North I-25 EIS
Transit Operations Plans
Technical Memorandum

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Colorado
Department of Transportation

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Under Contract to:
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1.0 Introduction

The Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA), in cooperation with the Colorado Department of Transportation (CDOT), initiated a Draft Environmental Impact Statement (DEIS) to identify and evaluate multi-modal transportation improvements along the 61-mile I-25 transportation corridor extending from the Fort Collins/Wellington area to Denver. An extensive process was undertaken to identify a range of alternatives that could be developed to meet the purpose and need of the project. These alternatives were then screened and combined to produce two build packages. These packages, together with the No-Action Alternative, were considered the reasonable alternatives and were fully evaluated in the DEIS.

Package A includes commuter rail line using the existing BNSF railroad track from Fort Collins to downtown Longmont. Package A also includes a new commuter rail line that would connect Longmont to the FasTracks North Metro end-of-line station in Thornton. Other components of Package A include nine commuter rail stations and a commuter rail maintenance facility; commuter bus service along US 85 between Greeley and downtown Denver as well as along E-470 from US 85 to Denver International Airport (DIA) and a commuter bus maintenance facility; and feeder bus routes along five east-west routes.

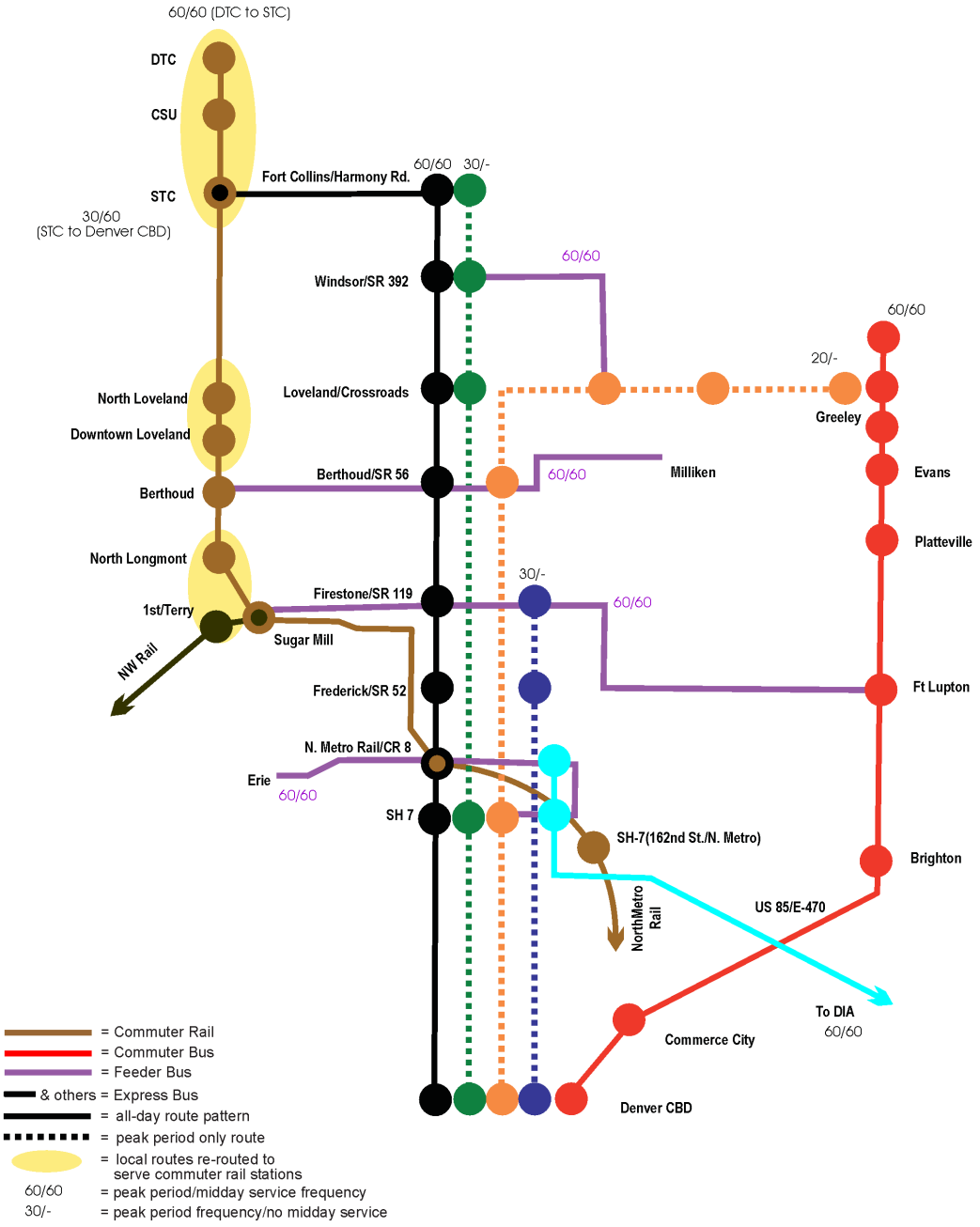
Package B includes tolled express lanes (TEL) on I-25 that would be used by buses, high-occupancy vehicles for free, and single-occupancy vehicles if they pay a toll. Package B includes 12 bus stations along I-25, US 34 into Greeley and Harmony Road into Fort Collins. Package B also includes a bus maintenance facility and feeder bus routes along five east-west streets, as well as bus service along E-470 from I-25 to DIA.

As a result of the DEIS, a Draft Preferred Alternative was created based on public input, travel demand model results and further analysis of the corridor. This vision includes components from both Packages A and B. Specifically, the following components are included in the Preferred Alternative:

- Commuter rail along the BNSF corridor from Fort Collins to Longmont and a connection to RTD's North Metro rail line at the proposed 162nd Avenue station, with North I-25 commuter rail service continuing to Denver Union Station (DUS) in downtown Denver;
- An extension of RTD's Northwest commuter rail line from 1st/Terry in Longmont to the proposed Sugar Mill station on the North I-25 rail line;
- Commuter bus on US 85 from Greeley to downtown Denver;
- Express bus on I-25 in tolled express lanes; and
- Feeder bus connections to proposed premium transit rail and bus routes.

Figure 1-1 provides a schematic of the proposed transit network in the Draft Committee Vision Plan for the North I-25 corridor. Following are detailed descriptions of each component of this plan.

Figure 1-1
Draft Preferred Alternative – Proposed Transit Network and Operating Plan
Preferred Alternative Operating Plan



2.0 Commuter Rail Service

The Draft Preferred Alternative includes commuter rail transit (DMU's) along the BNSF corridor in the North I-25 corridor. This service is presently envisioned as an extension of the proposed RTD FasTracks North Metro service from Denver Union Station (DUS) to 162nd Street. The Draft Preferred Alternative extends this rail service northwest to Longmont, and then north to Fort Collins along the existing BNSF railroad alignment. Proposed stops north of RTD's North Metro 162nd Avenue station are as follows:

- CR 8/I-25
- Sugar Mill in Longmont
- North Longmont at SH 66
- Berthoud at SH 56
- Downtown Loveland at 6th Street
- North Loveland at 29th Street
- South Fort Collins Transit Center (STC) at Mason Street/West Fairway Lane
- Colorado State University
- Downtown Fort Collins Transit Center (DTC) at Maple Street

In addition to the commuter rail service described above, a short extension of RTD's Northwest rail line is proposed from 1st/Terry to the North I-25's Sugar Mill station in Longmont. Passengers will be able to transfer between the North I-25 line and the Northwest line at Sugar Mill to travel to/from Boulder.

2.1 Proposed Operating Plan

RTD's North Metro rail service plan proposes Electric Multiple Unit (EMU) vehicles. Proposed peak period frequencies are 15 minutes, and proposed midday frequencies are 30 minutes along the entire line (*Commuter Rail Operations and Maintenance Cost Estimate Report*, RTD, September 2009).

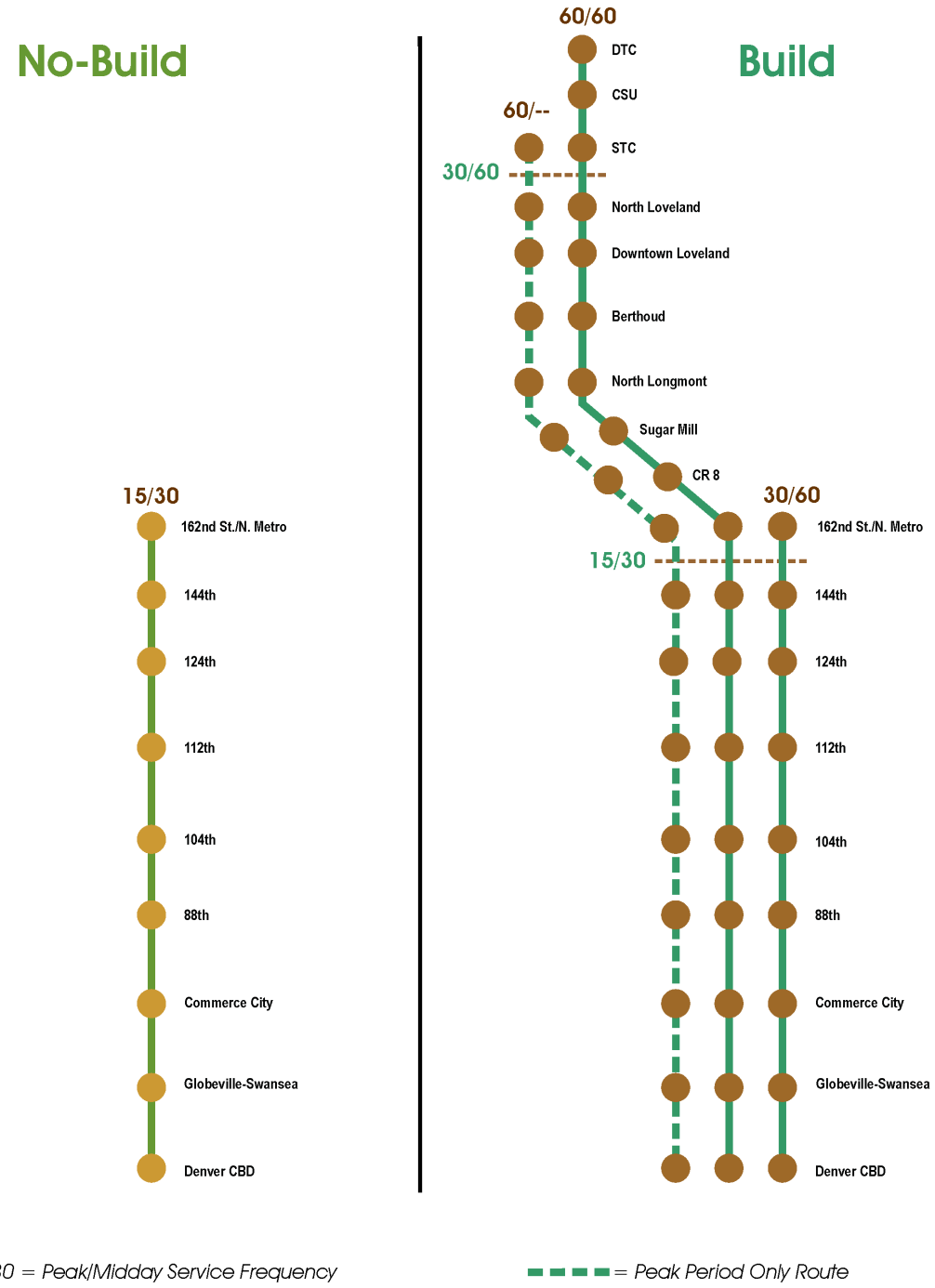
The North I-25 rail operating plan assumes modification to RTD's North Metro rail operating plan, with every other train on the North Metro rail line designated as a North I-25 train to/from Fort Collins. Thus, the proposed operating plan maintains planned RTD North Metro service frequencies. As noted above, EMU service is proposed for RTD's North Metro service. DMU's or traditional commuter rail trains are proposed for North I-25 service. Therefore, a mix of vehicle types will be operating on RTD's North Metro rail line.

Figure 2-1 illustrates the proposed weekday operating plan for the No-Build and Build scenarios. Since the North I-25 rail operating plan extends every other train on the North

Metro rail line to Fort Collins, the result is 30 minute peak period and 60 minute midday service between Denver and Fort Collins. During the peak period, every other train terminates at the South Fort Collins Transit Center (STC) at Mason Street/West Fairway Lane, while the remaining trains serve the full length to Downtown Fort Collins Transit Center (DTC) at Maple Street. Therefore, the segment from STC to DTC has 60 minute all-day service.

The proposed weekday span of service along the North I-25 line is approximately 4:30 a.m. to 10:00 p.m. The proposed weekend span of service is approximately 6:00 a.m. to 10:00 p.m.

Figure 2-1
North I-25 Commuter Rail Operating Plan Schematics



As previously noted, the Preferred Alternative includes an extension of RTD's Northwest rail line from 1st/Terry to the Sugar Mill station in Longmont. RTD's Northwest rail plan reflects 30-minute peak and midday period service to Longmont, with supplemental 30-minute peak period service to Boulder (for a combined 15-minute peak period service frequency between DUS and Boulder). All RTD Northwest rail trains that are currently proposed to go to 1st/Terry will be extended to Sugar Mill station.

2.2 Travel Time Estimates/Train Requirements

Travel time estimates have been updated to reflect the most current project alignment drawings (dated May 2007). Run time estimates for the North I-25 alignment assume one-minute station dwell times, and take into consideration train acceleration and deceleration rates and speed limitations through horizontal curves. Table 2-1 presents station-to-station travel time estimates for this project.

Table 2-1
North I-25 Station-to-Station Travel Time Estimates

Segment	Distance	Time	Avg. Speed
Fort Collins DTC			
	1.14	0:03:59	17.12
CSU			
	3.74	0:07:49	28.71
Fort Collins STC			
	7.08	0:09:13	46.08
North Loveland			
	1.66	0:04:15	23.46
Downtown Loveland			
	6.42	0:09:31	40.50
Berthoud			
	7.34	0:09:56	44.31
North Lognmont			
	4.02	0:09:09	26.39
Sugar Mill			
	11.96	0:13:50	51.90
CR 8/I-25			
	5.35	0:08:01	40.01
162nd St./N. Metro			
Total	**48.71**	**1:15:43**	**38.60**

RTD recently updated its travel time estimate for the North Metro alignment. The new run time estimate is 27.1 minutes. Thus, the full one-way travel time from Downtown Fort Collins to DUS (not including end-of-line dwell time) is as follows:

Fort Collins DTC to 162nd Street (North Metro) – 75.7 minutes
162nd Street to DUS – 27.2 minutes
Total Travel Time = 102.9 minutes

The one-way travel time from South Fort Collins (STC) to DUS is as follows:

Fort Collins STC to 162nd Street (North Metro) – 63.9 minutes
162nd Street to DUS – 27.2 minutes
Total Travel Time = 91.1 minutes

Layover/recovery time is added to estimated run times to obtain a cycle time. The cycle time must be divisible by the proposed service frequency. In this instance, the North I-25 trains require a 4-hour cycle time for both the peak and midday periods, regardless of whether the trains terminate at STC or DTC in Fort Collins. Thus, eight trains are required for peak period operations and four trains are required for midday operations.

Appendix A provides detailed travel time estimates for the North I-25 commuter rail alignment.

The proposed extension of Northwest trains to the Sugar Mill station is estimated to require about 4 additional minutes of travel time and is not anticipated to impact train requirements or revenue train-hour estimates on the Northwest rail line.

2.3 Rail Operating Plan Requirements

Rail operating plan requirements are a function of proposed service frequencies, train run time estimates and train consist (cars/train) requirements. Train consists are determined through a review of station-to-station line loads from the ridership forecasts. RTD's commuter rail operating plan assumes 86 seats per commuter rail vehicle. RTD's peak load standard for 2030 is 2.22 (i.e., 191 passengers per rail car). Passenger trip lengths on North I-25 trains, however, will be longer than average passenger trip lengths on RTD trains. Thus, a 1.0 load standard is proposed north of 162nd Avenue (to provide sufficient capacity to ensure no standees on trains north of 162nd Avenue). RTD's North Metro service plan proposes 3-car trains on all trains. A review of ridership projections for this project indicates that 3-car trains on all North Metro/North I-25 trains are sufficient to maintain loads less than 1.0 north of 162nd Avenue, and loads less than 2.22 at DUS. Table 2-2 presents line load projections for North Metro/North I-25 rail segments.

Table 2-2
Projected Line Loads for North Metro/North I-25 Rail Segments

Route Segment From	To	Peak Period Load (all route patterns)	Peak Hour Load	Trains/ Hour	Peak Hour Passengers/Train	Passengers/Car (3-car Trains)	Load Factor (3-car Trains)
Ft. Collins DTC	CSU	14	3	1	3	1	0.01
CSU	Ft. Collins STC	34	7	1	7	2	0.03
Ft. Collins STC	N. Loveland	650	137	2	68	23	0.26
N. Loveland	Downtown Loveland	906	190	2	95	32	0.37
Downtown Loveland	Berthoud	1,108	233	2	116	39	0.45
Berthoud	N. Longmont	1,151	242	2	121	40	0.47
N. Longmont	Sugar Mill	1,230	258	2	129	43	0.50
Sugar Mill	I-25/CR 8	1,299	273	2	136	45	0.53
I-25/CR 8	162nd Ave.	1,321	277	2	139	46	0.54
162nd Ave.	144th Ave.	2,519	529	2	264	88	1.03
144th Ave.	124th Ave.	3,351	704	2	352	117	1.36
124th Ave.	112th Ave.	4,925	1,034	4	259	86	1.00
112th Ave.	104th Ave.	6,200	1,302	4	326	109	1.26
104th Ave.	88th Ave.	7,752	1,628	4	407	136	1.58
88th Ave.	Commerce City	9,094	1,910	4	477	159	1.85
Commerce City	Brighton Blvd.	9,574	2,011	4	503	168	1.95
Brighton Blvd.	DUS	10,491	2,203	4	551	184	2.13

Note: Load factor = passengers/seats

The No Action rail operating plan (North Metro only) is provided in Table 2-3 while the proposed North Metro/North I-25 rail operating plan is presented in Table 2-4. The addition of North I-25 trains is projected to require 18 peak/22 fleet cars over North Metro's train requirements as calculated under No Action. It is important to note, however, that RTD's North Metro plans assume EMU service. The Fort Collins-DUS service will be operated with DMU's. Thus, a total of 24 peak/29 fleet DMU's will be required for North I-25 commuter rail service.

As noted above, an extension is also proposed on the Northwest rail line. Because the additional travel time for this extension is able to be absorbed in the overall cycle time (by reducing layover), there is no change in Northwest revenue train-hours/car-hours or vehicle requirements. The extension does minimally increase Northwest revenue train-miles/car-miles.

Table 2-3
No Action (North Metro and Northwest) Rail Service Plan and Statistics

Rail Line	From	To	Run Time (minutes)	Distance (miles)	Day	Headway Peak	Headway Base	Headway Eve.	Headway Late	Consist Peak	Consist Base	Consist Eve.	Consist Late	Vehicles Peak	Vehicles Total	Daily Revenue Service Statistics Train-Mi's.	Car-Miles	Train-Hs	Car-Hrs.	Trains Peak	Trains Base	Trains Eve.	Trains Late	Daily Trips
North Metro	SH 7/162nd	DUS	27.19	18.55	M-F	15	30	30	60	3.0	3.0	2.0	2.0	15	18	1,892	5,342	73	203	5	3	3	2	102
					Sat	n/a	30	30	60	0.0	2.0	2.0	2.0	6	n/a	1,447	2,894	61	122	0	3	3	2	78
					Sun	n/a	30	30	60	0.0	2.0	2.0	2.0	6	n/a	1,447	2,894	61	122	0	3	3	2	78
NW (a)	Longmont (1st/Terry)	DUS	62.0	40.41	M-F	30	30	30	60	2.0	2.0	2.0	2.0	10	12	3,152	6,304	100	200	5	5	5	3	78
					Sat	n/a	30	30	60	0.0	2.0	2.0	2.0	10	n/a	3,152	6,304	100	200	0	5	5	3	78
					Sun	n/a	30	30	60	0.0	2.0	2.0	2.0	10	n/a	3,152	6,304	100	200	0	5	5	3	78
Weekday Totals:														**25**	**30**	**5,044**	**11,646**	**173**	**403**	**10**	**8**	**8**	**5**	**180**
Saturday Totals:														**16**	**n/a**	**4,599**	**9,198**	**161**	**322**	**n/a**	**8**	**8**	**5**	**156**
Sunday Totals:														**16**	**n/a**	**4,599**	**9,198**	**161**	**322**	**n/a**	**8**	**8**	**5**	**156**
Annual Totals:														**25**	**30**	**1,792,100**	**3,981,600**	**61,830**	**138,190**	**10**	**8**	**8**	**5**	**63,060**

Note: Excludes Northwest commuter rail 30-minute peak-only pattern from Boulder (Pearl/30th) to DUS since unaffected by North I-25 project.

Table 2-4
North I-25/North Metro and Northwest Rail Service Plan and Statistics

Rail Line	From	To	Run Time (minutes)	Distance (miles)	Day	Headway Peak	Headway Base	Headway Eve.	Headway Late	Consist Peak	Consist Base	Consist Eve.	Consist Late	Vehicles Peak	Vehicles Total	Daily Revenue Service Statistics Train-Mi's.	Car-Miles	Train-Hs	Car-Hrs.	Trains Peak	Trains Base	Trains Eve.	Trains Late	Daily Trips
North Metro	SH 7/162nd	DUS	27.19	18.55	M-F	30	60	60	60	3.0	3.0	2.0	2.0	9	11	1,039	2,857	50	136	3	2	2	2	56
					Sat	n/a	60	60	60	0.0	2.0	2.0	2.0	4	n/a	816	1,632	44	88	0	2	2	2	44
					Sun	n/a	60	60	60	0.0	2.0	2.0	2.0	4	n/a	816	1,632	44	88	0	2	2	2	44
NW (a)	Sugar Mill	DUS	66.1	41.96	M-F	30	30	30	60	2.0	2.0	2.0	2.0	10	12	3,273	6,546	100	200	5	5	5	3	78
					Sat	n/a	30	30	60	0.0	2.0	2.0	2.0	10	n/a	3,273	6,546	100	200	0	5	5	3	78
					Sun	n/a	30	30	60	0.0	2.0	2.0	2.0	10	n/a	3,273	6,546	100	200	0	5	5	3	78
North I-25	Fort Collins DTC	DUS	102.91	67.26	M-F	60	60	60	n/a	3.0	3.0	2.0	0.0	12	15	2,287	6,591	68	196	4	4	4	0	34
					Sat	n/a	60	60	n/a	0.0	2.0	2.0	0.0	8	n/a	2,287	4,574	68	136	0	4	4	0	34
					Sun	n/a	60	60	n/a	0.0	2.0	2.0	0.0	8	n/a	2,287	4,574	68	136	0	4	4	0	34
North I-25	Fort Collins STC	DUS	91.11	62.38	M-F	60	n/a	n/a	n/a	3.0	0.0	0.0	0.0	12	14	749	2,246	24	72	4	0	0	0	12
					Sat	n/a	n/a	n/a	n/a	0.0	0.0	0.0	0.0	0	n/a	0	0	0	0	0	0	0	0	0
					Sun	n/a	n/a	n/a	n/a	0.0	0.0	0.0	0.0	0	n/a	0	0	0	0	0	0	0	0	0
Weekday Totals:														**43**	**52**	**7,347**	**18,240**	**242**	**604**	**16**	**11**	**11**	**5**	**180**
Saturday Totals:														**22**	**n/a**	**6,376**	**12,752**	**212**	**424**	**n/a**	**11**	**11**	**5**	**156**
Sunday Totals:														**22**	**n/a**	**6,376**	**12,752**	**212**	**424**	**n/a**	**11**	**11**	**5**	**156**
Annual Totals:														**43**	**52**	**2,574,900**	**6,053,800**	**85,030**	**200,660**	**16**	**11**	**11**	**5**	**63,060**
Change from No-Action:														***18***	***22***	***782,800***	***2,072,200***	***23,200***	***62,470***	***6***	***3***	***3***	***0***	***0***
North I-25 Only Annual Totals:														**24**	**29**	**1,025,580**	**2,756,580**	**30,940**	**83,300**	**8**	**4**	**4**	**0**	**15,470**

Notes:

1. North I-25 commuter rail plan retains 30 minute peak period service south of Fort Collins STC; every other train continues north to Fort Collins DTC at 60 minute peak period service.
2. North I-25 project assumes an extension of Northwest commuter rail trains to Sugar Mill. This extension can be accommodated without affecting Northwest Corridor revenue train-hours/car-hours or vehicle requirements, though revenue train-miles/car-miles increase.
3. Excludes Northwest commuter rail 30-minute peak-only pattern from Boulder (Pearl/30th) to DUS since unaffected by North I-25 project.

2.4 Passing Track Requirements

Much of the BNSF rail line is single track. Passing track will be required to accommodate train meets. A passing track analysis was recently updated to identify locations along the commuter rail alignment from 162nd Avenue to downtown Fort Collins that require passing track segments. The passing track analysis was based on assumed rail service to/from downtown Fort Collins at 30-minute frequencies in the peak periods and 60-minute frequencies in the midday period, with every other peak period train turning back at the Fort Collins South Transit Center (STC). Every other peak period train is being turned back at the Fort Collins STC to avoid a train meet and passing track requirements north of the STC. This analysis is described in detail in a paper that is provided in Appendix B. Four train meet locations were identified at the following locations:

- About 0.93 miles north of the North Loveland Station
- About 0.30 miles north of the Berthoud Station
- About 2.06 miles south of the North Longmont Station
- About 3.71 miles north of the I-25/CR 8 Station

Passing track requirements were identified for the following two scenarios:

1. Accommodating trains up to 2 minutes early/late; and
2. Accommodating trains up to 4 minutes early/late.

Thus, passing track segments have been defined in a manner that accommodates either 2 or 4 minutes of train running time on each side of a scheduled train meet (i.e., there is a total of either 4 or 8 minutes of passing track, depending on the scenario). The one exception to this assumption is at CSU. Since it is known that passing track cannot be accommodated north of CSU, passing track has only been identified to accommodate trains either 2 or 4 minutes early/late south of the CSU Station.

Resulting passing track requirements for both scenarios are noted in Table 2-5.

Table 2-5
Passing Track Requirements at Train Meet Locations

Meet Location	Passing Track Limits	+/- 2-min. Criteria Location from Station		+/- 4-min. Criteria Location from Station	
Loveland	N. End	15,880	Feet N. of N. Loveland Station	26,200	Feet N. of N. Loveland Station
Area Meet	S. End	0	At N. Loveland Station	4,410	Feet S. of N. Loveland Station
	Total Dist.	15,880	Total feet	30,610	Total feet
Berthoud	N. End	11,600	Feet N. of Berthoud Station	21,030	Feet N. of Berthoud Station
Area Meet	S. End	1,140	Feet S. of Berthoud Station	9,150	Feet S. of Berthoud Station
	Total Dist.	12,740	Total feet	30,180	Total feet
Longmont	N. End	4,560	Feet S. of N. Longmont Station	0	At N. Longmont Station
Area Meet	S. End	15,700	Feet S. of N. Longnont Station	19,820	Feet S. of N. Longnont Station
	Total Dist.	11,140	Total feet	19,820	Total feet
I-25	N. End	30,390	Feet N. of CR 8/I-25 Station	40,580	Feet N. of CR 8/I-25 Station
Area Meet	S. End	5,940	Feet N. of CR 8/I-25 Station	0	At CR 8/I-25 Station
	Total Dist.	24,450	Total feet	40,580	Total feet
Total Passing Track Req'd.		12.2	miles	23.0	miles
% of align.		25.0%		47.1%	

3.0 US 85 Commuter Bus Service

The Draft Preferred Alternative includes commuter bus service along US 85, connecting Greeley to downtown Denver. Service to DIA is available from this route with a transfer to RTD's 145x (Brighton/DIA Express) at Brighton. Proposed stops are as follows:

- Greeley at D Street
- Greeley at 8th Street
- South Greeley at 24th Street
- Evans at 42nd Street
- Platteville at Grand Avenue
- Fort Lupton at CR 14.5
- Brighton at SH 7
- Commerce City at Colorado Blvd./72nd Avenue
- Downtown Denver

An additional stop at E-470 and US 85 was initially proposed as a way to provide connections to I-25 express bus service, but was not pursued due to design constraints.

Commuter bus service is proposed to operate at 60-minute service frequencies during the peak and midday periods (approximately 5:00 a.m. to 9:00 p.m., or about 16 hours each weekday). No service is proposed on weekends. Table 3-1 displays the proposed operating plan for commuter bus and associated service statistics (peak/fleet vehicles, daily and annual revenue bus-miles and bus-hours of service). Commuter bus run time estimates are from the project's travel demand model and reflect anticipated congested peak highway speeds.

Table 3-1
US 85 Commuter Bus Service Plan and Statistics

Route	Run Time (minutes)	Distance (miles)	Day	Headway Peak	Headway Base	Headway Eve.	Vehicles Peak	Vehicles Total	Daily Revenue Veh Miles	Daily Revenue Veh Hrs	Annual Revenue Veh Miles	Annual Revenue Veh Hrs
US 85 commuter bus	127.0	58.4	M-F	60.0	60.0	n/a	5	6	1,869	80	474,600	20,320
Greeley to Downtown Denver			Sat	n/a	n/a	n/a			0	0	0	0
	ave mph	*27.59*	Sun	n/a	n/a	n/a			0	0	0	0
ESTIMATED TOTALS:							**5**	**6**	**1,869**	**80**	**474,600**	**20,320**

Note: Span of service assumed to be from 5 a.m. to 9 p.m.

4.0 Express Bus on I-25

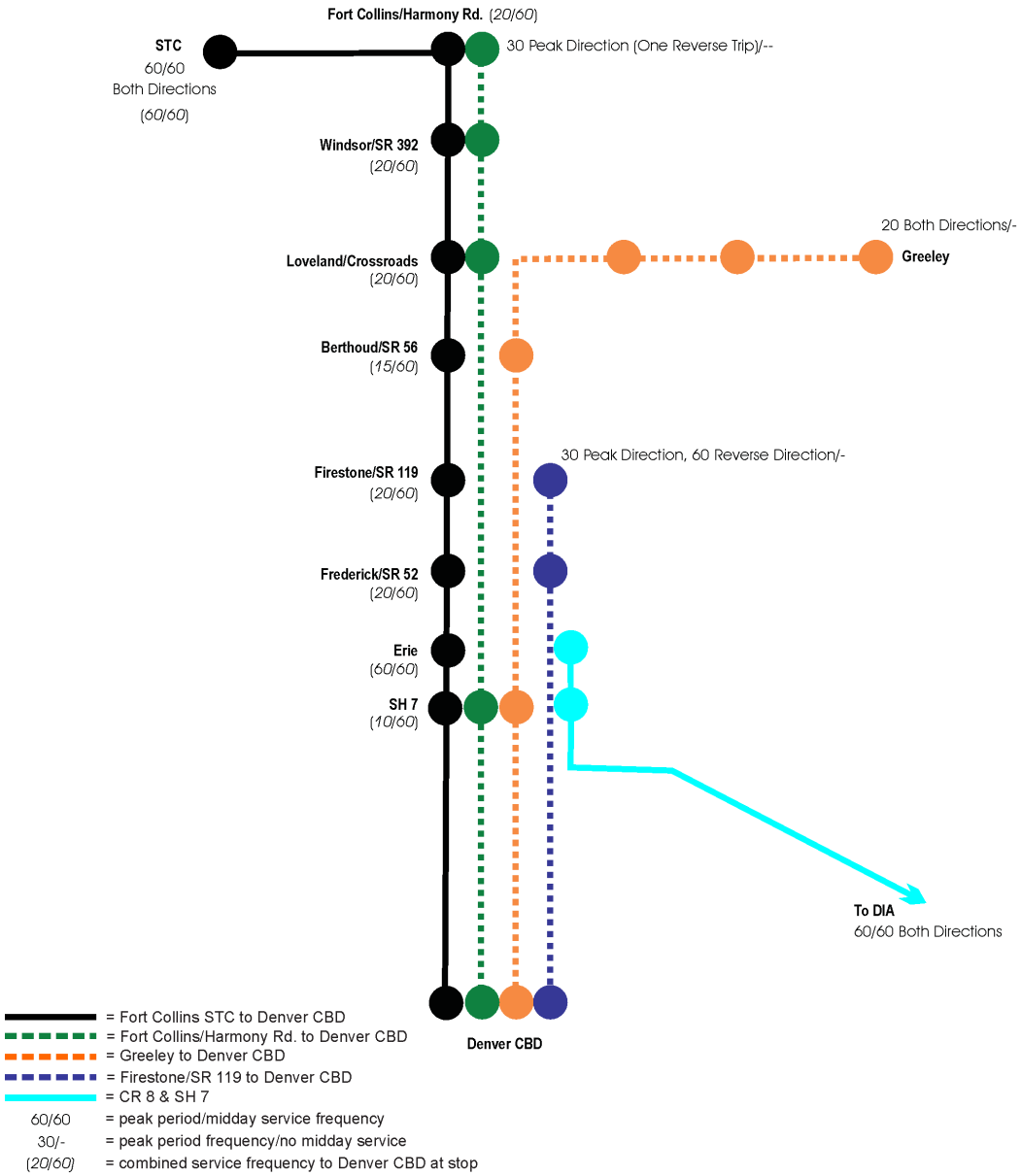
The preferred alternative includes express bus service in Tolled Express Lanes (TEL) on I-25. Enhanced stations are no longer located in the median of I-25, as they were in Package B. All route patterns will use the TEL's when they can operate four or more continuous miles. Proposed express bus stop locations include select stops in Fort Collins, as well as along I-25, and are as follows:

- Fort Collins South Transit Center
- Timberline Road/Harmony Road;
- The existing Harmony Road park-and-ride lot in Fort Collins, located on Harmony Road, just west of I-25;
- Downtown Greeley at 8th Avenue and 8th Street;
- US 34/83rd Avenue;
- US 34/SH 257;
- SH 392/Windsor – along frontage road on east side of I-25, south of SH 392;
- Crossroads/Loveland – south of Crossroads Blvd. and on west side of I-25, near railroad underpass;
- SH 56/Berthoud – on west side of I-25, immediately adjacent to I-25 SB exit ramp;
- SH 119/Firestone – on east side of I-25, immediately adjacent to I-25 NB exit ramp;
- SH 52/Frederick – on west side of I-25, immediately adjacent to I-25 SB exit ramp;
- CR 8 – on west side of I-25 at Commuter Rail station
- SH 7 – on west side of I-25, immediately adjacent to I-25 SB entrance ramp; and
- C-470 and US 85 (for connections to US 85 commuter bus service).

The proposed operating plan for I-25 express bus service assumes multiple route patterns as a means to minimize the number of times a bus must get out of the Tolled Express Lanes and into the general purpose lanes to access a bus stop. The proposed service plan provides all stop locations with at least 2 or 3 express bus trips in the peak periods, along with hourly all-stop service.

Figure 4-1 provides a schematic of the proposed I-25 express bus services.

Figure 4-1
North I-25 Express Bus Operating Plan Schematics
North I-25 Express Bus Service



Proposed route patterns are described below:

- Fort Collins STC to Denver CBD All-Stop: This pattern begins at the South Transit Center in Fort Collins, travels along Harmony Road to the park-and-ride at I-25 and along I-25 with stops at the following locations:

    - Harmony at Timberline
    - SH 392/Windsor
    - Crossroads/Loveland
    - SH 56/Berthoud
    - SH 119/Firestone
    - SH 52/Frederick
    - North I-25 rail station at CR 8 and I-25
    - SH 7
    - Denver CBD

  This route pattern is proposed to operate at 60-minute frequencies in both directions in the peak and midday periods. This route pattern would also operate on weekends.

- Fort Collins to Denver CBD Express: This pattern begins at the Harmony Road park-and-ride in Fort Collins. Two mid-route stops are proposed at SH 392/Windsor and at Crossroads/Loveland. Buses will exit I-25 at SH 392 to access the Windsor park-and-ride lot. Buses would then return to I-25 and utilize new bus pull-out lanes at the Crossroads/Loveland park-and-ride site. Buses then continue along I-25. This route includes one additional mid-route stop at SH 7. Buses will use pull-out bus lanes along the SH 7 interchange exit/entrance ramps, and a pedestrian bridge will provide access between the northbound bus pull-out lane and the park-and-ride lot on the west side of I-25. Proposed service frequencies are 30 minutes in the peak periods only. Service is envisioned as primarily peak direction only (inbound toward the Denver CBD in the morning, and outbound away from the Denver CBD in the afternoon), potentially with one reverse-direction trip during the morning and afternoon peak period.

- Greeley to Denver CBD Express: This pattern begins at 8th Avenue and 8th Street in downtown Greeley and travels along US 34 to I-25 with stops at 83rd Avenue and SH 257. Once on I-25, this route pattern includes two additional stops. The first mid-route stop is at SH 56/Berthoud. Buses would exit at SH 56 and utilize bus pull-out lanes on the ramp. A pedestrian bridge will provide access between the northbound bus pull-out lane and the park-and-ride lot on the west side of I-25. The second mid-route stop is at SH 7. Once again, buses will use bus pull-out lanes along the interchange exit/entrance ramps, and a pedestrian bridge will provide access between the northbound bus pull-out lane and the park-and-ride lot on the west side of I-25. Proposed service frequencies are 20 minutes in both directions during the peak periods only.

- SR 119 to Denver CBD Express: This pattern begins at the Firestone/SH 119 park-and-ride lot. One mid-route stop is proposed at SH 52/Frederick. Buses would exit at SH 52 and use bus pull-out lanes on the ramp. A pedestrian bridge will provide access between the northbound bus pull-out lane and the park-and-ride lot on the west side of I-25. Proposed service frequencies are 30-minutes in the peak direction during peak periods only. A few reverse-direction trips would be offered during the morning and afternoon peak periods.

- North Metro Rail/CR 8 to DIA Express: This pattern begins at North Metro Rail and CR 8 and travels south on I-25 to a stop at SH-7 and continues on E-470 to DIA. All other North I-25 express routes include a stop at SH 7, thus allowing for transfers to/from this route. This pattern provides 60 minute service in both directions during the peak and midday periods. Weekend service is also proposed.

All express routes that operate to downtown Denver would circulate to maximize trip distribution within downtown Denver. The proposed route alignment within downtown Denver is described as follows. During AM peak hours, southbound buses would enter downtown Denver via the North I-25 express lanes and go into downtown using 19th Street, turning southwest on Arapahoe and providing stops at 17th and 15th Streets. From there, buses would turn right on 15th Street, left at Little Raven and proceed to Elitch Gardens to layover before making the return trip. This downtown route is similar to the route of the current Front Range Express (FREX) bus from Colorado Springs to Denver. During hours when the reversible express lane flow is headed northbound, southbound buses would enter downtown Denver via the 20th Street interchange, take 20th to Arapahoe, and follow the remainder of the route described above.

During the PM peak hours, northbound buses would exit downtown Denver by turning right out of Elitch Gardens onto 15th Street, turning right again to access 14th Street and eventually turning left on Lawrence Street, picking up passengers at 15th and 17th Streets, and proceeding to the I-25 HOV entrance ramp on 20th Street. During hours when the reversible express lane flow is headed southbound, northbound buses would access I-25 via the 20th Street interchange.

Table 4-1 displays the proposed operating plans ad service statistics (peak/fleet vehicles, daily and annual revenue bus-hours and bus-miles of service) for the express bus routes.

Table 4-1
North I-25 Express Bus Service Plan and Statistics

Route	Run Time (minutes)	Distance (miles)	Day	Headway Peak	Headway Base	Headway Eve.	Vehicles Peak	Vehicles Total	Daily Revenue Veh Miles	Daily Revenue Veh Hrs	Annual Revenue Veh Miles	Annual Revenue Veh Hrs
Fort Collins STC to	78.0	59.3	M-F	60.0	60.0	n/a	3	4	1,898	48	482,000	12,190
Downtown Denver			Sat	n/a	60.0	n/a			1,541	39	78,600	1,990
	ave mph	*45.62*	Sun	n/a	60.0	n/a			1,542	39	92,500	2,340
ESTIMATED TOTALS:							**3**	**4**	**4,980**	**126**	**653,100**	**16,520**
Fort Collins/Harmony Rd.	64.0	54.9	M-F	30.0	n/a	n/a	5	6	769	30	195,300	7,620
to Downtown Denver			Sat	n/a	n/a	n/a			0	0	0	0
(primarily peak direction only;	*ave mph*	*51.50*	Sun	n/a	n/a	n/a			0	0	0	0
one reverse trip in am & pm)												
ESTIMATED TOTALS:							**5**	**6**	**769**	**30**	**195,300**	**7,620**
Greeley to	88.0	62.9	M-F	20.0	n/a	n/a	9	11	2,264	54	575,100	13,720
Downtown Denver			Sat	n/a	n/a	n/a			0	0	0	0
	ave mph	*42.88*	Sun	n/a	n/a	n/a			0	0	0	0
ESTIMATED TOTALS:							**9**	**11**	**2,264**	**54**	**575,100**	**13,720**
Firestone/SR 119 to	32.0	28.9	M-F	30.0	n/a	n/a	3	4	520	18	132,000	4,570
Downtown Denver			Sat	n/a	n/a	n/a			0	0	0	0
(primarily peak direction only;	*ave mph*	*54.15*	Sun	n/a	n/a	n/a			0	0	0	0
three reverse trips in am & pm)												
ESTIMATED TOTALS:							**3**	**4**	**520**	**18**	**132,000**	**4,570**
CR 8 & SH 7 to DIA	39.0	25.8	M-F	60.0	60.0	n/a	2	2	826	32	209,700	8,130
			Sat	n/a	60.0	n/a			671	26	34,200	1,330
	ave mph	*39.69*	Sun	n/a	60.0	n/a			670	26	40,200	1,560
ESTIMATED TOTALS:							**2**	**2**	**826**	**32**	**209,700**	**8,130**
TOTAL FOR ALL EXPRESS ROUTES:							***22***	***27***	***9,359***	***260***	***1,765,200***	***50,560***

Notes:
1. Peak period service defined as 5 to 8 a.m. and 3 to 6 p.m.
2. Midday/Base period service defined as 8 a.m. to 3 p.m. and 6 p.m. to 9 p.m.
3. Calculated total fleet = peak vehicle requirement * 1.2 (20% spare ratio).
4. Vehicle hour calculations based on operating complete periods, regardless of one-way or two-way operations.
5. Vehicle mile calculations take into account one-way vs. two-way trips.

5.0 North I-25 Feeder Route Service

As was done in prior modeling efforts, Transfort, COLT, Greeley and RTD bus routes that are presently in the transit network, such as the existing Greeley-Loveland bus route are modified as necessary to connect to proposed rail stations, as well as express and commuter bus stops. The following four new feeder bus routes are also proposed in the preferred alternative operating plan to enhance connections to I-25 express bus, US 85 commuter bus and commuter rail service:

- **West Greeley to Windsor**: This route begins at US 34/Highway 257 and proceeds north on Highway 257 to Windsor, then west on SR 392 to the Windsor park-and-ride at I-25. The service operates every 60 minutes during peak and midday periods.

- **Milliken/Johnstown/Berthoud**: This route operates from downtown Milliken and travels on CR 60 to Johnstown and south to the Berthoud park-and-ride at SR 56 and I-25. This route continues via SR 56 to the Berthoud Commuter Rail Station. Service frequencies for this route are 60 minutes during peak and midday periods.

- **Longmont/Firestone/Frederick/Ft. Lupton**: From the commuter bus stop in Fort Lupton, this route travels west on Highway 52 to Dacono, north on Colorado Boulevard (CR 13) serving Frederick and Firestone, and west on SR 199 to the Firestone park-and-ride at SR 119 and I-25. The route then continues west to Longmont via SR 119 to the Sugar Mill Commuter Rail Station. Service frequencies for this route are 60 minutes during peak and midday periods.

- **Erie/SH-7:** From downtown Erie, this route travels east on CR 8 to the park-and-ride and North Metro Commuter Rail Station at CR-8 and I-25, and continues east to CR 11, where the route travels south to CR-2, and west to the park-and-ride at SH-7 and I-25. Service frequencies for this route are 60 minutes during peak and midday periods.

Table 5-1 displays the proposed operating plans for the feeder routes; please refer to Figure 1-1 for a schematic representation of the feeder routes in relation to the overall transit network and operating plan.

Table 5-1
North I-25 Local Feeder Route Service Plan and Statistics

Route	Run Time (minutes)	Distance (miles)	Headway Day	Peak	Base	Eve.	Vehicles Peak	Total	Daily Revenue Veh Miles	Veh Hrs	Annual Revenue Veh Miles	Veh Hrs
Windsor-Greeley	24.0	10.5	M-F	60.0	60.0	n/a	1	1	337	16.0	85,700	4,060
(at US 85/SH 257)			Sat	n/a	n/a	n/a			0	0.0	0	0
	ave mph	*26.35*	Sun	n/a	n/a	n/a			0	0.0	0	0
ESTIMATED TOTALS:							**1**	**1**	**337**	**16**	**85,700**	**4,060**
Milliken-Johnstown-Berthoud	24.1	15.1	M-F	60.0	60.0	n/a	1	1	483	16.0	122,700	4,060
			Sat	n/a	n/a	n/a			0	0.0	0	0
	ave mph	*37.58*	Sun	n/a	n/a	n/a			0	0.0	0	0
ESTIMATED TOTALS:							**1**	**1**	**483**	**16**	**122,700**	**4,060**
Ft. Lupton-Firestone-Longmont	26.0	10.6	M-F	60.0	60.0	n/a	2	2	339	32.0	86,200	8,130
			Sat	n/a	n/a	n/a			0	0.0	0	0
	ave mph	*24.46*	Sun	n/a	n/a	n/a			0	0.0	0	0
ESTIMATED TOTALS:							**2**	**3**	**339**	**32**	**86,200**	**8,130**
Ft. Lupton-Firestone-Longmont	50.5	20.9	M-F	60.0	60.0	n/a	2	2	669	32.0	169,900	8,130
			Sat	n/a	n/a	n/a			0	0.0	0	0
	ave mph	*24.85*	Sun	n/a	n/a	n/a			0	0.0	0	0
ESTIMATED TOTALS:							**2**	**3**	**669**	**32**	**169,900**	**8,130**
ESTIMATED TOTALS:							**6**	**8**	**1,829**	**96**	**464,500**	**24,380**

Notes:
1. Peak period service defined as 5 to 8 a.m. and 3 to 6 p.m.
2. Midday/Base period service defined as 8 a.m. to 3 p.m. and 6 p.m. to 9 p.m.
3. Calculated total fleet = peak vehicle requirement * 1.2 (20% spare ratio).

6.0 Phase 1 Operating Plan

Given the long-term timeframe for expected implementation of the preferred alternative operating plan, different phases of implementation were developed for the North I-25 project. Phase 1 involves widening I-25 in various sections, various interchange replacements and upgrades, commuter rail right of way preservation, and initial I-25 express bus and US 85 commuter bus services with selective stops. Elements of the Phase 1 bus operating plan are discussed below.

- Fort Collins to Denver CBD Express: This express bus route along I-25 begins at the park-and-ride at Harmony Road and I-25, serving the following locations:
    - Harmony Road/I-25
    - SH 119/Firestone (skipped during peak period in peak direction)
    - SH 7
    - Denver CBD

  During the peak period in the peak direction (inbound in the morning, outbound in the afternoon), this route is proposed to operate at 15-minute frequencies, skipping the SH 119/Firestone stop. In the peak period reverse direction (outbound in the morning and inbound in the afternoon) as well as both directions during the midday, this route pattern would operate at 30-minute frequencies serving all identified stations. Service is also anticipated on weekends.

- Greeley to Denver CBD Express: This express bus route using I-25 begins at 8th Avenue and 8th Street in downtown Greeley and travels along US 34 to I-25, serving the following locations:
    - Downtown Greeley (8th Avenue and 8th Street)
    - US 34/83rd Avenue
    - SH 7
    - Denver CBD

  Proposed service is in the peak period only, with 20 minute headways in the peak direction and 30 minute headways in the reverse direction.

- SR 119 to Denver CBD Express: This pattern offers direct service from the Firestone/SH 119 park-and-ride lot to Denver CBD via I-25, with no interim stops. Proposed service frequencies are 15-minutes in the peak periods only, peak direction only.

- North Metro Rail/CR 8 to DIA Express: This pattern begins at North Metro Rail and CR 8 and travels south on I-25 to a stop at SH-7 and continues on E-470 to DIA with no other interim stops. All other North I-25 express routes include a stop at SH 7, thus allowing for transfers

to/from this route. This pattern provides 60 minute service during the peak and midday periods. Weekend service is also proposed.

- US 85 Commuter Bus: This service connects Greeley to Downtown Denver via US 85, using the same stops and pattern as the description provided in Section 3.0 of this report.

Other existing carpool lots, such as the one at SH 52, could be served by the Phase 1 Express Bus if adequate room is available for the bus to traverse the parking area and a safe staging area for riders can be provided.

Figure 6-1 provides a schematic of the proposed Phase 1 transit network. Table 6-1 displays the proposed operating plans and service statistics (peak/fleet vehicles, daily and annual revenue bus-hours and bus-miles of service). Bus run time estimates are from the project's travel demand model.

Figure 6-1

Phase 1 Operating Plan

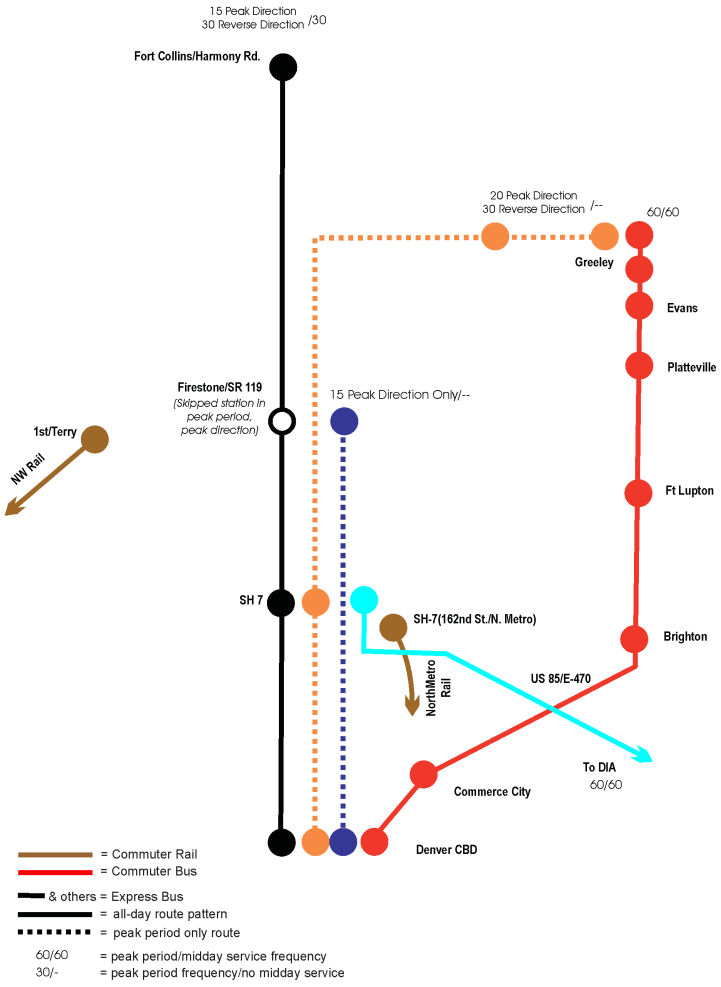


Table 6-1
Phase 1 Bus Service Plan and Statistics

Route	Run Time (minutes)	Distance (miles)	Day	Headway Peak	Headway Base	Headway Eve.	Vehicles Peak	Vehicles Total	Daily Revenue Veh Miles	Daily Revenue Veh Hrs	Annual Revenue Veh Miles	Annual Revenue Veh Hrs
COMMUTER BUS SERVICE												
US 85 commuter bus	98.2	57.3	M-F	60.0	60.0	n/a	4	5	1,835	64	466,000	16,260
Greeley to Downtown Denver			Sat	n/a	n/a	n/a			0	0	0	0
	ave mph	*35.05*	Sun	n/a	n/a	n/a			0	0	0	0
					TOTAL COMMUTER BUS SERVICE		**4**	**5**	**1,835**	**64**	**466,000**	**16,260**
EXPRESS BUS SERVICE												
Fort Collins/Harmony Rd. to Downtown Denver												
Peak hour peak direction	74.7	54.5	M-F	15.0	n/a	n/a	11	13	1,307	66	332,000	16,760
Reverse direction, midday	67.9	54.5	M-F	30.0	30.0	n/a			2,835	50	720,100	12,700
	ave mph peak	*43.73*	Sat	n/a	60.0	n/a			1,416	39	72,200	1,990
	ave mph base	*48.16*	Sun	n/a	60.0	n/a			1,417	39	85,000	2,340
ESTIMATED TOTALS:							**11**	**13**	**6,974**	**194**	**1,209,300**	**33,790**
Greeley to Downtown Denver												
Peak hour peak direction	99.4	62.6	M-F	20.0	n/a	n/a	11	13	1,126	66	286,000	16,760
Reverse direction	77.4	62.2	M-F	30.0	n/a	n/a			746	NA	189,600	NA
	ave mph peak	*37.77*	Sat	n/a	n/a	n/a			0	0	0	0
	ave mph base	*48.25*	Sun	n/a	n/a	n/a			0	0	0	0
ESTIMATED TOTALS:							**11**	**13**	**1,872**	**66**	**475,600**	**16,760**
Firestone/SR 119 to	46.7	28.8	M-F	30.0	n/a	n/a	4	5	460	24	116,800	6,100
Downtown Denver			Sat	n/a	n/a	n/a			0	0	0	0
(primarily peak direction only;	*ave mph*	*36.97*	Sun	n/a	n/a	n/a			0	0	0	0
two reverse trips in am & pm)												
ESTIMATED TOTALS:							**4**	**5**	**460**	**24**	**116,800**	**6,100**
CR 8 & SH 7 to DIA	24.6	24.4	M-F	60.0	60.0	n/a	1	1	781	16	198,500	4,060
			Sat	n/a	60.0	n/a			635	13	32,400	660
	ave mph	*59.51*	Sun	n/a	60.0	n/a			635	13	38,100	780
ESTIMATED TOTALS:							**1**	**1**	**781**	**16**	**198,500**	**4,060**
					TOTAL EXPRESS BUS SERVICE		***27***	***32***	***10,088***	***300***	***2,000,200***	***60,710***
TOTAL ALL PHASE 1 BUS ROUTES							***31***	***37***	***11,923***	***364***	***2,466,200***	***76,970***

Notes:
1. Peak period service defined as 5 to 8 a.m. and 3 to 6 p.m.
2. Midday/Base period service defined as 8 a.m. to 3 p.m. and 6 p.m. to 9 p.m.
3. Calculated total fleet = peak vehicle requirement * 1.2 (20% spare ratio).
4. Vehicle hour calculations based on operating complete periods, regardless of one-way or two-way operations.
5. Vehicle mile calculations take into account one-way vs. two-way trips.

Appendix A:
Commuter Rail Travel Time Estimates

DENVER I-25 NORTH EIS
DMU SOUTHBOUND TRAVEL TIME ESTIMATES
Fort Collins to 162nd Street (North Metro) Station
Draft Committee Vision Plan

Station	Max Spd . (mph)	Stationing	Distance (miles) Incr.	Distance (miles) Total	Run Time (hr:min:sec)	Dwell Time (hr:min:sec)	Total Time (hr:min:sec)
Fort Collins DTC		**256,425**		**0.00**		**0:00:00**	**0:00:00**
	25		1.14		0:02:59		
CSU		**250,425**		**1.14**		**0:01:00**	**0:03:59**
	35		3.74		0:06:49		
Fort Collins STC		**230,675**		**4.88**		**0:01:00**	**0:11:48**
	50		0.46		0:01:03		
Start of Curve 55		228,240		**5.34**		**0:00:00**	**0:12:51**
	50		0.12		0:00:08		
End of Curve 55		227,629		**5.45**		**0:00:00**	**0:12:59**
	75		2.18		0:02:15		
Start of Curve 52		216,101		**7.64**		**0:00:00**	**0:15:14**
	70		0.19		0:00:10		
End of Curve 52		215,074		**7.83**		**0:00:00**	**0:15:24**
	70		1.09		0:00:56		
Start of Curve 51		209,340		**8.92**		**0:00:00**	**0:16:20**
	70		0.31		0:00:16		
End of Curve 51		207,681		**9.23**		**0:00:00**	**0:16:36**
	70		0.43		0:00:22		
Start of Curve 50		205,435		**9.66**		**0:00:00**	**0:16:58**
	60		0.19		0:00:11		
End of Curve 50		204,442		**9.85**		**0:00:00**	**0:17:09**
	65		0.75		0:00:52		
Approach to Loveland		200,500		**10.59**		**0:00:00**	**0:18:01**
	45		1.36		0:02:00		
North Loveland		**193,300**		**11.96**		**0:01:00**	**0:21:01**
	35		1.66		0:03:15		
Downtown Loveland		**184,525**		**13.62**		**0:01:00**	**0:25:16**
	35		0.22		0:00:39		
Start of Curve 45		183,349		**13.84**		**0:00:00**	**0:25:55**
	35		0.18		0:00:19		
End of Curve 45		182,383		**14.02**		**0:00:00**	**0:26:14**
	45		0.40		0:00:37		
Start of Curve 44		180,249		**14.43**		**0:00:00**	**0:26:51**
	45		0.20		0:00:16		
End of Curve 44		179,205		**14.63**		**0:00:00**	**0:27:07**
	45		0.30		0:00:25		
Start of Curve 43		177,618		**14.93**		**0:00:00**	**0:27:32**
	35		0.08		0:00:09		
End of Curve 43		177,176		**15.01**		**0:00:00**	**0:27:41**
	35		0.02		0:00:02		
Start of Curve 42		177,066		**15.03**		**0:00:00**	**0:27:43**
	35		0.27		0:00:28		
End of Curve 42		175,640		**15.30**		**0:00:00**	**0:28:11**
	35		0.02		0:00:03		
Start of Curve 41		175,510		**15.32**		**0:00:00**	**0:28:14**
	40		0.35		0:00:33		
End of Curve 41		173,666		**15.67**		**0:00:00**	**0:28:47**
	40		0.04		0:00:03		
Start of Curve 40		173,463		**15.71**		**0:00:00**	**0:28:50**
	45		0.24		0:00:22		
End of Curve 40		172,185		**15.95**		**0:00:00**	**0:29:12**
	75		3.16		0:03:10		
Approach to Berthoud		155,500		**19.11**		**0:00:00**	**0:32:22**
	45		0.93		0:01:25		
Berthoud - SH 56		**150,610**		**20.04**		**0:01:00**	**0:34:47**
	45		0.34		0:00:51		

DMU SOUTHBOUND TRAVEL TIME ESTIMATES
Fort Collins to 162nd Street (North Metro) Station
Draft Committee Vision Plan

Station	Max Spd . (mph)	Stationing	Distance (miles) Incr.	Distance (miles) Total	Run Time (hr:min:sec)	Dwell Time (hr:min:sec)	Total Time (hr:min:sec)
Start of Curve 38		**148,801**		**20.38**		**0:00:00**	**0:35:38**
	45		0.16		0:00:13		
End of Curve 38		**147,968**		**20.54**		**0:00:00**	**0:35:51**
	45		0.00		0:00:00		
Start of Curve 37		**147,948**		**20.54**		**0:00:00**	**0:35:51**
	50		0.22		0:00:19		
End of Curve 37		**146,774**		**20.77**		**0:00:00**	**0:36:10**
	50		0.01		0:00:01		
Start of Curve 36		**146,708**		**20.78**		**0:00:00**	**0:36:11**
	55		0.20		0:00:17		
End of Curve 36		**145,673**		**20.98**		**0:00:00**	**0:36:28**
	60		0.64		0:00:42		
Start of Curve 34		**142,317**		**21.61**		**0:00:00**	**0:37:10**
	60		0.14		0:00:08		
End of Curve 34		**141,584**		**21.75**		**0:00:00**	**0:37:18**
	60		0.02		0:00:01		
Start of Curve 33		**141,458**		**21.77**		**0:00:00**	**0:37:19**
	60		0.18		0:00:11		
End of Curve 33		**140,490**		**21.96**		**0:00:00**	**0:37:30**
	65		0.87		0:00:53		
Start of Curve 31		**135,886**		**22.83**		**0:00:00**	**0:38:23**
	65		0.14		0:00:08		
End of Curve 31		**135,138**		**22.97**		**0:00:00**	**0:38:31**
	60		1.67		0:01:41		
Start of Curve 29		**126,322**		**24.64**		**0:00:00**	**0:40:12**
	50		0.24		0:00:18		
End of Curve 29		**125,033**		**24.88**		**0:00:00**	**0:40:30**
	50		0.47		0:00:34		
Start of Curve 28		**122,548**		**25.36**		**0:00:00**	**0:41:04**
	40		0.21		0:00:18		
End of Curve 28		**121,464**		**25.56**		**0:00:00**	**0:41:22**
	60		1.82		0:02:21		
North Longmont		**111,875**		**27.38**		**0:01:00**	**0:44:43**
	35		1.92		0:03:33		
Start of Curve 27		101,758		**29.29**		**0:00:00**	**0:48:16**
	35		0.26		0:00:27		
End of Curve 27		100,362		**29.56**		**0:00:00**	**0:48:43**
	35		0.01		0:00:01		
Start of Curve 26		100,320		**29.57**		**0:00:00**	**0:48:44**
	35		0.19		0:00:20		
End of Curve 26		99,294		**29.76**		**0:00:00**	**0:49:04**
	35		0.53		0:00:56		
Start of Curve 25		96,517		**30.29**		**0:00:00**	**0:50:00**
	20		0.18		0:00:32		
End of Curve 25		95,564		**30.47**		**0:00:00**	**0:50:32**
	20		0.01		0:00:02		
Start of Curve 24		95,492		**30.48**		**0:00:00**	**0:50:34**
	25		0.06		0:00:09		
End of Curve 24		95,197		**30.54**		**0:00:00**	**0:50:43**
	30		0.07		0:00:10		
Start of Curve 23		94,823		**30.61**		**0:00:00**	**0:50:53**
	35		0.11		0:00:13		
End of Curve 23		94,219		**30.72**		**0:00:00**	**0:51:06**
	35		0.18		0:00:18		
Start of Curve 22		93,287		**30.90**		**0:00:00**	**0:51:24**
	35		0.10		0:00:11		
End of Curve 22		92,761		**31.00**		**0:00:00**	**0:51:35**
	25		0.02		0:00:04		
Start of Curve 21		92,631		**31.02**		**0:00:00**	**0:51:39**
	20		0.07		0:00:12		

DENVER I-25 NORTH EIS
DMU SOUTHBOUND TRAVEL TIME ESTIMATES
Fort Collins to 162nd Street (North Metro) Station
Draft Committee Vision Plan

Station	Max Spd . (mph)	Stationing	Distance (miles) Incr.	Distance (miles) Total	Run Time (hr:min:sec)	Dwell Time (hr:min:sec)	Total Time (hr:min:sec)
End of Curve 21		92,280		**31.09**		**0:00:00**	**0:51:51**
	20		**0.31**		0:01:01		
Sugar Mill		**416,425**		**31.40**		**0:01:00**	**0:53:52**
	35		**0.22**		0:00:38		
Start of Curve -6		**415,280**		**31.62**		**0:00:00**	**0:54:30**
	40		**0.11**		0:00:12		
End of Curve -6		**414,694**		**31.73**		**0:00:00**	**0:54:42**
	40		**0.20**		0:00:18		
Start of Curve -5		**413,637**		**31.93**		**0:00:00**	**0:55:00**
	40		**0.19**		0:00:17		
End of Curve -5		**412,651**		**32.12**		**0:00:00**	**0:55:17**
	40		**0.02**		0:00:02		
Start of Curve -4		**412,557**		**32.13**		**0:00:00**	**0:55:19**
	45		**0.17**		0:00:16		
End of Curve -4		**411,639**		**32.31**		**0:00:00**	**0:55:35**
	65		**2.97**		0:03:05		
Start of Curve 12		**70,296**		**35.28**		**0:00:00**	**0:58:40**
	50		**0.51**		0:00:37		
End of Curve 12		**67,603**		**35.79**		**0:00:00**	**0:59:17**
	75		**6.35**		0:05:38		
Start of Curve 9		**34,072**		**42.14**		**0:00:00**	**1:04:55**
	45		**0.32**		0:00:26		
End of Curve 9		**32,383**		**42.46**		**0:00:00**	**1:05:21**
	45		**0.06**		0:00:04		
Start of Curve 8		**32,090**		**42.51**		**0:00:00**	**1:05:25**
	50		**0.17**		0:00:15		
End of Curve 8		**31,195**		**42.68**		**0:00:00**	**1:05:40**
	50		**0.68**		0:01:02		
County Rd 8 / I-25		**27,590**		**43.37**		**0:01:00**	**1:07:42**
	20		**0.04**		0:00:15		
Start of Curve 7		**27,363**		**43.41**		**0:00:00**	**1:07:57**
	35		**0.31**		0:00:37		
End of Curve 7		**25,746**		**43.72**		**0:00:00**	**1:08:34**
	40		**0.07**		0:00:08		
Start of Curve 6		**25,361**		**43.79**		**0:00:00**	**1:08:42**
	55		**0.40**		0:00:33		
End of Curve 6		**23,264**		**44.19**		**0:00:00**	**1:09:15**
	55		**0.06**		0:00:04		
Start of Curve 5		**22,927**		**44.25**		**0:00:00**	**1:09:19**
	60		**0.25**		0:00:19		
End of Curve 5		**21,582**		**44.50**		**0:00:00**	**1:09:38**
	60		**0.60**		0:00:38		
Start of Curve 4		**18,405**		**45.11**		**0:00:00**	**1:10:16**
	40		**0.24**		0:00:22		
End of Curve 4		**17,126**		**45.35**		**0:00:00**	**1:10:38**
	60		**1.93**		0:02:13		
Start of Curve 2		**6,928**		**47.28**		**0:00:00**	**1:12:51**
	60		**0.28**		0:00:17		
End of Curve 2		**5,429**		**47.56**		**0:00:00**	**1:13:08**
	50		**1.15**		0:01:35		
SH 7/Dent		**0**		**48.71**		**0:01:00**	**1:15:43**
TOTAL				**48.71**	**1:06:43**	**0:09:00**	**1:15:43**
	Avg Stn Spacing =		**5.41 miles**			**Avg Speed =**	**38.60**

Notes:
Distances and curve restrictions from plan drawings provided by Carter Burgess, dated May 2007.

Appendix B:
Commuter Rail Passing Track Analysis

NORTH I-25 DEIS
COMMUTER RAIL PASSING TRACK ANALYSIS
(Updated 8/28/2010)

1.0 Introduction

The Draft Committee Vision Plan includes commuter rail transit (DMU's) along the BNSF corridor in the North I-25 corridor. This service is presently envisioned as an extension of the RTD Fastracks North Metro service that is to run from Denver Union Station (DUS) to 162nd Street. The Draft Committee Vision Plan extends this rail service northwest to Longmont, and then north to Fort Collins. The proposed operating plan currently assumes rail service to/from Fort Collins at 30-minute frequencies in the peak periods and 60-minute frequencies in the midday period.

This paper presents an updated analysis of potential train meet locations. This is the fifth paper issued regarding the passing track analysis. The first paper was issued May 1, 2009 (with minor edits in a May 23, 2009 Update). That analysis assumed a connection to Denver Union Station (DUS) via RTD's Northwest rail alignment. A second paper was issued June 11, 2009. That analysis assumed a revised commuter rail alignment in the North I-25 Corridor, with the North I-25 service connecting to RTD's North Metro corridor. It also included a constrained layover time at DUS (i.e., no more than 10-minutes). A third paper was issued on July 2, 200. That analysis reflected the following changes to prior travel time assumptions:

- The prior analysis assumed a 31.5 minute travel time from DUS to the North Metro's 162nd Street Station. At that time, RTD provided updated travel times that reflect a 28.5 minute travel time (not including end-of-line dwell times).
- Prior work was based on run time estimates that were generated from 2005 and 2006 alignment drawings. Jacobs has provided more recent (May 2007) drawings. Run time estimates have been updated to reflect distances and curve data that is reflected in these 2007 plan drawings.
- The train meet analysis provided in the June 11, 2009 paper assumed an incorrect alignment (and thus, travel time estimate) in Longmont, that has since been corrected.

This fourth paper was issued on August 14, 2009 and is similar to the third paper, with the following exceptions:

- RTD's planning efforts for the North Metro rail line now reflect a travel time estimate that is now a little more than 27 minutes.

- The passing track analysis identifies requirements to accommodate trains +/- 2-minutes off schedule, ***and*** trains +/- 4-minutes off schedule.

This fifth paper reflects one additional change. Every other North I-25 peak period train is now turned back at the Fort Collins South Transit Center. Thus, train service from the STC to downtown Fort Collis is 60-minutes all-day. This change has been made to avoid a train meet in the CSU area, where there is insufficient right-of-way to accommodate passing track.

It is important to note that North Metro rail service is to be operated with Electric Multiple Unit (EMU) vehicles operating at 15-minute frequencies in the peak periods and 60-minute frequencies in the midday period. North I-25 rail plans assume either DMU or traditional commuter rail vehicle service. Thus, the proposed operating plan for this project will need to reflect a modification to the North Metro rail operating plan, with every other train on the North Metro rail line being designated as a North I-25 train to/from Fort Collins, and with every other train being either a DMU or traditional commuter rail train that is inserted between North Metro EMU trains. The combined train service along the North Metro rail alignment would remain at 15-minute peak/30-minute midday service frequencies.

2.0 Single Track Considerations

There are trade-offs to consider with single track operations. Single tracking is a means to lower capital costs, but this is often at the sacrifice of train schedule reliability. The length of a single track segment will dictate the minimum possible service frequency. Trains cannot operate on single track segments more than ½ the scheduled headway without adversely affecting trains in the opposite direction. For example, if trains are operating at 30-minute headways in both directions, the maximum allowable length of the single track segment cannot exceed 15 minutes in travel time, or else trains in the opposite direction will be consistently delayed. Shorter single track segments can better accommodate early or late arriving trains. Using the 30 minute headway example, if the single track segment can be traversed in 5 minutes, an arriving southbound train can be up to 10 minutes late without adversely affecting the arriving northbound train (assuming the northbound train is arriving on-time).

Passing track segments will be required when considering single track operations. Passing track segments are best located at the end-of-line or near stations. This provides locations where early/late trains can hold until trains in the opposite direction have passed, and where there are lower train speeds. A train control system is essential for alignments with single track segments. Consistent headways are also needed to provide a consistent schedule of train meets.

3.0 Travel Time Estimates/Cycle Time

As previously noted, travel time estimates have been updated to reflect the most current project alignment drawings (dated May 2007). Run time estimates for the North I-25 alignment assume one-minute station dwell times, take into consideration train acceleration and deceleration rates and speed limitations through horizontal curves. Table 1 presents updated station-to-station travel time estimates for this project. A detailed run time worksheet is provided at the end of this paper.

Table 1
North I-25 Station-to-Station Travel Time Estimates

Segment	Distance	Time	Avg. Speed
Fort Collins DTC			
	1.14	0:03:59	17.12
CSU			
	3.74	0:07:49	28.71
Fort Collins STC			
	7.08	0:09:13	46.08
North Loveland			
	1.66	0:04:15	23.46
Downtown Loveland			
	6.42	0:09:31	40.50
Berthoud			
	7.34	0:09:56	44.31
North Lognmont			
	4.02	0:09:09	26.39
Sugar Mill			
	11.96	0:13:50	51.90
CR 8/I-25			
	5.35	0:08:01	40.01
162nd St./N. Metro			
Total	**48.71**	**1:15:43**	**38.60**

As noted in the Introduction of this paper, RTD has recently updated its travel time estimate for the North Metro alignment. The new run time estimate is 27.1 minutes. Thus, the full one-way travel time from Fort Collins to DUS (not including end-of-line dwell time) is as follows:

Fort Collins DTC to 162nd Street (North Metro) – 75.7 minutes
162nd Street to DUS – 27.1 minutes
Total Travel Time = 102.8 minutes

Layover/recovery time is then added to estimated run times to obtain a cycle time. The cycle time must be divisible by the proposed service frequency. In this instance, it was determined that North I-25 trains require a 4-hour cycle time for both the peak and midday periods. Thus, eight trains are required for peak period operations and four trains are required for midday operations.

The proposed peak and midday period cycle times include layover time at DUS and in Fort Collins. RTD staff has noted that the maximum allowable layover time at DUS is 10 minutes (due to projected train volumes and station capacity constraints).

Prior analyses had indicated a train meet would occur at the CSU station. This is no longer the case with every other peak period train turning back at the Fort Collins STC. Prior analysis also suggested the need for double tail track north of the Fort Collins DTC. This tail track is no longer needed with the turn back of every other peak period train north of the Fort Collins STC. There are no train meets north of the STC, and trains have sufficient time to travel from the STC to the DTC, and back to the STC without interference from other train movements. However, the provision of a tail track, while not essential on the basis of this analysis, would provide more schedule flexibility (e.g., to accommodate future changes in travel time estimates) and operational reliability (e.g., for temporary storage of a disabled train).

The resulting breakdown of North I-25 train cycle times in the peak and midday time periods for the full alignment, and the calculation of train requirements is shown in the following table. Peak period trains that turn back at the Fort Collins STC will operate on the same cycle (4-hours), with longer layover times at the STC. This is necessary to keep trains on a consistent 30-minute peak/60-minute midday schedule south of the STC. Northbound train travel times are slightly longer (through dwell time adjustments) to obtain train meets at certain locations along the alignment.

Table 2
Cycle Time and Train Calculations

Cycle Time Component	Peak Period Cycle Time	Midday Period Cycle Time
DUS to Fort Collins Travel Time	1:44:29	1:44:29
Fort Collins Dwell and Layover	0:22:42	0:22:42
Fort Collins to DUS Travel Time	1:42:49	1:42:49
DUS Dwell and Layover	0:10:00	0:10:00
Total Cycle Time	**4:00:00**	**4:00:00**
Service Frequency	**30 min.**	**60 min.**
Trains Required	**8 trains**	**4 trains**

4.0 Projected Train Meet Locations

Once run times were updated and a cycle time was established, northbound and southbound train trips were graphed using a string line diagram. Table 4 at the end of this memo presents an example train schedule that was developed for this analysis, using the travel time information presented above. Figure 1 graphically illustrates where trains are scheduled to meet. Train meets on this graph are depicted at locations where the lines intersect. There are four train meets along the North Front Range alignment that are scheduled to occur at the following locations:

- About 0.93 miles north of the North Loveland Station
- About 0.30 miles north of the Berthoud Station
- About 2.06 miles south of the North Longmont Station
- About 3.71 miles north of the I-25/CR 8 Station

5.0 Passing Track Section Lengths

There is a trade-off between passing track length and operational reliability. Longer passing track segments provide greater flexibility to accommodate early and/or late arriving trains. Shorter passing track segments may provide capital cost savings, but at the expense of operational reliability. There is a higher likelihood of delayed trains with short passing track segments.

For purposes of this paper, passing track segment lengths have been identified for two scenarios:

3. Accommodating trains up to 2 minutes early/late; and
4. Accommodating trains up to 4 minutes early/late.

Thus, passing track segments have been defined in a manner that accommodates either 2 or 4 minutes of train running time on each side of a scheduled train meet (i.e., there is a total of either 4 or 8 minutes of passing track, depending on the scenario).

Resulting passing track requirements are noted in Table 3.

Table 3
Passing Track Requirements at Train Meet Locations

Meet Location	Passing Track Limits	+/- 2-min. Criteria Location from Station		+/- 4-min. Criteria Location from Station	
Loveland	N. End	15,880	Feet N. of N. Loveland Station	26,200	Feet N. of N. Loveland Station
Area Meet	S. End	0	At N. Loveland Station	4,410	Feet S. of N. Loveland Station
	Total Dist.	15,880	Total feet	30,610	Total feet
Berthoud	N. End	11,600	Feet N. of Berthoud Station	21,030	Feet N. of Berthoud Station
Area Meet	S. End	1,140	Feet S. of Berthoud Station	9,150	Feet S. of Berthoud Station
	Total Dist.	12,740	Total feet	30,180	Total feet
Longmont	N. End	4,560	Feet S. of N. Longmont Station	0	At N. Longmont Station
Area Meet	S. End	15,700	Feet S. of N. Longnont Station	19,820	Feet S. of N. Longnont Station
	Total Dist.	11,140	Total feet	19,820	Total feet
I-25	N. End	30,390	Feet N. of CR 8/I-25 Station	40,580	Feet N. of CR 8/I-25 Station
Area Meet	S. End	5,940	Feet N. of CR 8/I-25 Station	0	At CR 8/I-25 Station
	Total Dist.	24,450	Total feet	40,580	Total feet
Total Passing Track Req'd.		12.2	miles	23.0	miles
% of align.		25.0%		47.1%	

Once again, it is important to note that these train meet locations are based on travel time estimates that are provided at the end of this paper. Changes to these travel time assumptions will shift train meet locations, thus altering locations identified in this paper. Further, it is important to always keep in mind that operational reliability is a function of passing track length. Longer passing track segments, if they can be accommodated in this project, will greatly improve operational reliability.

6.0 Other Considerations

This paper has identified train meet locations, and passing track requirements for two scenarios: accommodating trains that are up to 2 minutes early/late and 4 minutes early/late. Train on-time performance will be critical for this service plan to work.

It is important to note that this analysis has been completed at a very preliminary stage in this project's development. As this project progresses, further planning efforts will undoubtedly result in changes to findings presented in this paper. Future work efforts that would impact this paper's findings include:

- ***Travel Time Estimates Refinement*** – The North I-25 travel time estimates are based on the most current alignment drawings. Station locations and horizontal curve locations and speeds are likely to change as this project progresses through engineering and design, thus altering this analysis. Travel times along the North Metro alignment are also likely to change as that project advances towards construction.

- ***Integration with North Metro Rail Plans*** – This analysis assumes the conversion of every other North Metro train from EMU to either DMU or traditional commuter rail vehicles. No consideration has yet been given to the operational integration of North Metro and North I-25 trains at the 162nd Street Station, or the potential impact early or late arriving trains would have on North Metro's train operations. Further analysis is required to determine North I-25 impacts on North Metro train operations and ridership forecasts.
- ***BNSF Operations*** – No consideration has yet been given to the impact of joint BNSF freight trains and North I-25 passenger trains along the alignment, and potential delays that may arise from these joint operations.
- ***Train Speeds Through Passing Track Segments*** – Trains will need to reduce speeds through junctions at the beginning and end of each passing track segment. This analysis has not attempted to take into consideration travel times associated with reduced speeds through junctions.

Table 3: Sample Train Schedule

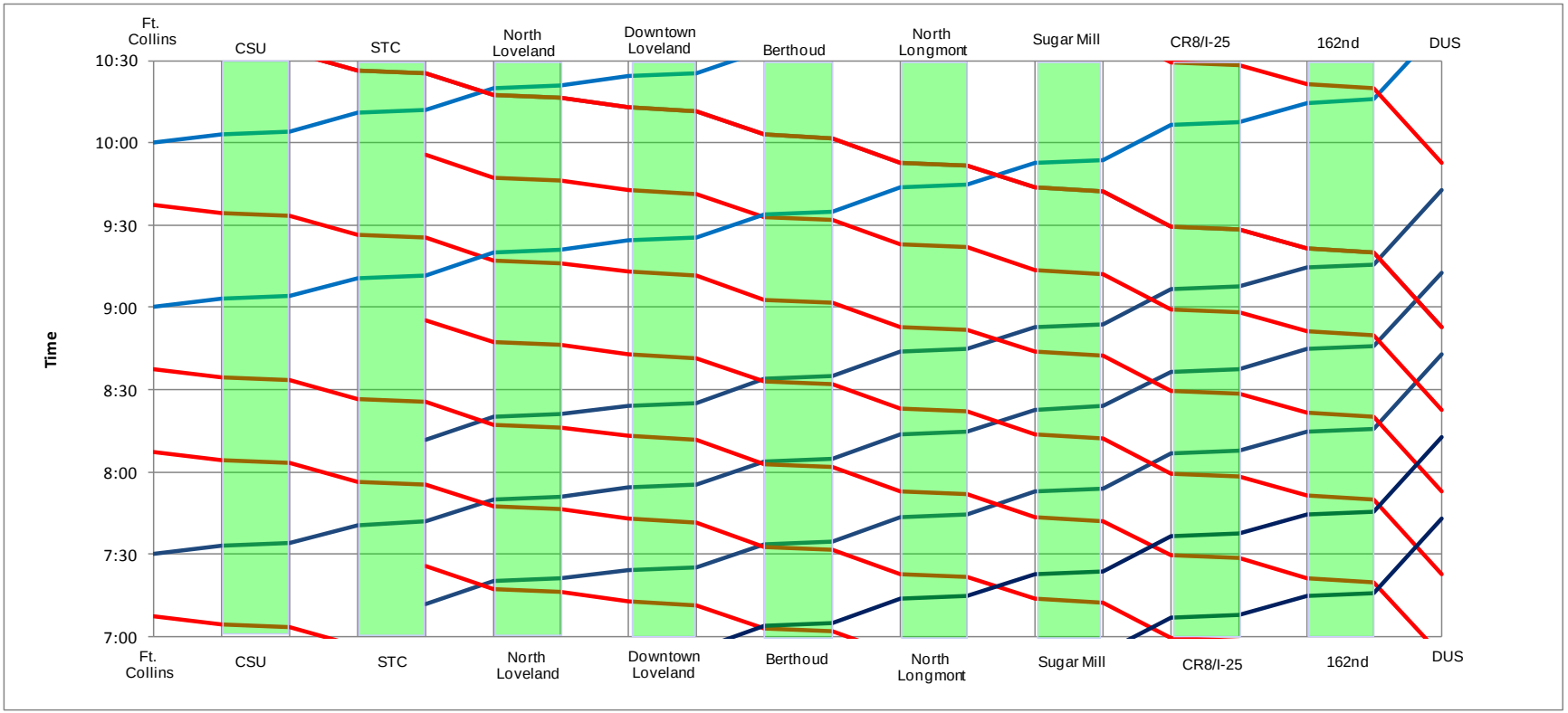
Southbound

Train #	Leave DTC	Arrive CSU	Leave CSU	Arrive STC	Leave STC	Arrive Love/29th	Leave Love/29th	Arrive Love/US34	Leave Love/US34	Arrive Berth/SH56	Leave Berth/SH56	Arrive Long/SH66	Leave Long/SH66	Arrive Sugar Mill	Leave Sugar Mill	Arrive CR8/1-25	Leave CR8/I-25	Arrive 162nd	Leave 162nd	Arrive DUS	Layover	Train #
7																						7
8																						8
1	4:30:00	4:32:59	4:33:59	4:40:48	4:41:48	4:50:01	4:51:01	4:54:16	4:55:16	5:03:47	5:04:47	5:13:43	5:14:43	5:22:52	5:23:52	5:36:42	5:37:42	5:44:43	5:45:43	6:12:49	0:10:00	1
2					5:11:48	5:20:01	5:21:01	5:24:16	5:25:16	5:33:47	5:34:47	5:43:43	5:44:43	5:52:52	5:53:52	6:06:42	6:07:42	6:14:43	6:15:43	6:42:49	0:10:00	2
3	5:30:00	5:32:59	5:33:59	5:40:48	5:41:48	5:50:01	5:51:01	5:54:16	5:55:16	6:03:47	6:04:47	6:13:43	6:14:43	6:22:52	6:23:52	6:36:42	6:37:42	6:44:43	6:45:43	7:12:49	0:10:00	3
4					6:11:48	6:20:01	6:21:01	6:24:16	6:25:16	6:33:47	6:34:47	6:43:43	6:44:43	6:52:52	6:53:52	7:06:42	7:07:42	7:14:43	7:15:43	7:42:49	0:10:00	4
5	6:30:00	6:32:59	6:33:59	6:40:48	6:41:48	6:50:01	6:51:01	6:54:16	6:55:16	7:03:47	7:04:47	7:13:43	7:14:43	7:22:52	7:23:52	7:36:42	7:37:42	7:44:43	7:45:43	8:12:49	0:10:00	5
6					7:11:48	7:20:01	7:21:01	7:24:16	7:25:16	7:33:47	7:34:47	7:43:43	7:44:43	7:52:52	7:53:52	8:06:42	8:07:42	8:14:43	8:15:43	8:42:49	0:10:00	6
7	7:30:00	7:32:59	7:33:59	7:40:48	7:41:48	7:50:01	7:51:01	7:54:16	7:55:16	8:03:47	8:04:47	8:13:43	8:14:43	8:22:52	8:23:52	8:36:42	8:37:42	8:44:43	8:45:43	9:12:49		7
8					8:11:48	8:20:01	8:21:01	8:24:16	8:25:16	8:33:47	8:34:47	8:43:43	8:44:43	8:52:52	8:53:52	9:06:42	9:07:42	9:14:43	9:15:43	9:42:49	0:10:00	8
2	9:00:00	9:02:59	9:03:59	9:10:48	9:11:48	9:20:01	9:21:01	9:24:16	9:25:16	9:33:47	9:34:47	9:43:43	9:44:43	9:52:52	9:53:52	10:06:42	10:07:42	10:14:43	10:15:43	10:42:49	0:10:00	2
4	10:00:00	10:02:59	10:03:59	10:10:48	10:11:48	10:20:01	10:21:01	10:24:16	10:25:16	10:33:47	10:34:47	10:43:43	10:44:43	10:52:52	10:53:52	11:06:42	11:07:42	11:14:43	11:15:43	11:42:49	0:10:00	4
6	11:00:00	11:02:59	11:03:59	11:10:48	11:11:48	11:20:01	11:21:01	11:24:16	11:25:16	11:33:47	11:34:47	11:43:43	11:44:43	11:52:52	11:53:52	12:06:42	12:07:42	12:14:43	12:15:43	12:42:49	0:10:00	6
8	12:00:00	12:02:59	12:03:59	12:10:48	12:11:48	12:20:01	12:21:01	12:24:16	12:25:16	12:33:47	12:34:47	12:43:43	12:44:43	12:52:52	12:53:52	13:06:42	13:07:42	13:14:43	13:15:43	13:42:49	0:10:00	8
2	13:00:00	13:02:59	13:03:59	13:10:48	13:11:48	13:20:01	13:21:01	13:24:16	13:25:16	13:33:47	13:34:47	13:43:43	13:44:43	13:52:52	13:53:52	14:06:42	14:07:42	14:14:43	14:15:43	14:42:49	0:10:00	2
7																						7
4	14:00:00	14:02:59	14:03:59	14:10:48	14:11:48	14:20:01	14:21:01	14:24:16	14:25:16	14:33:47	14:34:47	14:43:43	14:44:43	14:52:52	14:53:52	15:06:42	15:07:42	15:14:43	15:15:43	15:42:49	0:10:00	4
1					14:41:48	14:50:01	14:51:01	14:54:16	14:55:16	15:03:47	15:04:47	15:13:43	15:14:43	15:22:52	15:23:52	15:36:42	15:37:42	15:44:43	15:45:43	16:12:49	0:10:00	1
6	15:00:00	15:02:59	15:03:59	15:10:48	15:11:48	15:20:01	15:21:01	15:24:16	15:25:16	15:33:47	15:34:47	15:43:43	15:44:43	15:52:52	15:53:52	16:06:42	16:07:42	16:14:43	16:15:43	16:42:49	0:10:00	6
3					15:41:48	15:50:01	15:51:01	15:54:16	15:55:16	16:03:47	16:04:47	16:13:43	16:14:43	16:22:52	16:23:52	16:36:42	16:37:42	16:44:43	16:45:43	17:12:49	0:10:00	3
8	16:00:00	16:02:59	16:03:59	16:10:48	16:11:48	16:20:01	16:21:01	16:24:16	16:25:16	16:33:47	16:34:47	16:43:43	16:44:43	16:52:52	16:53:52	17:06:42	17:07:42	17:14:43	17:15:43	17:42:49	0:10:00	8
5					16:41:48	16:50:01	16:51:01	16:54:16	16:55:16	17:03:47	17:04:47	17:13:43	17:14:43	17:22:52	17:23:52	17:36:42	17:37:42	17:44:43	17:45:43	18:12:49	0:10:00	5
2	17:00:00	17:02:59	17:03:59	17:10:48	17:11:48	17:20:01	17:21:01	17:24:16	17:25:16	17:33:47	17:34:47	17:43:43	17:44:43	17:52:52	17:53:52	18:06:42	18:07:42	18:14:43	18:15:43	18:42:49	0:10:00	2
7					17:41:48	17:50:01	17:51:01	17:54:16	17:55:16	18:03:47	18:04:47	18:13:43	18:14:43	18:22:52	18:23:52	18:36:42	18:37:42	18:44:43	18:45:43	19:12:49		7
4	18:00:00	18:02:59	18:03:59	18:10:48	18:11:48	18:20:01	18:21:01	18:24:16	18:25:16	18:33:47	18:34:47	18:43:43	18:44:43	18:52:52	18:53:52	19:06:42	19:07:42	19:14:43	19:15:43	19:42:49	0:10:00	4
6	19:00:00	19:02:59	19:03:59	19:10:48	19:11:48	19:20:01	19:21:01	19:24:16	19:25:16	19:33:47	19:34:47	19:43:43	19:44:43	19:52:52	19:53:52	20:06:42	20:07:42	20:14:43	20:15:43	20:42:49	0:10:00	6
8	20:00:00	20:02:59	20:03:59	20:10:48	20:11:48	20:20:01	20:21:01	20:24:16	20:25:16	20:33:47	20:34:47	20:43:43	20:44:43	20:52:52	20:53:52	21:06:42	21:07:42	21:14:43	21:15:43	21:42:49		8

Table 3 (continued): Sample Train Schedule
Northbound

Train #	Leave DUS	Arrive 162nd	Leave 162nd	Arrive CR8/I-25	Leave CR8/I-25	Arrive Sugar Mill	Leave Sugar Mill	Arrive Long/SH66	Leave Long/SH66	Arrive Berth/SH56	Leave Berth/SH56	Arrive Love/US34	Leave Love/US34	Arrive Love/29th	Leave Love/29th	Arrive STC	Leave STC	Arrive CSU	Leave CSU	Arrive DTC	Layover	Depart DTC	Train #
7	5:22:49	5:49:55	5:51:25	5:58:26	5:59:26	6:12:16	6:13:46	6:21:55	6:22:55	6:31:51	6:32:51	6:41:32	6:43:02	6:46:17	6:47:17	6:55:30	6:56:30	7:03:19	7:04:19	7:07:18	0:22:42	7:30:00	7
8	5:52:49	6:19:55	6:21:25	6:28:26	6:29:26	6:42:16	6:43:46	6:51:55	6:52:55	7:01:51	7:02:51	7:11:32	7:13:02	7:16:17	7:17:17	7:25:30					0:45:18	8:11:48	8
1	6:22:49	6:49:55	6:51:25	6:58:26	6:59:26	7:12:16	7:13:46	7:21:55	7:22:55	7:31:51	7:32:51	7:41:32	7:43:02	7:46:17	7:47:17	7:55:30	7:56:30	8:03:19	8:04:19	8:07:18	----------	----------	1
2	6:52:49	7:19:55	7:21:25	7:28:26	7:29:26	7:42:16	7:43:46	7:51:55	7:52:55	8:01:51	8:02:51	8:11:32	8:13:02	8:16:17	8:17:17	8:25:30	8:26:30	8:33:19	8:34:19	8:37:18	0:22:42	9:00:00	2
3	7:22:49	7:49:55	7:51:25	7:58:26	7:59:26	8:12:16	8:13:46	8:21:55	8:22:55	8:31:51	8:32:51	8:41:32	8:43:02	8:46:17	8:47:17	8:55:30	----------	----------	----------	----------	----------	----------	3
4	7:52:49	8:19:55	8:21:25	8:28:26	8:29:26	8:42:16	8:43:46	8:51:55	8:52:55	9:01:51	9:02:51	9:11:32	9:13:02	9:16:17	9:17:17	9:25:30	9:26:30	9:33:19	9:34:19	9:37:18	0:22:42	10:00:00	4
5	8:22:49	8:49:55	8:51:25	8:58:26	8:59:26	9:12:16	9:13:46	9:21:55	9:22:55	9:31:51	9:32:51	9:41:32	9:43:02	9:46:17	9:47:17	9:55:30	----------	----------	----------	----------	----------	----------	5
6	8:52:49	9:19:55	9:21:25	9:28:26	9:29:26	9:42:16	9:43:46	9:51:55	9:52:55	10:01:51	10:02:51	10:11:32	10:13:02	10:16:17	10:17:17	10:25:30	10:26:30	10:33:19	10:34:19	10:37:18	0:22:42	11:00:00	6
7	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	7
8	9:52:49	10:19:55	10:21:25	10:28:26	10:29:26	10:42:16	10:43:46	10:51:55	10:52:55	11:01:51	11:02:51	11:11:32	11:13:02	11:16:17	11:17:17	11:25:30	11:26:30	11:33:19	11:34:19	11:37:18	0:22:42	12:00:00	8
2	10:52:49	11:19:55	11:21:25	11:28:26	11:29:26	11:42:16	11:43:46	11:51:55	11:52:55	12:01:51	12:02:51	12:11:32	12:13:02	12:16:17	12:17:17	12:25:30	12:26:30	12:33:19	12:34:19	12:37:18	0:22:42	13:00:00	2
4	11:52:49	12:19:55	12:21:25	12:28:26	12:29:26	12:42:16	12:43:46	12:51:55	12:52:55	13:01:51	13:02:51	13:11:32	13:13:02	13:16:17	13:17:17	13:25:30	13:26:30	13:33:19	13:34:19	13:37:18	0:22:42	14:00:00	4
6	12:52:49	13:19:55	13:21:25	13:28:26	13:29:26	13:42:16	13:43:46	13:51:55	13:52:55	14:01:51	14:02:51	14:11:32	14:13:02	14:16:17	14:17:17	14:25:30	14:26:30	14:33:19	14:34:19	14:37:18	0:22:42	15:00:00	6
8	13:52:49	14:19:55	14:21:25	14:28:26	14:29:26	14:42:16	14:43:46	14:51:55	14:52:55	15:01:51	15:02:51	15:11:32	15:13:02	15:16:17	15:17:17	15:25:30	15:26:30	15:33:19	15:34:19	15:37:18	0:22:42	16:00:00	8
2	14:52:49	15:19:55	15:21:25	15:28:26	15:29:26	15:42:16	15:43:46	15:51:55	15:52:55	16:01:51	16:02:51	16:11:32	16:13:02	16:16:17	16:17:17	16:25:30	16:26:30	16:33:19	16:34:19	16:37:18	0:22:42	17:00:00	2
7	15:22:49	15:49:55	15:51:25	15:58:26	15:59:26	16:12:16	16:13:46	16:21:55	16:22:55	16:31:51	16:32:51	16:41:32	16:43:02	16:46:17	16:47:17	16:55:30					0:46:18	17:41:48	7
4	15:52:49	16:19:55	16:21:25	16:28:26	16:29:26	16:42:16	16:43:46	16:51:55	16:52:55	17:01:51	17:02:51	17:11:32	17:13:02	17:16:17	17:17:17	17:25:30	17:26:30	17:33:19	17:34:19	17:37:18	0:22:42	18:00:00	4
1	16:22:49	16:49:55	16:51:25	16:58:26	16:59:26	17:12:16	17:13:46	17:21:55	17:22:55	17:31:51	17:32:51	17:41:32	17:43:02	17:46:17	17:47:17	17:55:30	----------	----------	----------	----------	----------	----------	1
6	16:52:49	17:19:55	17:21:25	17:28:26	17:29:26	17:42:16	17:43:46	17:51:55	17:52:55	18:01:51	18:02:51	18:11:32	18:13:02	18:16:17	18:17:17	18:25:30	18:26:30	18:33:19	18:34:19	18:37:18	0:22:42	19:00:00	6
3	17:22:49	17:49:55	17:51:25	17:58:26	17:59:26	18:12:16	18:13:46	18:21:55	18:22:55	18:31:51	18:32:51	18:41:32	18:43:02	18:46:17	18:47:17	18:55:30	----------	----------	----------	----------	----------	----------	3
8	17:52:49	18:19:55	18:21:25	18:28:26	18:29:26	18:42:16	18:43:46	18:51:55	18:52:55	19:01:51	19:02:51	19:11:32	19:13:02	19:16:17	19:17:17	19:25:30	19:26:30	19:33:19	19:34:19	19:37:18	0:22:42	20:00:00	8
5	18:22:49	18:49:55	18:51:25	18:58:26	18:59:26	19:12:16	19:13:46	19:21:55	19:22:55	19:31:51	19:32:51	19:41:32	19:43:02	19:46:17	19:47:17	19:55:30	----------	----------	----------	----------	----------	----------	5
2	18:52:49	19:19:55	19:21:25	19:28:26	19:29:26	19:42:16	19:43:46	19:51:55	19:52:55	20:01:51	20:02:51	20:11:32	20:13:02	20:16:17	20:17:17	20:25:30	20:26:30	20:33:19	20:34:19	20:37:18	----------	----------	2
7	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	7
4	19:52:49	20:19:55	20:21:25	20:28:26	20:29:26	20:42:16	20:43:46	20:51:55	20:52:55	21:01:51	21:02:51	21:11:32	21:13:02	21:16:17	21:17:17	21:25:30	21:26:30	21:33:19	21:34:19	21:37:18	----------	----------	4
6	20:52:49	21:19:55	21:21:25	21:28:26	21:29:26	21:42:16	21:43:46	21:51:55	21:52:55	22:01:51	22:02:51	22:11:32	22:13:02	22:16:17	22:17:17	22:25:30	22:26:30	22:33:19	22:34:19	22:37:18	----------	----------	6
8																							8

Figure 1:
Line Graph of Train Meets



Notes:

1. *Red lines indicate southbound train movements and should be read right to left.*
2. *Blue Lines indicate northbound rain movements and should be read left to right.*
3. *Intersecting lines indicate train meet locations.*