Draft
Alternatives Analysis
Durango Road Diets

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Prepared for
City of Durango, CO

September 2016
Durango Road Diets Study
Technical Memorandum 2:
Alternatives Analysis

Prepared for:

CITY of DURANGO

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INTRODUCTION

The City of Durango Road Diets Study provides infrastructure investment recommendations for converting the following two roadways from four lane roadways to three lane roadways with a two-way left turn lane:

- College Drive between Main Avenue and 8th Avenue
- 8th Avenue between College Drive and Santa Rita Drive

This technical memorandum provides a multi-modal summary of the proposed alternatives, as recommended by the City under Existing Plus Project Conditions and 2040 Plus Project Conditions. This technical memorandum is organized into chapters according to the proposed alternatives. Each chapter includes data and analysis of the proposed conditions, performance assessments, and relevant key findings. This memorandum shall be used in concurrence with Technical Memorandum 1: Existing Conditions for comparative purposes.

When converting from a four lane cross-section to a three lane cross-section multiple options exist for how College Drive and 8th Avenue could be configured. Fehr & Peers reviewed candidate options with City staff. Buffered bike lanes would increase the distance between bicyclists and vehicles in adjacent travel lanes. The center turn lane could either be a continuous two-way left-turn lane or could feature a landscaped median in portions. Each of these options is shown below; with the exception of the bicyclist stress analysis the results of either Plus Project option would be the same for traffic operations.
EXISTING

PLUS PROJECT (TWO-WAY LEFT TURN LANE OPTION)

PLUS PROJECT (MEDIAN OPTION)
KEY FINDINGS

This analysis reports key findings in the individual chapters of this report. The most relevant findings are summarized below:

- Under Existing Conditions, all 14 study intersections operate acceptably.
- Under Existing Plus Project Conditions, all 14 study intersections operate acceptably.
- Under 2040 Conditions, 13 intersections operate acceptably and one operates unacceptably.
- Under 2040 Plus Project Conditions, 11 intersections operate acceptably and three intersections operate unacceptably; however, all three of these intersections are side street stop controlled with a high delay at only one movement.
- At intersection 9 (8th Avenue / College Drive), a single lane roundabout would operate unacceptably under Existing Plus Project Conditions or 2040 Plus Project Conditions.
- At intersection 14 (8th Avenue / Santa Rita Drive), a single lane roundabout would operate acceptably under Existing Plus Project Conditions and 2040 Plus Project Conditions.
- At intersection 2 (Main Avenue / College Drive), the intersection would operate acceptably and with less vehicle delay if the signal timing did not include a pedestrian scramble (“Barnes Dance”) under Existing Plus Project Conditions and 2040 Plus Project Conditions. The average vehicle delay would drop by 11.8 seconds under Existing Plus Project Conditions and would drop by 18.3 seconds under 2040 Plus Project Conditions.
- 9 of the 37 traffic collisions, or 24 percent of the total traffic collisions during the study period from 2011-2015 within the concentrated study area, have the potential to be prevented with the implementation of a road diet within the study area on College Drive and 8th Avenue.
BACKGROUND

The transportation operations analysis addresses unsignalized and signalized intersection operations using the procedures and methodologies contained in the Highway Capacity Manual 2010 (HCM, Transportation Research Board) for the weekday PM peak hour traffic operations. Study intersection operations were evaluated using level of service calculations as analyzed in SimTraffic microsimulation software.

LEVEL OF SERVICE CRITERIA

To measure and describe the operational status of the local roadway network and intersections, transportation engineers and planners commonly use a grading system called level of service (LOS) in accordance with the Transportation Research Board’s HCM 2010. LOS characterizes the operational conditions of an intersection’s traffic flow; ranging from LOS A (indicating free flow traffic conditions with little or no delay) to LOS F (representing over-saturated conditions where traffic flows exceeds the design capacity, resulting in long queues and delays). These grades represent the perspective of drivers and are an indication of the comfort and convenience associated with driving. The acceptable threshold within the City of Durango is LOS D or better according to the City of Durango’s Land Use and Development Code (Sec. 5-1-2-2, Adequacy of Streets). LOS E and F are considered unacceptable. The LOS is determined differently depending on the type of control at the intersection.

At signalized intersections, the operation analysis uses various intersection characteristics (such as traffic volumes, lane geometry, and signal phasing) to estimate the intersection’s volume-to-capacity (v/c) ratio. For signalized intersections the HCM defines the intersection LOS as the average delay per vehicle for the overall intersection, which includes all approaches. Signalized intersection LOS definitions are shown in Table 1.

At unsignalized intersections, the operation analysis uses various intersection characteristics (such as traffic volumes, lane geometry, and stop-controlled approaches) to estimate the intersection’s volume-to-capacity (v/c) ratio. For unsignalized intersections the HCM separates the intersections into two control types: side-street stop control (SSSC) and all way stop control (AWSC). Side-street stop control intersection LOS is defined as the average delay per vehicle for only the worst approach movement. For AWSC intersections, the LOS is defined as the average delay per vehicle for all movements. Unsignalized intersection LOS definitions are shown in Table 2.
### TABLE 1:
**SIGNALIZED INTERSECTION LEVEL OF SERVICE DEFINITIONS**

<table>
<thead>
<tr>
<th>Level of Service</th>
<th>Description</th>
<th>Average Control Delay Per Vehicle (Seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Operations with very low delay occurring with favorable progression and/or short cycle lengths.</td>
<td>&lt; 10.0</td>
</tr>
<tr>
<td>B</td>
<td>Operations with low delay occurring with good progression and/or short cycle lengths.</td>
<td>&gt;10 to 20</td>
</tr>
<tr>
<td>C</td>
<td>Operations with average delays resulting from fair progression and/or longer cycle lengths. Individual cycle failures begin to appear.</td>
<td>&gt;20 to 35</td>
</tr>
<tr>
<td>D</td>
<td>Operations with longer delays due to a combination of unfavorable progression, long cycle lengths, and high V/C ratios. Many vehicles stop and individual cycle failures are noticeable.</td>
<td>&gt;35 to 55</td>
</tr>
<tr>
<td>E</td>
<td>Operations with high delay values indicating poor progression, long cycle lengths, and high V/C ratios. Individual cycle failures are frequent occurrences.</td>
<td>&gt;55 to 80</td>
</tr>
<tr>
<td>F</td>
<td>Operations with delays unacceptable to most drivers occurring due to over-saturation, poor progression, or very long cycle lengths.</td>
<td>&gt; 80</td>
</tr>
</tbody>
</table>

### TABLE 2:
**UNSIGNALIZED INTERSECTION LEVEL OF SERVICE DEFINITIONS**

<table>
<thead>
<tr>
<th>Level of Service</th>
<th>Description</th>
<th>Average Control Delay Per Vehicle (Seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Little or no delay.</td>
<td>&lt;10</td>
</tr>
<tr>
<td>B</td>
<td>Short traffic delay.</td>
<td>&gt;10 to 15</td>
</tr>
<tr>
<td>C</td>
<td>Average traffic delays.</td>
<td>&gt;15 to 25</td>
</tr>
<tr>
<td>D</td>
<td>Long traffic delays.</td>
<td>&gt;25 to 35</td>
</tr>
<tr>
<td>E</td>
<td>Very long traffic delays.</td>
<td>&gt;35 to 50</td>
</tr>
<tr>
<td>F</td>
<td>Extreme traffic delays with intersection capacity exceeded.</td>
<td>&gt;50</td>
</tr>
</tbody>
</table>
EXISTING ROADWAY NETWORK

**College Drive** is a four lane arterial roadway within the study area. Its western terminus is just past US 550 and it continues east and north, where its eastern terminus is at Florida Road shortly past Fort Lewis College within the City of Durango. Within the study area, the speed limit on College Drive is 30 miles per hour (MPH) from 8th Avenue to 4th Ave and 25 MPH from 4th Ave to US 550. College Drive is knowns as East College Drive to the east of Main Avenue and as West College Drive to the west.

**8th Avenue** is a four lane arterial roadway within the study area. Its northern terminus is at Fort Lewis Drive on the Fort Lewis College campus. South of Santa Rita Drive, 8th Avenue becomes State Highway 3 and continues south. Within the study area, the speed limit on 8th Avenue is 35 MPH.

STUDY INTERSECTIONS

The 14 intersections included in the SimTraffic analysis are listed below:

1. US Highway 550 / West College Drive
2. Main Avenue / West College Drive
3. 2nd Avenue / East College Drive
4. 3rd Avenue / East College Drive
5. 4th Avenue / East College Drive
6. 5th Avenue / East College Drive
7. 6th Avenue / East College Drive
8. 7th Avenue / East College Drive
9. 8th Avenue / East College Drive
10. 8th Avenue / 5th Street
11. 8th Avenue / 4th Street
12. 8th Avenue / 3rd Street
13. 8th Avenue / 2nd Street
14. 8th Avenue / Santa Rita Drive
EXISTING AND EXISTING PLUS PROJECT

INTERSECTION OPERATIONS

The existing operations of the study intersections were evaluated for the highest one-hour volumes during the weekday PM peak period (4:30PM – 5:30PM).

The operations model included the existing roadways, intersection geometry, traffic control, and existing traffic. Analysis included assessing the intersection delay and LOS performance for each of the studied intersections. SimTraffic, a microsimulation tool that mimics real-world conditions, was used for the analysis of these two corridors. SimTraffic is relevant for corridor studies because it tracks each vehicle throughout the entire network and measures the full impact of queueing and vehicle blockage. For instance, if vehicles at a study intersection queue back to the previous intersection, such as on College Drive between Main Avenue and East 2nd Avenue, SimTraffic can identify the full queue length, while a macrosimulation tool such as Synchro would not account for queues that extend past another intersection.

The Existing Conditions analysis provides a baseline for the Plus Project analyses. Figure 1 and Figure 2 present PM peak hour turning movement volumes, lane configurations, and traffic control devices at the 14 study intersections under Existing Conditions (Figure 1 presents intersections 1-8 while Figure 2 presents intersections 9-14). Figure 3 and Figure 4 present the same intersections under the Existing Plus Project PM peak hour conditions.

In this study, the Project is defined as the following:

- A lane reduction on College Drive from a four lane road with two lanes in each direction to a three lane road with one lane in each direction and a two-way left turn lane.
- A lane reduction on 8th Avenue from a four lane road with two lanes in each direction to a three lane road with one lane in each direction and a two-way left turn lane
- Trips generated by the proposed Downtown Durango Hotel (approximately 185 rooms) located at 2nd Avenue / 5th Street

Table 3 provides the LOS and intersection delay results of the capacity analysis for the PM peak hour. Appendix A provides the detailed LOS calculations for the Existing Conditions and Existing Plus Project Conditions.
Figure 1
Existing Peak Hour Traffic Volumes and Lane Configurations - Durango Road Diets
Figure 2

Existing Peak Hour Traffic Volumes and Lane Configurations - Durango Road Diets
### Existing Plus Project Peak Hour Traffic Volumes and Lane Configurations - Durango Road Diets

<table>
<thead>
<tr>
<th>Location</th>
<th>Volume Data</th>
<th>Lane Configurations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Hwy 550/College Dr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Main Ave/College Dr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. 2nd Ave/College Dr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. 3rd Ave/College Dr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. 4th Ave/College Dr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. 5th Ave/College Dr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. 6th Ave/College Dr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. 7th Ave/College Dr</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Existing Plus Project Peak Hour Traffic Volumes and Lane Configurations - Durango Road Diets

<table>
<thead>
<tr>
<th>Location</th>
<th>Traffic Volumes</th>
<th>Lane Configurations</th>
</tr>
</thead>
<tbody>
<tr>
<td>9. 8th Ave/College Dr</td>
<td>(85) (201)</td>
<td>(7) (142) (145)</td>
</tr>
<tr>
<td></td>
<td>(204) (310)</td>
<td>(44) (125) (274)</td>
</tr>
<tr>
<td>10. 8th Ave/5th St</td>
<td>(85) (128)</td>
<td>(6) (18) (2)</td>
</tr>
<tr>
<td></td>
<td>(37) (750)</td>
<td>(3) (18) (7)</td>
</tr>
<tr>
<td>11. 8th Ave/4th St</td>
<td>(85) (938)</td>
<td>(6) (15) (2)</td>
</tr>
<tr>
<td></td>
<td>(37) (750)</td>
<td>(3) (18) (7)</td>
</tr>
<tr>
<td>12. 8th Ave/3rd St</td>
<td>(85) (938)</td>
<td>(6) (15) (2)</td>
</tr>
<tr>
<td></td>
<td>(37) (750)</td>
<td>(3) (18) (7)</td>
</tr>
<tr>
<td>13. 8th Ave/2nd St</td>
<td>(146) (684)</td>
<td>(1) (31) (1)</td>
</tr>
<tr>
<td></td>
<td>(147) (354)</td>
<td>(330) (39) (1)</td>
</tr>
<tr>
<td>14. 8th Ave/Santa Rita Dr</td>
<td>(146) (684)</td>
<td>(1) (31) (1)</td>
</tr>
<tr>
<td></td>
<td>(147) (354)</td>
<td>(330) (39) (1)</td>
</tr>
</tbody>
</table>

Figure 4
### TABLE 3: PM PEAK HOUR EXISTING AND EXISTING PLUS PROJECT INTERSECTION LEVEL OF SERVICE RESULTS

<table>
<thead>
<tr>
<th>ID</th>
<th>Intersection</th>
<th>Control</th>
<th>Approach</th>
<th>Existing PM Peak Hour</th>
<th>Existing + Project PM Peak Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Delay</td>
<td>LOS</td>
</tr>
<tr>
<td>1</td>
<td>US 550 / College Dr</td>
<td>Signal</td>
<td>Overall</td>
<td>22.8</td>
<td>C</td>
</tr>
<tr>
<td>2</td>
<td>Main Ave / College Dr</td>
<td>Signal</td>
<td>Overall</td>
<td>31.4</td>
<td>C</td>
</tr>
<tr>
<td>3</td>
<td>2nd Ave / College Dr</td>
<td>SSSC² / Signal NB / Overall</td>
<td>11.7</td>
<td>B</td>
<td>9.3</td>
</tr>
<tr>
<td>4</td>
<td>3rd Ave / College Dr</td>
<td>Signal</td>
<td>Overall</td>
<td>15.7</td>
<td>B</td>
</tr>
<tr>
<td>5</td>
<td>4th Ave / College Dr</td>
<td>SSSC</td>
<td>NB / SB</td>
<td>13.2</td>
<td>B</td>
</tr>
<tr>
<td>6</td>
<td>5th Ave / College Dr</td>
<td>SSSC</td>
<td>NB</td>
<td>10.2</td>
<td>B</td>
</tr>
<tr>
<td>7</td>
<td>6th Ave / College Dr</td>
<td>Signal</td>
<td>Overall</td>
<td>5</td>
<td>A</td>
</tr>
<tr>
<td>8</td>
<td>7th Ave / College Dr</td>
<td>SSSC</td>
<td>SB</td>
<td>10.8</td>
<td>B</td>
</tr>
<tr>
<td>9</td>
<td>8th Ave / College Dr</td>
<td>Signal</td>
<td>Overall</td>
<td>17</td>
<td>B</td>
</tr>
<tr>
<td>10</td>
<td>8th Ave / 5th St</td>
<td>SSSC</td>
<td>WB / EB</td>
<td>11.3</td>
<td>B</td>
</tr>
<tr>
<td>11</td>
<td>8th Ave / 4th St</td>
<td>SSSC</td>
<td>EB</td>
<td>7.9</td>
<td>A</td>
</tr>
<tr>
<td>12</td>
<td>8th Ave / 3rd St</td>
<td>SSSC</td>
<td>WB</td>
<td>11.1</td>
<td>B</td>
</tr>
<tr>
<td>13</td>
<td>8th Ave / 2nd St</td>
<td>SSSC</td>
<td>EB</td>
<td>5.7</td>
<td>A</td>
</tr>
<tr>
<td>14</td>
<td>8th Ave / Santa Rita Dr</td>
<td>Signal</td>
<td>Overall</td>
<td>9.4</td>
<td>A</td>
</tr>
</tbody>
</table>

_Fehr & Peers, July 2016_

1: Delay is measured in seconds  
2: SSSC = Side Street Stop Control
KEY FINDINGS: EXISTING CONDITIONS AND EXISTING PLUS PROJECT CONDITIONS

- Under Existing Conditions, all 14 study intersections operate acceptably.
- Under Existing Plus Project Conditions, all 14 study intersections operate acceptably.
- Among all 14 study intersections, the level of service either remains the same or degrades by one level of service. Of those intersections that degrade, they degrade from LOS A to LOS B or LOS B to LOS C.
- At intersection 2 (Main Avenue / College Drive), the level of service remains the same (LOS C) under Existing Conditions and Existing Plus Project Conditions as the lane configurations for the intersection remain the same under both scenarios. The delay reduces slightly as the simulation software draws an average from selected runs.
- At intersection 3 (2nd Avenue / College Drive), the highest average recorded delay is 11.7 seconds during the study time period. However, City staff have observed that side-street delay for 2nd Avenue outside the determined vehicle peak hour on College Drive can be extensive due to higher pedestrian activity at those time periods.
- At intersection 4 (3rd Avenue / College Drive), the level of service degrades from LOS B under Existing Conditions to LOS C under Existing Plus Project Conditions and the overall delay increases from 15.7 seconds to 20.0 seconds.
- At intersection 9 (8th Avenue / College Drive), the level of service degrades from LOS B in Existing Conditions to LOS C in Existing Plus Project Conditions and the overall delay increases from 17.0 seconds to 28.8 seconds. This is the most significant increase in delay under Existing Plus Project Conditions, however the intersection remains within the acceptable level of service.
2040 AND 2040 PLUS PROJECT

INTERSECTION OPERATIONS

To determine the 2040 Conditions and 2040 Plus Project Conditions, an annual growth rate of one percent was calculated from recent traffic counts in the area. As approved by the City, this growth rate was applied to the existing traffic data at all study intersections.

The 2040 Conditions analysis provides a baseline comparison for the 2040 Plus Project Conditions analysis. Figure 5 and Figure 6 present the 2040 PM peak hour turning movement volumes, lane configurations, and traffic control devices at the 14 study intersections. Figure 7 and Figure 8 present the same information under 2040 Plus Project PM peak hour conditions.

In this study, the Project is defined as the following:

- A lane reduction on College Drive from a four lane road with lanes in each direction to a three lane road with one lane in each direction and a two-way left turn lane
- A lane reduction on 8th Avenue a four lane road with two lanes in each direction to a three lane road with one lane in each direction and a two-way left turn lane
- Trips generated by the proposed Downtown Durango Hotel (approximately 185 rooms) located at 2nd Avenue / 5th Street

Table 4 provides the LOS and intersection delay results of the capacity analysis for the PM peak hour. Appendix A provides the detailed LOS calculations for the 2040 Conditions and the 2040 Plus Project Conditions.

In order to account for the worst case scenario for northbound and southbound left turn movements, two-stage left turns were not accommodated in the simulation model. Alternatively, vehicles completing a westbound or an eastbound left turn were accommodated in the simulation model. Westbound and eastbound left turn movement volumes are higher than northbound and southbound left turn movements. As such, the majority of vehicles attempting left turn movements are accommodated.
Figure 5
Cumulative Peak Hour Traffic Volumes and Lane Configurations - Durango Road Diets
Figure 6
Cumulative Peak Hour Traffic Volumes and Lane Configurations - Durango Road Diets
Figure 7

Cumulative Plus Project Peak Hour Traffic Volumes and Lane Configurations - Durango Road Diets
Figure 8
Cumulative Plus Project Peak Hour Traffic Volumes and Lane Configurations - Durango Road Diets
### TABLE 4: PM PEAK HOUR 2040 AND 2040 PLUS PROJECT INTERSECTION LEVEL OF SERVICE RESULTS

<table>
<thead>
<tr>
<th>ID</th>
<th>Intersection</th>
<th>Control</th>
<th>Approach</th>
<th>Cumulative PM Peak Hour</th>
<th>Cumulative + Project PM Peak Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Delay</td>
<td>LOS</td>
</tr>
<tr>
<td>1</td>
<td>US 550 / College Dr</td>
<td>Signal</td>
<td>Overall</td>
<td>26.7</td>
<td>C</td>
</tr>
<tr>
<td>2</td>
<td>Main Ave / College Dr</td>
<td>Signal</td>
<td>Overall</td>
<td>35.2</td>
<td>D</td>
</tr>
<tr>
<td>3</td>
<td>2nd Ave / College Dr</td>
<td>SSSC&lt;sup&gt;2&lt;/sup&gt;</td>
<td>NB / Overall</td>
<td>16.5</td>
<td>C</td>
</tr>
<tr>
<td>4</td>
<td>3rd Ave / College Dr</td>
<td>Signal</td>
<td>Overall</td>
<td>17.9</td>
<td>B</td>
</tr>
<tr>
<td>5</td>
<td>4th Ave / College Dr</td>
<td>SSSC</td>
<td>NB</td>
<td>19.5</td>
<td>C</td>
</tr>
<tr>
<td>6</td>
<td>5th Ave / College Dr</td>
<td>SSSC</td>
<td>NB</td>
<td>13.1</td>
<td>B</td>
</tr>
<tr>
<td>7</td>
<td>6th Ave / College Dr</td>
<td>Signal</td>
<td>Overall</td>
<td>5.5</td>
<td>A</td>
</tr>
<tr>
<td>8</td>
<td>7th Ave / College Dr</td>
<td>SSSC</td>
<td>NB</td>
<td>15.9</td>
<td>C</td>
</tr>
<tr>
<td>9</td>
<td>8th Ave / College Dr</td>
<td>Signal</td>
<td>Overall</td>
<td>24</td>
<td>C</td>
</tr>
<tr>
<td>10</td>
<td>8th Ave / 5th St</td>
<td>SSSC</td>
<td>EB</td>
<td>13.7</td>
<td>B</td>
</tr>
<tr>
<td>11</td>
<td>8th Ave / 4th St</td>
<td>SSSC</td>
<td>WB</td>
<td>12.1</td>
<td>B</td>
</tr>
<tr>
<td>12</td>
<td>8th Ave / 3rd St</td>
<td>SSSC</td>
<td>WB</td>
<td>41.7</td>
<td>E</td>
</tr>
<tr>
<td>13</td>
<td>8th Ave / 2nd St</td>
<td>SSSC</td>
<td>EB</td>
<td>10.7</td>
<td>B</td>
</tr>
<tr>
<td>14</td>
<td>8th Ave / Santa Rita Dr</td>
<td>Signal</td>
<td>Overall</td>
<td>11.9</td>
<td>B</td>
</tr>
</tbody>
</table>

*Fehr & Peers, July 2016*

1: Delay is measured in seconds

2: SSSC = Side Street Stop Control
KEY FINDINGS: 2040 AND 2040 PLUS PROJECT CONDITIONS

- Under 2040 Conditions, 13 intersections operate acceptably and one intersection operates unacceptably.
- Under 2040 Plus Project Conditions, 11 intersections operate acceptably and three intersections operate unacceptably.
- Each of the signalized intersections remains at an acceptable level of service under 2040 Plus Project Conditions.
  - At intersection 2 (Main Avenue / College Drive), the level of service remains the same (LOS D) under 2040 and 2040 Plus Project Conditions as the lane configurations for the intersection remain the same under both scenarios. The delay increases slightly as the simulation software draws an average from selected runs.
  - At intersection 3 (2nd Avenue / College Drive), the level of service improves from LOS C to LOS B as the intersection’s traffic control was assumed to be improved from a side-street stop control to a signal.
  - At intersection 4 (3rd Avenue / College Drive), the level of service remains the same (LOS C) under 2040 and 2040 Plus Project Conditions. The delay increases slightly as the simulation software draws an average from selected runs.
  - At intersection 9 (8th Avenue / College Drive), the level of service degrades from LOS C in 2040 Conditions to LOS D in 2040 Plus Project Conditions. The overall delay increases from 24.4 seconds to 42.7 seconds. This is the most significant increase in delay under 2040 Plus Project Conditions. However the intersection remains within the acceptable level of service.
- Three of the Side Street Stop Controlled intersections operate at an unacceptable level of service under 2040 Plus Project Conditions.
  - At intersection 5 (4th Avenue / College Drive), the level of service degrades from LOS C in 2040 Conditions to LOS E in 2040 Plus Project Conditions due to the increased delay of 39 seconds experienced at the northbound approach. 25 vehicles experience this increased delay out of 1,593 total vehicles served at this intersection during the PM peak hour.
  - At intersection 10 (8th Avenue / 5th Street), the level of service degrades from LOS B in 2040 Conditions to LOS E in 2040 Plus Project Conditions due to the increased delay of 43.7 seconds experienced at the eastbound approach. 27 vehicles experience this increased delay out of 1,566 total vehicles served at this intersection during the PM peak hour.
  - At intersection 12 (8th Avenue / 3rd Street), the level of service degrades from LOS E in 2040 Conditions to LOS F in 2040 Plus Project Conditions due to the increased delay of 50.7
seconds experiences at the westbound approach. 66 vehicles experience this increased delay out of 1,783 vehicles served at this intersection during the peak hour.
ROUNDABOUT ANALYSIS

OPERATIONS

To consider alternative intersection configurations, single lane roundabouts were analyzed at two intersections along the study corridors. Roundabouts have the potential to be safer and more efficient than conventional intersection control (traffic signals or stop signs). Research indicates that that collisions occur less frequently and are less severe; maintenance costs are generally lower; and delay is reduced as vehicles are yielding instead of stopping. Additionally, roundabouts can accommodate more vehicles given the same right-of-way and vehicles generally produce fewer greenhouse gases due to fewer delays and less stopping. Alternately, roundabouts that do not have a balanced flow (i.e. some movements are significantly heavier than others) can result in a reduction of the overall entry capacity which would in turn increase vehicle delay.

The following two intersections were analyzed as signal lane roundabouts:

- 8th Avenue / College Drive (intersection 9)
- 8th Avenue / Santa Rita Drive (intersection 14)

Table 5 provides the PM peak hour LOS and intersection delay results of the capacity analysis for single-lane roundabouts at the two intersections listed above under Existing Plus Project and 2040 Plus Project Conditions.

<table>
<thead>
<tr>
<th>ID</th>
<th>Intersection</th>
<th>Scenario</th>
<th>Control</th>
<th>Approach</th>
<th>PM Peak Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Delay¹</td>
</tr>
<tr>
<td>9</td>
<td>8th Ave / College Dr</td>
<td>Existing + Project</td>
<td>Roundabout</td>
<td>Overall</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cumulative + Project</td>
<td></td>
<td></td>
<td>96.4</td>
</tr>
<tr>
<td>14</td>
<td>8th Ave / Santa Rita Dr</td>
<td>Existing + Project</td>
<td>Roundabout</td>
<td>Overall</td>
<td>12.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cumulative + Project</td>
<td></td>
<td></td>
<td>27.3</td>
</tr>
</tbody>
</table>

*Fehr & Peers, July 2016*

¹ Delay is measured in seconds
KEY FINDINGS: ROUNDBOARD ANALYSIS

- At intersection 9 (8th Avenue / College Drive), a single-lane roundabout would not operate acceptably under Existing Plus Project Conditions or 2040 Plus Project Conditions.
  - Under Existing Plus Project Conditions, the level of service degrades to LOS E with an overall delay of 36.0 seconds. The unacceptable delay is caused by the high volume of northbound left turn movements. In order to operate acceptably, this intersection would need to have two northbound approach lanes (one northbound left turn only, one shared northbound left turn and northbound through) and two lanes on the east side of the roundabout to accommodate those approach lanes. These modifications would expand the overall footprint of the intersection.
  - Under 2040 Plus Project Conditions, the level of service degrades to LOS F with an overall delay of 96.4 seconds. The unacceptable delay is caused by the high volume of northbound left turn movements.
- At intersection 14 (8th Avenue / Santa Rita Drive), a single lane roundabout would operate acceptably under Existing Plus Project Conditions and 2040 Plus Project Conditions.
  - Under Existing Plus Project Conditions, the level of service remains acceptable (LOS B) and the overall delay is 12.5 seconds.
  - Under 2040 Plus Project Conditions, the level of service remains acceptable (LOS D) and the overall delay is 27.3 seconds.
- According to the Federal Highway Administration's (FHWA), Roundabouts: An Informational Guide, the inscribed circle diameter of a roundabout should be 100 – 130 feet. Given the existing roadway alignment, a substantial amount of grading would be necessary east of 8th Avenue in order to accommodate this footprint. Without this grading, the roadway legs on 8th Avenue would need to be re-aligned to accommodate a roundabout. Therefore, it is recommended that further feasibility analysis be conducted in order to determine the feasibility and cost of a roundabout at intersection 14 (8th Avenue / Santa Rita Drive).
- The traffic control at intersection 14 (8th Avenue / Santa Rita Drive) would likely not have a significant impact on the intersection operations of intersection 9 (8th Avenue / College Drive). When analyzed in SimTraffic, the existing control (signal) at intersection 14 (8th Avenue / Santa Rita Drive) and the proposed control (roundabout) at intersection 14 (8th Avenue / Santa Rita Drive) produced similar delay at intersection 9 (8th Avenue / College Drive). As noted in Appendix A, when intersection 14 (8th Avenue / Santa Rita Drive) is controlled by a signal, the average delay at intersection 9 (8th Avenue / College Drive) is 44.4 seconds (LOS D) and when intersection 14 (8th...
Avenue / Santa Rita Drive) is controlled by a roundabout, the average delay at intersection 9 (8th Avenue / College Drive) is 44.7 seconds (LOS D).

BARNES DANCE ANALYSIS

OPERATIONS

To consider alternative intersection operations, the elimination of the pedestrian scramble (“Barnes Dance”) at intersection 2 (Main Avenue / College Drive) was analyzed. While pedestrian scrambles can have benefits for pedestrians, research shows that these intersections typically lead to higher delay for vehicles.

Table 6 provides the PM peak hour LOS and intersection delay results of the Barnes Dance analysis at the intersection of Main Avenue and College Drive under Existing Plus Project and 2040 Plus Project Conditions.

**TABLE 6: BARNES DANCE INTERSECTION LEVEL OF SERVICE RESULTS**

<table>
<thead>
<tr>
<th>ID</th>
<th>Intersection</th>
<th>Scenario</th>
<th>Control</th>
<th>Approach</th>
<th>With Barnes Dance</th>
<th>Without Barnes Dance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PM Peak Hour</td>
<td>PM Peak Hour</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Delay</td>
<td>LOS</td>
</tr>
<tr>
<td>2</td>
<td>Main Ave /</td>
<td>Existing + Project</td>
<td>Signal</td>
<td>Overall</td>
<td>29.1</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>College Dr</td>
<td>Cumulative + Project</td>
<td></td>
<td></td>
<td>38.2</td>
<td>D</td>
</tr>
</tbody>
</table>

Fehr & Peers, July 2016
1: Delay is measured in seconds

KEY FINDINGS: BARNES DANCE ANALYSIS

- At intersection 2 (Main Avenue / College Drive), the intersection would operate acceptably and with less vehicle delay if the signal timing did not include a pedestrian scramble (“Barnes Dance”).
  - Under Existing Plus Project Conditions, the vehicle level of service would improve to LOS B and the average vehicle delay would decrease from 29.1 seconds to 17.3 seconds, a reduction of 11.8 seconds in average vehicle delay.
  - Under 2040 Plus Project Conditions, the vehicle level of service would improve to LOS B and the average vehicle delay would decrease from 38.2 seconds to 19.9 seconds, a reduction of 18.3 seconds in average vehicle delay.
- Though the pedestrian scramble (“Barnes Dance”) does increase vehicle delay, it accommodates the high pedestrian volumes associated with the adjacent land uses near intersection 2 (Main Avenue / College Drive). Additionally, “Barnes Dance” intersections have been shown to reduce the amount of vehicle-pedestrian conflicts. According to the FHWA’s study *A Review of Pedestrian...*
Safety Research in the United States and Abroad\(^2\), sites with exclusive pedestrian signal timing had approximately half as many vehicle-pedestrian collisions as sites with standard signal timing.

PEDESTRIAN AND BICYCLE LEVEL OF TRAFFIC STRESS

This multimodal performance analysis provides a quantitative measure of the level of comfort and safety of pedestrians and bicyclists on the existing facilities on College Drive and 8th Avenue. Fehr & Peers has created a tool which calculates comfort-based indices for active transportation designs, providing a Level of Traffic Stress (LTS) score from 1 to 4. LTS 1 is highly comfortable for all users, LTS 2 is generally comfortable for most users, LTS 3 is uncomfortable but possible, and LTS 4 is very uncomfortable or impossible. The methodology used to calculate the Pedestrian Level of Traffic Stress (LTS) and Bicycle Level of Traffic Stress (LTS) is discussed in the white paper found in Appendix B.

This analysis generally functions on a “weakest link” approach, which accounts for the importance of gaps or weak points in the system. Within the City of Durango, pedestrian and bicycle activity tends to be higher near commercial land uses, tourist attractions, and dense housing.

PEDESTRIAN LEVEL OF TRAFFIC STRESS

Pedestrian facilities on the corridor are scored based on the quality and type of infrastructure on the segments and the treatments at the intersections. The LTS scoring for Existing Pedestrian Conditions is shown in Figure 9.

SEGMENTS

As noted in Technical Memorandum 1, under Existing Conditions, pedestrian facilities on the College Drive corridor primarily receive LTS 3. This is due to the narrow existing sidewalks that are less than or equal to six feet and frequent driveway curb cuts. On College Avenue between Main Avenue and 3rd Avenue, the pedestrian LTS is 2 due to the wider sidewalks and 25 MPH posted speed limit. Under Existing Plus Project Conditions, the majority of pedestrian facilities remain at LTS 3 due to the narrow sidewalks and frequent driveway curb cuts and the facilities between Main Avenue and 3rd Avenue remain at LTS 2.

Under Existing Conditions, the narrow sidewalks and 35 MPH posted speed limit on 8th Avenue contributes to LTS 3 along that corridor. On 8th Avenue between 3rd Street and 2nd Street, the LTS is 4 due to the 35 MPH speed limit and the lack of sidewalks. Under Existing Plus Project Conditions, the majority of pedestrian facilities remain at LTS 3 due to the narrow sidewalks and 35 MPH posted speed limit and the facilities between 3rd Street and 2nd Street remain at LTS 4.
INTERSECTIONS

Under Existing Conditions, the north and south legs on almost all crossings of College Drive (except US 550 which is a major thoroughfare) are at LTS 2, due to the number of travel lanes and the volume of traffic. Most east and west legs along College Drive were also at LTS 2 with the exception of the eastbound approach at 2nd Avenue and College Drive, the eastbound and westbound approach at 4th Avenue and College Drive, and the eastbound and westbound approach at 5th Avenue and College Drive. These intersection approaches each receive a LTS 1 score. Under Existing Plus Project Conditions, each of the LTS scores remain the same due to the volume of traffic.

Along the 8th Avenue corridor, the majority of north and south legs are LTS 2 due to the number of travel lanes to cross and the volume of traffic. The northbound and southbound approach at 8th Avenue and Santa Rita Drive both received a LTS 4 score due to lack of sidewalks. Under Existing Plus Project Conditions, the LTS scores remain the same due to the volume of traffic.

BICYCLE LEVEL OF TRAFFIC STRESS

The bicycle network was analyzed for its on-street network along the two corridors. Segments and crossings were analyzed based on their safety and comfort. The LTS scoring for Existing Bicycle Conditions is shown in Figure 9. The LTS scoring for Existing Plus Project Conditions is shown in Figure 10.

SEGMENTS

Under Existing Conditions, the on-street bicycle network is a LTS 3 across the extents of the College Drive corridor. While there is a bicycle lane for a portion of the corridor, the four lane roadway without a raised median attributes to an uncomfortable bicycling experience for users. Under Existing Plus Project Conditions, the bicycle network remains an LTS 3 due to the absence of a median. However, with the presence of a median under Existing Plus Project Conditions, the level of traffic stress on the College Drive corridor drops to a LTS 1.

Under Existing Conditions, there is no bicycle lane present along the 8th Avenue corridor and the posted speed limit is 35 MPH. In addition to being a four lane roadway with no median, these characteristics lead to a very uncomfortable experience for users and a LTS 4. Under Existing Plus Project Conditions however, the level of traffic stress drops to an LTS 3 due to the presence of bicycle lanes. The level of traffic stress
remains at LTS 3 due to the 35 MPH posted speed limit. The segment of 8th Avenue between 2nd Street and 1st Street remains at LTS 4.

INTERSECTIONS

Under Existing Conditions, all eastbound and westbound intersection approaches on College Drive are LTS 2 except for westbound at US 550 and College Drive and eastbound and westbound at 3rd Avenue and College Drive and 8th Avenue and College Drive. Each of these are LTS 3 due to excessive taper length for right turn vehicle movements. When vehicles have excessive taper length, the conflict zone between vehicles and bicycles is lengthened and bicycle comfort level is compromised. The majority of northbound and southbound approaches on College Drive are LTS 1 with the exception of US 550, Main Avenue, 3rd Avenue, and 8th Avenue. At US 550, additional hazards are present and at the other locations the vehicles do not have an adequate right turn taper length. Under Existing Plus Project Conditions, the majority of traffic stress remains the same with the exception of the eastbound and westbound at 3rd Avenue and College Drive and 8th Avenue and College Drive as the excessive taper length is eliminated due to the lane reduction.

Along the 8th Avenue corridor, each one of the northbound and southbound approaches is a LTS 4 as the posted speed limit is 35 MPH, contributing to a very uncomfortable experience for the majority of users. Each of the westbound and eastbound approaches on 8th Avenue are LTS 1 however as the posted speed limit is 25 MPH and the physical conditions are comfortable for more users. The level of traffic stress remains the same under Existing Plus Project Conditions as the posted speed limit remains 35 MPH. If the posted speed limit were reduced to 30 MPH or lower, LTS 2 would exist.
Figure 9
Level of Traffic Stress (LTS)
Durango Road Diets

Intersection LTS
1 - Highly Comfortable
2 - Generally Comfortable
3 - Uncomfortable But Possible
4 - Very Uncomfortable or Impossible

Roadway LTS
2 - Generally Comfortable
3 - Uncomfortable But Possible
4 - Very Uncomfortable or Impossible
Bicycle Level of Traffic Stress (LTS) Existing Plus Project
Durango Road Diets

**Intersection LTS**
- 1 - Highly Comfortable
- 2 - Generally Comfortable
- 3 - Uncomfortable But Possible
- 4 - Very Uncomfortable or Impossible

**Roadway LTS**
- 1 - Highly Comfortable
- 2 - Generally Comfortable
- 3 - Uncomfortable But Possible
- 4 - Very Uncomfortable or Impossible

Figure 10
TRANSIT

Within the study area, the City operates two regular bus service routes (Route 2 and Route 3) and one evening bus service route (Route 6). For this corridor travel time analysis, Route 2 was analyzed because it runs along the segment of College Drive from Main Avenue past the eastern edge of the study area during the PM peak hour, providing a base travel time for existing transit conditions.

The scheduled time to travel the corridor from Main Avenue / College Drive to 8th Avenue / College Drive is three minutes. Under Existing Conditions, Route 2 on average operates on schedule along College Drive with an average travel time of two minutes and 52 seconds. Under Existing Plus Project, the corridor delay would rise by 24 seconds, increasing the travel time along the corridor to three minutes and 16 seconds. Under 2040 Conditions, Route 2 on average would operate along College Drive with an average travel time of two minutes and 59 seconds. Under 2040 Plus Project Conditions, the delay is increased by 23 seconds, increasing the travel time along the corridor to three minutes and 22 seconds.
SAFETY ANALYSIS

Collision data helps identify specific intersections or roadway segments that experience a greater number of traffic collisions. This can direct a course of action to create safer roadways. Additionally, in understanding the most common types of traffic violations, safety concerns can be addressed to mitigate future collisions.

TRAFFIC COLLISION/VIOLATION DATA

As noted in the Existing Conditions Memorandum, 58 traffic collisions were reported from 2011-2015. The data was collected from the Durango Police Department. Table 7 and Figure 9 summarize the traffic collisions during this period by violation code. Of the 58 traffic collisions, 37 those occurred within the concentrated study area. The table also summarizes which collisions have the potential to be prevented by the implementation of a road diet based upon the nature of the collision. Many careless driving crashes, for example, could be prevented by the installation of a two-way left-turn lane, while no improper backing crashes would be prevented by a road diet in the study area.

**TABLE 7: TRAFFIC COLLISIONS BY VIOLATION CODE**

<table>
<thead>
<tr>
<th>Violation Code</th>
<th>Driver Action*</th>
<th>Total Count</th>
<th>%</th>
<th>Preventable by Road Diet</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>Careless Driving</td>
<td>18</td>
<td>31.0%</td>
<td>2</td>
</tr>
<tr>
<td>13</td>
<td>Followed Too Closely</td>
<td>10</td>
<td>17.2%</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>No Action</td>
<td>7</td>
<td>12.1%</td>
<td>2</td>
</tr>
<tr>
<td>14</td>
<td>Improper Backing</td>
<td>7</td>
<td>12.1%</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>Failed to Yield ROW</td>
<td>7</td>
<td>12.1%</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>Lane Violation</td>
<td>3</td>
<td>5.2%</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>Turned from Wrong Lane or Position</td>
<td>2</td>
<td>3.4%</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>Exceeded Safe/Posted Speed</td>
<td>1</td>
<td>1.7%</td>
<td>0</td>
</tr>
<tr>
<td>16</td>
<td>Reckless Driving</td>
<td>1</td>
<td>1.7%</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>Disregard Stop Sign</td>
<td>1</td>
<td>1.7%</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Not Reported</td>
<td>1</td>
<td>1.7%</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>58</strong></td>
<td><strong>100.0%</strong></td>
<td><strong>9</strong></td>
</tr>
</tbody>
</table>

*See Colorado State Traffic Records Advisory Committee's Investigating Officer’s Traffic Collision Reporting Manual, page 44
Figure 11
Collisions
Durango Road Diets
KEY FINDINGS: SAFETY ANALYSIS

- 9 of the 37 traffic collisions, or 24 percent of the total traffic collisions during the study period from 2011-2015, have the potential to be prevented with the implementation of a road diet within the concentrated study area on College Drive and 8th Avenue.
- Two of the “Careless Driving” violations could be prevented by a road diet within the concentrated study area as they involved a vehicle waiting in the inside travel lane with the intent of completing a left turn. The recommended road diet includes a two-way left-turn lane which would accommodate the vehicles attempting to complete a left turn.
- One of the “Followed Too Closely” violations within the concentrated study area could be prevented by a road diet as they involved vehicles waiting to make a left turn. The recommended road diet includes a two-way left-turn lane which would accommodate the vehicles attempting to complete a left turn.
- Two of the “No Action” violations within the concentrated study area could be prevented by a road diet as they involved drivers stopping to make left turns or swerving into travel lanes without looking into traffic. The recommended road diet includes a two-way left-turn lane which would accommodate the vehicles attempting to complete a left turn. Additionally, these vehicles would cross one travel lane instead of two, reducing the vehicle crossing distance.
- One of the “Failed to Yield Right of Way” violations within the concentrated study area could be prevented by a road diet as they involved drivers turning left across multiple lanes of traffic. The recommended road diet would enable the vehicle to cross one travel lane instead of two, reducing the vehicle crossing distance.
- Two of the “Lane Violation” collisions within the concentrated study area could be prevented by a road diet as they involve merging into other lanes traveling in the same direction. The road diet would consist of one travel lane in each direction, inhibiting this action.
- One of the “Turned from Wrong Lane or Position” violations could be prevented by a road diet as they involved more than one lane of travel. The road diet would consist of one travel lane in each direction, inhibiting this action.
CONCLUSION: SAFETY ANALYSIS

Historically, road diets have been shown to enhance safety and access for all users, forming a welcome environment for various transportation modes and creating more livable spaces. According to the FHWA, road diets typically reduce collisions by 19 to 47 percent. The recommendations from the City of Durango Road Diets Study align with these conclusions as the safety study suggests that 24 percent of the total traffic collisions during the study period are preventable by a road diet.