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~~July 24, 2020~~ September 3, 2020

Bent Grass Metro District
c/o Randy Case II
102 East Pikes Peak Avenue, #200
Colorado Springs, CO 80903

RE: Bent Grass Meadows Drive &
Meridian Road
El Paso County, Colorado
Updated Transportation Memorandum
LSC #194900

Dear Randy:

LSC Transportation Consultants, Inc. has prepared this updated traffic impact study for the intersection of Bent Grass Meadows Drive & Meridian Road in El Paso County, Colorado. The study area is shown in Figure 1. LSC has completed the following studies in the vicinity of the site:

Bent Grass Subdivision PUD Traffic Impact Analysis - October 6, 2006
Bent Grass East Commercial – Preliminary Plan - January 25, 2013
Bent Grass East Commercial – Report Supplement #2 - March 14, 2013
Bent Grass Subdivision Filing 1 Updated Traffic Impact Analysis - July 14, 2014
Bent Grass East Commercial Filing No. 2 Updated Traffic Impact Analysis - July 17, 2014.
Falcon Dental East Commercial Filing No. 2A - March 7, 2016
Bent Grass Meadows Drive/Meridian Road Traffic Signal Warrant Analysis - October 2, 2017
Bent Grass Residential Filing No. 2 Traffic Impact Study – April 17, 2020

REPORT CONTENTS

The report contains the following:

- The existing roadway and traffic conditions in the site's vicinity including the roadway widths, surface conditions, lane geometries, traffic controls, and posted speed limits, etc.;
- The existing traffic volumes on the study-area roadways;
- The projected short-term traffic volumes on the study-area roadways following the completion of Bent Grass Meadows Drive between the Woodmen frontage road and Meridian road;

- The projected average weekday and peak-hour vehicle trips to be generated by the site at buildout;
- The assignment of the projected additional study-area site-generated traffic volumes to the study-area roadways and intersections;
- The projected total traffic volumes on the study-area roadway network;
- The projected levels of service at the intersections of Meridian Road/Bent Grass Meadows Drive and Meridian Park Drive/Bent Grass Meadows Drive at the site access point to Bent Grass Meadows Drive;
- A traffic-signal warrant analysis of the intersection of Meridian Road/Bent Grass Meadows Drive;
- A vehicle queueing analysis at the key study-area intersections; and
- Recommendations for all necessary short-term intersection improvements and phasing of these improvements including the potential closure of or restrictions to the existing 7-Eleven access to Bent Grass Meadows Drive.

LAND USE

Figures 2a and 2b show the existing and future land uses served by the section of Bent Grass Meadows Drive in the area just west of Meridian Road. The area south of Bent Grass Meadows Drive includes 104 existing single-family homes that are part of Bent Grass Residential Filing No 1, 178 lots for single-family homes in the approved Bent Grass Residential Filing No. 2 development, and the Bent Grass East Commercial development. There is an existing mobile home with accompanying sheds and utility garages just north of the Bent Grass Residential Filing 1. There are also two vacant parcels just northwest of the intersection of Meridian/Bent Grass Meadows with a total area of 7.94 acres. Although there are no known plans to develop these parcels at this time, previous studies have assumed they would be developed with a mix of retail and office uses.

The Bent Grass East Commercial development has been divided into nine traffic analysis zones. The location of each zone is shown in Figure 2. The existing and future land uses assumed for each zone are shown in Table 1.

The Bent Grass East Commercial development is partially developed with a gas station with convenience store, a veterinary clinic, and a dental clinic. Plans have been approved to expand the veterinary clinic from 4,171 square feet to 8,342 and to provide additional parking for the dental clinic.

There is currently one vacant lot east of Meridian Park Drive, Lot 1A Bent Grass East Commercial Filing 2A, and one vacant lot west of Meridian Park Drive, Tract BB Bent Grass East Commercial Filing 2B. The south half of Tract BB is planned to be subdivided into four lots. Figure 3 shows the site plan for this area. Access for these lots is planned to Meridian Park Drive aligning with the south 7-Eleven access point and to Bent Grass Meadows Drive about 530 feet west of Meridian Park Drive.

EXISTING ROADWAY AND TRAFFIC CONDITIONS

Area Roadways

The roadways in the study area are identified below, followed by a brief description. Figure 1 shows the roadway system.

- **Meridian Road** is shown on the *El Paso County 2040 Major Transportation Corridors Plan* and the *Preserved Corridor Network Plan* as a four-lane Principal Arterial. Meridian Road was recently expanded from two lanes to four lanes between Woodmen Road and Rolling Thunder and may soon be connected to US Highway 24 (US Hwy 24). The posted speed limit is 55 miles per hour (mph).
- **Bent Grass Meadows Drive** is a Non-Residential Collector that currently extends north from the Woodmen North Frontage Road for about 2,000 feet and west from Meridian Road for about one-half mile. Ultimately, Bent Grass Meadows Drive will be extended further west and then curve south to connect to the existing section north of the Woodmen frontage road. The Bent Grass Meadows Drive/Meridian Road intersection is planned to be signalized in the future, once warrants for signalization are satisfied.

Existing Traffic Conditions

Figure 4 shows the existing morning and afternoon peak-hour traffic volumes at the intersections of Meridian Road/Bent Grass Meadows Drive and Meridian Park Drive/Bent Grass Meadows Drive and the existing 7-Eleven access between these two intersections. The traffic volumes are from traffic counts conducted in the fall of 2018. The traffic count reports are attached.

Existing Levels of Service

Level of service (LOS) is a quantitative measure of the level of congestion or delay at an intersection. Level of service is indicated on a scale from "A" to "F." LOS A represents control delay of less than 10 seconds for unsignalized and signalized intersections. LOS F represents control delay of more than 50 seconds for unsignalized intersections and more than 80 seconds for signalized intersections. Table 2 shows the level of service delay ranges.

Table 2: Intersection Levels of Service Delay Ranges

Level of Service	Signalized Intersections	Unsignalized Intersections
	Average Control Delay (seconds per vehicle)	Average Control Delay (seconds per vehicle) ⁽¹⁾
A	10.0 sec or less	10.0 sec or less
B	10.1-20.0 sec	10.1-15.0 sec
C	20.1-35.0 sec	15.1-25.0 sec
D	35.1-55.0 sec	25.1-35.0 sec
E	55.1-80.0 sec	35.1-50.0 sec
F	80.1 sec or more	50.1 sec or more

(1) For unsignalized intersections if V/C ratio is greater than 1.0 the level of service is LOS F regardless of the projected average control delay per vehicle.

The intersections of Meridian Road/Bent Grass Meadows Drive and Meridian Park Drive/Bent Grass Meadows Drive and the existing 7-Eleven access between these two intersections were analyzed to determine the existing levels of service, based on the unsignalized method of analysis procedures found in the *Highway Capacity Manual, 6th Edition* by the Transportation Research Board. Figure 4 shows the level of service analysis results. The level of service reports are attached.

The eastbound left-turn movement at the stop sign-controlled intersection of Meridian/Bent Grass Meadows is currently operating at LOS F during the morning peak hour and LOS E during the afternoon peak hour. The eastbound right-turn movement is currently operating at LOS D during the morning peak hour and LOS B during the afternoon peak hour.

All movements at the intersection of Meridian Park/Bent Grass Meadows Drive and the 7-Eleven access to Bent Grass Meadows Drive are currently operating at LOS A during the peak hour as stop sign-controlled intersections.

TEMPORARY 7-ELEVEN ACCESS EVALUATION

The access to 7-Eleven on Bent Grass Meadows Drive was permitted and constructed as a temporary access and will be allowed to remain open with continued use, subject to reevaluation should the following occur (from the deviation report submitted):

...traffic operational problems caused by increased traffic volumes begin to occur 2) crash experience of 5 or more crashes during a one-year time period of type that could be corrected through access closure or 3) the volume "trigger points" established in this deviation are reached. Should any of these occur, traffic engineering evaluation of the access would be conducted to determine if 1) the operational and/or problems either occurring or imminently likely with additional traffic volumes are caused by motorists

turning in and out of the access 2) the problems can be remedied through design and modification of the access or 3) as a last resort, the access must be closed.

Volume trigger points proposed are peak-hour volumes using Bent Grass Meadows Drive just west of Meridian Road. A trigger volume of 200 entering and 200 exiting peak-hour trips is the point at which reevaluation should occur as per the foregoing. This 200 is comprised of 89 entering and 89 exiting trips generated by the convenience store/gas station and 110 trips entering and 110 trips exiting to be generated by other commercial lots within the Preliminary Plan area.

To develop the triggers identified above, the SimTraffic traffic simulation model used in the Preliminary Plan traffic study was modified for short-term conditions with the proposed temporary access point. Traffic volumes in addition to the projected convenience store traffic volumes were loaded into the model and operations were simulated numerous times to identify the most logical volume trigger point. The trigger point has been based on 1) the point at which the eastbound left-turn queue extending back from the Meridian/Bent Grass Meadows intersection backed through the temporary access intersection and average of about five percent of the time during the afternoon peak hour and/or 2) the westbound left-turn queue at the temporary site access exceeded one or two vehicles. Queues regularly backing through the site access intersection have the potential to cause different operational and safety problems. Westbound queues at the site access extending back more than one or two vehicle lengths for a period of time can restrict the available distance for traffic turning from Meridian onto Bent Grass to maneuver to the right of these queued left-turning vehicles or stop safely at the back of the left-turn queue. This queue should be monitored most closely. However, the simulation model indicated limited queue occurrence and short queue length and duration due to low opposing volumes arriving from the west along Bent Grass Meadows Drive. This analysis is based on several analysis parameters. These can be found in the attached Synchro analysis sheets. The results can be seen in the attached SimTraffic analysis results printouts. The analysis model used two-stage left turns from Bent Grass Meadows to northbound Meridian Road.

As shown in Figure 4, 402 vehicles were counted on Bent Grass Meadows Drive just west of Meridian Road (219 eastbound vehicles and 183 westbound vehicles) during the morning peak hour.

SHORT-TERM BASELINE TRAFFIC

Figure 5 shows the projected changes to the existing traffic volumes shown in Figure 4, following changes to the road network expected in the short term. These include the completion of Bent Grass Meadows Drive between Meridian Road and the Woodmen frontage road, which is planned with the Bent Grass Residential Filing 2 development and closure of the 7-Eleven access.

Figure 6 shows the additional traffic projected to be added to the area street network in the short term. These volumes include traffic due to the approved expansion of the veterinary clinic located on Bent Grass East Commercial Filing No. 2B Lot 2B and the Bent Grass Residential Filing No. 2 development. The volumes shown in Figure 6 also include an increase in through traffic on Meridian Road, based on a growth rate of 5 percent per year.

TRIP GENERATION

Estimates of the vehicle trips generated by the development of the currently-vacant parcels within Bent Grass East Commercial have been made using the nationally published trip-generation rates found in *Trip Generation, 10th Edition* by the Institute of Transportation Engineers (ITE). Table 1 shows the land use assumed for each vacant parcel within Bent Grass East Commercial. There are currently no plans for the portion of Tract BB just south of Bent Grass Meadows Drive and for Filing 2A Lot 1A. It was assumed that these areas would be developed with similar uses and densities proposed for Tracts A and D. Table 1 also shows a trip-generation estimate for Bent Grass Residential Filings 1 and 2.

The total number of vehicle trips generated has been reduced to take into account the “pass-by” phenomena. A pass-by trip is made by a motorist who would already be on the adjacent roadways regardless of the proposed development, but who stops in at the site while passing by. The motorist would then continue on his or her way to a final destination in the original direction. The pass-by percentages shown on Table 1 are from the *Trip Generation Handbook - An ITE Proposed Recommended Practice, 3rd Edition, 2017* by ITE.

Development of the currently-vacant parcels within Bent Grass East Commercial (not including the approved expansion of the veterinary clinic) can be expected to generate an additional 4,595 vehicle-trips on the average weekday, with about half entering and half exiting in a 24-hour period. During the morning peak hour, which generally occurs for one hour between 6:30 and 8:30 a.m., about 212 additional vehicles would enter and 126 additional vehicles would exit the site. During the afternoon peak hour, which generally occurs for one hour between 4:15 and 6:15 p.m., about 228 additional vehicles would enter and 233 additional vehicles would exit the site.

TRIP DISTRIBUTION AND ASSIGNMENT

The estimated directional distribution of the site-generated traffic volumes on the adjacent roadways is an important factor in determining the site’s traffic impacts. Figure 7 shows the directional distribution estimates for the primary site-generated traffic. The estimates have been based on the following factors: the land use proposed for the site and its location; the existing and planned street and roadway system in the vicinity; and the existing distribution based, on recent traffic counts at the intersection of Meridian/Bent Grass Meadows.

The pass-by trips from Meridian Road were assigned based, in large part, on the magnitude and direction of the existing traffic volumes.

When the distribution percentages (from Figure 7) were applied to the trip-generation estimates (from Table 1), the site-generated traffic volumes on the area roadways were determined. Figure 8 shows the additional site-generated traffic volumes projected, due to development of the currently-proposed land uses assumed for TAZs 5, 6, and 7. Figure 9 shows the additional site-generated traffic volumes, due to development of the remaining vacant parcels within Bent Grass Commercial, based on the land uses assumed for TAZs 8 and 9.

2021 TOTAL TRAFFIC

Figure 10 shows the projected short-term total traffic volumes at the site access point and key adjacent intersections. The short-term total traffic volumes are the sum of the existing traffic volumes (from Figure 4), the short-term changes in existing traffic patterns (from Figure 5), the additional short-term baseline traffic (from Figure 6), site-generated traffic due to TAZs 5, 6, and 7 (from Figure 8), and site-generated traffic due to TAZs 8 and 9 (from Figure 9).

PROJECTED LEVELS OF SERVICE

The intersections of Meridian Road/Bent Grass Meadows Drive and Meridian Park Drive/Bent Grass Meadows Drive were analyzed to determine the projected levels of service, based on the unsignalized method of analysis procedures found in *the Highway Capacity Manual, 6th Edition* by the Transportation Research Board. Synchro was used to analyze the signal-control scenarios. The 7-Eleven access to Bent Grass Meadows Drive was assumed to be closed in the short term. Figure 10 and Table 3 show the level of service analysis results. Table 3 also includes the corresponding vehicular-delay values, for comparison. The level of service technical reports are attached.

The eastbound left-turn movement at the stop sign-controlled intersection of Meridian/Bent Grass Meadows is currently operating at LOS F during the morning peak hour and LOS E during the afternoon peak hour. If signalized, all movements are projected to operate at LOS D or better during the peak hours, based on the projected 2020 total traffic volumes, which assume full buildout of the Bent Grass East Commercial development.

The intersection of Meridian Park/Bent Grass Meadows Drive is projected to operate at LOS B or better for all movements as a stop sign-controlled intersection, based on the projected 2020 total traffic volumes, which assume full buildout of the Bent Grass East Commercial development.

TRAFFIC SIGNAL WARRANT ANALYSIS

Vehicular Volume Traffic Signal Warrants

The combination of major street approach volumes (includes the sum of northbound and southbound approach volumes) and minor street volumes (eastbound and westbound approaches analyzed separately) at the subject intersection were analyzed to determine if the

combination currently exceeds or would exceed the threshold criteria for Eight-Hour and/or Four-Hour Vehicular-Volume Traffic-Signal Warrants in the *2009 Manual on Uniform Traffic Control Devices* (MUTCD). Table 4 shows the warrant evaluation. Table 4 shows the existing condition and the projected traffic condition following buildout of the approved and currently-proposed land uses within Bent Grass East Commercial development (TAZs 4, 5, 6, and 7).

Based on the analysis shown in Table 4, four of the eight hours analyzed currently meet the thresholds for an Eight-Hour Vehicular-Volume Warrant. With the addition of traffic projected to be generated by the approved expansion of the veterinary clinic located on Lot 3B of Filing No. 2B, seven of the eight hours analyzed are projected to meet the threshold. With the addition of traffic projected to be generated by development of the currently-proposed land uses (TAZs 5, 6, and 7) all eight hours analyzed are projected to meet the thresholds.

Two of the eight hours analyzed currently meet the thresholds for a Four-Hour Vehicular-Volume Warrant. A Four-Hour Vehicular-Volume Warrant is projected to be met with the addition of traffic projected to be generated by the approved expansion of the veterinary clinic located on Lot 3B of Filing No. 2B.

Warrant 7 Analysis (Crash Experience)

The following is from the MUTCD:

Support:

01 The Crash Experience signal warrant conditions are intended for application where the severity and frequency of crashes are the principal reasons to consider installing a traffic control signal.

Standard:

02 The need for a traffic control signal shall be considered if an engineering study finds that all of the following criteria are met:

- A. Adequate trial of alternatives with satisfactory observance and enforcement has failed to reduce the crash frequency; and*
- B. Five or more reported crashes, of types susceptible to correction by a traffic control signal, have occurred within a 12-month period, each crash involving personal injury or property damage apparently exceeding the applicable requirements for a reportable crash; and*
- C. For each of any 8 hours of an average day, the vehicles per hour (vph) given in both of the 80 percent columns of Condition A in Table 4C-1 [from the MUTCD] (see Section 4C.02), or the vph in both of the 80 percent columns of Condition B in Table 4C-1 exists on the major-street and the higher-volume minor-street approach, respectively, to the intersection, or the volume of pedestrian traffic is not less than 80 percent of the requirements specified in the Pedestrian Volume warrant. These major-street and minor-street volumes shall be for the same 8 hours. On the minor street, the higher volume shall not be required to be on the same approach during each of the 8 hours.*

The Colorado State Patrol provided LSC with crash data for the intersection of Bent Grass Meadows Drive and Meridian Road from 2015 through November 2018. From December 2017 to November 2018 there were ten reported crashes at this intersection. Eight of the crashes involved an eastbound left-turning vehicle and a southbound through vehicle. The remaining two crashes involved a northbound left-turning vehicle and a southbound through vehicle. In one of these crashes an eastbound left-turning vehicle waiting in the Meridian Road median blocked the line of sight for the northbound left-turning vehicle. All ten of these crashes would be considered susceptible to correction by a traffic-control signal. A copy of these data are attached for reference.

Based on analysis of the available data, item B above has been satisfied, as five or more crashes susceptible to correction by a traffic-control signal were reported in a twelve-month period. Item C is also currently satisfied. Item A would likely need to be discussed with El Paso County. This is the final remaining item before the warrant is satisfied.

ALTERNATIVE INTERSECTION TRAFFIC CONTROL

Per El Paso County requirement, the following are three potential alternatives to a “conventional,” signalized, full-movement intersection, for which analysis results are presented in the preceding paragraph. These include modern roundabout, unsignalized “channelized-T” type intersection, and a “channelized-T” type intersection with a directional traffic signal.

Modern Roundabout Intersection

A modern roundabout intersection at Bent Grass Meadows Drive/Meridian Road would be a multi-lane roundabout.

Advantages

- The delay for the side-street left turn (eastbound approach) would improve from LOS F to LOS C in the short term.
- Generally, modern roundabouts have safety advantages over signal-controlled intersections. This is because crashes tend to be lower speed, there are fewer conflict points, and the types (angle) of crashes tend to be those which generally result in less severe accidents. Granted, conventional-T intersections have significantly fewer conflict points than four-leg conventional intersections.
- A roundabout may be more aesthetically appealing than a traditional signal-controlled intersection and, generally, roundabouts have lower traffic noise levels.
- Long-term operation and maintenance cost is likely to be lower with a roundabout than a traffic signal.

Disadvantages

- It would likely be difficult, if not impossible, to fit a multi-lane roundabout at this location given the limited ROW available on the east side of the intersection.
- The projected afternoon short-term level of service for northbound through movement is projected to be worse than with either stop sign or signal control.
- The travel speed through the intersection compared with a signalized intersection during the signal green phase would be slower for through traffic on Meridian Road. This may adversely affect travel times along the corridor. Also, if and when signalized intersections in the Meridian Road corridor are put into coordination, a roundabout would likely disrupt coordination.

Channelized-T Intersection

The channelized-T-type intersection allows for an intersection with generally lower overall and side-street delay than with a conventional-T intersection and with fewer stops for the through traffic on the major roadway when compared to a conventional signalized-T intersection. An example of a channelized-T-type intersection is at the intersection of US Highway 24 and Garrett Road near Falcon (El Paso County). That particular intersection is signalized with a “directional signal,” but a channelized-T at some locations can also operate as an unsignalized intersection with stop sign control on the minor street (Note: the analysis for this intersection indicates LOS F for the side-street left turn, if not signalized). The raised median configuration would allow for “free” (no stopping) movement for the northbound through movement through the intersection. The eastbound left turn would cross the southbound lanes and into a channelized northbound left-turn acceleration lane for merging into northbound through traffic. This left-turn acceleration lane would need to be added on Meridian Road.

Table 3 shows the level of service results for a signalized and unsignalized channelized-T intersection traffic control.

Advantages

- The intersection of Meridian/Bent Grass Meadows could likely operate at a satisfactory level of service as a stop sign-controlled intersection for longer as an unsignalized, channelized-T intersection than if it were to remain a conventional-T intersection.
- Signal control would be required to maintain an acceptable level of service, the channelized-T configuration would result in lower delay for through traffic, especially for the northbound traffic, which would operate as a free movement. The overall intersection delay is projected to be better with a channelized-T intersection.
- There is the potential, depending on the time of day and traffic volumes, to allow for a longer side-street signal phase, due to one-way signal progression and no red phase for northbound traffic.

Disadvantages

- The channelized-T configuration may only be viable until (and if) a dual eastbound left-turn lane is needed and/or Meridian Road is widened to six lanes. However, either may not occur for many years.
- The channelized-T configuration may be confusing for some drivers and the merging movement into northbound traffic requires a more complex movement than with a signal. However, most motorists entering the intersection from the west would be regular users and would quickly learn to navigate the intersection.
- A channelized-T intersection would require the construction of raised channelizing medians on Meridian Road and the ongoing maintenance of those medians. This would add significant cost to the project.
- The section of Meridian Road between this intersection and the Woodmen Hills Drive/Meridian Road intersection would need to be designed to accommodate a northbound left-turn acceleration lane from Bent Grass Meadows Boulevard, a taper, and a northbound left-turn lane approaching Woodmen Hills Drive. Based on a posted speed limit of 55 mph, the El Paso County Engineering Criteria Manual (ECM) requires a 960-foot-long acceleration lane plus a 222-foot taper. Based on a design speed of 60 mph, the ECM requires a 290-foot-long left-turn lane approaching Woodmen Hills Drive plus storage length. The current lane length is about 700 feet plus a standard-length taper. The total length of the acceleration lane, lane tapers, and existing northbound left-turn lane for Woodmen Hills would be between 2,100 feet (1,880, if a continuous lane with a shared 222' taper length). The total distance between the intersections is about 2,000 feet (centerline to centerline).
- A channelized-T can be more difficult for pedestrians than a conventional signalized intersection. However, there may be ways to better accommodate pedestrians – such as adding a pedestrian-only phase for southbound traffic. More research would be needed regarding pedestrian accommodation.

VEHICLE QUEUING ANALYSIS

For Predicting Closure of 7-Eleven Access

A queuing analysis was performed using Synchro/SimTraffic for Bent Grass Meadows Drive between Meridian Road and Meridian Park Drive to determine when the existing 7-Eleven access, located between these two intersections, would need to be closed or restricted to exit only and right-out only. The 2020 background morning and afternoon peak-hour traffic volumes were entered into the Synchro model. The intersection of Bent Grass Meadows/Meridian was modeled as a signal-controlled intersection. The simulation was run five times. Additional traffic was added until the eastbound left-turn queue approaching Meridian Road was projected to overflow the existing turn lane, the westbound left-turn lane approaching the 7-Eleven access was projected to overflow the existing turn lane, and/or the eastbound right-turn queue approaching Meridian Road blocked the 7-Eleven access. The queuing reports are attached.

When 113 entering and 63 exiting vehicles (representing approximately 50 percent development of the currently-vacant parcels within Bent Grass East Commercial) were added to the projected 2020 background traffic volumes shown in Figure 5, the westbound left-turn queue approaching the 7-Eleven access is projected to exceed the existing turn-lane length. The eastbound right-turn queue approaching Meridian Road is also projected to extend to the 7-Eleven access.

With Closure of the 7-Eleven Access

A queuing analysis was performed using Synchro/SimTraffic for Bent Grass Meadows Drive between Meridian Road and Meridian Park Drive. The 2021 total morning and afternoon peak-hour traffic volumes were entered into the Synchro model. The simulation was run five times. The queuing analysis assumes dual eastbound left-turn lanes and an exclusive eastbound right-turn lane with a southbound acceleration lane on Bent Grass Meadows Drive approaching Meridian Drive. The queuing reports are attached.

Based on the projected 2021 total traffic volumes, the projected maximum eastbound left-turn queue on Bent Grass Meadows Drive approaching Meridian Road is 128 feet. The maximum westbound left-turn queue approaching Meridian Park Drive is 130 feet. These queues could be accommodated if Bent Grass Meadows Drive were restriped as shown in Figure 11.

The projected maximum northbound left-turn queue on Meridian Road approaching Bent Grass Meadows Drive is 170 feet. The existing northbound left-turn lane at this intersection is about 700 feet long.

Southbound Right Turn Lane Storage Length at Meridian/Bent Grass Meadows Drive

There is currently a 340-foot southbound right-turn deceleration lane plus 225-foot taper on Meridian Road approaching Bent Grass Meadows Drive (355 feet plus 225-foot taper to a point about 15 feet south of the PC along the radius). The ECM requires a minimum of 50 feet for storage for auxiliary turn lanes (longer, if necessary, to accommodate projected queues). The existing lane at 580 feet (lane plus taper) provides 50 feet for storage.

From the AASHTO "Green Book" section 9.7.2.2, storage distance (for auxiliary turn lanes): is the distance provided for the storage of the queue of stopped vehicles waiting to turn.

A deceleration lane should be sufficiently long to store the number of vehicles likely to accumulate in a queue during a critical period. The critical period would be when the southbound approach has the green signal and southbound through traffic is proceeding through the intersection. As the southbound right turning traffic and southbound through traffic move on the same phase (the SB green), right turning traffic would accumulate only during unusual circumstances (unusual for this particular intersection) – such as a pedestrian crossing the west leg of the intersection (in which case a right turning vehicle(s) would need to

yield to the pedestrian). The storage length should be sufficient to avoid spillback of turning vehicles into the through-travel lanes waiting for a signal change or for a gap in the opposing traffic flow. No spillback would occur as a result of opposing vehicular traffic flow (northbound left turning traffic), as the southbound right turning traffic and southbound through traffic will move on the same phase and northbound left turning traffic on the permissive phase must give right-of-way to southbound right turning vehicles.

The queuing reports from Synchro are attached showing the projected 95th percentile and 50th percentile queues for this turning movement. These are based on all cycles, for most of which there will not be a conflicting pedestrian. Considering the queue results and the probability of a pedestrian conflict or other unusual circumstance, the current lane will provide sufficient storage length. Also, the queues projected are for the peak periods, during which time the queues would also be longer in the adjacent southbound through lane with higher through volumes on Meridian Road. The queues for the southbound through lanes are significantly longer than the southbound right turn queue would be.

CONCLUSIONS AND RECOMMENDATIONS

Trip Generation

- Development of the currently-vacant parcels within Bent Grass East Commercial can be expected to generate an additional 4,595 vehicle trips on the average weekday, with about half entering and half exiting in a 24-hour period. During the morning peak hour, which generally occurs for one hour between 6:30 and 8:30 a.m., about 212 additional vehicles would enter and 126 additional vehicles would exit the site. During the afternoon peak hour, which generally occurs for one hour between 4:15 and 6:15 p.m., about 228 additional vehicles would enter and 233 additional vehicles would exit the site.

Level of Service

- The eastbound left-turn movement at the stop sign-controlled intersection of Meridian/Bent Grass Meadows is currently operating at LOS F during the morning peak hour and LOS E during the afternoon peak hour. If signalized, all movements are projected to operate at LOS D or better during the peak hours, based on the projected 2021 total traffic volumes, which assume full buildout of the Bent Grass East Commercial development.
- The intersection of Meridian Park/Bent Grass Meadows Drive is projected to operate at LOS B or better for all movements as a stop sign-controlled intersection, based on the projected 2021 total traffic volumes, which assume full buildout of the Bent Grass East Commercial development.

Traffic Signal Warrant Analysis

- As discussed in the Traffic Signal Warrant Analysis section above, a Four-Hour Vehicular-Volume Traffic-Signal Warrant is projected to be met with the addition of traffic projected to be generated by the approved expansion of the veterinary clinic located on Lot 3B of Filing No. 2B. Seven of the eight hours analyzed are projected to meet the threshold for an Eight-Hour Vehicular-Volume Traffic-Signal Warrant. All eight hours analyzed are projected to meet the thresholds with the addition of traffic projected to be generated by the currently-proposed land uses (TAZs 5, 6, and 7).
- **Crash Experience Warrant:** As discussed in the Traffic-Signal Warrant Analysis section above, in order for a Crash-Experience Warrant to be considered, three criteria need to be met. The existing number of reported crashes in the last twelve months and the vehicular volumes at the intersection of Bent Grass Meadows/Meridian meet criteria B and C. Criteria A states, "Adequate trial of alternatives with satisfactory observance and enforcement has failed to reduce the crash frequency." Item A would likely need to be discussed with El Paso County. This is the final remaining item before the warrant is satisfied.

Alternative Intersection Traffic Control

- Please refer to the report section above for discussion and details. Although the analysis indicates lower intersection delay and fewer stops for northbound through traffic with the signalized channelized-T intersection, the conventional signalized intersection is likely a more viable solution, given the added cost of a channelized-T intersection and the identified need for a future eastbound dual left-turn lane at this intersection.

Roadway Improvements

- Table 5 identifies the proposed short-term roadway improvements that will be needed at and just west of the intersection of Meridian Road/Bent Grass Meadows Drive. Figure 10 shows the location of each improvement. Table 5 also gives a recommended trigger for when each improvement will be needed.
- Table 5 also presents potential future improvements which are not proposed at this time. The locations of these future improvements are shown in Figure 12.
- The following auxiliary lanes are already in-place:
 - There is currently a 700-foot single northbound left-turn lane on Meridian Road approaching Bent Grass Meadows Drive. A vehicle queueing analysis indicates that this intersection could continue to operate with a single left-turn lane, based on the 2021 total traffic volumes, which assume buildout of the Bent Grass East Commercial Development.
 - There is currently a ~~34035~~-foot southbound right-turn deceleration lane plus ~~225215~~-foot taper on Meridian Road approaching Bent Grass Meadows Drive (355 feet plus 225 foot taper to a point about 15 feet south of the PC along the radius). e-The ECM requires a minimum of 50 feet for storage for auxiliary turn lanes. The existing lane at 580 feet (lane plus taper) provides 50 feet for storage. Please refer to the queuing

~~analysis section for additional details. —This lane exceeds the length required by the El Paso County Engineering Criteria Manual.~~

* * * * *

Please contact me if you have any questions regarding this report.

Respectfully Submitted,

LSC TRANSPORTATION CONSULTANTS, INC.

By: ~~Kirstin D. Ferrin~~ Jeffrey C. Hodsdon, P.E.
~~Senior Transportation Engineer~~ Principal

JCH:KDF/jas

Enclosures: Tables 1, 3, 4, and 5
Figures 1-12
Crash Reports
Traffic Count Report
Level of Service Reports
Queuing Reports