



Appendix B

Technical Memoranda and Reports

Disclaimer:

Technical memoranda and reports were prepared as independent documents to support the preparation of the Final Environmental Impact Statement (FEIS) for the Dallas CBD Second Light Rail Alignment (D2 Subway). Information from these documents was incorporated into the FEIS to provide information on existing conditions, and in some cases, assess potential impacts to the resources. Information contained in the FEIS is the most current and supersedes information in the technical memoranda and reports.



B-17

Definition of Operating Plans Technical Memorandum



Memo

Date: February 13, 2020 (updated from October 7, 2019 draft)

Project: GPC6 Task Order 39: D2 Subway Project Development Services

To: Kay Shelton, DART Assistant Vice President – Capital Planning
Ernie Martinez, DART D2 Project Manager – Capital Planning
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From: Susan Rosales, Connetics Transportation Group

Subject: D2 Subway Project (Downtown Dallas Second Light Rail Alignment)
Definition of Operating Plans

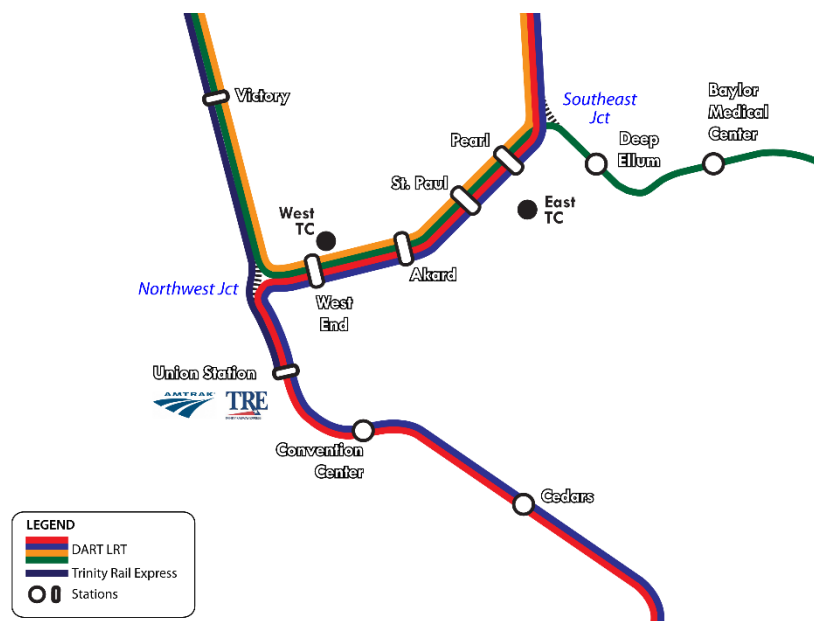
The purpose of this Technical Memorandum is to describe DART's LRT operating plan incorporating the D2 Subway Project alignment for the following scenarios:

1. Routine Operations
2. Special Event State Fair Service
3. Incident Management

Routine Operations

Currently, DART operates four light rail transit (LRT) lines. Each line generally offers 15 minute peak period service frequencies and 20 minute midday and evening service frequencies on weekdays. On weekends, service frequencies are 20 minutes, tapering to 30 minutes in the evenings. All four LRT lines currently converge on the transit mall in downtown Dallas, as shown in **Figure 1**.

Figure 1. Existing DART Light Rail Transit Configuration in Downtown Dallas



The D2 alignment will be used by DART's Orange Line and Green Line, whereas DART's Red Line and Blue Line will remain on the transit mall in downtown Dallas, as shown in **Figure 2**. This frees up capacity on the transit mall, allowing additional Red Line service to be added during the peak hour to address core capacity. Endpoints for each of the four lines will remain the same as existing service, as summarized in **Table 1** and **Figure 3**. The D2 project incorporates full wye movements at the Deep Ellum Junction as well as the Southeast Junction, allowing operational flexibility for interaction between the lines.

Figure 2. DART Light Rail Transit Configuration with D2 Alignment

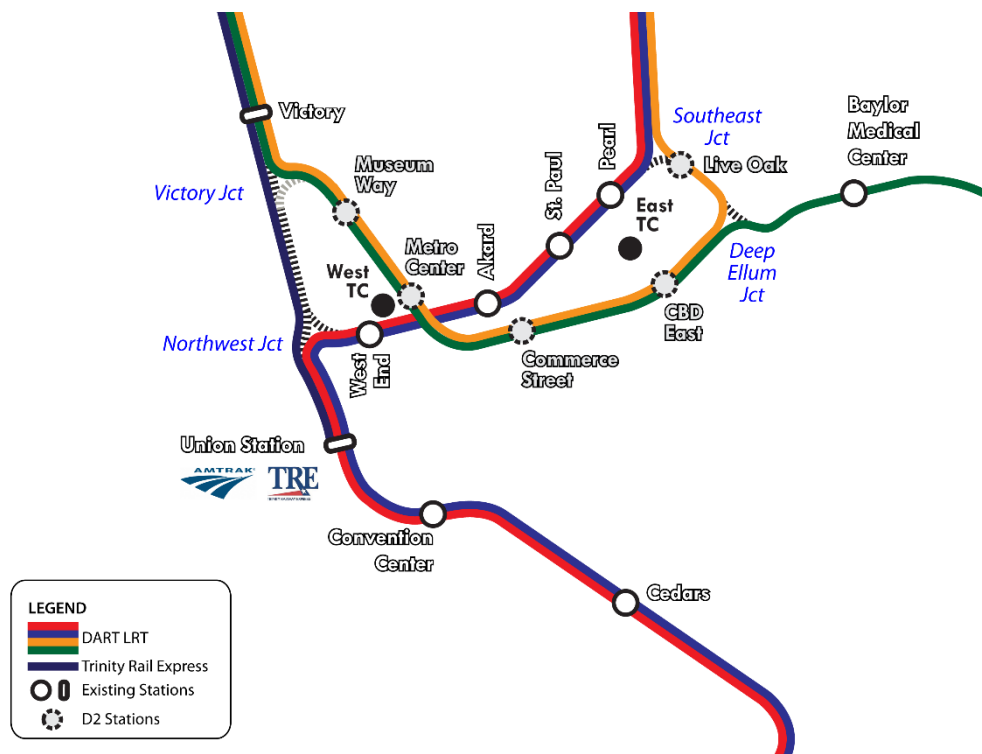


Table 1. DART Light Rail Transit Lines

LRT Line	Downtown Alignment	From	To
Red Line	Transit Mall	Parker Road	Westmoreland
Blue Line	Transit Mall	Downtown Rowlett	UNT Dallas
Green Line	D2	North Carrollton/Frankford	Buckner
Orange Line	D2	DFW Airport Terminal A	Parker Road (weekday peak) or LBJ Central (all other times)

Figure 3. DART Light Rail Transit System with D2



Each line's span of service and service frequencies are presented in **Table 2**, and the resulting operating plan is schematically illustrated in **Figure 4**.

Table 2. DART Light Rail Transit Span and Service Frequency by Line

LRT Line	Weekday		Weekend	
	Span	Service Frequencies	Span	Service Frequencies
Red Line	4am – 2am	15 minute peak*; 20 minute midday and evening	3:15am – 2am	20 minute base; 30 minute early morning and evening
Blue Line	3:30am – 2am	15 minute peak; 20 minute midday and evening	3:30am – 2am	20 minute base; 30 minute early morning and evening
Green Line	3:15am – 1:45am	15 minute peak; 20 minute midday and evening	3:45am – 1:45am	20 minute base; 30 minute early morning and evening
Orange Line	2:45am – 2am	15 minute peak; 20 minute midday and evening	2:45am – 2am	20 minute base; 30 minute early morning and evening

*Plus one added insert train from Parker Road to Cedars Station during heaviest peak hour

Station-to-station travel times were estimated for the D2 alignment, accounting for speed limitations introduced by curves and station placement. This geometric data is used in tandem with vehicle acceleration and deceleration rates to provide vehicle travel times between stations along the D2 segment. Because these stations serve central Dallas, a dwell time of 30 seconds per station was assumed.

Table 3 and **Table 4** provide resulting travel times. For the Green Line, the D2 alignment is about 0.13 miles shorter and saves about 2.8 minutes compared to the transit mall. For the Orange Line, the D2 alignment adds about 0.4 miles and adds about 1.2 minutes compared to the transit mall.

Table 3. D2 Green Line Travel Times between Victory Station and Baylor UMC Station

Begin Station	End Station	Distance	Travel Time	Dwell Time	Total Time	Avg. Speed
VICTORY STATION	MUSEUM WAY STATION	0.45	0:02:05	0:00:30	0:02:35	12.8
MUSEUM WAY STATION	METRO CENTER STATION	0.42	0:01:07	0:00:30	0:01:37	22.4
METRO CENTER STATION	COMMERCE ST STATION	0.44	0:01:30	0:00:30	0:02:00	17.6
COMMERCE ST STATION	CBD EAST STATION	0.38	0:01:17	0:00:30	0:01:47	17.8
CBD EAST STATION	BAYLOR UMC STATION	0.74	0:02:42	0:00:30	0:03:12	16.4
TOTALS		2.42	0:08:41	0:02:30	0:11:11	16.7

Table 4. D2 Orange Line Travel Times between Victory Station and Cityplace/Uptown Station

Begin Station	End Station	Distance	Travel Time	Dwell Time	Total Time	Avg. Speed
VICTORY STATION	MUSEUM WAY STATION	0.45	0:02:05	0:00:30	0:02:35	12.8
MUSEUM WAY STATION	METRO CENTER STATION	0.42	0:01:07	0:00:30	0:01:37	22.4
METRO CENTER STATION	COMMERCE ST STATION	0.44	0:01:30	0:00:30	0:02:00	17.6
COMMERCE ST STATION	CBD EAST STATION	0.38	0:01:17	0:00:30	0:01:47	17.8
CBD EAST STATION	LIVE OAK STATION	0.39	0:02:02	0:00:30	0:02:32	11.5
LIVE OAK STATION	CITYPLACE/UPTOWN STATION	1.33	0:03:09	0:00:30	0:03:39	25.3



TOTALS	3.40	0:11:10	0:03:00	0:14:10	18.3
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Special Event Service

State Fair

DART provides special event service during the annual State Fair held each fall. The fairgrounds are served by two Green Line stations -- Fair Park Station, located on Parry Avenue at the main entrance to the fairgrounds, and MLK, Jr. Station, located south of R.B. Cullum Blvd. and convenient to the MLK fairground entrance (Gate 6) and the Cotton Bowl Stadium.

The current service concept for State Fair service makes the following modifications to routine service:

- Extra Green Line trains are added approximately every 20 minutes between Victory and Lawnview stations from 9:30 a.m. to 3:30 p.m. weekdays and 9:30 a.m. to 7:30 p.m. on weekends, effectively providing 10 minute Green Line service between Victory and Lawnview.
- Blue Line weekend evening service is enhanced from 30 minutes to 15 minutes.
- Orange Line trains are extended to Parker Road Station (except game day for Red River Showdown).

If basically maintaining the same service plan as currently employed for special event service, passengers riding DART light rail lines transfer at the following locations, given the realignment of Green and Orange Line service to D2:

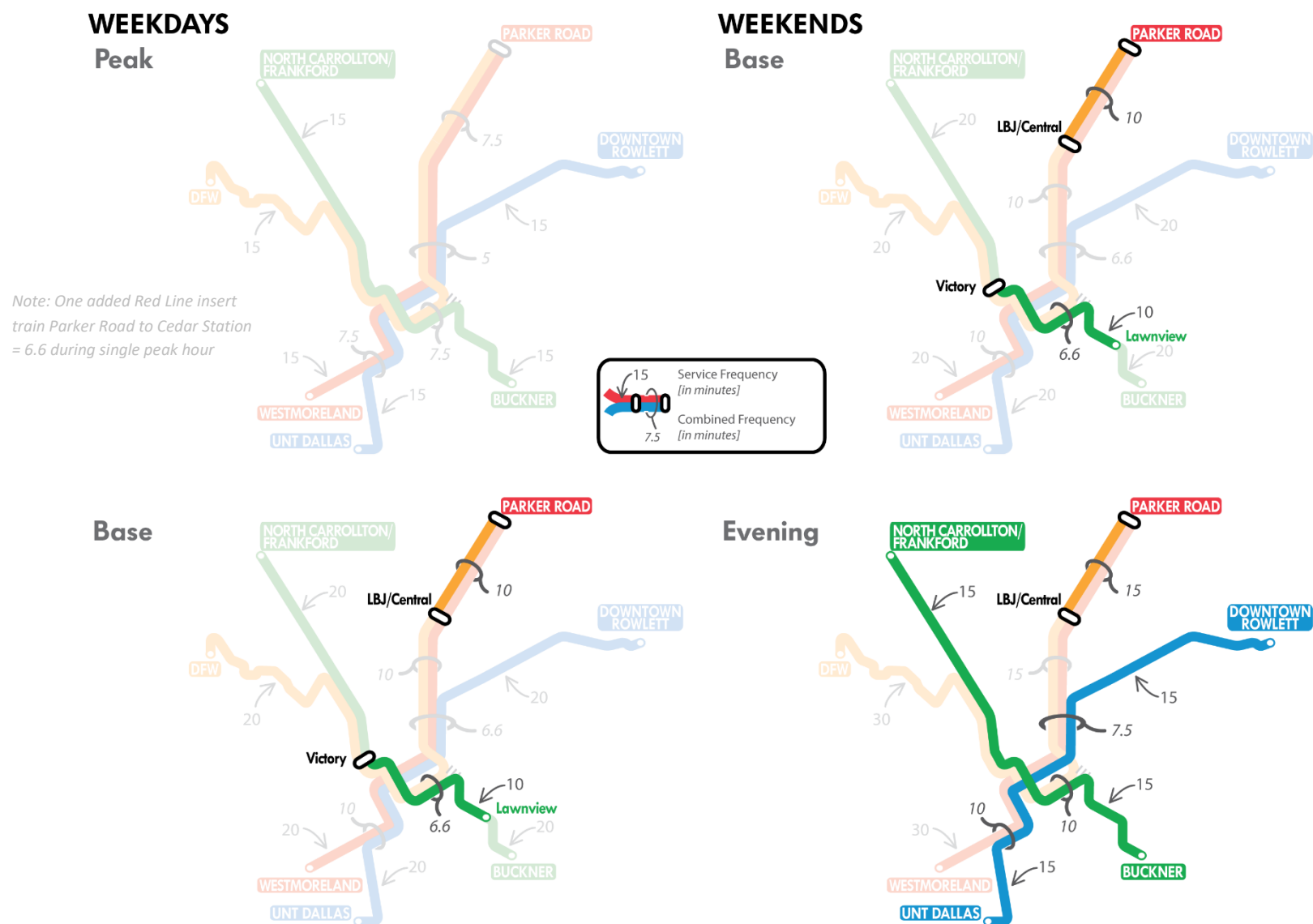
- Red and Blue Line passengers transfer to the Green Line at West End/Metro Center.
- Westbound Orange Line passengers transfer to the Green Line at CBD East Station.
- Eastbound Orange Line passengers transfer to the Green Line at Bachman Station.
- TRE passengers transfer to the Green Line at Victory Station.

The State Fair service plan, as based on current service but with the realignment of Green and Orange Line service to D2, highlights changes compared to routine service in **Figure 5**.

Since the D2 alignment provides additional capacity in downtown Dallas and the project incorporates all movements at the Southeast and Deep Ellum junctions, State Fair service can consider other patterns providing direct service to the fairgrounds:

- Parker Road to fairgrounds
- Downtown Rowlett to fairgrounds
- DFW to fairgrounds (beyond the three weekend PM trips in current State Fair schedule)
- Westmoreland to fairgrounds
- UNT Dallas to fairgrounds

Figure 5. DART Changes to Routine Light Rail Transit Operations for State Fair Service (based on existing practices)



The extent to which these additional patterns can be accommodated is limited by the headway limitations of the Green Line segment from the Deep Ellum junction to the fairgrounds. It is worth noting that Red and Blue Line southbound transfers to the Green Line would cause undesirable backtracking to transfer at West End/Metro Center, so these corridors may warrant particular consideration of direct service. The remaining movements (Red and Blue Line northbound transfers to the Green Line as well as either direction of Orange Line) do not necessitate major out-of-direction travel.

Table 5. Potential State Fair Operating Plans with D2

LRT Line	D2 Based on Current Plan		D2 Example of Alternate Plan	
	Weekday	Weekend	Weekday	Weekend
Red Line	15 min peak; 20 min base	20 min base; 30 min eve	15 min peak; 20 min base (full); 20 min base Parker Rd to Lawnview	20 min base; 30 min eve (full); 20 min base; 30 min eve Parker Rd to Lawnview
Blue Line	15 min peak; 20 min base	20 min base; 15 min eve	15 min peak; 20 min base	20 min base; 15 min eve
Green Line	15 min peak; 20 min base (full); 20 min base Victory to Lawnview	20 min base; 15 min eve (full); 20 min base Victory to Lawnview	15 min peak; 20 min base (full); 20 min base Victory to Lawnview	20 min base; 15 min eve (full); 20 min base Victory to Lawnview
Orange Line	15 min peak; 20 min base; extend all trips to Parker Rd	20 min base; 30 min eve; extend all trips to Parker Rd	15 min peak; 20 min base	20 min base; 30 min eve

The example shown in **Table 5** and **Figure 6** focuses adding Red Line direct fairground service from Parker Road to Lawnview via the Southeast and Deep Ellum junctions except during weekday peak periods. Blue Line southbound trains would be able to take advantage of this direct service by transferring at SMU/Mockingbird, rather than having to transfer at West End/Metro Center and backtrack through downtown Dallas on the Green Line. The transfer between the Blue and Red Line fairground service at SMU/Mockingbird (or Cityplace/Uptown) could be a timed transfer. The Green Line supplemental service between Victory and Lawnview is maintained to respond to increased transfers from northbound Red and Blue, transfers from TRE at Victory station, and transfers from the Orange Line from either direction.

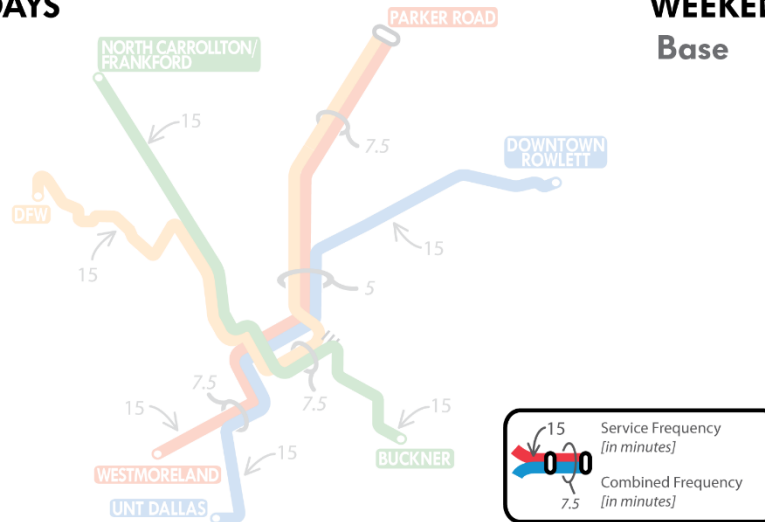
The example's resulting 12 trains an hour (5 minute average headway) between SMU/Mockingbird and the Southeast Junction can clearly be accommodated, as this matches the current trunk headway in this segment for weekday peak period service.

The example would lead to 9 trains an hour (6.6 minute average headways) between the Deep Ellum Junction and Lawnview. As noted earlier, the Green Line's minimum frequency between trains would need to be confirmed in order to determine how much direct service to the fairgrounds can be accommodated.

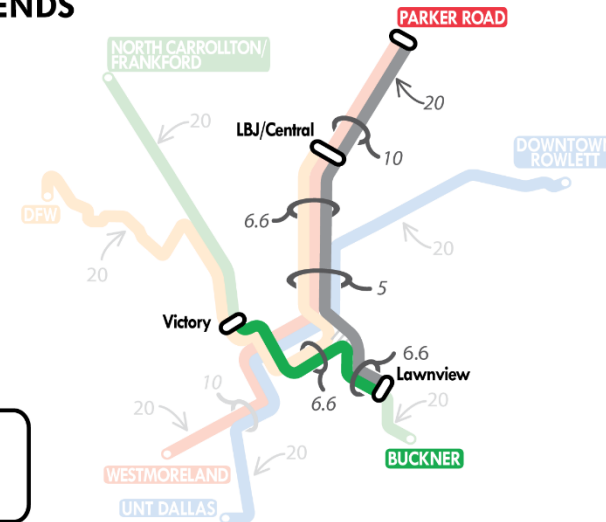
While other patterns can be incorporated, the intent is to make the direct service to the fairgrounds regular and frequent enough for riders to depend on the service.

Figure 6. DART Changes to Routine Light Rail Transit Operations for State Fair Service (alternate concept incorporating D2)

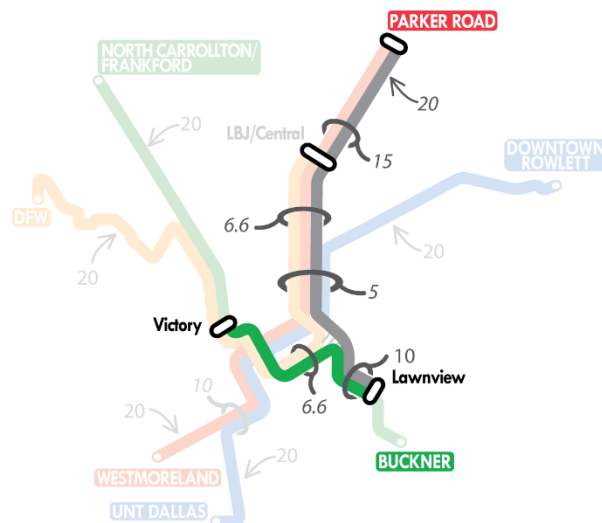
WEEKDAYS
Peak



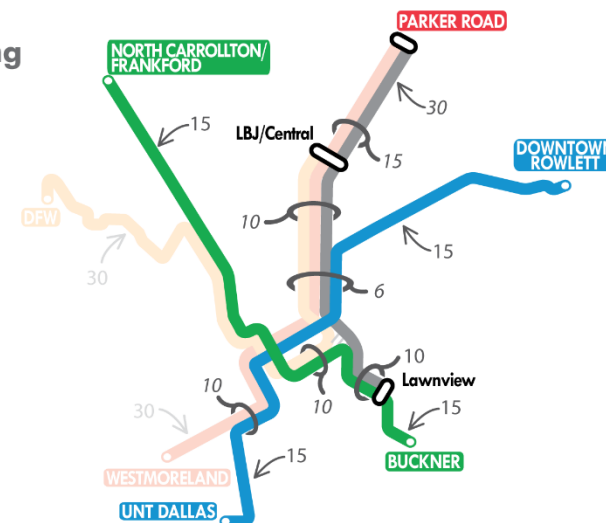
WEEKENDS
Base



Base



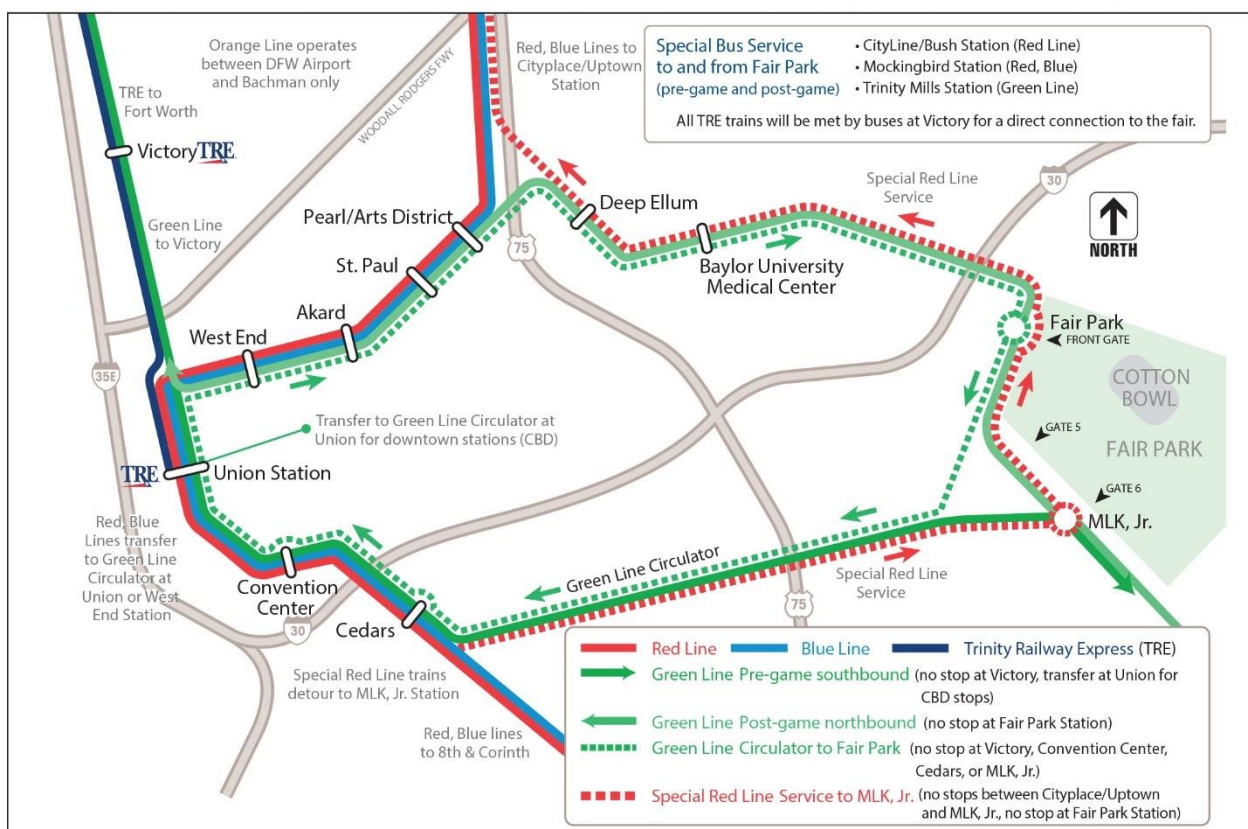
Evening



Red River Showdown

Existing Service. The Red River Showdown annual football game is held on a single day during the State Fair. DART's current service provides a sophisticated system of additional train service, including the integration of the Green Line Circulator loop, special Red Line service, and additional shuttle buses. Due to capacity constraints on the transit mall, DART employs its yard lead connections to cut across downtown Dallas to the south. This connection is used as a bypass for rerouting Green Line southbound trips as well as special Red Line service to the stadium before the game. The Green Line circulator maintains access to downtown stations that are bypassed by these rerouted trips. **Figure 7** provides a schematic of service focusing on central Dallas and the fairgrounds.

Figure 7. DART Light Rail Transit Current Operations for Red River Showdown



- Green Line.** Southbound Green Line trains operate every 10 minutes from North Carrollton/Frankford Station for MLK, Jr. Station as early as four hours before the game. Prior to kick-off, these trains use an alternate routing proceeding from Market Center Station to Union Station, then directly to MLK, Jr. Station, thereby skipping Victory, West End, Akard, St. Paul, Pearl/Arts District, Deep Ellum, Baylor and Fair Park stations. The skipped downtown stations are accessed by transferring to the Green Line circulator at Union Station.



Northbound Green Line trains leave every 10 minutes from Buckner Station for MLK, Jr. Station as early as three hours before kickoff. These trains skip Fair Park Station, but continue to serve all other stations.

The special Green Line circulator starts four hours before the game and operates every 10 minutes, serving stations noted in **Figure 6**. The Green Line circulator does not stop at Convention Center or Cedars stations and operates continually until approximately four hours after the game.

- **Red Line.** Red Line trains following the typical route between Parker Road and Westmoreland Station operate on a regular Saturday schedule with 20 minute service transitioning to 30 minutes in the evenings. Southbound Red Line passengers transfer to the Green Line Circulator at Pearl/Arts District Station while northbound Red Line passengers transfer at Akard Station.

For direct service to the stadium, specially marked southbound Red Line trains operate every 10 minutes from Parker Road Station to MLK, Jr. Station starting as early as four hours before kickoff. The specially marked southbound Red Line trains do not stop after Cityplace/Uptown Station and head directly to MLK, Jr. Station using the yard lead routing as described for the Green Line. After the game, these specially marked northbound Red Line trains depart from MLK, Jr. Station for the trip back to Parker Road Station, skipping the Fair Park Station.

- **Blue Line.** Southbound Blue Line trains operate every 15 minutes from Downtown Rowlett Station starting four hours before kickoff, with transfers to the Green Line Circulator at Pearl/Arts District Station. Northbound Blue Line passengers follow a regular Saturday schedule and can transfer to the Green Line Circulator at Akard Station.
- **Orange Line.** Eastbound Orange Line passengers from DFW Airport and Irving's five stations transfer to the Green Line at Bachman Station at 20 minute headways. Orange Line trains only operate between DFW Airport and Bachman stations from approximately four hours before the game to four hours after the game, when service along the full route to Parker Road is resumed at 30 minute headways.

Potential Reconfigured Game Day Service with D2. A second alignment through downtown opens up greater opportunities to provide game day service using existing revenue track. This replaces the need to use the yard lead track and potentially eliminates the Green Line Circulator. The following concept is an example of how Game Day service may operate, incorporating D2.

- **Green Line.** Green Line trains operate every 15 minutes between North Carrollton/Frankford Station and Lawndale or Buckner from three to four hours before kickoff, serving all usual Green Line stations. (Northbound and Southbound may choose to serve either Fair Park or MLK, Jr. Stations if there are limitations to stopping at both.)

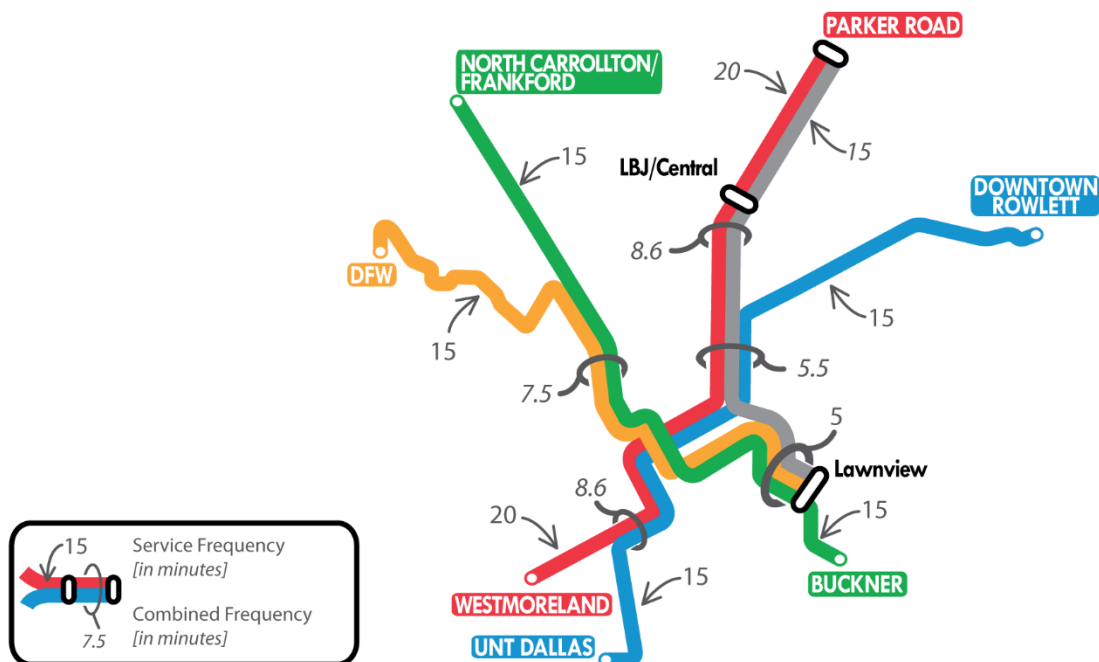
- **Orange Line.** On game day, all Orange Line trains are reconfigured to operate every 15 minutes between DFW and Lawndale. This in effect leads to 7.5-minute combined Green and Orange Line service south of Bachman.
- **Red Line.** Red Line trains following the typical route between Parker Road and Westmoreland Station operate on a regular Saturday schedule with 20 minute service transitioning to 30 minutes in the evenings. Red Line passengers heading from either direction can transfer to the Green or Orange Line at West End/Metro Center to continue to the fairgrounds.

Direct Red Line service to the stadium is added, with southbound trains operating every 15 minutes from Parker Road Station via Southeast Junction and Deep Ellum Junction to Fair Park Station or MLK, Jr. Station starting as early as four hours before kickoff. (The southern terminus would be located where available, and may extend south to Lawnview.)

- **Blue Line.** Blue Line trains operate every 15 minutes between Downtown Rowlett Station and UNT Dallas from three to four hours before kickoff. Southbound Blue Line riders can transfer at SMU/Mockingbird to catch Red Line service heading directly to the stadium. Northbound Blue Line riders can transfer to the Green or Orange Line at West End/Metro Center.

Figure 8 illustrates the before- and after-game concept incorporating D2.

Figure 8. DART Potential Game Day Operating Concept with D2



This example leads to the following combined service levels:

- Bachman to Deep Ellum Junction: Green and Orange = 8 trains/hour (7.5 minute average headway)
- Deep Ellum Junction to Fairgrounds: Green, Orange and Red special = 12 trains/hour (5 minute average headway)
- SMU/Mockingbird to Southeast Junction: Red regular, Red special, Blue = 11 trains/hour (5.5 minute average headway)
- Southeast Junction to 8th/Corinth: Red regular, Blue = 7 trains/hour (8.6 minute average headway)

A summary of the current plan versus the example D2 plan is provided in **Table 6**. As can be seen, the example leads to somewhat less frequent service on the Green Line north of Bachman and less frequent Red Line stadium service. This is offset by more frequent service between Bachman and the fairgrounds, improved frequency and direct service from DFW rather than truncating the Orange Line, and improved travel times to the stadium by eliminating the alternate routing using the yard lead.

Table 6. Potential Red River Showdown Operating Plans with D2

LRT Line	Current Game Day Plan	Potential D2 Game Day Plan
Red Line	20 minute regular; 10 minute stadium with skipped CBD stations	20 minute regular; 15 minute stadium (bypasses downtown routing)
Blue Line	15 minute regular	15 minute regular
Green Line	10 minute with skipped CBD stations southbound; separate 10 minute CBD circulator	15 minute regular (no need for separate circulator)
Orange Line	20 minute DFW to Bachman	15 minute DFW to Lawnview (together with Green Line, provides 7.5-minute trunk service Bachman-Lawnview)

The key segment that determines the amount of service to the fairgrounds is from Deep Ellum Junction to the fairgrounds. Proposed headways among various lines can be rebalanced based on the maximum allowable level of service. It is understood that there will be delays associated with waiting for train slots at Southeast Junction and Deep Ellum Junction. Regardless, bypassing the downtown routing is still likely to save time even with the delays at the junctions.

Incident Management

Whether due to DART service interruptions/disabled vehicles in downtown Dallas or emergency actions interfering with DART right-of-way (e.g., fire hoses blocking Bryan-Pacific transit mall), the D2 alignment provides an alternate path through downtown Dallas and allows DART to reroute LRT service from one downtown corridor to the other.

If there is a service interruption/disabled vehicle in the D2 segment, then Green and Yellow Lines would revert back to the transit mall per existing operations.

If there is a service interruption/disabled vehicle in the Bryan-Pacific transit mall segment, then southbound Red and Blue Lines can bypass the Southeast Junction and enter D2 at the Deep Ellum

Junction, proceed to Victory Station, then use the pocket track to switch southward continuing past Northwest Junction onto Union Station and continuing southward. Northbound Red and Blue Lines would proceed northward from Union Station to Victory Station, then use the pocket track to switch southward and onto the D2 alignment, turning northward at Deep Ellum Junction back toward the Southeast Junction where they pick up their usual alignment. **Figure 9** reflects the rerouting of both the Red and Blue Lines onto D2.

Figure 9. DART Incident Management Plan Rerouting Off Transit Mall – Both Red and Blue Lines

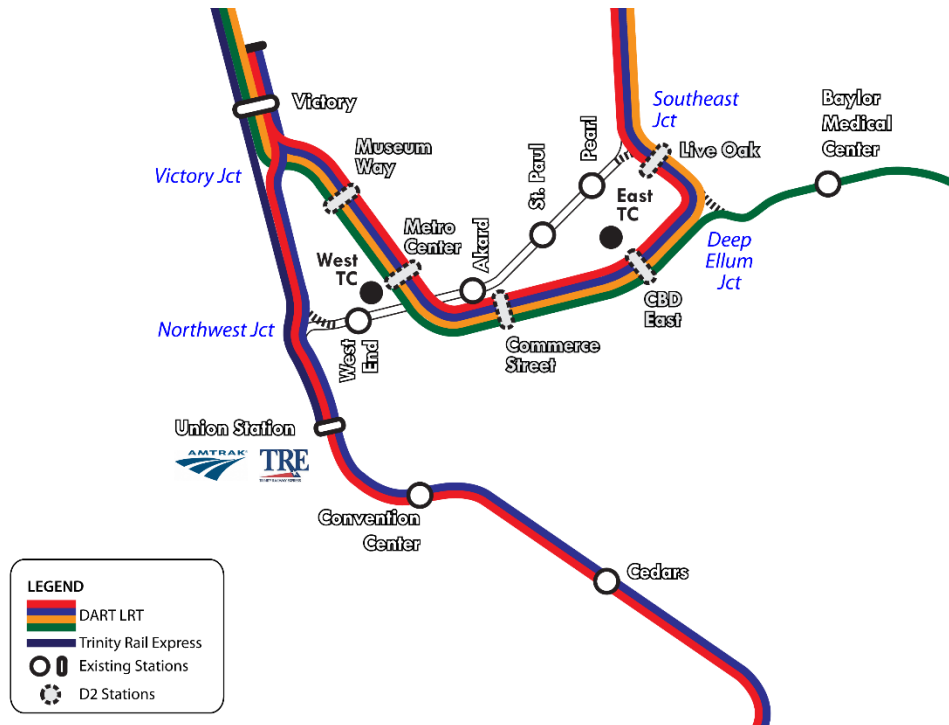


Figure 10 is a modified plan that focuses on rerouting just the Red Line onto D2 while truncating the Blue Line on either end of downtown. This concept puts less stress on D2 operations. This alternate plan may lead to less impacts during a peak period when demands on D2 would be greatest.

Figure 10. DART Incident Management Plan Rerouting Off Transit Mall – Red Line Only

