Project Report
South Kirkwood Road Traffic Study
Meadows Place, TX
October 9, 2015
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1 Introduction

The Houston – Galveston Area Council (H-GAC) commissioned HDR, Inc. to conduct a study of the South Kirkwood Road corridor in the city of Meadows Place, TX. The study area (highlighted in Figure 1-1) for this analysis extended from West Bellfort Avenue on the north to West Airport Boulevard on the south with a primary focus on the four unsignalized intersections located within. The objective of this study was to evaluate alternative cross-sections for S Kirkwood Road and intersection traffic controls for the corridor. As part of this study, traffic data was collected, warrant analysis was conducted, and existing and proposed conditions were analyzed using Synchro and SIDRA traffic software. The purpose of this report is to document the study methodology, analysis results and recommendations.

Figure 1-1. Study Area Map

![Study Area Map](source: Google Earth)

2 Data Collection

Turning movement counts were collected at the following study area intersections from 6am to 9am; 11am to 1pm and 4pm to 7pm on June 2, 2015.
1. S Kirkwood Road and W Bellfort Avenue (signalized intersection)
2. S Kirkwood Road and Scottsdale Drive (all-way stop controlled intersection)
3. S Kirkwood Road and Dorrance Lane (all-way stop controlled intersection)
4. S Kirkwood Road and Brighton Lane (all-way stop controlled intersection)
5. S Kirkwood Road and Brook Meadows Lane (all-way stop controlled intersection) and
6. S Kirkwood Road and W Airport Boulevard (signalized intersection).

In addition to that, twenty-four (24) hour bi-directional Automatic Traffic Recorder (ATR) counts were collected on June 2, 2015 at the following two locations:

1. S Kirkwood Road, south of W Bellfort Avenue and
2. S Kirkwood Road, north of W Airport Boulevard.

The traffic counts collected during AM and PM peak periods were used for AM and PM peak hour traffic analysis, while the counts for all eight hours were used for warrant analysis.

3 Existing Roadway Network

The section of Kirkwood Road within the study area is two lanes in each direction with an Average Daily Traffic (ADT) of approximately 11,500 vehicles per day (vpd). Based on a review of peak period traffic counts, the ADTs along Dorrance Lane and West Airport Road were estimated as 3500 vpd and 17,800 vpd, respectively.

The two intersections on the north and south end of the study area (S Kirkwood Rd/W Bellfort Ave and S Kirkwood Rd/W Airport Rd) are signalized and experience high congestion. These intersections were included in the analyses to capture the impacts of the residual queues from these intersections on the unsignalized intersections.

All approaches of the intersection of S Kirkwood Road and W Bellfort Avenue provide one left-turn lane, one through lane, and one shared through/right-turn lane.

The intersection at Kirkwood Road/Airport Road is going through major construction causing lane shifts and lane closures, thus adding to the congestion levels. This construction is assumed to be completed for the future alternatives analysis. During the construction phase, the eastbound and southbound approaches provide one left-turn lane and one shared through/right-turn lanes. The northbound and westbound approaches provide one shared left-turn/through/right-turn lane. Post construction, the northbound and southbound approaches will provide two left-turn lanes, one through lane, and one shared through/right-turn lane. Eastbound will provide one left-turn lane, two through lanes and one right-turn lane. Westbound approach will provide two left-turn lanes, two through lanes and one right-turn lane.

All four unsignalized intersections operate with all-way stop control and consist of one shared left/through/right lanes on eastbound and westbound approaches. The northbound and southbound approaches provide one shared left-turn/through lane and one shared through/right-turn lanes.

4 Traffic Volume Development

Based on a review of the turning movement counts and ATR counts, the morning and evening peak hours for this corridor were identified as 7:15am to 8:15am and 4:45pm to 5:45pm. The peak hour traffic volumes for the study intersections were balanced and shown in Figures 1 and 2 in Appendix A.
The future analysis year for this study was selected as 2035 and the existing traffic volumes were projected to the year 2035. Background growth rates were reviewed from H-GACs Regional Transportation Plan (RTP) for S Kirkwood Road. Based on projected regional growth, and in consultation with H-GAC, the following growth rates were used to forecast future volumes along the study corridor:

- 2% annual growth for S Kirkwood Road and W Bellfort Avenue
- 0.8% annual growth for Scottsdale Drive, Dorrance Lane, Brighton Lane and Brook Meadows Lane and
- 1% annual growth for W Airport Boulevard.

The 2035 future volumes obtained by growing the existing traffic volumes using the growth rates listed above are illustrated in Figures 3 and 4 and provided in Appendix A.

5 Warrant Analysis

The four unsignalized intersections within the study area currently operate with all-way stop control. In order to evaluate the appropriate traffic control at these intersections, the following warrant analyses were conducted using the traffic counts collected in June 2015 and the guidelines established in Texas Manual on Uniform Traffic Control Devices, 2011 Edition (TMUTCD):

- Signal warrant analysis
- Pedestrian beacon warrant analysis
- All-way stop warrant analysis.

According to the TMUTCD, installation of a traffic signal, pedestrian hybrid beacon, or all-way stop control should be considered only if warrants are met for the given traffic control at the intersection. Thus, satisfaction of these warrants was considered a pre-requisite for advancement of these traffic control measures as viable alternatives.

Signal and pedestrian beacon warrants were reviewed for the intersection of S Kirkwood Road and Dorrance Lane intersection, while the all-way stop warrants were reviewed for all four unsignalized intersections. Compared with the intersection of Kirkwood with Dorrance Lane, the intersections of Kirkwood with Scottsdale Drive, Brighton Lane and Brook Meadows Lane have relatively low traffic and pedestrian volumes. For this reason, the signal and pedestrian beacon warrants were not considered for these intersections.

The results of the warrant analysis are presented in See Table 5-1 below and the detailed worksheets are provided in Appendices B, C and D.

<table>
<thead>
<tr>
<th>Table 5-1.Warrant Analysis Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Intersection</strong></td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td>Kirkwood Road and Scottsdale Drive</td>
</tr>
<tr>
<td>Kirkwood Rd and Dorrance Lane</td>
</tr>
</tbody>
</table>
As shown in Table 5-1, traffic signal warrants are met for the intersection of Kirkwood Road and Dorrance Lane. This intersection experiences high volumes during four out of eight hours for which the traffic data was collected. Volumes at this intersection exceed the thresholds listed in Warrants 2 (Four hour volumes) and 3 (Peak hour volume). Therefore, installing a traffic signal may be considered for this intersection.

Pedestrian beacon warrants are not met for the intersection of Kirkwood Road and Dorrance Lane. The traffic counts indicate that fewer than 10 pedestrians-per-hour (PPH) cross Kirkwood Road at Dorrance Lane in any of the eight counted hours. Therefore, installing a pedestrian hybrid beacon should not be considered for this intersection.

All-way stop warrants are met for the intersections of Kirkwood Road with Scottsdale Drive and Dorrance Lane. The intersection of Kirkwood Road with Scottsdale Drive meets the warrant based on observed crash rates. The intersection of Kirkwood Road with Dorrance Lane satisfies traffic signal warrants, as noted above, and hence can be considered for an all-way stop warrant as an interim means to control traffic, until a traffic signal can be installed. Therefore, retention of the all-way stops currently installed at these intersections can be considered as part of an advanced alternative. However, the minimum thresholds for all-way stop warrants are not currently met for the intersections of Kirkwood Road with Brighton Lane or Brook Meadows Lane. Therefore, the existing all-way stop controls at these two intersections should be removed, and these intersections should not be considered for all-way stop control as part of an advanced alternative.

6 Traffic Control Alternative Scenarios

The alternatives identified included different combinations of roadway cross-sections along Kirkwood Road (two-lane or four-lane) and traffic control (signalization, roundabout or all-way stop) at the four unsignalized intersections. The following eight alternatives were analyzed in this study:

1. Four-lane cross-section (two lanes in each direction) along Kirkwood Road and all-way stop control at four unsignalized intersections. This is essentially the existing configuration and hence this alternative can be used as the 2035 ‘No-Build’ condition for comparison purposes.
2. Four-lane cross-section along Kirkwood Road; traffic signal at Dorrance Lane intersection and two-way stop control at remaining unsignalized intersections.
3. Four-lane cross-section along Kirkwood Road; roundabouts at one to four unsignalized intersections and two-way stop control at remaining intersections.
4. Four-lane cross-section along Kirkwood Road; and two-way stop control at all four unsignalized intersections.
5. Two-lane cross-section (one lane in each direction) along Kirkwood Road; traffic signal at Dorrance Lane intersection and two-way stop control at remaining unsignalized intersections.
6. Two-lane cross-section along Kirkwood Road; roundabouts at one to four unsignalized intersections and two-way stop control at remaining intersections.
7. Two-lane cross-section along Kirkwood Road; and **two-way stop control** at all four unsignalized intersections and
8. Two-lane cross-section along Kirkwood Road; **Pedestrian Beacon** at Dorrance Lane intersection and two-way stop control at remaining unsignalized intersections.

## 7 Traffic Capacity Analyses

Capacity analyses were conducted for the study area roadways and intersections to evaluate 2015 existing conditions and to select a preferred alternative among eight different geometric and traffic control scenarios considered for 2035 future conditions. Analyses were conducted for AM and PM peak hours on a typical weekday based on traffic volume projections described in this report. Depending on the traffic control to be analyzed, Synchro version 9 or SIDRA version 6 were used for the intersection capacity analyses.

### 7.1 Methodology

Capacity analysis is a method by which traffic volumes are compared to the calculated roadway and intersection capacities to evaluate existing and future traffic conditions. The Transportation Research Board describes the methodology used in the 2010 Highway Capacity Manual (HCM). In general, the terminology “Level of Service” (LOS) is used to provide a “qualitative” evaluation based on certain “quantitative” calculations related to empirical values. The definition of LOS as contained in the 2010 HCM is briefly described below.

Level of Service range from A to F. In general, LOS A represents the best traffic operating condition and LOS F represents the worst condition (typically associated with congestion and long delays). The LOS values for unsignalized and signalized intersections are defined in terms of average delay. Delay is used as a measure of driver discomfort, frustration, efficiency, etc. See Table 7-1 for the LOS criteria for signalized and unsignalized intersections. Any lane group that operates at LOS E or F requires mitigation to achieve LOS D or better.

<table>
<thead>
<tr>
<th>Level of Service</th>
<th>Signalized</th>
<th>Unsignalized and Roundabout*</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Less than or equal to 10.0</td>
<td>Less than or equal to 10.0</td>
</tr>
<tr>
<td>B</td>
<td>Greater than 10.0 to 20.0</td>
<td>Greater than 10.0 to 15.0</td>
</tr>
<tr>
<td>C</td>
<td>Greater than 20.0 to 35.0</td>
<td>Greater than 15.0 to 25.0</td>
</tr>
<tr>
<td>D</td>
<td>Greater than 35.0 to 55.0</td>
<td>Greater than 25.0 to 35.0</td>
</tr>
<tr>
<td>E</td>
<td>Greater than 55.0 to 80.0</td>
<td>Greater than 35.0 to 50.0</td>
</tr>
</tbody>
</table>
Table 7-1. LOS Criteria for Signalized and Unsignalized Intersections

<table>
<thead>
<tr>
<th>Level of Service</th>
<th>Signalized</th>
<th>Unsignalized and Roundabout*</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>Greater than 80.0</td>
<td>Greater than 50.0</td>
</tr>
</tbody>
</table>

Source: HCM 2010

* For Roundabouts, LOS F is assigned if the volume-to-capacity ratio of a lane exceeds 1.0 regardless of the control delay

7.2 Existing Conditions

The existing conditions (geometry, traffic control and traffic volumes) were modeled in Synchro software and calibrated to reflect the current operating conditions. The current operating conditions were collected during field observations and documented in terms of queue lengths and a qualitative assessment of congestion.

The results of the existing Synchro analysis are summarized and provided in Tables 1 and 2 of Appendix E. As shown in the Tables, all unsignalized intersections along Kirkwood Road operate at a LOS A in the 2015 existing conditions during both AM and PM peak periods, with the exception of the intersection at Dorrance Lane which operates at a LOS B during both peak periods. No significant capacity constraints or operation issues were observed at these intersections during the existing conditions.

7.3 Alternatives Evaluation

The alternative analyses were conducted using 2035 projected traffic volumes. The alternatives 1, 2, 4, 5 and 7 consisting of stop-controlled and signalized intersections were analyzed using Synchro software. The alternatives 3 and 6 including roundabouts were analyzed using SIDRA, which is generally recognized as a superior tool for roundabout intersection analysis. Alternative 8, consisting of a pedestrian hybrid beacon, cannot be adequately modeled using either software package. Therefore, a qualitative assessment based on the existing and expected future operations is provided later in this section. The analysis results for alternatives 1, 2, 4, 5 and 7 are provided in Tables 1 and 2 in Appendix E. The results for alternatives 3 and 6 are provided in Table 3 in Appendix E.

Based on a review of the results in Appendix E, a process of elimination was applied to derive fewer favorable alternatives; subsequently, a recommended alternative was selected for further evaluation using Microsimulation from the remaining scenarios based on a qualitative evaluation of each.

The alternatives eliminated (4, 5, 7 and 8) and the reasoning is provided below:

7.3.1 Alternative 4 - Four-lane cross-section along Kirkwood Road; and two-way stop control at all four unsignalized intersections:

Due to high volume at the Dorrance Lane intersection, a two-way stop control operation results in significant delays to the Dorrance Lane approaches. Both the eastbound approach in the AM peak period and the westbound approach in the PM peak period operate at LOS F. Due to the significant
delays and unacceptable levels of service experienced by Dorrance Lane approaches, this alternative was eliminated from further consideration.

7.3.2 Alternative 5 - Two-lane cross-section along Kirkwood Road; traffic signal at Dorrance Lane intersection and two-way stop control at remaining unsignalized intersections:

As part of this alternative, Kirkwood Road was reduced to one lane in each direction and a traffic signal was proposed at the intersection of Dorrance Lane and Kirkwood Road. This will improve the operation at that intersection significantly. However, the eastbound approach of Scottsdale Drive will operate at LOS E during the AM peak period and both eastbound and westbound approaches will operate at LOS F during PM peak period. Due to the increased delays and negative impacts to operation of the side streets, this alternative was eliminated.

7.3.3 Alternative 7 – Two-lane cross-section along Kirkwood Road; and two-way stop control at all four unsignalized intersections:

This alternative was analyzed using Synchro software and as shown in Tables 1 and 2, the eastbound approach of Scottsdale Drive and Dorrance Lane will operate at a LOS E/F during the AM peak period. During the PM peak period, the westbound approach of Brook Meadows Lane and both eastbound and westbound approaches of Scottsdale Drive and Dorrance Lane will operate at LOS E/F. Due to the increased delays and negative impacts to operation of the side streets; this alternative was eliminated from further consideration.

7.3.4 Alternative 8 – Two-Lane cross-section along Kirkwood Road; Pedestrian beacon at Dorrance Lane intersection and two-way stop control at remaining unsignalized intersections:

As part of this alternative, a pedestrian beacon was considered along Kirkwood Road at the intersection with Dorrance Lane. Based on the pedestrian hybrid beacon warrant analysis described in this report, a pedestrian hybrid beacon is not warranted at this intersection.

If a pedestrian beacon were installed at this intersection, the intersection would need to operate under two-way stop control conditions when the beacon is not operational. Analysis of this intersection under two-way stop control reveals that Dorrance Lane approaches are expected to experience significant delays and queueing due to lack of available gaps.

Due to a lack of warrant and deterioration of levels of service for two-way stop control operation at Dorrance Lane, this alternative is eliminated from further consideration.

7.3.5 Comparison of Remaining Alternatives (1, 2, 3 and 6):

During the next stage of evaluation, the remaining alternatives were compared with each other. Alternative 1 is the no-build condition with a four-lane cross-section along Kirkwood Road and all-way stop controls at four intersections. Alternative 2 will operate with four-lane cross-section, signalized intersection at Dorrance Lane intersection and two-way stop control at remaining intersections.

As shown in Tables 1 and 2 in Appendix E, all intersections will operate at acceptable LOS C or better in alternative 1, during both AM and PM peak hours.

As proposed in alternative 2, installing a traffic signal at Dorrance Lane intersection while operating the remaining intersections with two-way stop controls will improve the overall operation of the
corridor even further. All intersections will operate at LOS A with an exception of Dorrance Lane, which will operate at LOS B during both AM and PM peak hours. However, this alternative needs a traffic signal installation and continued signal operating and maintenance costs associated with the technical hardware, signal timing equipment, and electricity needs.

The roundabout alternatives (3 and 6) were analyzed using SIDRA software and the results are summarized in Table 3 of Appendix E. Alternative 3 assumes a four-lane cross-section along Kirkwood Road and multi-lane roundabouts at the four unsignalized intersections. Alternative 6, on the other hand, assumes a two-lane cross-section along Kirkwood Road and single-lane roundabouts at the four unsignalized intersections. As shown in Appendix E, the multi-lane roundabouts will operate at a LOS A for all peak periods and single lane roundabouts will operate at acceptable LOS C or better.

A comparison of advantages and disadvantages for single-lane and multi-lane roundabouts is provided in the Table 7-2 below:

<table>
<thead>
<tr>
<th>Table 7-2. Comparison of Single-Lane and Multi-Lane Roundabouts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Roundabout Type</strong></td>
</tr>
</tbody>
</table>
| Four Lane Cross-section+ Multi Lane Roundabouts (Alternative 3) | • Reduces the traffic queue between intersections due to increased storage of the two lanes  
• Slightly less delay when compared to single lane alternative | • Increased driver confusion with multi-lane approaches  
• Increased risk of accidents on the multi-lane approaches and exits  
• Providing additional capacity in a roundabout results in higher entry speeds during peak periods when conflicts are highest (drivers use the entire width of both entry lanes to flatten out their entry angle and increase their entry speed)  
• Increased right of way needs at the intersections  
• Close proximity of intersections provides limited distance for drivers to change lanes between each intersection which could have an impact on lane utilization for left turning vehicles along the corridor |
| Two Lane Cross-section+ Single Lane Roundabouts (Alternative 6) | • Reduced driver confusion  
• Lower risk of accidents  
• Doesn’t warrant pedestrian signal with single approach lanes  
• Reduced right of way needs at the intersections  
• Increases green space between intersections | • Less width for emergency responders to navigate around stalled vehicles (can be mitigated with mountable curbs)  
• Slightly more intersection delay when compared to multi-lane alternative |

Though Alternative 3 (multi-lane roundabout) operates at a better LOS A, there are more disadvantages (see Table 7-2) associated with it such as increased Right-of-Way needs and safety concerns. These factors impact the favorability of this alternative.
On the other hand, a single-lane roundabout is expected to provide multiple other benefits such as safer operations, increased green space and smoother traffic flow.

As described in [3], roundabouts provide environmental benefits due to reduced delay and the number and duration of stops. This can reduce noise and air quality impacts as well as fuel consumption. The central island and splitter islands offer the opportunity to provide attractive entries or centerpieces to communities through use of landscaping and monuments, thus providing an aesthetic neighborhood.

The discussion of eliminated and preferred alternatives described above is summarized in Table 7-3:

<table>
<thead>
<tr>
<th>Type of Traffic Control</th>
<th>Two-Lane Cross-section</th>
<th>Four-Lane Cross-section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedestrian Beacon</td>
<td>NO (warrants not met)</td>
<td>NO (warrants not met)</td>
</tr>
<tr>
<td>Two-Way Stop Control</td>
<td>NO (poor LOS)</td>
<td>NO (poor LOS)</td>
</tr>
<tr>
<td>Four-Way Stop Control</td>
<td>NO (poor LOS)</td>
<td>YES</td>
</tr>
<tr>
<td>Signal at Dorrance Ln</td>
<td>NO (poor LOS)</td>
<td>YES</td>
</tr>
<tr>
<td>Roundabout Control</td>
<td>YES (single-lane roundabout)</td>
<td>YES (multi-lane roundabout)</td>
</tr>
</tbody>
</table>

8 Conclusion

As discussed in the previous section and listed in Table 7-3, there are four alternatives feasible for the Kirkwood Road corridor which will provide acceptable LOS during the design year 2035. The preferred alternative will be determined after the public outreach effort taken up by the City of Meadows Place. Input from other stakeholders such as City of Houston for bike plans and Houston-Galveston Area Council may also be considered.

9 References

1. Texas Department of Transportation
   2011 Texas Manual on Uniform Traffic Control Devices (TMUTCD)
2. Transportation Research Board
3. Federal Highway Administration
   2010 Technical Summary - Roundabouts, Washington D.C.
4. Federal Highway Administration