

2016 Annual Report on Roadway Traffic Congestion in the Denver Region

December 2017

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1. Introduction

The Denver Regional Council of Governments has prepared annual reports on traffic congestion since 2006 and tracked average daily vehicle miles traveled (VMT) since 2000. Some of the trends that have emerged are:

- Traffic congestion is worse within the region, due primarily to population growth.
- Transportation options such as walking, bicycling and transit are more widely available to help people avoid driving in congestion.
- The region's residents and visitors have greater access to real-time information on traffic conditions, major incidents and travel options to avoid driving alone.

2. How much do people in the region travel on a typical day?

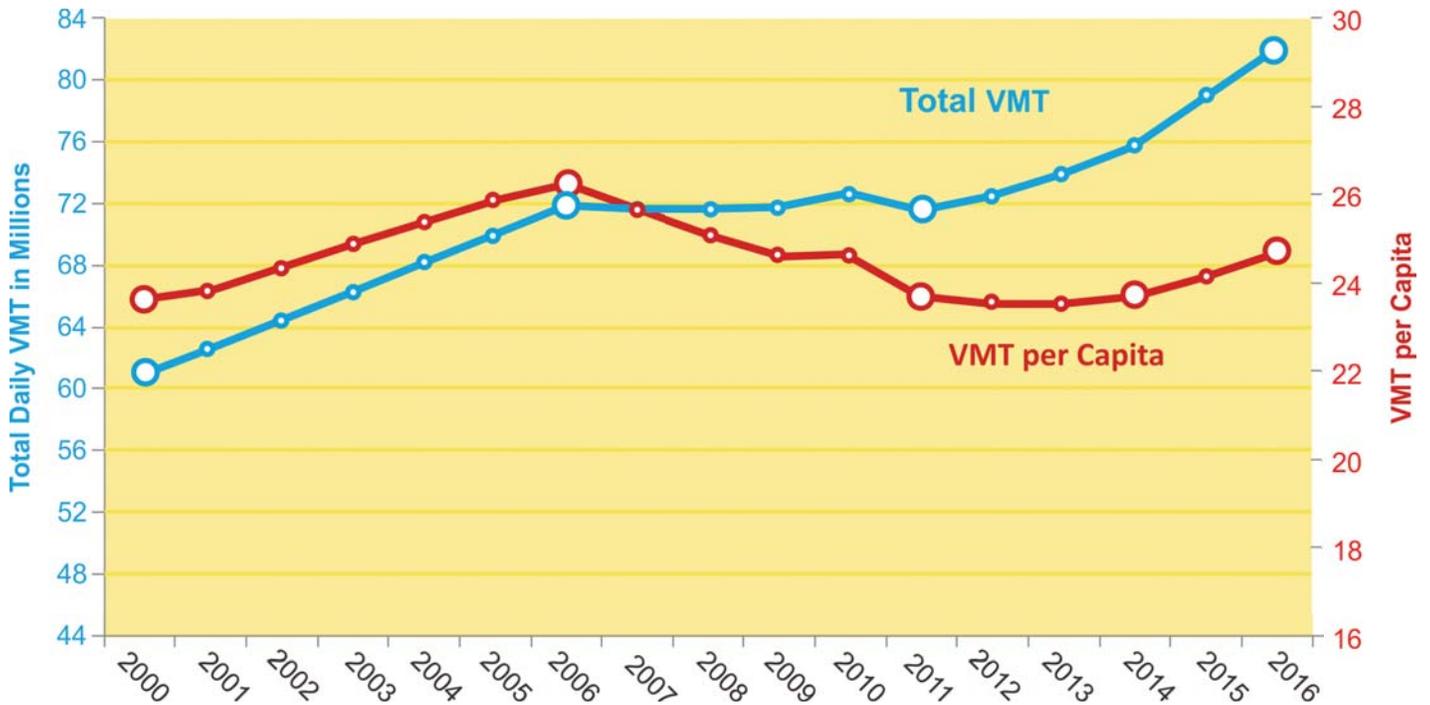
Every year, DRCOG staff estimates the annual change in the total VMT per day per day on all Denver region roadways. Staff consolidates data from Federal Highway Administration annual reports, automated traffic recorders, the Colorado Department of Transportation's Highway Performance Monitoring System, traffic counts at locations with results for both the current and past analysis years, and other sources such as toll highway transactions.

Figure 1 depicts average weekday VMT by all types of motor vehicles for the Denver region during the past 16 years. The solid blue line shows total daily VMT rising steadily through 2006, flattening out through 2011, but increasing during the past five years, with a large uptick over the past two years.

In 2016, the Denver region experienced another year of high VMT growth, with an estimated increase of 3.5 percent, from 79.2 to 81.9 million VMT per day. Factoring in vehicle passengers, people traveled more than 110 million person miles per day. The 2016 increase represents the second-highest year of VMT growth since DRCOG began tracking the data in 2000. By comparison, the average annual growth from 2000 to 2014 was 1.6 percent per year.



Figure 1
Average Daily VMT in the Denver Region (2000 - 2016)



Though VMT grew by 3.5 percent, the total population in the region increased by only 2 percent in 2016. Thus per capita VMT rose to 25.5 miles per day, the second straight year of significant growth. There are several reasons for this growth, including:

- a flourishing economy
- increased population
- increase in commercial activity, service trips and package deliveries
- increase of ride-hailing vehicle travel
- lower and stable fuel prices (longest period since the mid-1980s), and
- increase in fuel economy and high mpg vehicles.

Reduction in per capita VMT is one of DRCOG’s Metro Vision goals and is closely related to federal mandates to reduce harmful pollutant emissions. VMT is also a direct contributor to increased traffic congestion. DRCOG and its partners should continue to support helping people avoid and adapt to congestion by:

- providing and encouraging viable **mobility choices** (transit, walk, bicycle)
- creating opportunities for **shorter trips** (such as via mixed land use patterns)
- facilitating **carpool and vanpool** options (pre-organized and real-time)
- encouraging **teleworking** and flexible work hours
- supporting and using the **transportation demand management services** of DRCOG (waytogo.org) and its partner transportation management associations, and
 - ◆ improving **real-time traveler information** regarding major incidents on roadways or rail transit, and regarding optional travel modes.

3. Measuring Traffic Congestion on DRCOG's Regional Roadway System

DRCOG estimates current and future traffic congestion on its Regional Roadway System, made up of freeways and major streets (principal arterials).

What causes day-to-day traffic congestion?

- **number** of vehicles on a roadway
- **types** of vehicles
 - ◆ heavy trucks
 - ◆ recreation vehicles
- **movements** of vehicles
 - ◆ weaving
 - ◆ on-ramp merge points
 - ◆ vehicles changing speeds (hills, distractions)

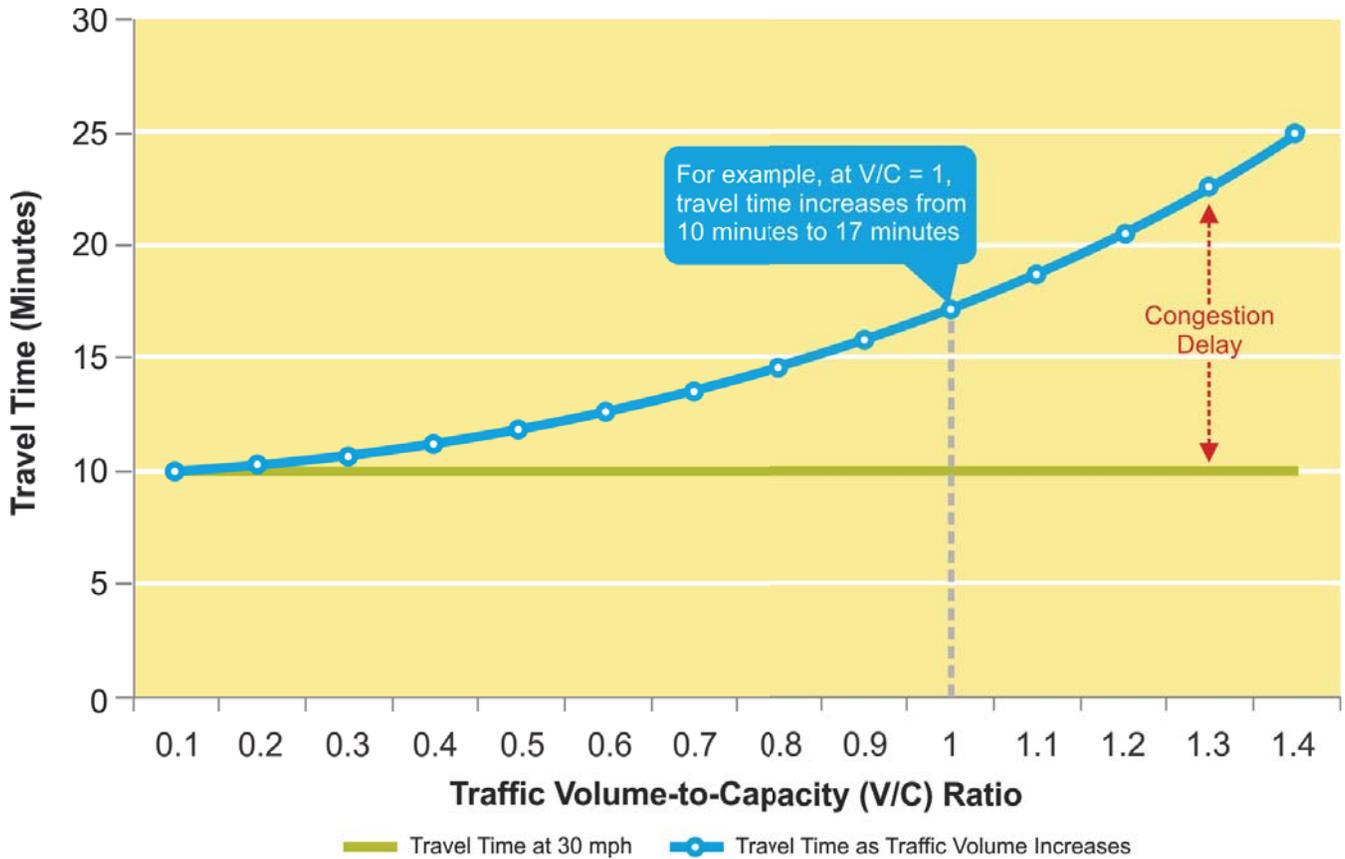
Without an occurrence such as severe weather or a crash, traffic congestion is related primarily to the number of vehicles on a roadway compared to the physical space on the roadway – the traffic **volume**. Vehicles using the roadway system carry people, goods and service equipment.

The roadway's **capacity** consists of its physical characteristics such as lanes, lane width, curb cuts and traffic signals. DRCOG estimates the volume and capacity for every segment in the Regional Roadway System for every hour of an average day. As the hourly **volume (V)** of a roadway segment approaches the **capacity (C)**, expressed in a ratio as **V/C**, there is an increase in average travel time. A delay formula is used to estimate the speed and travel time of a roadway given its volume to capacity ratio, as in **Figure 2**. The primary reason busy streets across the region experience congestion every day is too much traffic volume compared to the capacity of the roadway.



Figure 2
Time to Travel Five Miles

Based on Volume-to-Capacity (V/C) Ratio (Example Street with 30 mph Free Flow Speed)



DRCOG staff continues to use the delay formula methodology for principal arterials. For 2016, however, DRCOG implemented the use of INRIX speed data in its congestion calculations, specifically for freeway segments. INRIX gathers billions of data points from GPS navigation systems, smartphones and delivery vehicles. Minute-by-minute speed observations are recorded on roadways 24 hours a day, 365 days a year.

INRIX data is provided to DRCOG at no cost by the Colorado Department of Transportation and will also be used to provide the Federal Highway Administration with required performance measures. DRCOG will continue to estimate volumes on every freeway segment on the system, but INRIX speed data, averaged by hour for every weekday of the year, is now the primary source of data used to estimate congestion on freeway segments. To estimate future congestion, DRCOG staff uses changes in volume and speed from its Focus travel model between 2016 and 2040.

To score the level of congestion on the region’s roadways, five distinct measures are calculated reflecting the duration, severity, magnitude, variation and reliability of roadway congestion. The measures reflect the various ways the public experiences congestion. Roadways with severe congestion, defined by a score of 11 or more (out of 20), are highlighted in **Figure 4** (pages 8-9) for 2016 and 2040.

4. Annual Congestion Performance Measures

DRCOG maintains a database to monitor traffic congestion and performance measures for the 2,400-mile Regional Roadway System (Figure 4). The congestion database identifies key attributes associated with roadway capacity and traffic volume for each segment of the system.

Table 1 displays several measures for the Regional Roadway System, with 2040 estimates based on forecasts from the DRCOG regional travel demand model. In preparing the model, staff make the key assumption that more than 1.1 million additional people will live in the Denver region by 2040, a 34 percent increase from 2016. The model estimates significant growth among transit, bicycle and walking trips in 2040, with each of these modes of travel claiming a higher share of total trips. Travel options such as transit, bicycling and walking encourage people to avoid or adapt to traffic congestion. However, the increase in travel by such non-single-occupant vehicle options will not likely be enough to offset the growth in motor vehicle travel and associated traffic congestion.

The **Regional Roadway System** represents the DRCOG-designated freeways, tollways, major regional arterials and principal arterials. The system includes the most heavily traveled and important connecting corridors of the region. This system handles almost 80 percent of the total traffic in the region.

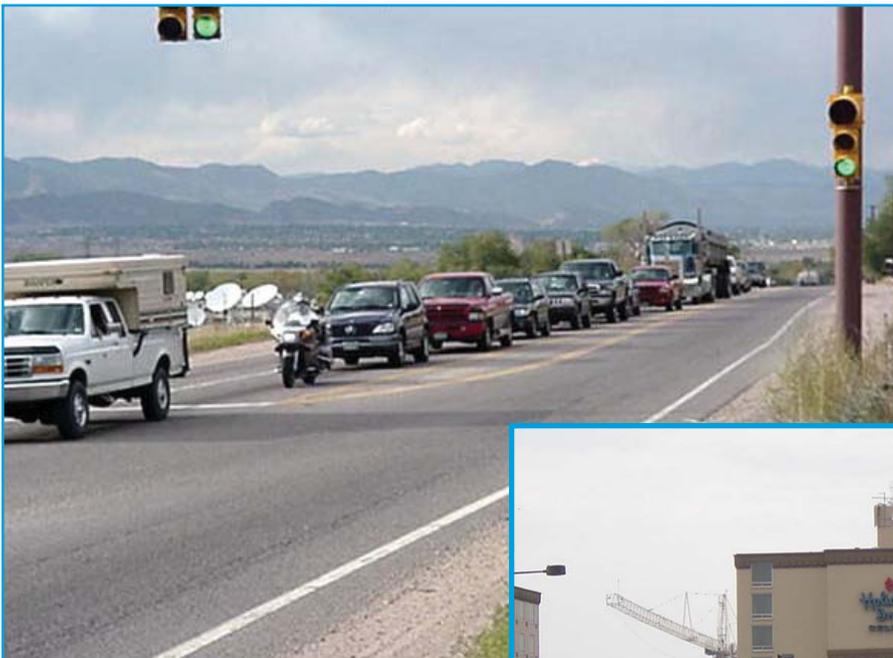


Table 1
Current and Future Congestion on Denver Regional Freeways and Arterials
(Does not include minor local streets)

	2016		2040 (RTP)		Percent Change Between 2016 and 2040
	Average Weekday	Annual Total Estimate (1)	Average Weekday	Annual Total Estimate (1)	
Vehicle Measures:					
Vehicle Miles of Travel	62,550,000	21,141,937,000	85,697,000	28,965,577,000	37%
Vehicle Hours of Travel	1,405,000	475,050,000	1,995,000	674,232,000	42%
Vehicle Hours of Delay	218,000	73,822,000	399,000	134,782,000	83%
Travel Delay Per Driven Registered Vehicle (2)	7 minutes	40 hours	9 minutes	53 hours	32%
Travel Delay Per Household	10 minutes	57 hours	13 minutes	74 hours	29%
Person Measures:					
Person Miles of Travel	85,260,000	28,817,831,000	116,578,000	39,403,397,000	37%
Person Hours of Travel	1,948,000	658,399,000	2,727,000	921,683,000	40%
Person Hours of Delay	301,000	101,900,000	550,000	185,798,000	82%
Travel Delay Per Resident	5m 30s	34 hours	7m 30s	42 hours	36%
Other:					
Percent of Travel Time in Delayed Conditions	15%	n.a.	20%	n.a.	30%
Travel Time Variation (Peak vs. Off-Peak)	1.21	n.a.	1.38	n.a.	14%
Lane Miles of Roads Congested for Three or More Hours	1,373	n.a.	2,820	n.a.	105%
(Percent of Total Lane Miles)	20%	n.a.	38%	n.a.	n.a.
Economic Travel Delay Costs:					
Commercial Vehicles (3)	\$1,500,000	\$504,700,000	\$2,200,000	\$742,300,000	47%
Passenger Vehicle Persons (3)	\$3,000,000	\$1,025,100,000	\$4,400,000	\$1,471,100,000	43%
Total Cost of Delay	\$4,500,000	\$1,529,800,000	\$6,500,000	\$2,213,400,000	45%
Transit and Other Regionwide Measures:					
Total RTD Transit Boardings	332,000	N/A	580,000	N/A	75%
Rail Transit Boardings	91,200	N/A	200,000	N/A	119%
RTD Park-n Ride Parking Space Utilization (Out of 32,011 Spaces)	62%	N/A	N/A	N/A	n.a.
Modeled Bicycle and Pedestrian Trips	1,409,700	N/A	2,081,800	N/A	48%
Traffic Crashes (2014)	207	69,831	N/A	N/A	N/A

Sources: DRCOG Congestion Mitigation Program Database, Regional Transportation District Ridership Statistics, 2040 Regional Transportation Plan

Technical Notes:

(1) Annual Total Estimate is Average Weekday total multiplied by 338

(2) Assumption of 1,798,912 registered vehicles driven per day in 2015 and 2,415,682 in 2040

(3) Cost calculations incorporate \$12 per hour per adult in car, \$48.30 per hour per light commercial vehicle operator, and \$71 per hour for heavy commercial truck.

Figure 3 Key Congested Locations in 2016 and 2040

Segments with a Mobility Grade of D or F

Congested Corridors: Mobility Grade
 Grades of "A" through "F" were assigned based on a combination of scores for the following measures:

Duration: How long does the congestion last? (number of congested hours per day)

Severity: How much of driving time is in delayed conditions? (percent of travel time in delay in peak hour)

Magnitude: What is the total amount of delay for all travelers? (total delay for all vehicles per mile)

Variation: What is the variation in travel time between off-peak and rush hour?

Reliability: How often do crashes or incidents occur?

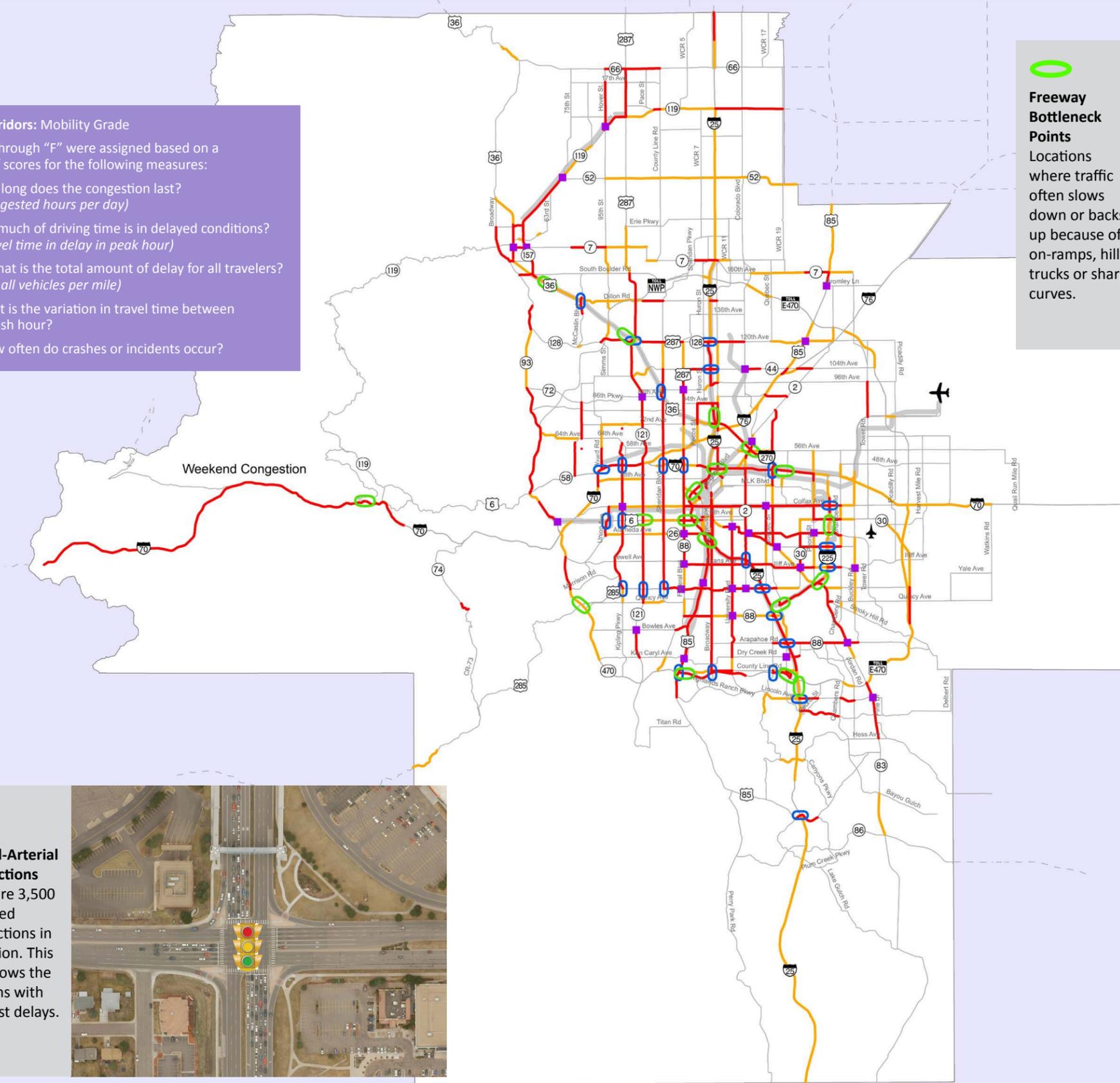
Freeway Bottleneck Points
 Locations where traffic often slows down or backs up because of on-ramps, hills, trucks or sharp curves.



Arterial-Freeway Ramp Intersections
 Extensive congestion occurs where arterial streets intersect with freeway ramps in a series of signalized intersections.



Arterial-Arterial Intersections
 There are 3,500 signalized intersections in the region. This map shows the locations with the most delays.



Congested Corridors in 2016 and 2040
 (Congestion Mobility Grade of D or F)

- Corridor Congested in 2016
- Additional Corridors Congested by 2040
- Rapid Transit

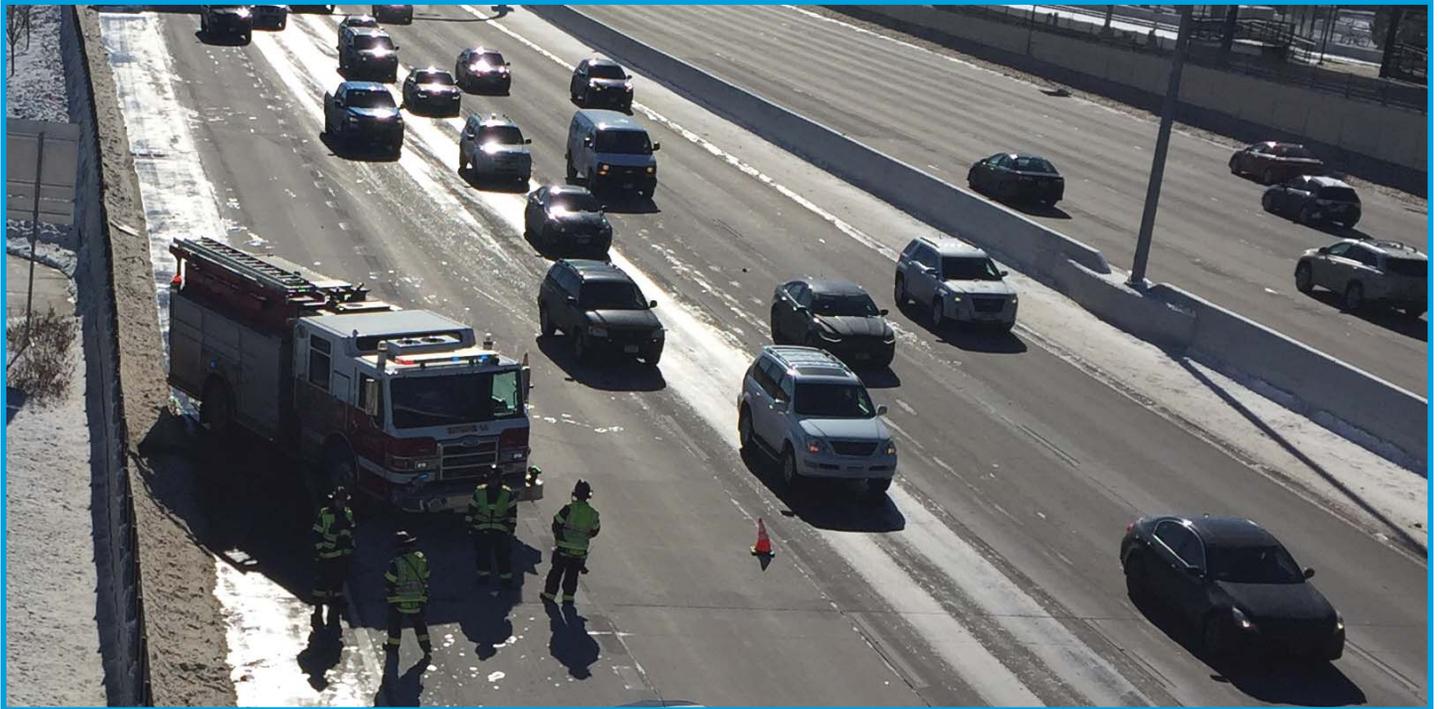
Congested Points In 2016

- Arterial / Arterial Intersections
- Arterial / Freeway Ramp Intersections
- Freeway Bottleneck Points

0 5 10
Miles

5. Crashes and Congestion

Every year in the DRCOG region, there are about 69,800 crashes, or approximately 200 per day. When a crash occurs, the primary concerns are injuries or death. In addition to injury and fatality, crashes create an estimated 50 percent of all traffic delay. INRIX data provides several tools to examine the effects of crashes and other incidents on the roadway system.



Planning time index:

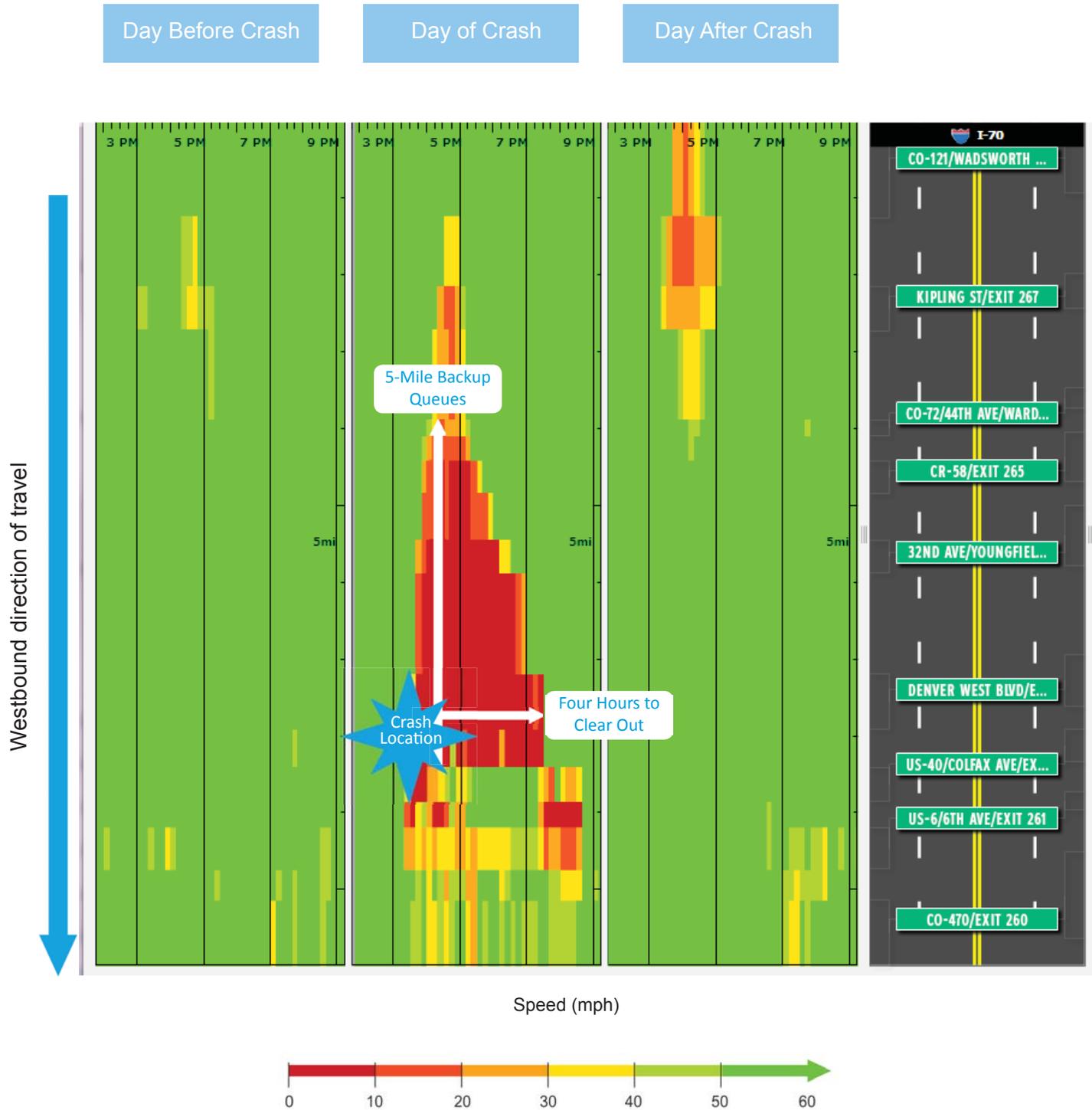
Although most recurring congestion happens at predictable times, crashes cause travel to be even more unreliable. INRIX measures the amount and severity of unexpected delay for all freeway segments and provides a value called **planning time index**. DRCOG now uses planning time index in lieu of crashes per mile to measure travel reliability. As an example, on a three-mile segment of Interstate 70 between Interstate 25 and Colorado Boulevard:

- 251 crashes occurred in 2014.
- Colorado Department of Transportation Motorist Assist responded to approximately 2,700 breakdowns, abandoned vehicles and other pullovers on average, in recent years.
- 1.7 is the routine peak hour travel time variation.
 - ◆ Travel in peak hour normally takes 70 percent longer than the off-peak time of 3 minutes.
- 3.6 is the peak hour planning time index measure
 - ◆ To play it safe, people should plan for travel time nearly four times longer than off-peak.

Extent of delay caused by a crash:

INRIX data is also used to examine the effects of specific roadway incidents. **Figure 4**, a direct output from INRIX, depicts average roadway speed on three separate days on I-70 westbound from the vicinity of Wadsworth Boulevard to U.S. Route 40 (Exit 259). The green center column (labeled “Day of Crash”) shows the extent to which traffic was affected on the day of a serious crash, decreasing the average speed to less than 20 mph for more than four hours and creating a backup longer than five miles.

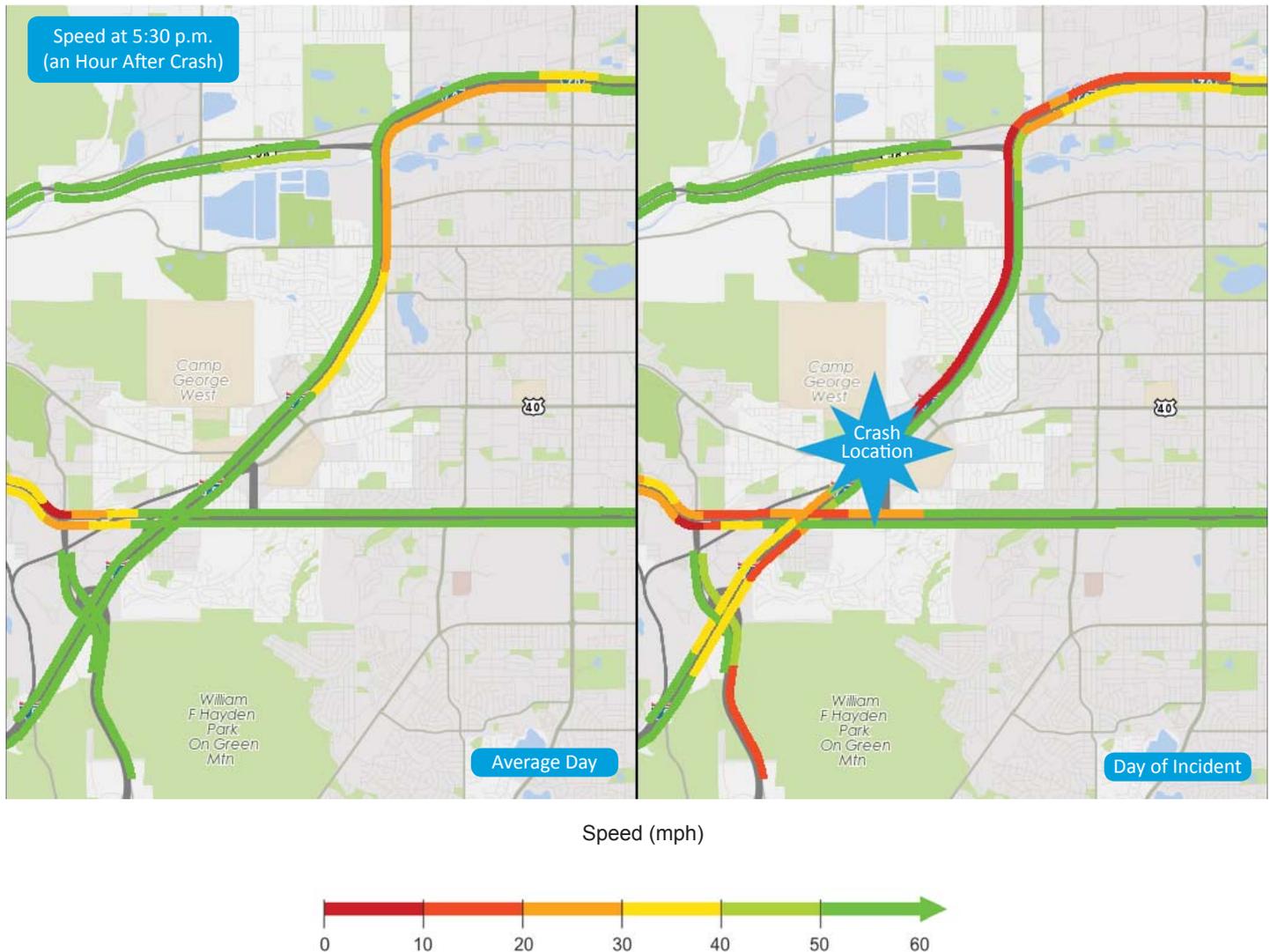
Figure 4
Extent of delay caused by a crash



Crash effects on nearby roadways:

Figure 5, a direct output from IRNIX, shows how the same incident depicted in **Figure 4** affected the surrounding area. On the left, there is an average day with little roadway congestion. The map on the right shows how the crash not only affected I-70, but nearby freeways as well.

Figure 5
Crash effects on nearby roadways



Professionals involved with incident response can use the INRIX database to visualize conditions and evaluate the effects of any incident since 2012. Understanding how crashes affect the roadway network at, and in the vicinity of, the incident can inform incident management plans, optimize use of traveler alerts, identify possible deficiencies in roadway design and mitigate how future crashes affect other travelers.

6. Congestion Mitigation Program Transportation Projects Recently Completed or Underway

Several congestion relief projects have been completed by local governments, the Colorado Department of Transportation and the Regional Transportation District in 2016 or are underway, as shown in [Table 2](#). Transit and bicycle/pedestrian projects provide travel options for avoiding congestion.

Table 2
Example Transportation Projects Addressing Congestion and Mobility

Interchange/Roadway Projects:	Status
I-25 from 120th Avenue to State Hwy 7: Add managed lanes	Completed
U.S. Route 6 at 19th Street (Golden): Grade-separated intersection	Completed
Arapahoe Road at I-25: Interchange reconfiguration	Underway
E-470 from Parker Road to Quincy Avenue: Widening	Underway
C-470 from Kipling Parkway to I-25: Add managed lanes	Underway
Rapid Transit Projects:	
	Status
R Line I-225 Corridor (Nine Mile Station to Peoria Station) light rail	Completed
G Line/Gold Line (Ward Road Station to Denver Union Station) commuter rail	Underway
North Metro Rail Line (Denver Union Station to Eastlake at 124th Station) commuter rail	Underway
Southeast Rail (Lincoln Station to RidgeGate Station) light rail	Underway
Bicycle/Pedestrian Projects:	
	Status
Village Center and Goldsmith Gulch Trail Extension: Fair Drive to Yosemite Street	Completed
State Hwy 119: Airport Road Bike/Pedestrian Underpass	Completed
Nederland Sidewalks Phase 2	Completed
Peoria-Smith Commuter Rail Station Bike/Pedestrian Access Improvements	Completed
Nine Mile Station: Bike/Pedestrian Access Improvements	Completed
Colfax Avenue Bike/Pedestrian Improvements: Fitzsimons Parkway to Peoria Street	Completed
Metro Center Station Area Bike/Pedestrian Connector Facility	Completed
Clay Community Trail: Clear Creek Regional Trail to 60th Avenue	Completed
23rd Avenue Bike/Pedestrian Path at Fitzsimons Station	Completed

Visit DRCOG's partner agency websites for more information:

Colorado Department of Transportation
coloradodot.info

Regional Transportation District
rtd-denver.com

Traveler Information
cotrip.org

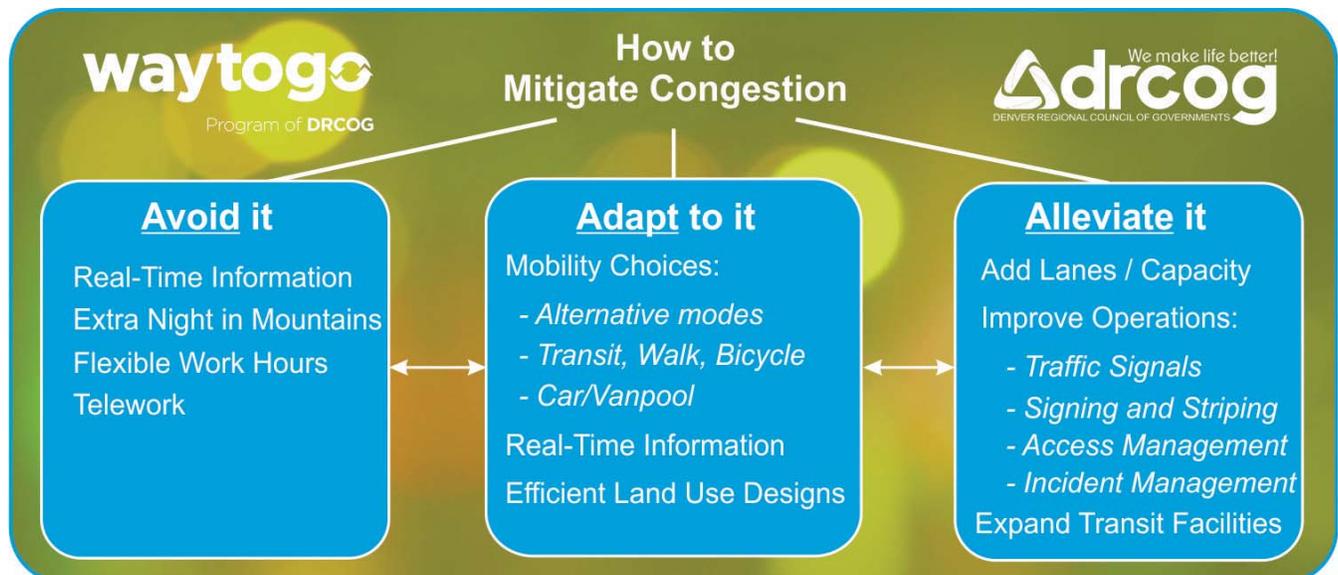
For ways to avoid or adapt to congestion via mobility options please visit:

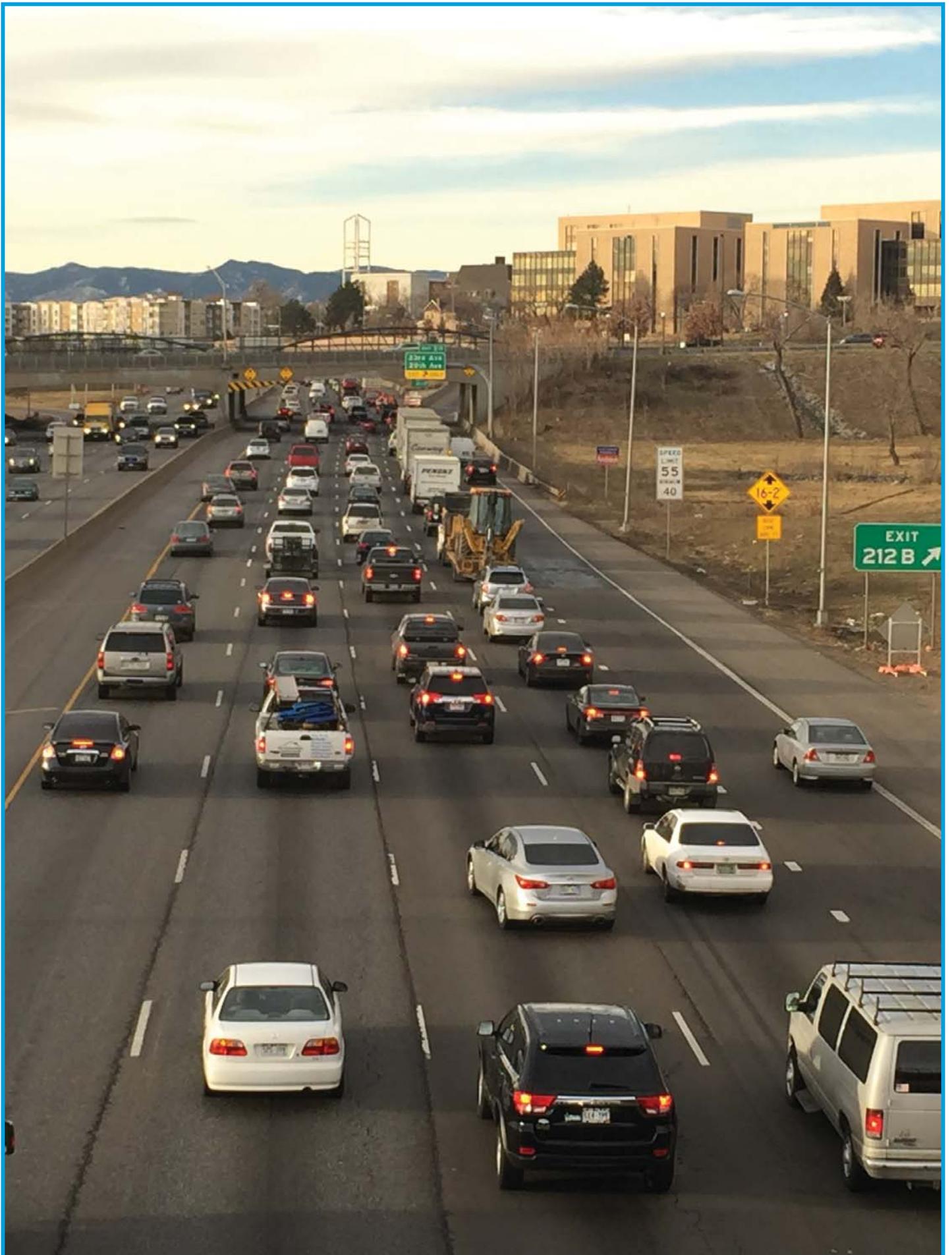
Way to Go
waytogo.org

Preparation of this report has been financed in part through grants from the U.S. Department of Transportation, Federal Highway Administration and Federal Transit Administration. This report and others are available at the DRCOG congestion mitigation webpage at drcog.org/congestion.

Contact Robert Spotts, senior transportation/air quality planner, at rspotts@drcog.org for additional information regarding DRCOG's congestion mitigation program.

The Three A's of Congestion Mitigation







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