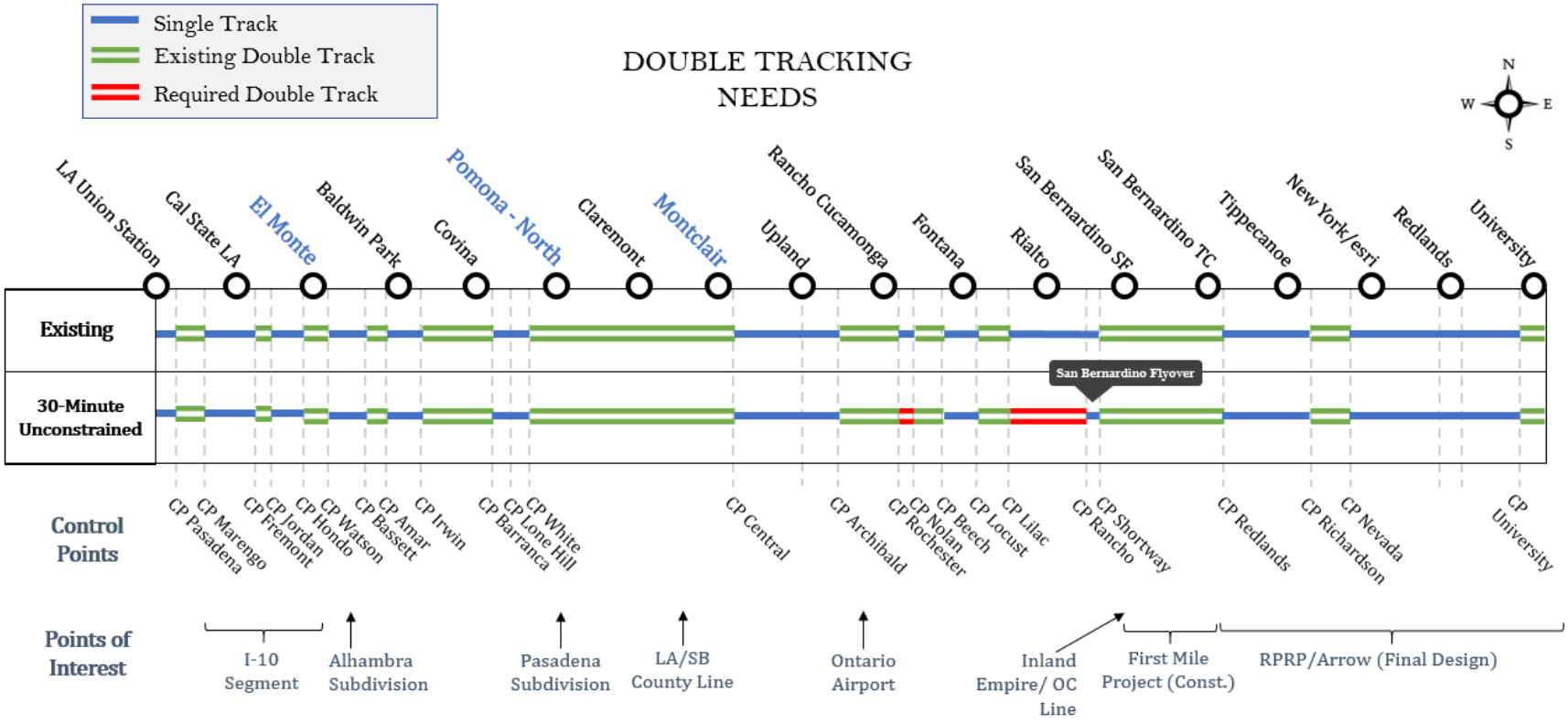
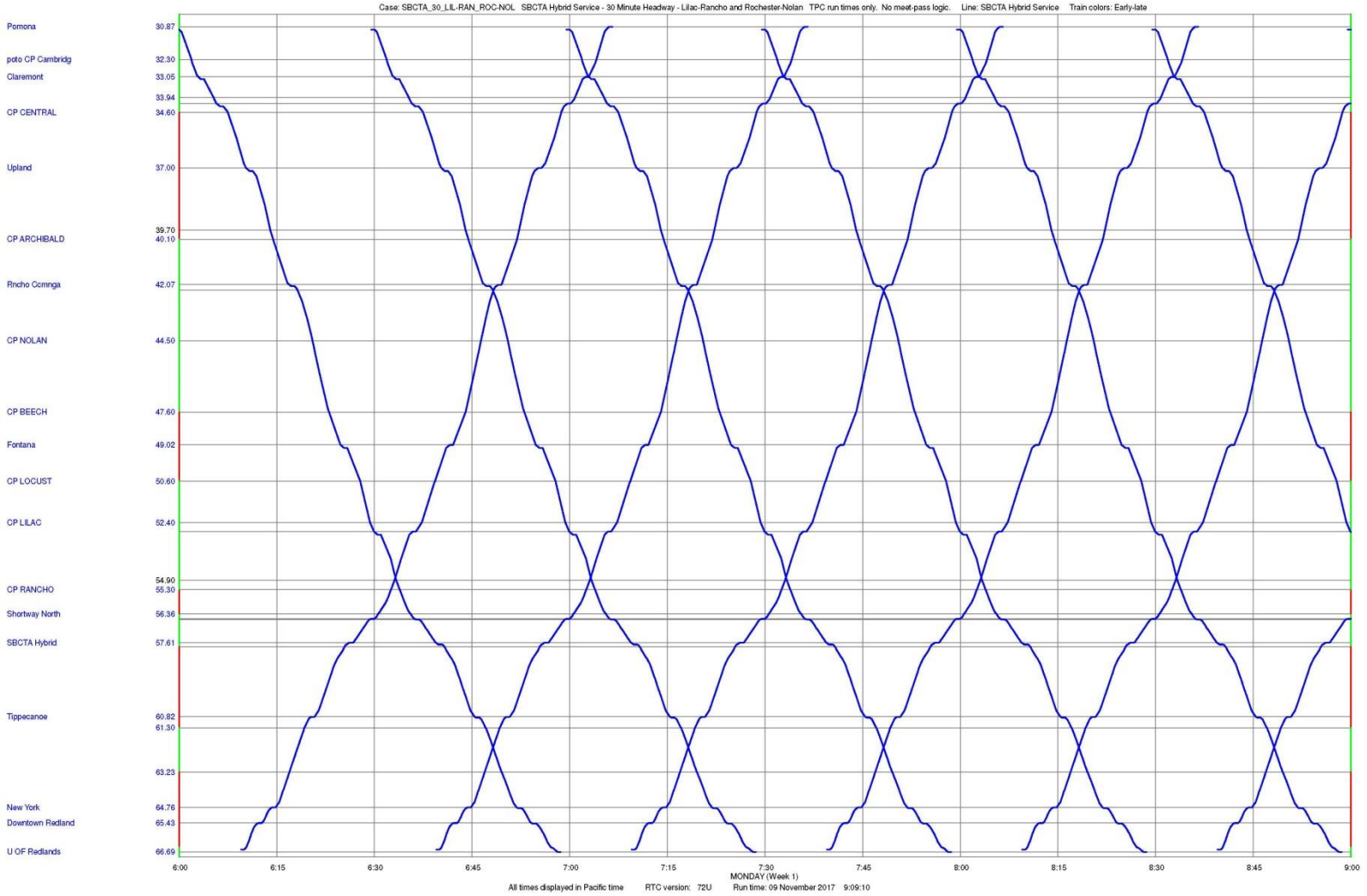


Figure 3-3. Stringline Chart for 30-Minute Service Frequencies with Rancho to Lilac and Rochester to Nolan Double Track Segments



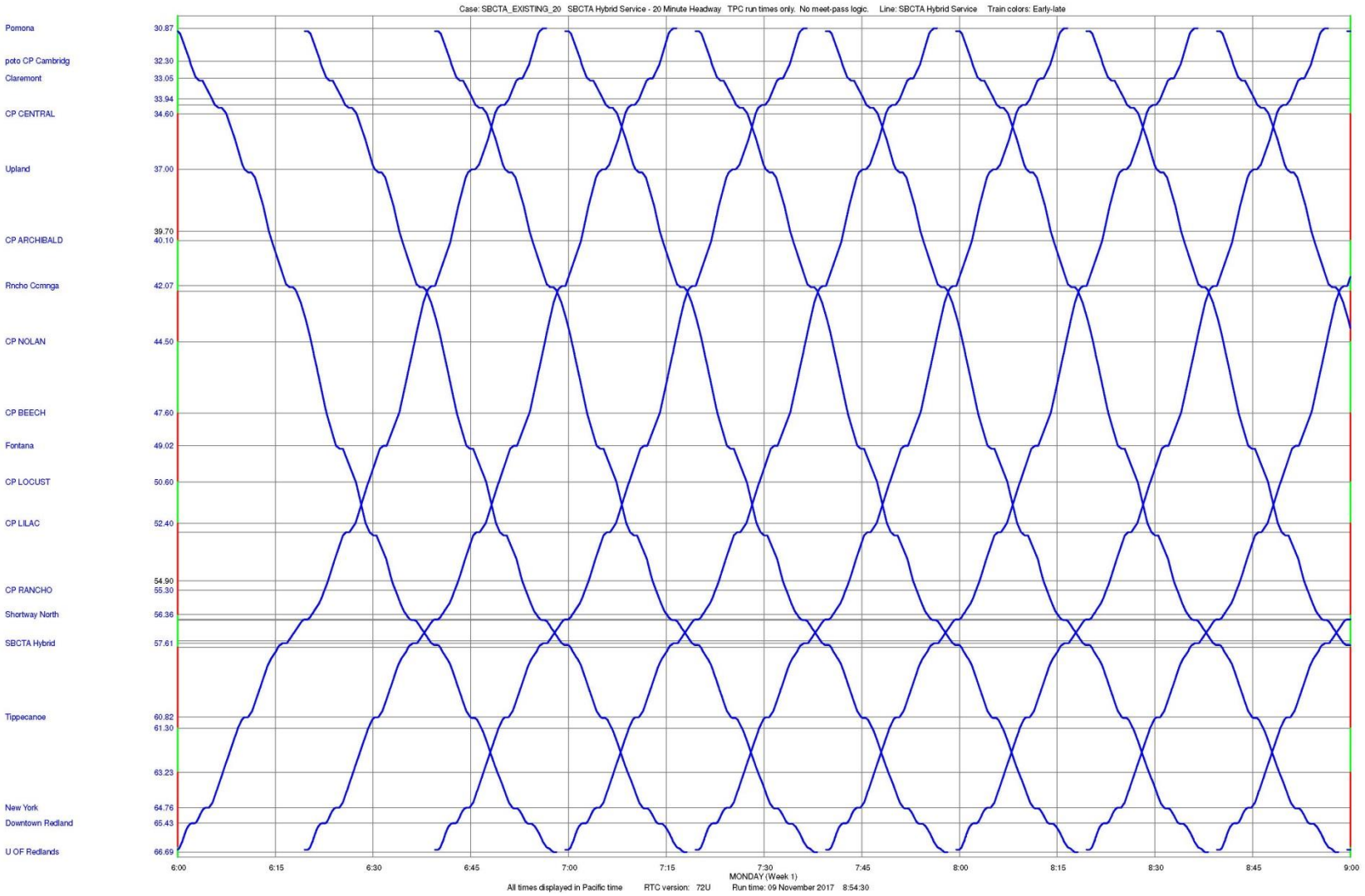
Under this infrastructure scenario, train meets occur on double track segments near the center of those segments, which allows for late trains to meet opposing trains without causing delays. This infrastructure scenario provides sufficient operational flexibility for a reliable HR operation with 30-minute service frequencies between University of Redlands and Pomona (North).

3.4 20-Minute Hybrid-Rail Service Frequencies

3.4.1 Existing Infrastructure

HR trains were again slotted so the eastbound and westbound trains would meet on the planned passing siding on the RPRP Redlands branch. The stringline chart on Figure 3-4 indicates where the trains would meet with no meet-pass conflicts on the existing San Gabriel Subdivision and Redlands branch infrastructure.

Figure 3-4. Stringline Chart for 20-Minute Service Frequencies, Existing Infrastructure



With the trains programmed to meet at the Redlands branch passing track, meets on the San Gabriel Subdivision occur near the following locations:

- On the double track segment between SBTC and the old Santa Fe Depot
- On the double track segment between CP Lilac (MP 52.4) and CP Locust (MP 50.7)
- At the Rancho Cucamonga station (MP 42.0), the same meet location for the 30-minute service scenario. This is on a double track section but close to single track at CP Rochester (MP 42.4)
- On a single track segment just east of CP Central (MP 34.6)

3.4.2 Proposed Infrastructure Improvements

Compared to the 30-minute service frequency scenario, trains are not meeting between CP Rancho and CP Lilac, so construction of that siding would not be necessary for this scenario.

Meets are still occurring, however, at the Rancho Cucamonga station, near CP Rochester. Extending double track from CP Rochester to CP Nolan would provide the same operational benefits for both the 30-minute and 20-minute service frequency scenarios.

Regarding the new meet location east of CP Central, it is recommended to extend the existing double track eastward from CP Central approximately 2 miles west of the Upland Station at MP 37.0. This would create a continuous double track segment from CP White (MP 30.4) to a location near MP 36.6, a distance of 6.2 miles.

The following infrastructure improvements are recommended to support the 20-minute service frequency scenario (Figure 3-5):

- Extend double track 2.1 miles between CP Rochester (MP 42.4) and CP Nolan (MP 44.5), creating 7.3 miles of continuous double track
- Extend double track approximately 2 miles from CP Central (MP 34.6) to MP 36.6 (CP 55.3), creating 6.2 miles of continuous double track

Figure 3-6 depicts the stringline chart for 20-minute service frequencies with the addition of double track segments between CP Rochester and CP Nolan, as well as CP Central and a location west of the Upland Station.

Under this infrastructure scenario, train meets occur on double track segments near the center of those segments, which allows for late trains to meet opposing trains without causing delays. This infrastructure scenario provides sufficient operational flexibility for a reliable HR operation with 20-minute service frequencies between University of Redlands and Pomona (North).

Figure 3-5. Recommended Double Tracking Locations: Phase 2A (i) 20-Minute Hybrid Rail Service

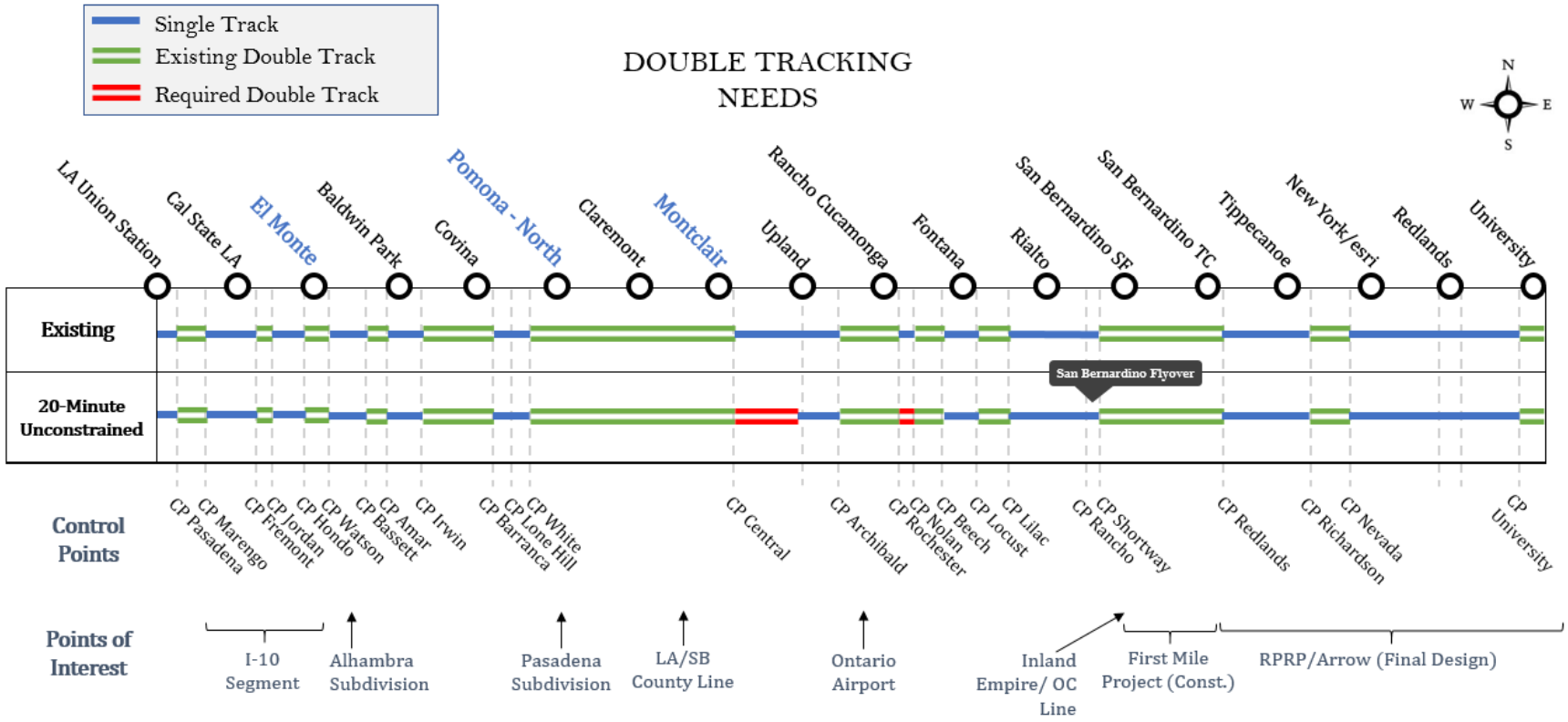
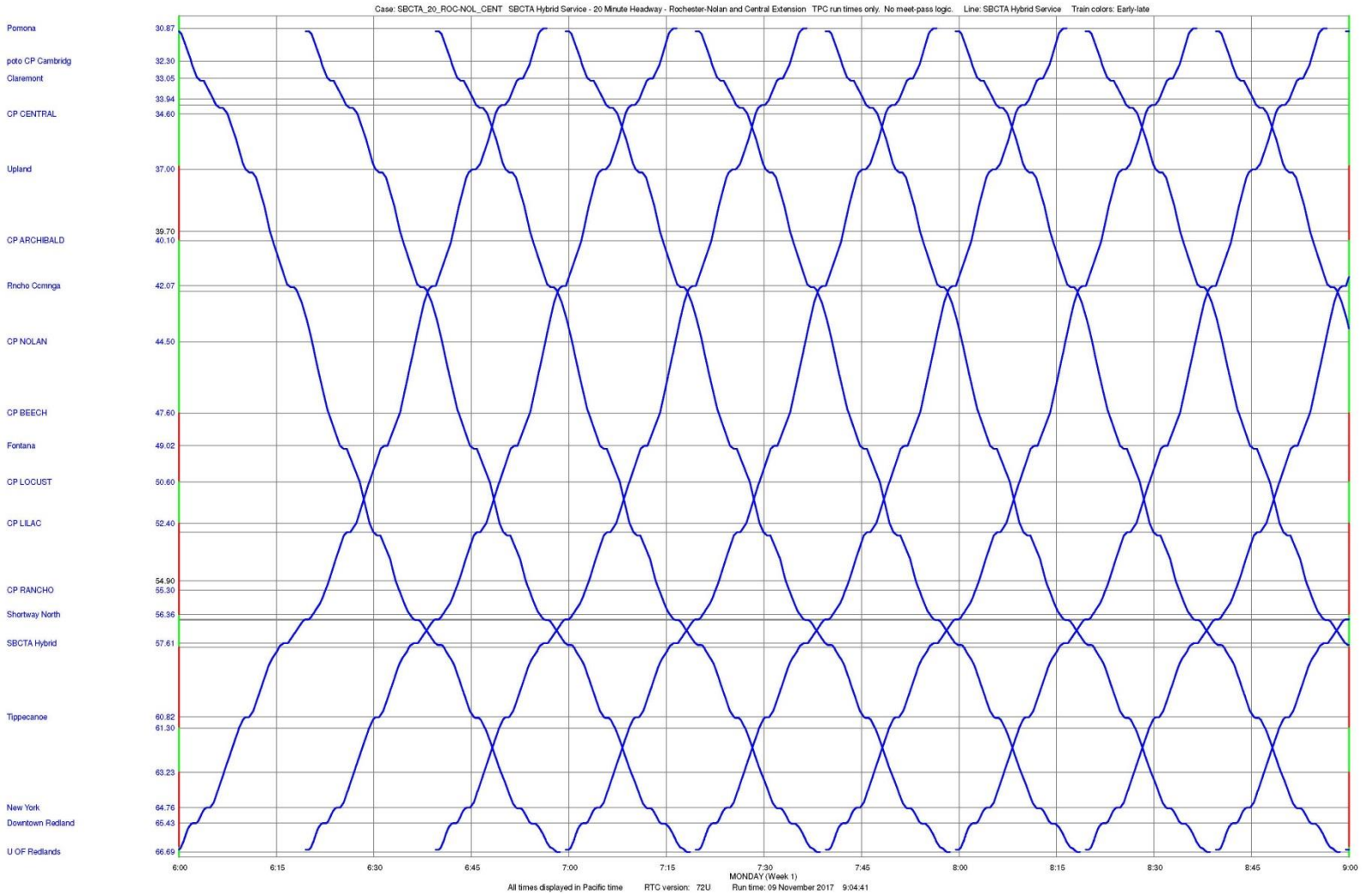


Figure 3-6. Stringline Chart for 20-Minute Service Frequencies with CP Rochester - CP Nolan and CP Central - Upland Double Track Segments

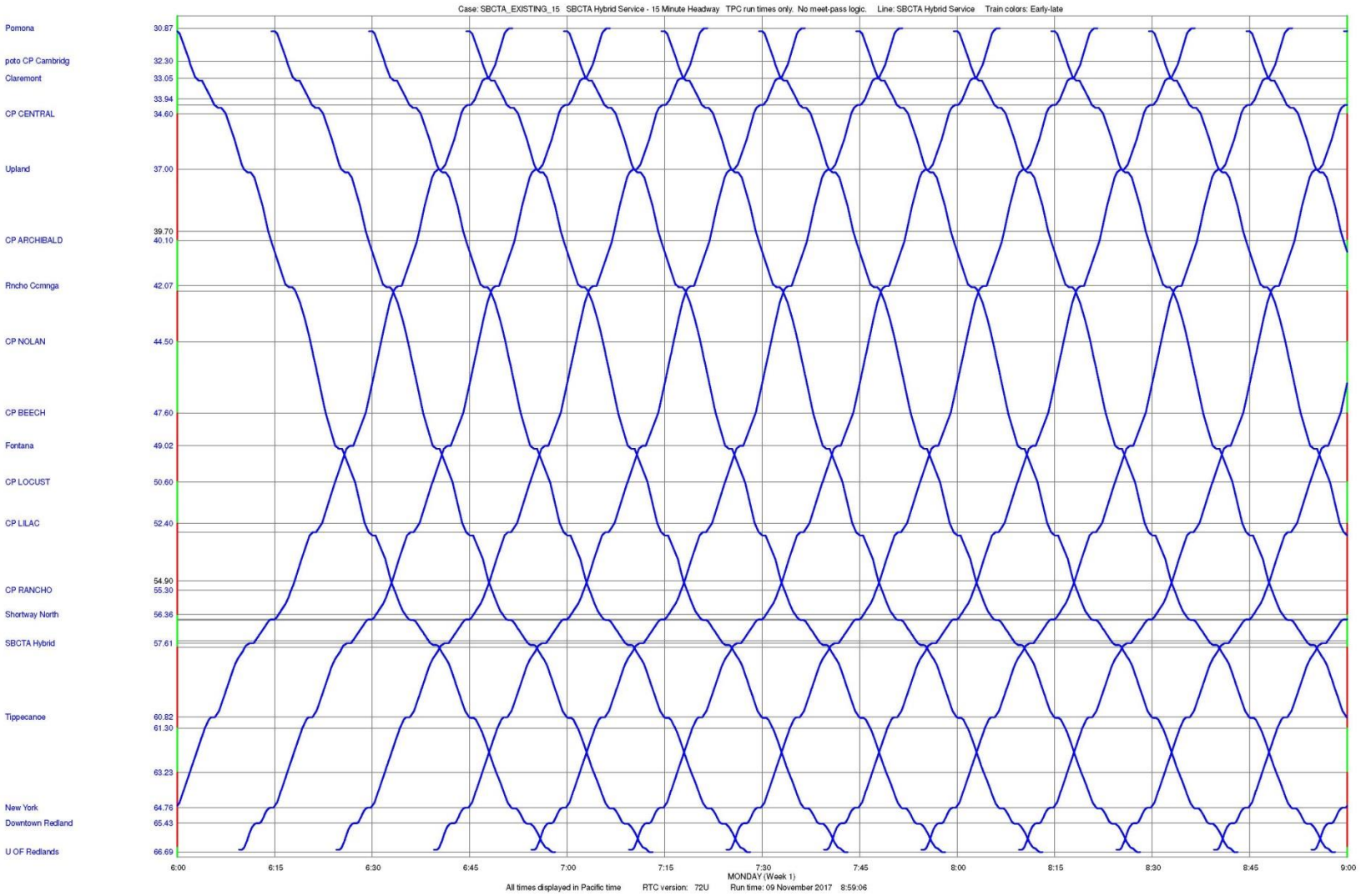


3.5 15-Minute Hybrid-Rail Service Frequencies

3.5.1 Existing Infrastructure

HR trains were slotted so the eastbound and westbound trains would meet on the planned passing siding on the RPRP Redlands branch. The stringline chart on Figure 3-7 indicates where the trains would meet with no meet-pass conflicts on the existing San Gabriel Subdivision and Redlands branch infrastructure.

Figure 3-7. Stringline Chart for 15-Minute Service Frequencies, Existing Infrastructure



With this service frequency, trains meet near the following locations on the Redlands branch and the San Gabriel Subdivision:

- Between University of Redlands and downtown Redlands
- On the Redlands branch passing track
- On the Redlands branch slightly east of SBTC
- CP Rancho
- Fontana Station
- At the Rancho Cucamonga station (MP 42.0), the same meet location for the 30-minute service scenario. This is on a double track section but very close to single track at CP Rochester (MP 42.4)
- At the Claremont Station

3.5.2 Proposed Infrastructure Improvements

The following infrastructure improvements are recommended to support the 15-minute service frequency scenario (Figure 3-8):

- Extend the University of Redlands station track approximately 0.5 mile to the east side of the 6th Street grade crossing
- Extend SBTC double track approximately 1,500 feet east of SBTC
- Extend double track 2.9 miles from CP Lilac (MP 52.4) to CP Rancho (CP 55.3)
- Extend double track 3.2 miles between CP Beech (MP 47.5) and CP Locust (CP 50.7)
- Extend double track 2.1 miles between CP Rochester (MP 42.4) and CP Nolan (MP 44.5)
- Extend double track 5.6 miles between CP Archibald (MP 40.2) and CP Central (MP 34.6)

Figure 3-9 depicts the stringline chart for 15-minute service frequencies with the addition of the infrastructure improvements, as detailed above.

These improvements create a continuous double track main line between the SBTC and Pomona (North), with the exception of the single track section over the San Bernardino Flyover. In addition to supporting 15 minute HR headways, this improvement would also support more efficient and reliable operation for Metrolink diesel-hauled trains and BNSF freight trains operating between CP Cambridge and CP Rancho. On the Redlands branch, the proposed passing siding is used, but the increased frequency will require additional double track east of SBTC and west of the University of Redlands station to provide some operational flexibility for meets at those locations.

Figure 3-8. Recommended Double Tracking Locations: Phase 2A (i) 15-Minute Hybrid Rail Service

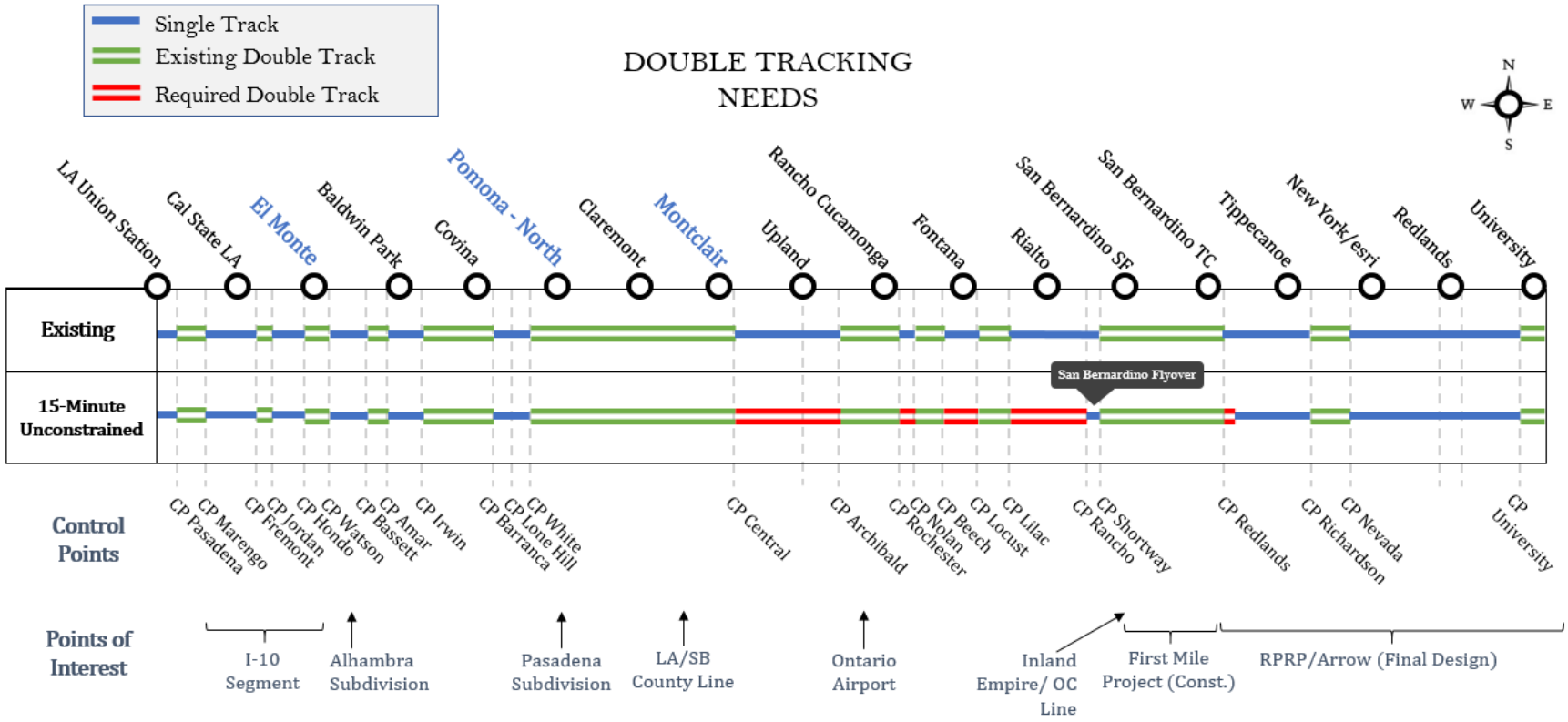
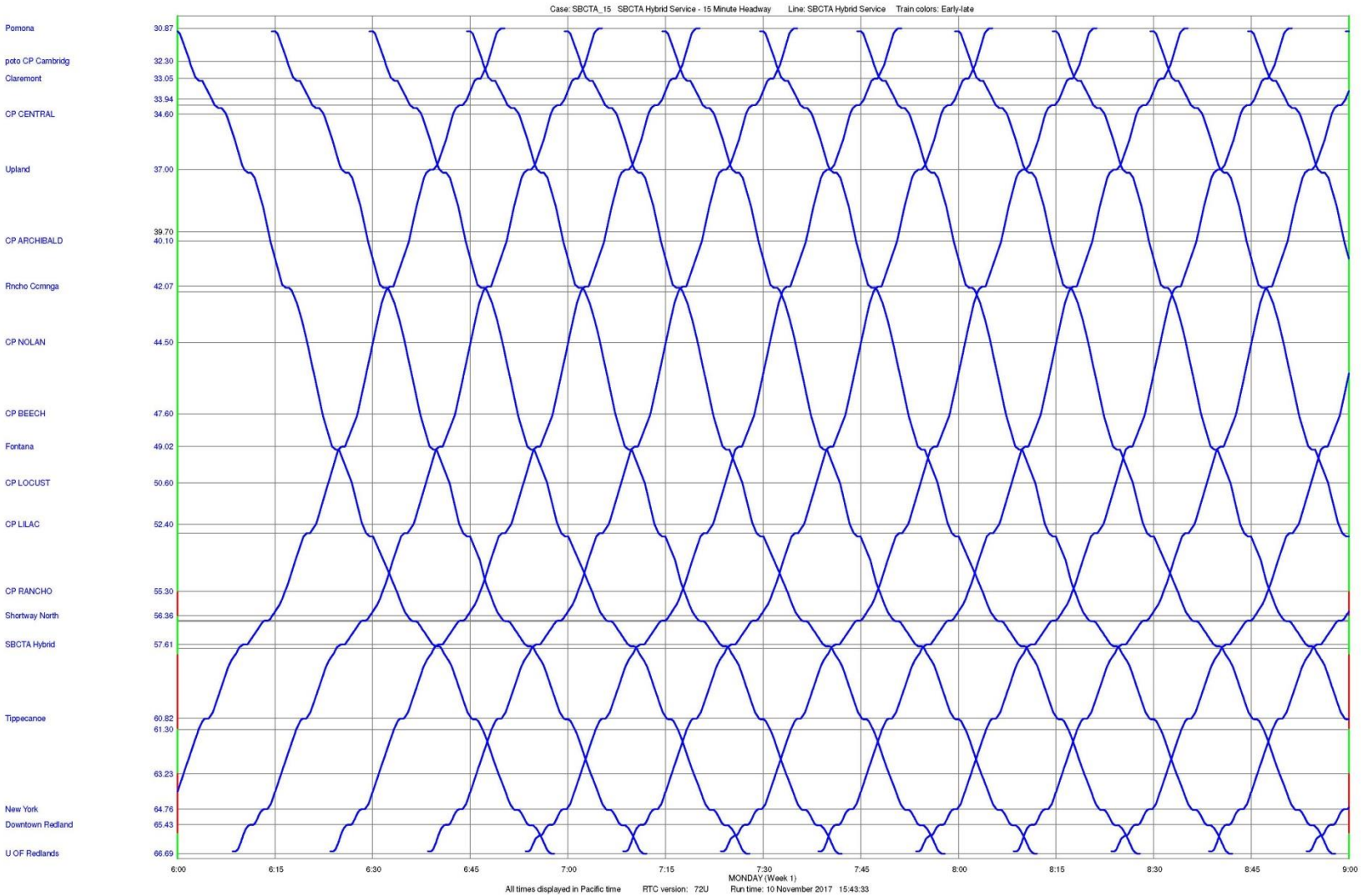


Figure 3-9. Stringline Chart for 15-Minute Service Frequencies, Proposed Infrastructure Improvements



4 Phase 2A (ii): Enhanced Hybrid-Rail and Metrolink Service, University of Redlands to Pomona (North)

4.1 Scope

The purpose of this modeling phase is to determine if existing San Gabriel Subdivision and RPRP infrastructure could support enhanced HR and current Metrolink services between Pomona (North) and University of Redlands, or if additional infrastructure would be required. Thirty-minute and 15-minute peak service headways will be analyzed.

4.2 Modeling Assumptions

For this modeling phase, the following assumptions were used:

- Per SBCTA direction, all peak directional Metrolink trains meet with Arrow service trains at SBTC.
- To support service goals, HR trains are overlaid on top of existing scheduled Metrolink trains.
- If a Metrolink train occupies a service frequency slot, HR trains will not be operated for that schedule slot.
- All HR equipment turns have a minimum allotment of 9 minutes.
- One-minute dwell times for HR station stops on the San Gabriel Subdivision (to reflect extra time needed to board and deploy the ramp) and 30-second dwells on the Redlands Branch (all level boarding) are allotted.
- One minute of recovery time for HR schedules between SBTC and University of Redlands and 2 minutes of recovery time between SBTC and Pomona (North) is allotted.
- All train meets on the Redlands branch occur on the planned RPRP passing track.
- Approximate 1-hour non-peak service between University of Redlands and Pomona (North) will occur.

4.3 30-Minute Peak/Hourly Off-Peak Hybrid-Rail with Existing Metrolink Service

For this scenario, approximate 30-minute peak (6 to 9 a.m., 3 to 7 p.m.) and hourly off-peak schedules were developed between Pomona (North) and University of Redlands for combined Metrolink/HR service. HR trains were added to support the service goals where practicable, as long as equipment cycles were possible.

Figure 4-1 and Figure 4-2 depict stringline charts for HR service overlaid on top of current Metrolink schedules to provide 30-minute peak/hourly off-peak service between Pomona (North) and University of Redlands. One chart covers the 4 a.m. to noon time frame; the other covers 2 to 10 p.m. On the stringline charts, Metrolink SBL trains are shown in magenta, IEOC trains in light blue, and HR trains in dark blue.

Figure 4-1. Stringline Chart for 30-Minute AM Peak Metrolink and HR Service, Pomona (North) to University of Redlands

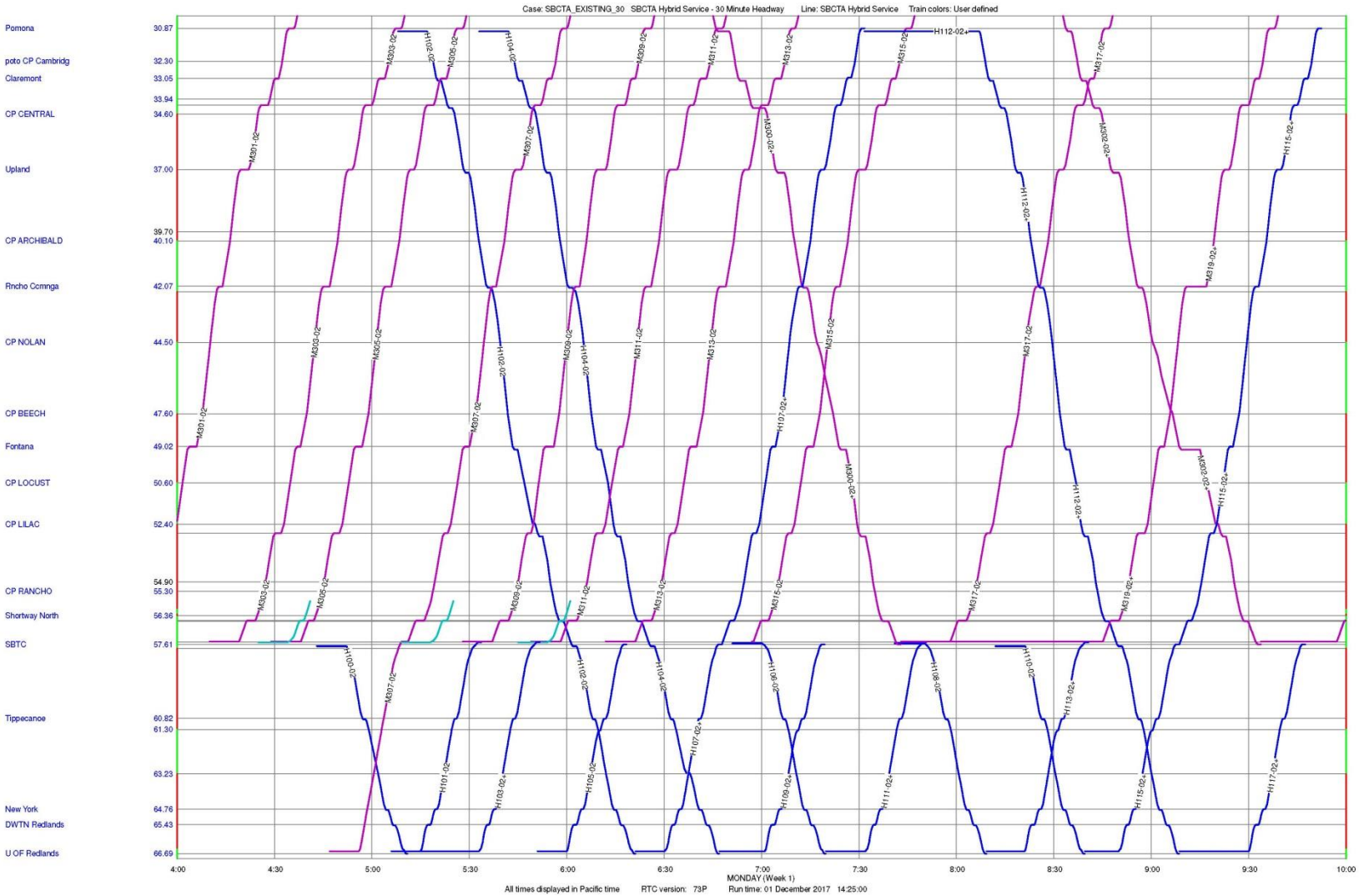
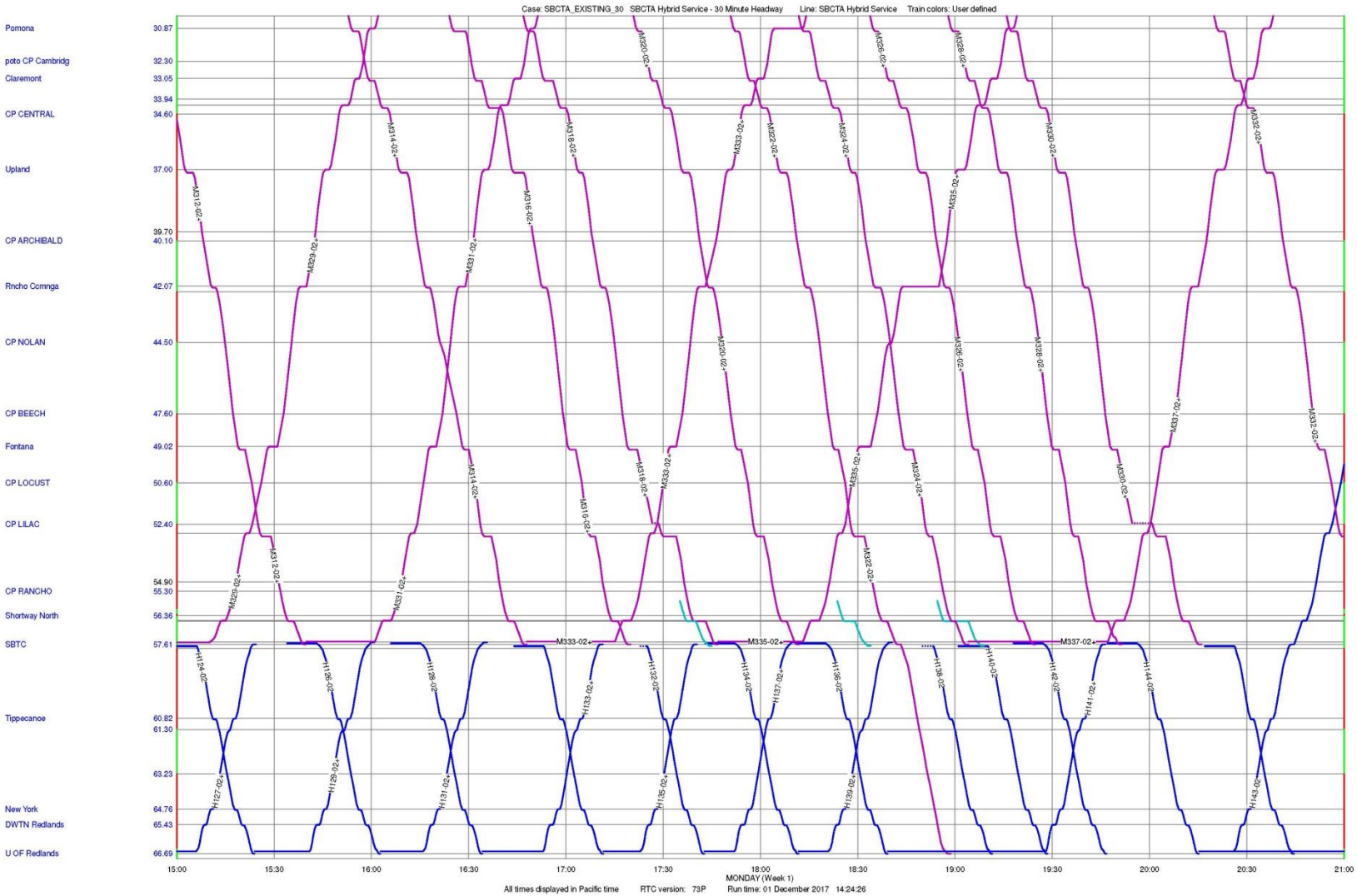


Figure 4-2. Stringline Chart for 30-Minute PM Peak Metrolink and HR Service, Pomona (North) to University of Redlands



4.3.1 Summary

This schedule supports 30-minute peak and hourly off-peak service between Pomona (North) and SBTC and provides platform transfers between all peak Metrolink and Arrow service trains at SBTC.

The schedule is able to use existing San Gabriel Subdivision infrastructure and does not require any additional infrastructure to support the service, aside from a layover track west of the Pomona (North) station.

The schedule does not support 30-minute reverse peak service between Pomona (North) and SBTC. As Metrolink trains cover most of the 30-minute peak frequencies between the stations, a significant amount of equipment would need to be deadheaded to Pomona (North) in the morning and SBTC in the afternoon to cover the reverse-peak equipment needs. Also, a significant amount of infrastructure would be required to provide capacity for these trains operating against the flow of peak traffic.

The schedule would be supported by five HR equipment sets, as indicated in the schedule and equipment cycle sheet shown in Appendix A.

4.4 15-Minute Peak/Hourly Off-Peak Hybrid-Rail with Existing Metrolink Service

For this scenario, approximate 15-minute peak (6 to 9 a.m., 3 to 7 p.m.) and hourly off-peak schedules were developed between Pomona (North) and University of Redlands for combined Metrolink/HR service. HR trains were added to support the service goals where practicable, as long as equipment cycles were possible. Since every other train during peak is a Metrolink train to and from LAUS, there are only enough reverse peak HR trains to provide service every 30 minutes. On the Redlands branch, approximate 15-minute frequencies are provided all day.

Figure 4-3 and Figure 4-4 depict stringline charts for HR service overlaid on top of current Metrolink schedules to provide 15-minute peak/hourly off-peak service between Pomona (North) and University of Redlands. One chart covers the 4 a.m. to noon time frame; the other covers 2 to 10 p.m. Metrolink trains are depicted as black lines, and HR trains are color-coded by train set and equipment cycle.

Figure 4-3. Stringline Chart for 15-Minute AM Peak Metrolink and Hybrid-Rail Service, Pomona (North) to University of Redlands

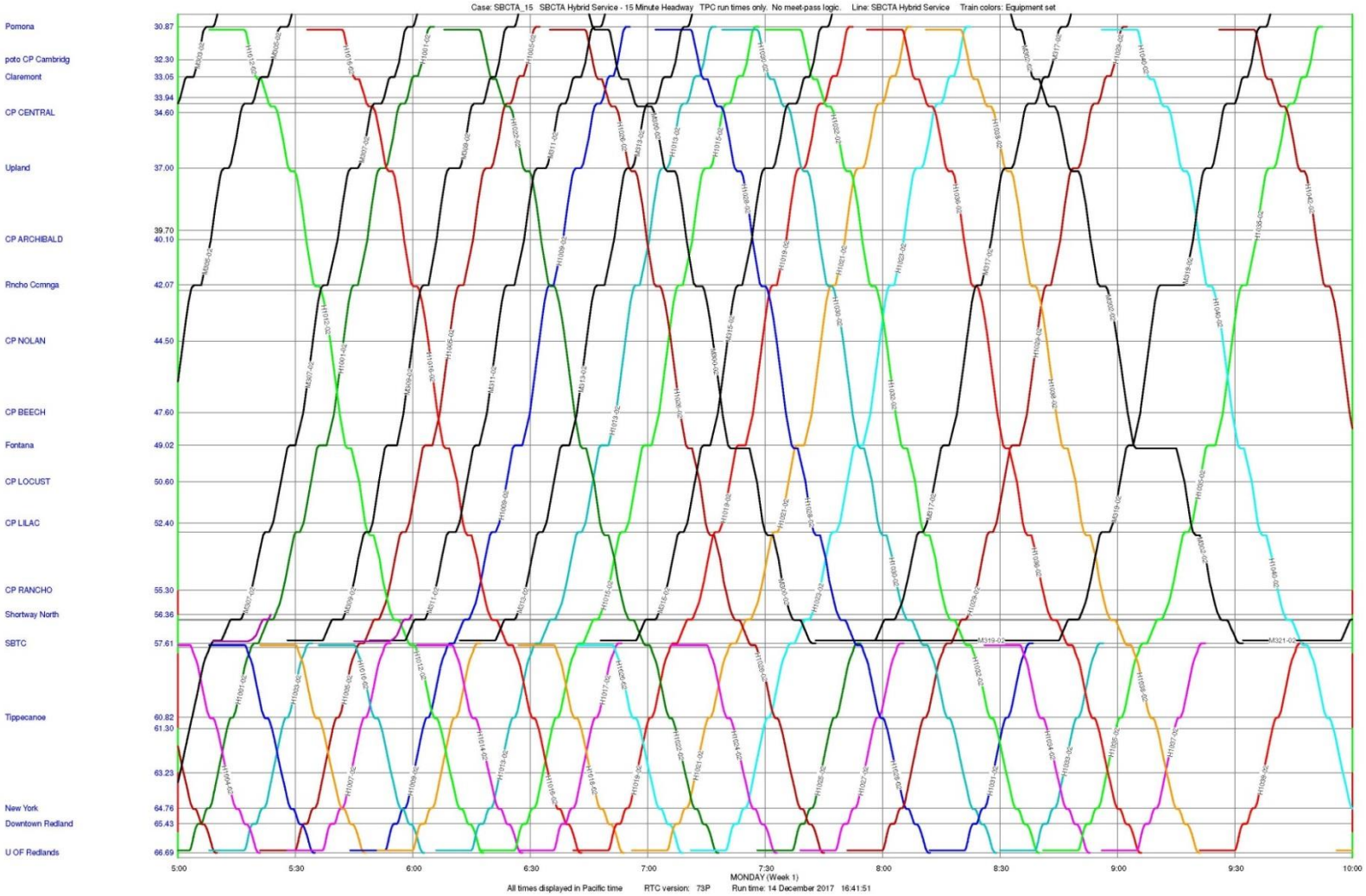
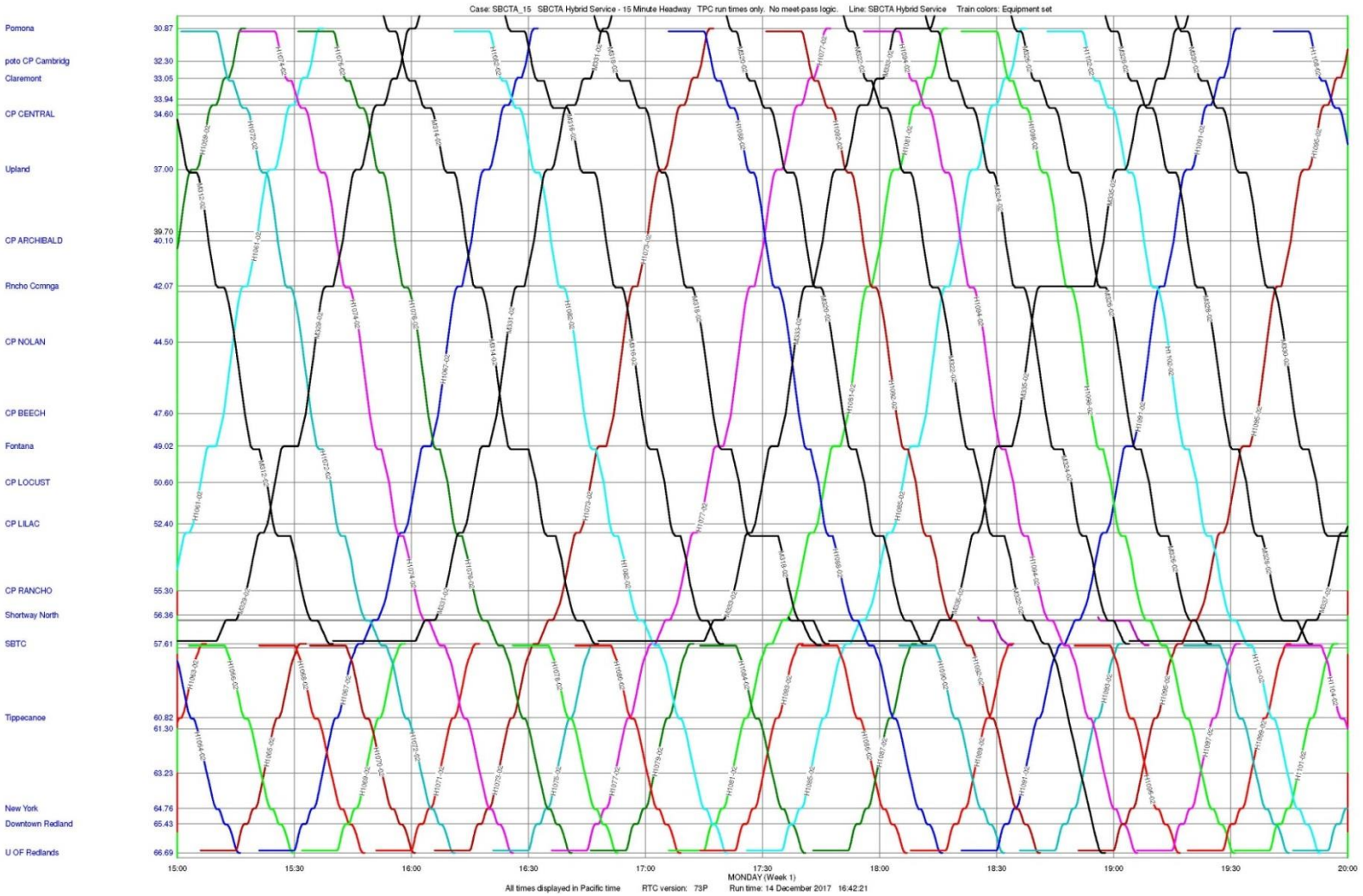


Figure 4-4. Stringline Chart for 15-Minute PM Peak Metrolink and Hybrid-Rail Service, Pomona (North) to University of Redlands

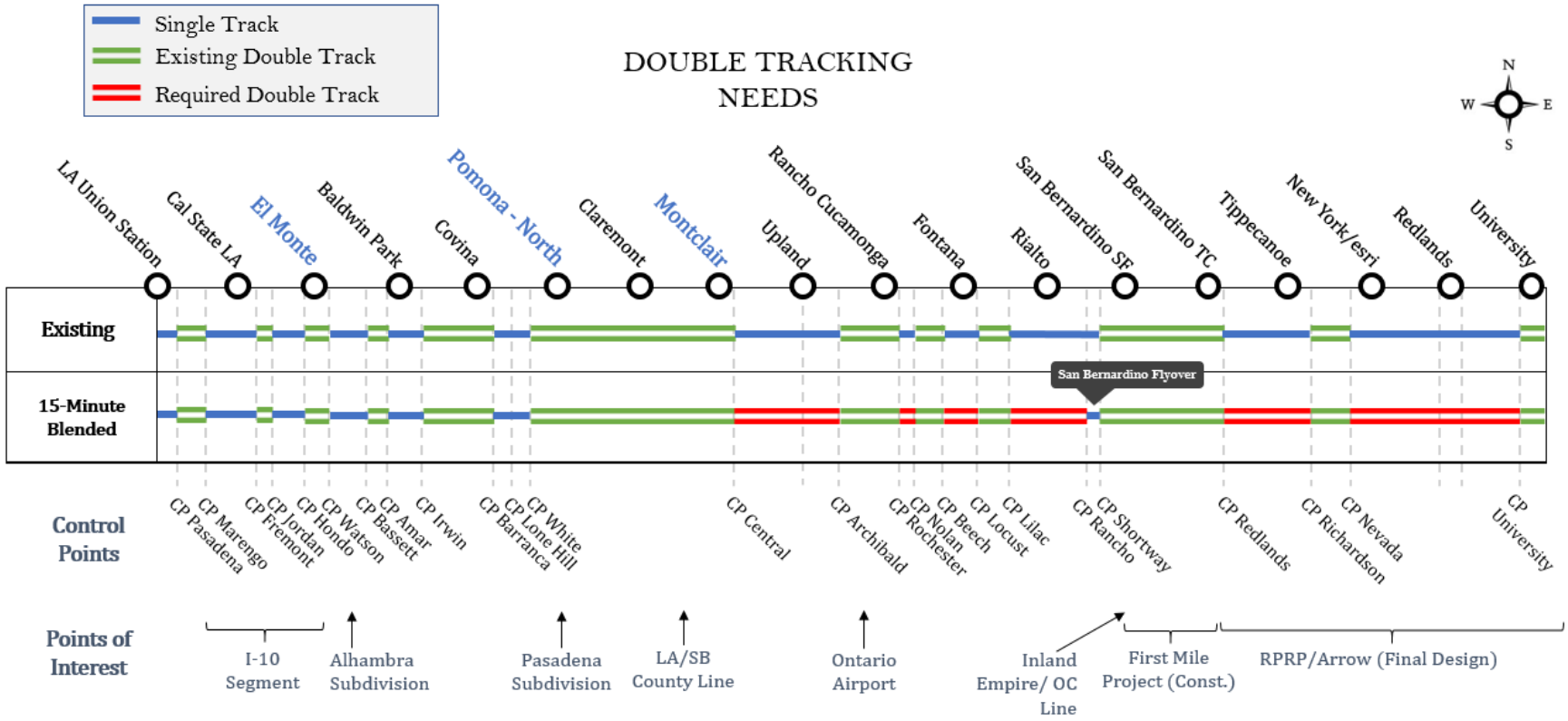


4.4.1 Summary

This schedule supports 15-minute peak and hourly off-peak service between Pomona (North) and SBTC and provides platform transfers between all peak Metrolink and Arrow service trains at SBTC.

The schedule requires double tracking of the Redlands branch and the San Gabriel Subdivision between SBTC and Pomona (North), with the exception of the San Bernardino Flyover, which can remain single track. The Redlands branch needs to be double tracked in part because of the requirement that Arrow HR trains meet every Metrolink peak train at SBTC, which eliminates the possibility of clock face type schedules and forces trains to meet at multiple points on the branch (Figure 4-5).

Figure 4-5. Recommended Double Tracking Locations: Phase 2A (ii) 15-Minute Peak/Hourly Off-Peak Hybrid Rail with Existing Metrolink Service



The schedule also requires the Pomona (North) layover track be long enough to accommodate two HR trainsets, independent of their future length. For most of the time, HRs can change operating ends on a main track at the Pomona (North) station, but this scenario requires two HR trainsets laying overnight at Pomona (North). The sets could also deadhead in the morning and evening between Pomona (North) and the HR maintenance facility, but the layover track would still need to be capable of holding at least one train set.

The schedule can be supported by nine HR equipment sets, as indicated in the schedule and equipment cycle sheet shown in Appendix A.

Metrolink trains were modeled using existing schedules. HR trains were overlaid on top of the service where they could operate without any impact on Metrolink services.

If LHC and HR services are to operate within the same San Bernardino Line corridor, a more efficient way to serve the corridor would be to adjust both services to provide a single, integrated schedule, similar to how the Pacific Surfliner service operates with Coaster and Metrolink commuter services on the Los Angeles – San Diego – San Luis Obispo rail corridor. This operation would allow for more efficient utilization of existing and planned infrastructure, maximize utilization of both services' equipment fleet and operating crews, and provide a more consistent, effective service offering for passengers. This schedule integration could be achieved regardless of whether one or two operating entities provide the services.

5 Phase 2A (iii): Enhanced Hybrid-Rail and Metrolink Service, University of Redlands to El Monte

5.1 Scope

The purpose of this modeling phase is to determine if existing San Gabriel Subdivision and RPRP infrastructure could support enhanced HR service between El Monte and University of Redlands, or if additional infrastructure would be required. Thirty-minute and 15-minute peak service headways will be analyzed.

5.2 Modeling Assumptions

For this modeling phase, the following assumptions were used:

- The schedule originally developed for modeling 30-minute and 15-minute peak services between University of Redlands and Pomona (North) was used. HR trains were extended between Pomona (North) and El Monte.
- A hypothetical layover/terminal track was added west of the El Monte station for HR trains to change operating ends off the main line.
- Per SBCTA direction, all peak directional Metrolink trains meet with Arrow service trains at SBTC.
- To support service goals, HR trains are overlaid on top of existing scheduled Metrolink trains.
- If a Metrolink train occupies a service frequency slot, HR trains will not be operated for that schedule slot.
- All HR equipment turns have a minimum allotment of 9 minutes.
- One-minute dwell times for HR station stops on the San Gabriel Subdivision (to reflect extra time needed to board and deploy the ramp) and 30-second dwells on the Redlands Branch (all level boarding) allotted.
- One minute of recovery time for HR schedules between SBTC and University of Redlands and 2 minutes of recovery time between SBTC and El Monte allotted.
- All train meets on the Redlands branch occur on the planned RPRP passing track.
- Approximate one-hour non-peak service between University of Redlands and El Monte will occur.

5.3 30-Minute Peak/Hourly Off-Peak Hybrid-Rail with Existing Metrolink Service

Per the previous model run results from Section 4, no new infrastructure was added between Pomona (North) and University of Redlands. The schedule originally developed for modeling 30-minute and 15-minute peak services between University of Redlands and Pomona (North) was used. HR trains were extended between Pomona (North) and El Monte.

Figure 5-1 and Figure 5-2 depict stringline charts for HR service overlaid on top of current Metrolink schedules to provide 30-minute peak/hourly off-peak service between El Monte and University of Redlands. One chart covers the 4 a.m. to noon time frame; the other covers 2 to 10 p.m. On the stringline charts, Metrolink SBL trains are shown in magenta, IEOC trains in light blue, and HR trains in dark blue.

Figure 5-1. Stringline Chart for 30-Minute Service Frequencies, Pomona (North) to El Monte, AM Service

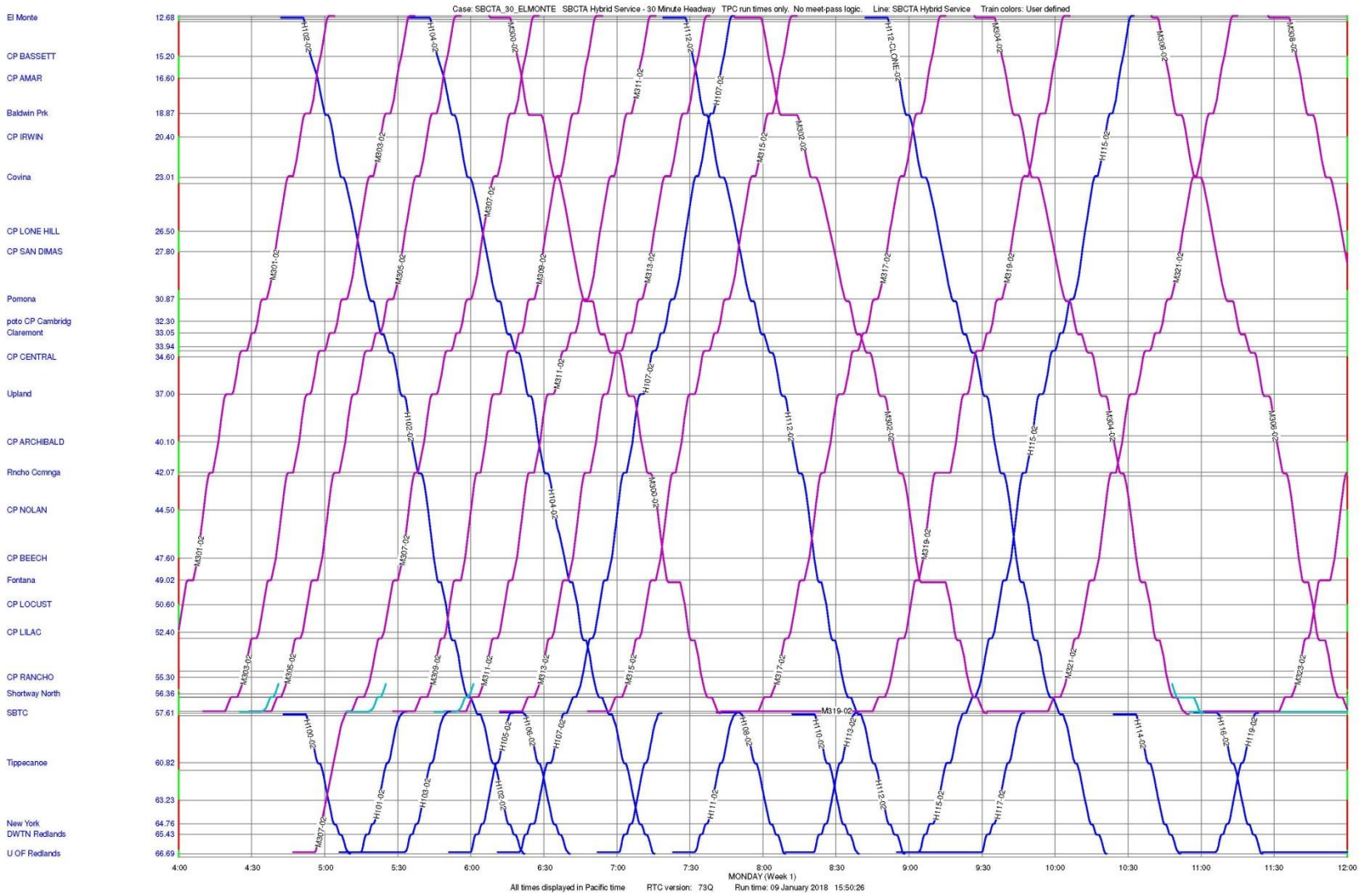
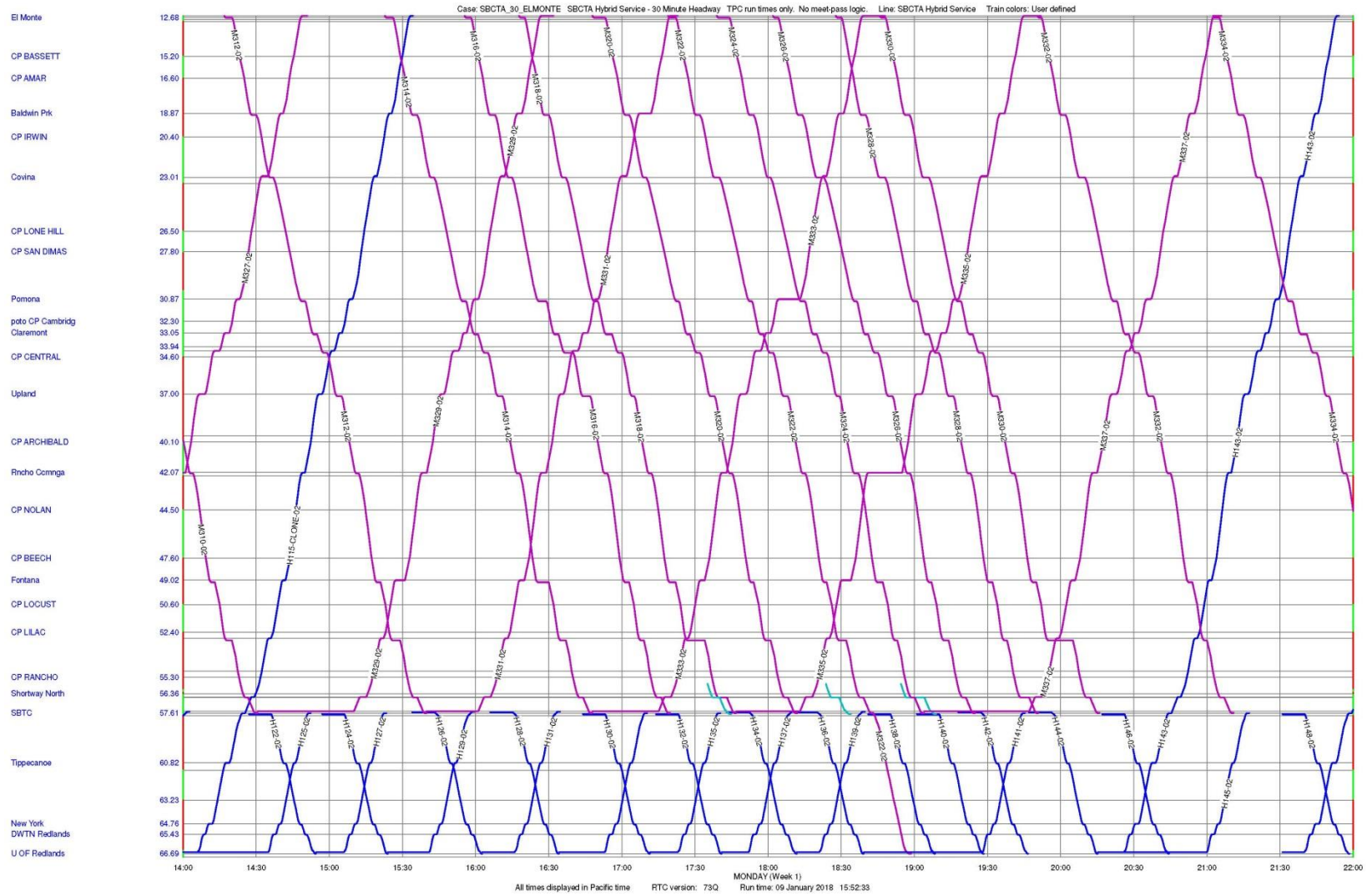


Figure 5-2. Stringline Chart for 30-Minute Service Frequencies, Pomona (North) to El Monte, PM Service

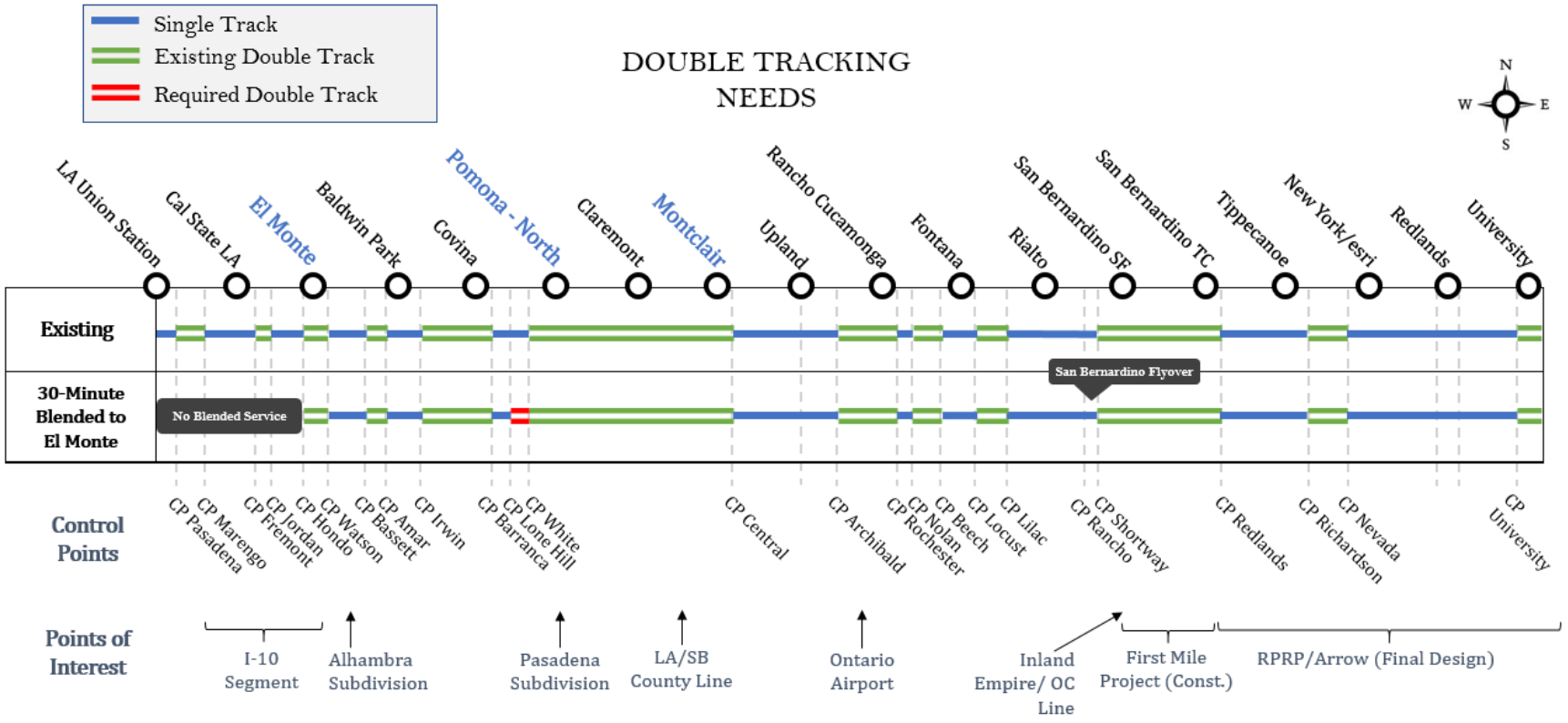


5.3.1 Summary

This schedule supports 30-minute peak and hourly off-peak service between El Monte and SBTC and provides platform transfers between all peak Metrolink and Arrow trains at SBTC.

The schedule is able to use existing San Gabriel Subdivision infrastructure east of Pomona (North) but requires a siding to be constructed between CP Lone Hill (MP26.5) and CP San Dimas (MP27.8). This is a smaller segment of the Lone Hill-White siding that was recommended in the Metrolink San Bernardino Line (SBL) Infrastructure Improvement Strategic Study.

Figure 5-3. Recommended Double Tracking Locations: Phase 2A (iii) 30-Minute Peak/Hourly Off-Peak Hybrid Rail with Existing Metrolink Service



The schedule does not support 30-minute reverse peak service between El Monte and SBTC. As Metrolink trains cover most of the 30-minute peak frequencies between the stations, a significant amount of equipment would need to be deadheaded to El Monte in the morning and SBTC in the afternoon to cover the reverse-peak equipment needs. Also, a significant amount of infrastructure would be required to provide capacity for these trains operating against the flow of peak traffic.

The schedule can be supported by seven HR equipment sets, as indicated in the schedule and equipment cycle sheet shown in Appendix A.

5.4 15-Minute Peak/Hourly Off-Peak Hybrid-Rail with Existing Metrolink Service

When 15 minute headways were modeled between Pomona (North) and University of Redlands, the results indicated that double tracking of the entire route segment was required to support the combination of Metrolink and HR services, with the exception of the San Bernardino Flyover. Extending that high level of service from Pomona (North) to El Monte will likewise require double tracking of nearly the entire segment.

Figure 5-4 and Figure 5-5 depict stringline charts covering only the route segment between El Monte and Pomona (North), for HR service overlaid on top of current Metrolink schedules to provide 15-minute peak/hourly off-peak service. In these particular charts, RTC does not recognize meet-pass conflicts. In other words, trains operate as if there is a double track railroad already in place, even though the charts still indicate existing single and double track sections. One chart covers the 4 a.m. to noon time frame; the other covers 2 to 10 p.m. On the stringline charts, Metrolink SBL trains are shown in magenta, IEOC trains in light blue, and HR trains in dark blue.

Figure 5-4. Stringline Chart for 15-Minute Service Frequencies, Pomona (North) to El Monte, AM Service

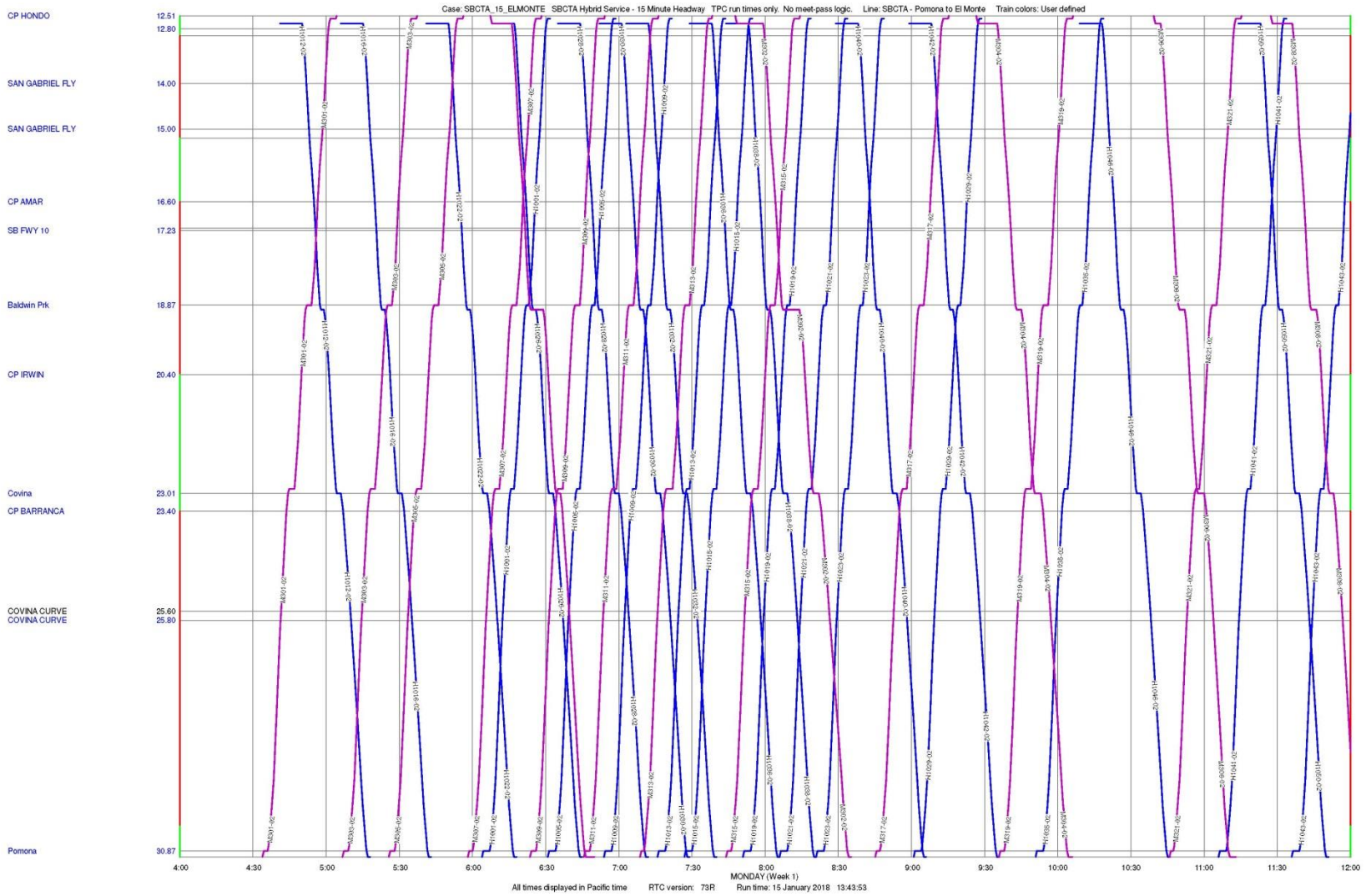
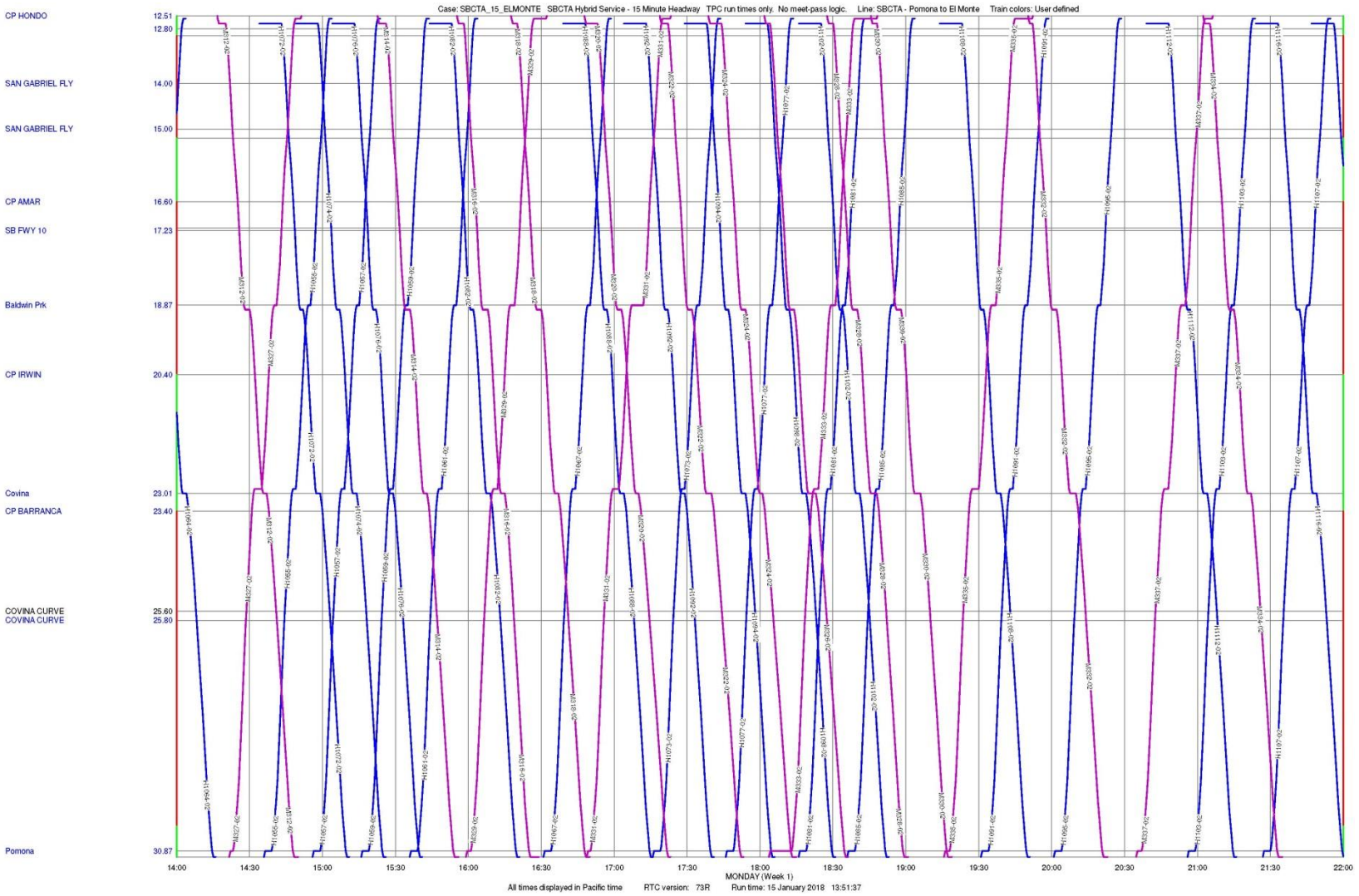


Figure 5-5. Stringline Chart for 15-Minute Service Frequencies, Pomona (North) to El Monte, PM Service



5.4.1 Summary

As the charts indicate, meets occur nearly everywhere on the segment during a typical day of operation, which will require the double tracking of most, if not all, of the route segment

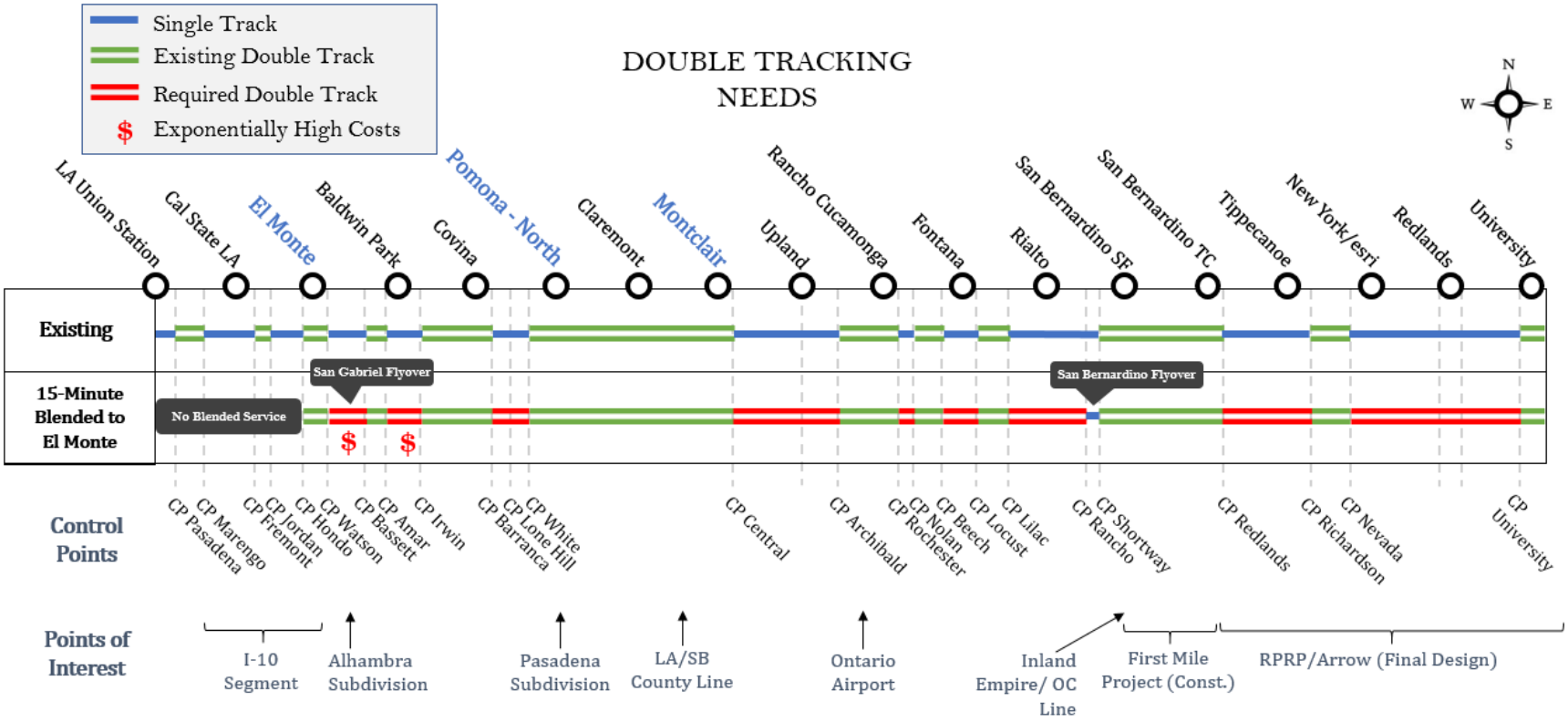
Four key locations have been identified that pose significant cost and/or right-of-way challenges to adding a second track. The locations are:

- San Gabriel Flyover (MP 13.9 to 15.0)
- I-10 underpass (MP 17.2)
- Baldwin Park station (MP 18.9)
- Narrow right-of-way through curve east of Covina station (MP 25.6 to 26.0)

Given the short length of the I-10 underpass restriction, it may be possible to operate 15-minute headways while maintaining the single track, although any single track segment will pose some constraints on reliable, flexible operations. In this scenario, integrated LHC and HR schedules would not reduce the need for these improvements.

Because of the major infrastructure improvements required to support this level of service, schedules and equipment cycles were not developed for this service scenario.

Figure 5-6. Recommended Double Tracking Locations: Phase 2A (iii) 15-Minute Peak/Hourly Off-Peak Hybrid Rail with Existing Metrolink Service



6 Phase 3: Long-Term Scenario, Hybrid-Rail Service to Ontario International Airport

6.1 Scope

This phase will use the updated RTC model from Phase 2A (ii) to help determine infrastructure improvements needed to support expanded HR service to the Ontario International Airport (ONT). Two service scenarios will be modeled:

- 30-minute peak/hourly off-peak service between University of Redlands and Rancho Cucamonga, with HR trains diverting to ONT
- 15-minute peak/hourly off-peak service between University of Redlands and Rancho Cucamonga, with HR trains diverting to ONT

6.2 Modeling Assumptions

For this modeling phase, the following assumptions were used:

- Infrastructure developed in the Phase 2 models were used.
- A new track alignment was developed between ONT and the San Gabriel Subdivision near Rancho Cucamonga. This alignment follows the preferred alignment from the *Ontario Airport Rail Access Study* (SBCTA 2014) and allows both eastbound and westbound trains to directly access the branch to ONT (Appendix B).
- To support service goals, HR trains were overlaid on existing scheduled Metrolink trains.
- If a Metrolink train occupies a service frequency slot, HR trains are not operated for that schedule slot.
- Only HR trains are routed through ONT.
- The ONT station is a stub-ended station. A 10-minute dwell time is allotted to all trains at ONT to facilitate passenger detraining and entraining, as well as changing the operating ends of the trainset.

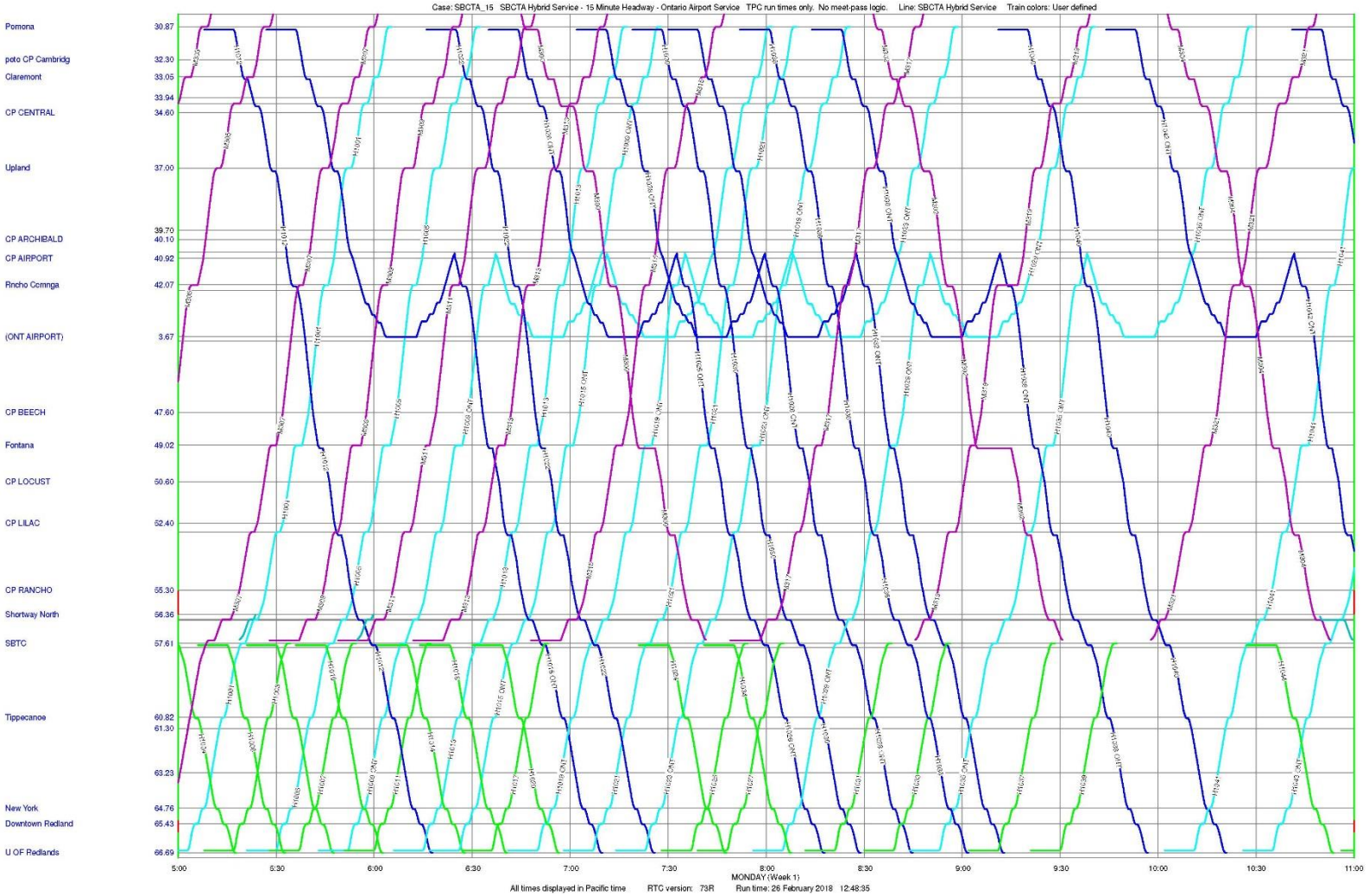
6.3 15-Minute Peak/Hourly Off-Peak Hybrid-Rail with Service to Ontario International Airport

For this scenario, existing Metrolink service is overlaid with HR service to provide combined 15-minute peak and hourly off-peak service between Pomona (North) and University of Redlands. HR trains will divert off the main line in both directions to serve ONT. This is the same schedule used in Section 4.4, with the exception of HR trains diverting to serve ONT.

Per the modeling performed in Phase 2, double tracking of the San Gabriel Subdivision and Redlands Branch between Pomona (North) and University of Redlands was required to support the combination of Metrolink and HR services, with the exception of the San Bernardino Flyover and a short single track segment in downtown Redlands.

Figure 6-1 depicts the stringline charts for AM service covering the route segment between Pomona (North) and University of Redlands. On the charts, Metrolink LHC trains are shown in purple, eastbound HR trains in dark blue, westbound HR trains in light blue, and RPRP trains in green. Trains entering and exiting the ONT branch create a cup-shaped line in the diagram.

Figure 6-1. Stringline Chart for 15-Minute Service Frequencies, Pomona (North) to ONT and University of Redlands, AM Service



6.3.1 6.3.1 Summary

As described above, double tracking of entire main line from University of Redlands to Pomona is assumed, with the exception of a single track section through downtown Redlands and the San Bernardino Flyover. In addition, the following infrastructure improvements were added to the model:

- Crossovers and two connecting tracks between CP Archibald, CP Rancho, and the ONT branch to allow for eastbound and westbound movements to and from ONT
- Double tracking of the ONT branch, with a universal crossover midpoint on the branch and one west of the ONT station tracks

The maximum speed on the ONT branch is 30 miles per hour, as determined in the *Ontario Airport Rail Access Study* (SBCTA 2014). With this maximum speed and the time required to change HR operating ends at ONT, it takes 30 minutes for a train to divert from the main line, stop at all four stations on the branch in each direction, and return to the main line.

Consideration should be given to examine ways to reduce the trip times on the ONT branch. Alternatives to the planned infrastructure include, but are not limited to:

- Increase maximum speed to 50 miles per hour (the same maximum speed as the Redlands branch), where infrastructure and safety permit
- Design a loop track configuration for the ONT station to reduce station dwell and better accommodate higher levels of service

A hypothetical schedule for this service scenario is depicted in

Table 6-1 and Table 6-2. As HR trains were overlaid on existing Metrolink schedules, service frequencies to and from ONT vary widely during the day. Future Metrolink and HR schedules will need to be coordinated to optimize integrated service on the route's future infrastructure. Integrated schedules will provide more consistent service to ONT and a more efficient operation with better HR equipment utilization. Given the lack of schedule integration and resulting poor HR equipment utilization, HR equipment cycles were not developed for this scenario.

6.4 30-Minute Peak/Hourly Off-Peak Hybrid-Rail with Service to Ontario International Airport

This scenario is based upon the service scenario developed for Phase 2A (ii), where HR service supplements existing Metrolink service on existing infrastructure. The modeling assumptions of this phase include:

- This service has an approximate 30-minute peak (6 to 9 a.m., 3 to 7 p.m.) and hourly reverse and off-peak schedules between Pomona (North) and University of Redlands for combined Metrolink/HR service.
- Four HR trains in each direction were added to support the service goals.
- This service provides platform transfers between all peak Metrolink and Arrow service trains at SBTC.
- This service uses existing San Gabriel Subdivision infrastructure, aside from a layover track west of the Pomona (North) station.
- This service does not support 30-minute reverse peak service between Pomona (North) and SBTC. As Metrolink trains cover most of the 30-minute peak frequencies between the stations, a significant amount of equipment would need to be deadheaded to Pomona (North) in the morning and SBTC in the afternoon to cover the reverse-peak equipment needs. Also, a significant amount of infrastructure would be required to provide capacity for the HR trains operating against the flow of peak traffic.

To add ONT service to this model, the following additional assumptions were made:

- No new train services or infrastructure were added on the San Gabriel Subdivision, with the exception of crossovers and turnouts needed to access the ONT branch.
- Given that only four HR trains in each direction are added to the main line schedule, HR shuttle trains would operate between ONT and Rancho Cucamonga to meet with peak Metrolink trains as often as possible.

The eight HR trains operate at inconsistent times of the day, as their original intention was to backfill existing Metrolink trains to provide a more reliable service between Pomona (North) and SBTC. If an HR shuttle service was provided to meet Metrolink trains, the shuttle trainsets and crews would sit idle while the main line HR trains were operating to ONT. Some additional non-peak and reverse peak mainline HR trains could be added, but it would add to the shuttle problem.

It appears the best way to serve ONT with HR trains, if no main line infrastructure improvements are made, is to run HR shuttle service exclusively between ONT and Rancho Cucamonga, where an HR station track would be constructed to facilitate platform transfers with Metrolink LHC trains. If one-seat, consistent HR service between Pomona (North), ONT, SBTC and Redlands is desired, double tracking of most of the main line is likely required, as the Phase 3A modeling results indicated.

6.5 Hybrid-Rail Shuttle Service to Ontario International Airport

The *Ontario Airport Rail Access Study* evaluated various alternatives that would connect the airport with Metrolink service. Alternatives A-3 and A-4 envisioned a diesel multiple-unit rail car -type shuttle service between the airport and Metrolink Rancho Cucamonga station. The study envisioned a dedicated track that begins at a stub-ended platform track at the station and travels west along the south side of the San Gabriel Subdivision for approximately 1.5 mile before turning south on the branch to ONT.

To provide 30-minute shuttle frequencies to match the 30-minute HR and Metrolink services, as envisioned in Sections 4.3 and 5.3, two HR vehicles would be required. A hypothetical schedule is shown in

Table 6-1. This schedule assumes that:

- Running time between ONT and Rancho Cucamonga, including two intermediate station stops, is 12 minutes (per the RTC model)
- Ten minutes is allotted at each endpoint station to facilitate changing operating ends of the HR trainset, entraining and detraining passengers, and allow for a cross platform transfer between Metrolink and shuttle trains at Rancho Cucamonga

Table 6-1. Schedule Excerpt for 30-Minute Service Frequencies, Ontario Airport Shuttle

		Set 1	Set 2
Ontario Airport	Dp	9:00 AM	9:30 AM
Rancho Cucamonga	Ar	9:12 AM	9:42 AM
	Dp	9:22 AM	9:52 AM
Ontario Airport	Ar	9:34 AM	10:04 AM
	Dp	9:44 AM	10:14 AM
Rancho Cucamonga	Ar	9:56 AM	10:26 AM
	Dp	10:06 AM	10:36 AM

		Set 1	Set 2
Ontario Airport	Ar	10:18 AM	10:48 AM
	Dp	10:28 AM	10:58 AM
Rancho Cucamonga	Ar	10:40 AM	11:10 AM

Schedules can be adjusted to facilitate better connections with Metrolink trains, which will be made easier as Metrolink moves to more consistent, clock face-type schedules.

In this scenario, trains will meet on the branch. A siding will be required to accommodate the meet, and the exact location of which will depend on:

- Desired schedule times
- Any increases in speed above the 30 miles per hour maximum speed used in the *Ontario Airport Rail Access Study*
- The final ONT branch alignment
- Right-of-way and/or environmental constraints

To provide 15-minute frequency to match to 15-minute HR and Metrolink services, as envisioned in Sections 4.4 and 5.4, three HR vehicles would be required. A hypothetical schedule is shown in Table 6-2, using the same assumptions as the 30-minute frequency scenario.

Table 6-2. Schedule Excerpt for 15-Minute Service Frequencies, Ontario Airport Shuttle

		Set 1	Set 2	Set 3
Ontario Airport	Dp	9:00 AM	9:15 AM	9:30 AM
Rancho Cucamonga	Ar	9:12 AM	9:27 AM	9:42 AM
	Dp	9:22 AM	9:37 AM	9:52 AM
Ontario Airport	Ar	9:34 AM	9:49 AM	10:04 AM
	Dp	9:44 AM	9:59 AM	10:14 AM
Rancho Cucamonga	Ar	9:56 AM	10:11 AM	10:26 AM
	Dp	10:06 AM	10:21 AM	10:36 AM
Ontario Airport	Ar	10:18 AM	10:33 AM	10:48 AM
	Dp	10:28 AM	10:43 AM	10:58 AM
Rancho Cucamonga	Ar	10:40 AM	10:55 AM	11:10 AM

As with the 30-minute scenario, schedules can be adjusted to facilitate better Metrolink train connections.

Operating three trainsets simultaneously would require infrastructure to accommodate two separate train meets on the route. For this particular schedule, one meet would occur west of the Rancho Cucamonga station, near where the dedicated shuttle track veers south toward the airport. If it occurs along the San Gabriel Subdivision right-of-way, there may not be sufficient room for two main tracks and two shuttle tracks within the current right-of way limits.

The exact locations of these sidings are dependent on the same factors described for the 30-minute service frequency scenario.

7 References

Metrolink. 2014. *Metrolink San Bernardino Line* (SBL) *Infrastructure Improvement Strategic Study.* Prepared by HDR Engineering, Inc. Los Angeles, California.

San Bernardino County Transit Authority (SBCTA). 2014. *Ontario Airport Rail Access Study.* Prepared by HDR Engineering, Inc. Los Angeles, California.

Appendix A. Schedule and Equipment Cycle Sheet

Schedule and Equipment Cycle for 30-Minute Peak Metrolink and Hybrid-Rail Service, Pomona (North) to University of Redlands

Phase 2 Schedules
Existing Metrolink Service, 30 minute peak, hourly off peak Hybrid Service

Platform connections at SBTC with Metrolink trains (except express trains) when feasible

Updated December 1, 2017

Turns From	IEMF	Pomona	Pomona	H101		H103	H105	H107		H109			H111				H113	H115			H117	H119			H121	H123		H125			H127			H129			H131			Express	H133			H135			H137			H139			H141			H145
	H100	H102	H104	H106	M300	H108	H110	H112	M302	H114	M304	M802	H116	M306	M308	H118	H120	M310	H122	H124	M312	H126	H128	M314	H130	M316	H132	M808	M318	H134	M320	H136	M810	M322	H138	M324	M812	H140	M326	H142	M328	H144	M330	H146	M332	H148
LAUS					05:46				07:25		09:06			10:19	11:06			12:42			13:56			15:02		15:34			15:56		16:25			16:56		17:16			17:39		18:06		18:25		19:30	
Pomona (North)		05:17	05:42		06:50			08:07	08:35		10:06			11:13	12:06		13:00	13:42			14:50			15:56		16:29			16:50		17:23			17:53		18:15			18:36		19:01		19:19		20:23	
Claremont		05:21	05:46		06:55			08:11	08:40		10:11			11:18	12:11		13:04	13:47			14:55			16:01		16:34			16:56		17:28			17:58		18:20			18:41		19:06		19:24		20:28	
Montclair		05:24	05:49		07:01			08:14	08:44		10:15			11:22	12:15		13:07	13:51			14:59			16:05		16:40			17:00		17:32			18:02		18:24			18:45		19:10		19:28		20:32	
Upland		05:29	05:54		07:07			08:19	08:50		10:21			11:28	12:21		13:12	13:57			15:05			16:11		16:47			17:05		17:38			18:08		18:29			18:51		19:16		19:34		20:38	
Rancho Cucamonga		05:36	06:01		07:14			08:26	08:57		10:28			11:35	12:28		13:19	14:04			15:12			16:18		16:54			17:12		17:45			18:15		18:37			18:58		19:23		19:41		20:45	
Fontana		05:44	06:09		07:26			08:34	09:15		10:37			11:44	12:37		13:27	14:13			15:21			16:30		17:03			17:22		17:54			18:24		18:47			19:07		19:32		19:50		20:54	
Rialto		05:50	06:15		07:32			08:40	09:21		10:43			11:51	12:45		13:33	14:20			15:29			16:37		17:09			17:34		18:01			18:32		18:53			19:14		19:38		20:05		21:00	
Old Sante Fe		05:56	06:21		07:39			08:46	09:28		10:50	10:57		11:58	12:52		13:39	14:26			15:36			16:44		17:16		17:40	17:43		18:08		18:29	18:39		19:00	19:04		19:21		19:47		20:12		21:07	
SBTC	04:52	06:00	06:25	07:00	**07:43**	**07:50**	08:21	08:50	09:33	10:15	10:55	11:01	11:06	12:02	**12:57**	**13:02**	13:43	**14:31**	**14:36**	15:06	**15:41**	**15:43**	16:15	**16:48**	**16:53**	**17:21**	**17:23**	**17:44**	**17:48**	**17:52**	**18:12**	**18:20**	18:33	**18:43**	**18:50**	**19:05**	**19:08**	**19:10**	**19:25**	**19:27**	**19:51**	**19:56**	**20:16**	**20:26**	**21:12**	**21:40**
Tippecanoe	04:58	06:06	06:31	07:06		07:56	08:27	08:56		10:21			11:12			13:08	13:49		14:42	15:12		15:49	16:21		16:59		17:29				17:58		18:26			18:56				19:16		19:33		20:02		20:32		21:46	
New York/ESRI	05:04	06:12	06:37	07:12		08:02	08:33	09:02		10:27			11:18			13:14	13:55		14:48	15:18		15:55	16:27		17:05		17:35				18:04		18:32			19:02				19:22		19:39		20:08		20:38		21:52	
Downtown Redlands	05:06	06:14	06:39	07:14		08:04	08:35	09:04		10:29			11:20			13:16	13:57		14:50	15:20		15:57	16:29		17:07		17:37				18:06		18:34			19:04				19:24		19:41		20:10		20:40		21:54	
University of Redlands	05:10	06:20	06:45	07:18		08:08	08:39	09:10		10:33			11:24			13:20	14:03		14:55	15:25		16:02	16:34		17:12		17:42				18:11		18:39			19:09				19:29		19:46		20:15		20:45		21:59	
Turns To	H103	H107	H109	H111		H113	H115	H117		H119			H121			H123	H125		H127	H129		H131	H133		H135		H137				H139		H141			H143				H145		IEMF		EMF		H147		IEMF	

Turns From					Express		IEMF			H100		IEMF		H102			H104	H106		H108		H110	H112			H114			H116			H118	H120			H122	H124		H126	H128			H130			H132	H134	H136		H138	H140	h146
	M301	M803	M303	M305	M307	M805	H101	M309	M807	H103	M311	H105	M313	H107	M315	H109	H111	M317	H113	M319	H115	H117	M321	H119	M323	M815	H121	M327	H123	H125	M329	H127	H129	M331	H131	H133	M333	H135	M335	H137	H139	H141	M337	H143	H145	H147
University of Redlands					04:56		05:15			05:33		06:00		06:28		07:01	07:32		08:21		08:50	09:30		11:06			12:00		13:44	14:35		15:06	15:41		16:16	16:53		17:23		17:52	18:21	19:28		20:26	21:00	21:40	
Downtown Redlands							05:18			05:36		06:03		06:31		07:04	07:35		08:24		08:53	09:33		11:09			12:03		13:47	14:38		15:09	15:44		16:19	16:56		17:26		17:55	18:24	19:31		20:29	21:03	21:43	
New York/ESRI							05:20			05:38		06:05		06:33		07:06	07:37		08:26		08:55	09:35		11:11			12:05		13:49	14:40		15:11	15:46		16:21	16:58		17:28		17:57	18:26	19:33		20:31	21:05	21:45	
Tippecanoe							05:26			05:44		06:11		06:39		07:12	07:43		08:32		09:01	09:41		11:17			12:11		13:55	14:46		15:17	15:52		16:27	17:04		17:34		18:03	18:32	19:39		20:37	21:11	21:51	
SBTC	03:47	04:34	04:19	04:38	05:11	05:18	**05:33**	**05:37**	05:54	**05:51**	**05:58**	**06:18**	**06:21**	06:45	06:57	07:19	**07:50**	**07:58**	**08:39**	**08:45**	09:07	**09:48**	**09:57**	**11:24**	**11:32**	**12:19**	**12:18**	**13:33**	14:02	**14:53**	**15:10**	15:24	**15:59**	**16:01**	16:34	**17:11**	**17:15**	17:41	18:13	18:10	18:39	**19:46**	**19:47**	20:43	21:18	21:57	
San Bernardino	03:52	04:38	04:24	04:42	05:16	05:23		05:42	05:59		06:03		06:26	06:49	07:02			08:03		08:50	09:11		10:02		11:37	12:24		13:38			15:15			16:06			17:20			18:18				19:52	20:47		22:01	
Rialto	03:59		04:32	04:50	05:23			05:49			06:11		06:33	06:56	07:09			08:10		08:58	09:18		10:09		11:44			13:45			15:22			16:13			17:27			18:25				19:59	20:54		22:08	
Fontana	04:06		04:38	04:57	05:30			05:56			06:17		06:40	07:03	07:16			08:17		09:04	09:25		10:16		11:53			13:52			15:31			16:20			17:34			18:34				20:06	21:01		22:15	
Rancho Cucamonga	04:14		04:47	05:06	05:38			06:04			06:26		06:49	07:11	07:24			08:25		09:17	09:33		10:25		12:02			14:01			15:40			16:29			17:43			18:55				20:15	21:09		22:23	
Upland	04:22		04:54	05:13	05:46			06:12			06:34		06:56	07:18	07:32			08:33		09:24	09:40		10:33		12:09			14:09			15:47			16:36			17:51			19:03				20:23	21:16		22:30	
Montclair	04:28		05:00	05:19	05:52			06:18			06:39		07:02	07:23	07:38			08:39		09:30	09:45		10:39		12:15			14:15			15:53			16:42			17:57			19:09				20:28	21:21		22:35	
Claremont	04:31		05:04	05:23	05:55			06:21			06:43		07:06	07:26	07:41			08:42		09:33	09:48		10:43		12:18			14:19			15:56			16:46			18:01			19:13				20:32	21:24		22:38	
Pomona (North)	04:36		05:09	05:28	06:00			06:26			06:48		07:10	07:32	07:46			08:47		09:38	09:54		10:47		12:23			14:23			16:01			16:50			18:13			19:18				20:37	21:30		22:44	
LAUS	05:26		05:59	06:20	06:50			07:16			07:40		08:02		08:36			09:39		10:30			11:39		13:15			15:14			17:00			17:53			19:10			20:14				21:29				
Turns To							H106			H108		H110		H112		H114	H116		H118		H120	H122		H124			H126		H128	H130		H132	H134		H136	H138		H140		H142	H144	H146		Pomona	H148	Pomona	

Hybrid equipment sets:

Trainset 1
Trainset 2
Trainset 3
Trainset 4
Trainset 5

Schedule and Equipment Cycle for 15-Minute Peak Metrolink and Hybrid-Rail Service, Pomona (North) to University of Redlands

Schedule and Equipment Cycle for 30-Minute Peak Metrolink and Hybrid-Rail Service, El Monte to University of Redlands

Phase 2 Schedules
Existing Metrolink Service, 30 minute peak, hourly off peak Hybrid Service to El Monte

Platform connections at SBTC with Metrolink trains (except express trains) when feasible

Updated January 15, 2018

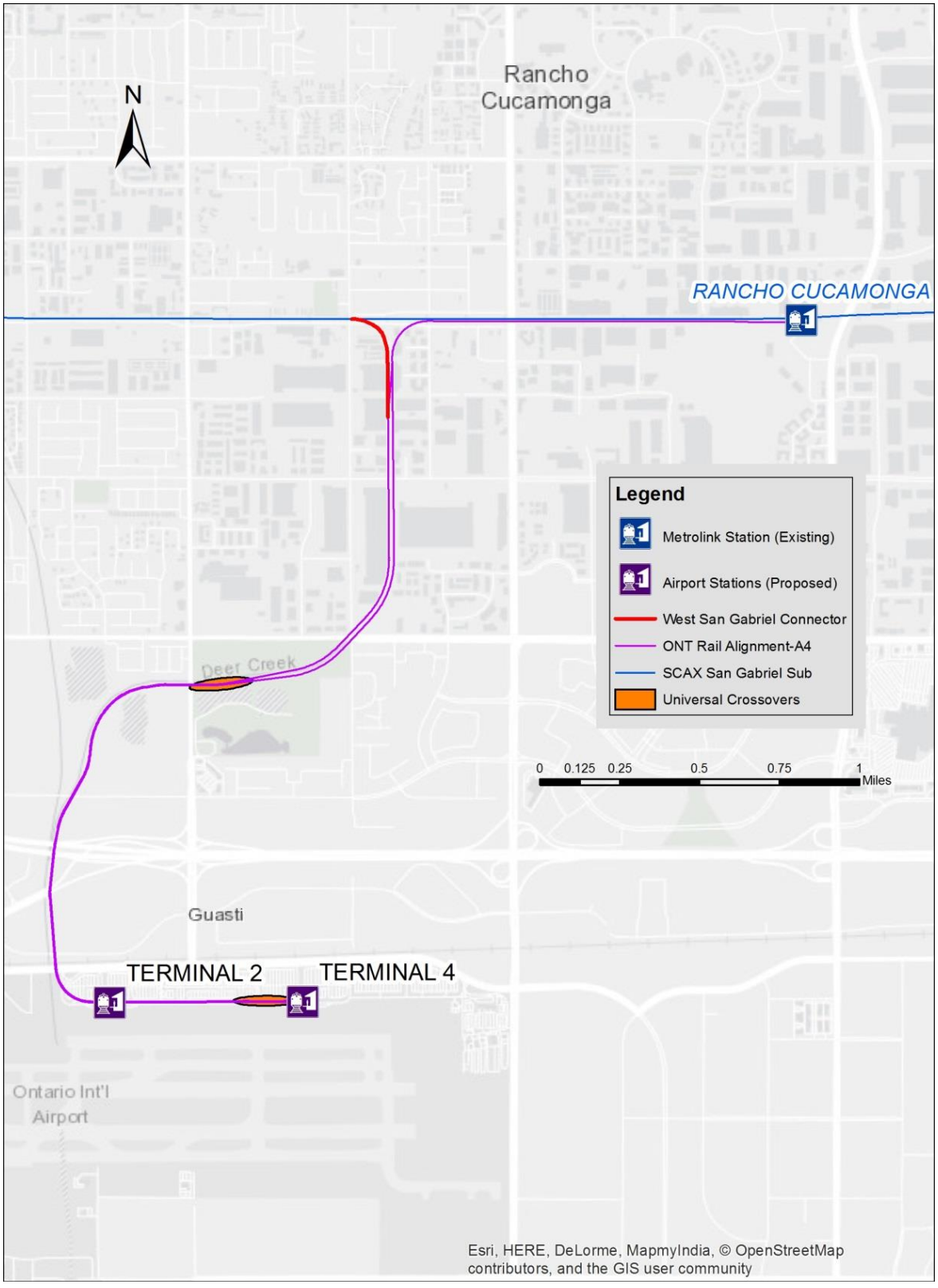
Turns From																																									
	H100	H102	H104	H106	M300	H108	H110	H112	M302	H114	M304	M802	H116	H118	M306	M308	H120	H122	M310	H124	H126	M312	H128	H130	M314	H132	M316	H134	M808	M318	H136	M320	H138	M810	M322	H140	M324	M812	H142	M326	H144	M328	H146	M330	H148	M332	H150	M334	M336
LAUS					05:46				07:25		09:06				10:19	11:06			12:42			13:56			15:02		15:34			15:56		16:25			16:56		17:16			17:39		18:06		18:25		19:30		20:42	21:49
El Monte		04:51		05:43	06:16			07:28	07:59	08:51	09:35				10:42	11:36		12:14	13:11			14:20			15:26		15:58			16:20		16:53			17:22		17:44			18:04		18:30		18:48		19:52		21:05	22:11
Baldwin Prk		05:00		05:52	06:29			07:37	08:14	09:00	09:45				10:52	11:46		12:23	13:22			14:30			15:36		16:08			16:30		17:03			17:32		17:54			18:14		18:40		18:58		20:02		21:15	22:21
Covina		05:07		05:59	06:36			07:44	08:22	09:07	09:53				11:00	11:53		12:30	13:29			14:37			15:43		16:15			16:37		17:10			17:40		18:01			18:23		18:48		19:06		20:10		21:22	22:29
Pomona (North)		05:19		06:11	06:50			07:56	08:35	09:19	10:06				11:13	12:06		12:42	13:42			14:50			15:56		16:29			16:50		17:23			17:53		18:15			18:36		19:01		19:19		20:23		21:35	22:42
Claremont		05:23		06:15	06:55			08:00	08:40	09:23	10:11				11:18	12:11		12:46	13:47			14:55			16:01		16:34			16:56		17:28			17:58		18:20			18:41		19:06		19:24		20:28		21:41	22:47
Montclair		05:26		06:18	07:01			08:03	08:44	09:26	10:15				11:22	12:15		12:49	13:51			14:59			16:05		16:40			17:00		17:32			18:02		18:24			18:45		19:10		19:28		20:32		21:45	22:51
Upland		05:31		06:23	07:07			08:08	08:50	09:31	10:21				11:28	12:21		12:54	13:57			15:05			16:11		16:47			17:05		17:38			18:08		18:29			18:51		19:16		19:34		20:38		21:50	22:57
Rancho Cucamonga		05:38		06:30	07:14			08:15	08:57	09:38	10:28				11:35	12:28		13:01	14:04			15:12			16:18		16:54			17:12		17:45			18:15		18:37			18:58		19:23		19:41		20:45		21:57	23:04
Fontana		05:46		06:36	07:26			08:23	09:15	09:46	10:37				11:44	12:37		13:09	14:13			15:21			16:30		17:03			17:22		17:54			18:24		18:47			19:07		19:32		19:50		20:54		22:07	23:13
Rialto		05:52		06:42	07:32			08:29	09:21	09:52	10:43				11:51	12:45		13:15	14:20			15:29			16:37		17:09			17:34		18:01			18:32		18:53			19:14		19:38		20:05		21:00		22:13	23:19
Old Sante Fe		05:58		06:48	07:39			08:35	09:28	09:58	10:50	10:57			11:58	12:52		13:21	14:26			15:36			16:44		17:16		17:40	17:43		18:08		18:29	18:39		19:00	19:04		19:21		19:47		20:12		21:07		22:20	23:26
SBTC	04:52	06:02	06:21	06:52	**07:43**	**07:50**	08:21	08:39	09:33	10:02	10:55	11:01	10:33	11:06	12:02	**12:57**	**13:02**	13:25	**14:31**	**14:36**	15:06	**15:41**	**15:43**	16:15	**16:48**	**16:53**	**17:21**	**17:23**	**17:44**	**17:48**	**17:52**	**18:12**	**18:20**	18:33	**18:43**	**18:50**	**19:05**	**19:08**	**19:10**	**19:25**	**19:27**	**19:51**	**19:56**	**20:16**	**20:26**	**21:12**	**21:40**	22:24	23:31
Tippecanoe	04:58	06:08	06:27	06:58		07:56	08:27	08:45		10:08			10:39	11:12			13:08	13:31		14:42	15:12		15:49	16:21		16:59		17:29			17:58		18:26			18:56					19:16		19:33		20:02		20:32		21:46		
New York/ESRI	05:04	06:15	06:33	07:05		08:02	08:33	08:52		10:15			10:45	11:18			13:14	13:38		14:48	15:18		15:55	16:27		17:05		17:35			18:04		18:32			19:02					19:22		19:39		20:08		20:38		21:52		
Downtown Redlands	05:06	06:18	06:35	07:08		08:04	08:35	08:55		10:18			10:47	11:20			13:16	13:41		14:50	15:20		15:57	16:29		17:07		17:37			18:06		18:34			19:04					19:24		19:41		20:10		20:40		21:54		
University of Redlands	05:10	06:23	06:39	07:13		08:08	08:39	09:00		10:23			10:51	11:24			13:20	13:46		14:55	15:25		16:02	16:34		17:12		17:42			18:11		18:39		19:03	19:09				19:29		19:46		20:15		20:45		21:59		
Turns To																																																	

Turns From					Express																																											
	M301	M803	M303	M305	M307	M805	H101	M309	M807	H103	M311	H105	M313	H107	M315	H109	H111	M317	H113	M319	H115	H117	M321	H119	M323	M815	H121	M327	H123	H125	H127	M329	H129	H131	M331	H133	H135	M333	H137	M335	H139	H141	H143	M337	H145	H147	H149
University of Redlands					04:56		05:15			05:33		06:00		06:20		07:01	07:32		08:21		09:04	09:30		11:06			12:00		13:44	14:06	14:35		15:06	15:41		16:16	16:53		17:23		17:52	18:21	19:28		20:26	21:00	21:40
Downtown Redlands							05:18			05:36		06:03		06:23		07:04	07:35		08:24		09:07	09:33		11:09			12:03		13:47	14:09	14:38		15:09	15:44		16:19	16:56		17:26		17:55	18:24	19:31		20:29	21:03	21:43
New York/ESRI							05:20			05:38		06:05		06:26		07:06	07:37		08:26		09:10	09:35		11:11			12:05		13:49	14:12	14:40		15:11	15:46		16:21	16:58		17:28		17:57	18:26	19:33		20:32	21:05	21:46
Tippecanoe							05:26			05:44		06:11		06:33		07:12	07:43		08:32		09:17	09:41		11:17			12:11		13:55	14:19	14:46		15:17	15:52		16:27	17:04		17:34		18:03	18:32	19:39		20:39	21:11	21:53
SBTC	03:47	04:34	04:19	04:38	05:11	05:18	**05:33**	**05:37**	05:54	**05:51**	**05:58**	**06:18**	**06:21**	06:39	06:57	07:19	**07:50**	**07:58**	**08:39**	**08:45**	09:23	**09:48**	**09:57**	**11:24**	**11:32**	**12:19**	**12:18**	**13:33**	14:02	14:25	**14:53**	**15:10**	15:24	**15:59**	**16:01**	16:34	**17:11**	**17:15**	17:41	18:13	18:10	18:39	**19:46**	**19:47**	20:45	21:18	21:59
San Bernardino	03:52	04:38	04:24	04:42	05:16	05:23		05:42	05:59		06:03		06:26	06:43	07:02			08:03		08:50	09:27		10:02		11:37	12:24		13:38		14:29		15:15			16:06			17:20		18:18				19:52	20:49		22:03
Rialto	03:59		04:32	04:50	05:23			05:49			06:11		06:33	06:50	07:09			08:10		08:58	09:34		10:09		11:44			13:45		14:36		15:22			16:13			17:27		18:25				19:59	20:56		22:10
Fontana	04:06		04:38	04:57	05:30			05:56			06:17		06:40	06:56	07:16			08:17		09:04	09:40		10:16		11:53			13:52		14:42		15:31			16:20			17:34		18:34				20:06	21:02		22:16
Rancho Cucamonga	04:14		04:47	05:06	05:38			06:04			06:26		06:49	07:04	07:24			08:25		09:17	09:48		10:25		12:02			14:01		14:50		15:40			16:29			17:43		18:55				20:15	21:10		22:24
Upland	04:22		04:54	05:13	05:46			06:12			06:34		06:56	07:11	07:32			08:33		09:24	09:55		10:33		12:09			14:09		14:57		15:47			16:36			17:51		19:03				20:23	21:17		22:31
Montclair	04:28		05:00	05:19	05:52			06:18			06:39		07:02	07:16	07:38			08:39		09:30	10:00		10:39		12:15			14:15		15:02		15:53			16:42			17:57		19:09				20:28	21:22		22:36
Claremont	04:31		05:04	05:23	05:55			06:21			06:43		07:06	07:19	07:41			08:42		09:33	10:03		10:43		12:18			14:19		15:05		15:56			16:46			18:01		19:13				20:32	21:25		22:39
Pomona (North)	04:36		05:09	05:28	06:00			06:26			06:48		07:10	07:23	07:46			08:47		09:38	10:07		10:47		12:23			14:23		15:09		16:01			16:50			18:13		19:18				20:37	21:29		22:43
Covina	04:47		05:20	05:39	06:11			06:37			06:59		07:22	07:33	07:57			08:58		09:49	10:17		10:58		12:34			14:35		15:19		16:12			17:02			18:24		19:30				20:48	21:39		22:53
Baldwin Prk	04:54		05:27	05:46	06:18			06:44			07:06		07:29	07:39	08:04			09:05		09:56	10:23		11:05		12:41			14:41		15:25		16:19			17:12			18:31		19:37				20:55	21:45		22:59
El Monte	05:04		05:37	05:56	06:28			06:54			07:16		07:38	07:50	08:14			09:15		10:06	10:34		11:15		12:51			14:51		15:36		16:32			17:23			18:48		19:52				21:06	21:56		23:10
LAUS	05:26		05:59	06:20	06:50			07:16			07:40		08:02		08:36			09:39		10:30			11:39		13:15			15:14				17:00			17:53			19:10		20:14				21:29			
Turns To																																																	

Hybrid equipment sets:

Trainset 1	
Trainset 2	
Trainset 3	
Trainset 4	
Trainset 5	

Appendix B. Alignment Diagram


N
Rancho
Cucamonga
RANCHO CUCAMONGA
Legend
Metrolink Station (Existing)
Airport Stations (Proposed)
West San Gabriel Connector
ONT Rail Alignment-A4
SCAX San Gabriel Sub
Universal Crossovers
0 0.125 0.25 0.5 0.75 1
Miles
Deer Creek
Guasti
TERMINAL 2
TERMINAL 4
Ontario Int'l
Airport
Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap
contributors, and the GIS user community