Traffic Impact Study

Kenwood Road Development

Capital Investment Group

May 25, 2018

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Appendices

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SECTION 1 - EXECUTIVE SUMMARY

Overall Summary and Recommendations

A Traffic Impact Study (TIS) was required by the Ohio Department of Transportation (ODOT) and Hamilton County Engineers Office to determine the off-site roadway impacts that the proposed Kenwood Road Development will have on the adjacent roadway network.

Capital Investment Group plans to redevelop the existing site with a proposed hotel, retail and restaurant space, office space, and low-rise multifamily housing. Parking will be provided for the site and for employees of the Jewish Hospital – Mercy Health.

The site area, shown in **Figure 1**, is located on the west side of Kenwood Road in Hamilton County, OH.

The study area includes seven (7) existing intersections which include one (1) access point to the site on Happiness Way across from the Hospital driveway. Additionally, there are three (3) proposed site access points including one (1) along Happiness Way, one (1) Right-In/Right-Out (RIRO) access point along Kenwood Road, and one (1) access point in the Kenwood Place shopping center. The intersections are numerically identified throughout this study as:

1. Kenwood Road and Galbraith Road
2. Kenwood Road and Kenwood Mall/Hospital Driveway
3. Kenwood Road and Happiness Way
4. Kenwood Road and Kenwood Place/Towne Center
5. Kenwood Road and Orchard Lane
6. Kenwood Road and Montgomery Road (US 22/SR 3)
7. Happiness Way and Site Access 1/Hospital Driveway
8. Happiness Way and Site Access 2
9. Kenwood Road and Site Access 3 (RIRO)
10. Site Access 4 and Kenwood Place Drive

The TIS is scoped to study four (4) different analysis scenarios. The following analysis scenarios were studied for the Weekday AM, Midday, PM, and Saturday, along with Black Friday Midday and PM peak hours:

- Opening Year (2020) Background
- Opening Year (2020) Build
- Horizon Year (2040) Background
- Horizon Year (2040) Build

This TIS analyzes the roadway network for the site traffic volumes as agreed upon within the MOU.

Figure 1: Site Area; Source: Google Earth, N.T.S.

Based on the results of the capacity and queuing analysis, the following improvements are recommended to address the impacts expected on the surrounding roadway network for each applicable scenario. Improvements in 2040 include recommendations from 2020. All turn lane lengths include a 50 foot taper within the recommendations unless stated otherwise.

2020 Background

- No improvements necessary.

2020 Build

- **Intersection 3: Kenwood Road and Happiness Way**
  - Signalize intersection
- **Intersection 7: Happiness Way and Site Access 1/Hospital Driveway**
  - Construct a northbound access driveway with one ingress lane and one egress lane. Align opposite the existing Hospital drive.
- **Intersection 8: Happiness Way and Site Access 2**
  - Construct a northbound access driveway with one ingress lane and one egress lane
- **Intersection 9: Kenwood Road and Site Access 3 (RIRO)**
  - Construct an eastbound access driveway with one right turn only ingress lane and one right turn only egress lane
- **Intersection 10: Site Access 4 and Kenwood Place Drive**
  - Construct a southbound access driveway with one ingress lane and one egress lane to connect with the adjacent development access to Kenwood Road (signalized).

2040 Background

- **Intersection 6: Kenwood Road and Montgomery Road (US 22/SR 3)**
  - Construct a 760 foot right turn lane for the eastbound approach, an 800 foot right turn lane for the northbound approach, and a 300 foot right turn lane for the southbound approach
  - Extend the eastbound left turn lane length to 375 feet
  - Add right turn overlap for all right turn lanes
  - Construct a second left turn lane on all four approaches (375 feet for eastbound, 350 feet for westbound, 420 feet for northbound and 220 feet for southbound)
  - Construct a third northbound and southbound through lane

*Note: These improvements would require a significant amount of right-of-way beyond the control of the developer. These apply without the development of the proposed site.

2040 Build

(2040 Background improvements apply)

- **Intersection 3: Kenwood Road and Happiness Way**
  - Extend the northbound left turn lane length to 300 feet
- **Intersection 6: Kenwood Road and Montgomery Road (US 22/SR 3)**
  - Optimize cycle length

Adjust corridor coordinated timings.

Based on the results of the capacity and queuing analysis for the Black Friday scenarios, the following improvements would be necessary to address the impacts expected on the surrounding roadway network. These improvements are in addition to normal operation. Improvements in 2040 include recommendations from 2020.

2020 Background Black Friday

- **Intersection 6: Kenwood Road and Montgomery Road (US 22/SR 3)**
  - Construct a right turn lane for the northbound approach

2020 Build Black Friday

(2020 Background Black Friday improvements apply)

- **Intersection 3: Kenwood Road and Happiness Way**
  - Signalize intersection
- **Intersection 6: Kenwood Road and Montgomery Road (US 22/SR 3)**
  - Construct a right turn lane for the southbound approach

2040 Background Black Friday

- **Intersection 1: Kenwood Road and Galbraith Road**
  - Construct a right turn lane for the northbound approach and a right turn lane for the southbound approach
  - Provide a second left turn lane for the westbound approach
  - Provide a third southbound through lane
- **Intersection 4: Kenwood Road and Kenwood Place/Towne Center**
  - Construct a right turn lane for the northbound and southbound approaches
  - Provide a second left turn lane for the westbound approach
  - Provide a third through lane for the southbound approach
- **Intersection 5: Kenwood Road and Orchard Lane**
  - Provide a third southbound through lane
- **Intersection 6: Kenwood Road and Montgomery Road (US 22/SR 3)**
  - Construct right turn lanes for the eastbound and southbound approaches
  - Provide a second left turn lane for all approaches
  - Provide a third through lane for all approaches
  - Provide a second westbound right turn lane

2040 Build Black Friday

(2040 Background Black Friday improvements apply)

- **Intersection 1: Kenwood Road and Galbraith Road**
  - Provide a second westbound right turn lane
- **Intersection 3: Kenwood Road and Happiness Way**
  - Extend the northbound left turn lane length

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SECTION 2 – INTRODUCTION

This Traffic Impact Study (TIS) was prepared for the proposed Kenwood Road Development located on the west side of Kenwood Road and south of Happiness Way in Sycamore Township, Hamilton County, Ohio. The study area includes seven (7) existing intersections which include one (1) access point to the site on Happiness Way across from the Hospital driveway. Additionally, there are three (3) proposed site access points including one (1) along Happiness Way, one (1) RIRO access point along Kenwood Road, and one (1) access point in the Kenwood Place shopping center. The intersections are numerically identified throughout this study as:

1. Kenwood Road and Galbraith Road
2. Kenwood Road and Kenwood Mall/Hospital Driveway
3. Kenwood Road and Happiness Way
4. Kenwood Road and Kenwood Place/Towne Center
5. Kenwood Road and Orchard Lane
6. Kenwood Road and Montgomery Road (US 22/SR 3)
7. Happiness Way and Site Access 1/Hospital Driveway
8. Happiness Way and Site Access 2
9. Kenwood Road and Site Access 3 (RIRO)
10. Site Access 4 and Kenwood Place Drive

The purpose of this document is to evaluate the current and future traffic conditions along the existing street network based on the anticipated traffic generated from the proposed development and to determine the most appropriate roadway improvement plan.

Capital Investment Group has retained Woolpert, Inc. to prepare this TIS to evaluate the efficiency of the existing roadway network with the proposed development.

Scope of Work

A TIS scoping meeting was held on March 22, 2018 to develop a Memorandum of Understanding (MOU) dated April 3, 2018 that was revised and approved on May 9, 2018. A copy of the MOU is included in **Appendix 11** for reference.

The scope of work for this study includes:

1. Video turning movement counts were collected on Thursday March 22, 2018 during the hours of 7:00 AM – 7:00 PM and Saturday March 24, 2018 during the hours of 12:00 – 4:00 PM for the studied intersections numbered 1-7. Kenwood Road and Happiness Way (Intersection #3) was counted for 24 hours on Thursday March 22, 2018.
2. The peak hour traffic volumes were determined for the Weekday AM, Midday, PM, and Saturday time periods to determine the related traffic scenarios. Additionally, the Black Friday Midday and PM time periods were analyzed using counts provided by the Hamilton County Engineers Office.
3. A 3.0% annual linear growth rate provided by ODOT was utilized to grow the existing volumes to the Opening Year (2020) and Horizon Year (2040).
4. An analysis to determine the amount of traffic generated by the proposed Kenwood Road Development utilizing the ITE Trip Generation Manual, 10th Edition was completed.
5. The directional distribution was based on the existing traffic network.
6. Based on the directional distribution, the generated traffic volumes were assigned to the adjacent street network to determine the Opening Year and the Horizon Year Build Traffic Volumes.
7. The prepared MOU, including the anticipated traffic volumes, was submitted to Hamilton County and ODOT for preliminary review and approval.
8. The following are the studied traffic scenarios:
   - Opening Year (2020) Background
   - Opening Year (2020) Build
   - Horizon Year (2040) Background
   - Horizon Year (2040) Build

9. Perform turn lane warrants at the unsignalized intersections using the ODOT State Highway Access Management Manual for all studied scenarios listed in item 8.
10. Perform capacity analysis to determine the capacity of the study area intersections during the Weekday AM, Midday, PM, and Saturday, along with Black Friday Midday and PM peak periods for all scenarios listed in item 8.
11. Perform turn lane queuing analysis using the 95th percentile queue length computed by Synchro. ODOT turn lane lengths from the ODOT Location and Design Manual will be used for comparison.
12. Based upon the analysis performed, recommendations will be developed (if needed) to mitigate any traffic impacts that the Kenwood Road Development may have on the adjacent street network. Recommendations will be presented to meet a Level of Service of C or better unless existing is a D.

References

1. Highway Capacity Manual, 5th Edition, Updated 2010, Transportation Research Board.
2. Trip Generation Manual, 10th Edition, Institute of Transportation Engineers' (ITE).
3. Synchro Version 10.
4. Traffic Access and Impact Studies for Site Development, Institute of Transportation Engineers' (ITE).
5. Ohio Manual on Uniform Traffic Control Devices (OMUTCD), 2012, Ohio Department of Transportation (ODOT).
6. ODOT Location and Design Manual, 2014, Ohio Department of Transportation (ODOT).
7. State Highway Access Management Manual, 2003, Ohio Department of Transportation (ODOT).
8. Most recent concept plan prepared by Woolpert

SECTION 3 – EXISTING CONDITIONS

Study Area

The project site is located on the west side of Kenwood Road north of the Kenwood Road and Montgomery Road intersection in Sycamore Township, Hamilton County, Ohio. The study area includes seven (7) existing intersections which include one (1) access point to the site on Happiness Way across from the Hospital driveway. Additionally, there are three (3) proposed site access points including one (1) along Happiness Way, one (1) RIRO access point along Kenwood Road, and one (1) access point in the Kenwood Place shopping center. The intersections are numerically identified throughout this study as:

1. Kenwood Road and Galbraith Road
2. Kenwood Road and Kenwood Mall/Hospital Driveway
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Roadway Network

Galbraith Road is a three-lane undivided east/west Hamilton County maintained urban minor arterial with a posted speed limit of 35 mph that is located north of the site.

Kenwood Road is a five-lane undivided north/south Hamilton County maintained urban minor arterial with a posted speed limit of 35 mph that bounds the site to the east.

Montgomery Road (US 22/SR 3) is a five-lane undivided east/west ODOT maintained principal arterial with a posted speed limit of 40 mph that is located south of the site.

Happiness Way is a two-lane east/west Sycamore Township maintained local road with a posted speed limit of 25 mph that bounds the site to the north.

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Traffic Volumes

Video turning movement counts were collected by Cummins Consulting Services on Thursday March 22, 2018 during the hours of 7:00 AM – 7:00 PM and Saturday March 24, 2018 during the hours of 12:00 – 4:00 PM for the studied intersections numbered 1-7. Kenwood Road and Happiness Way (Intersection #3) was counted for 24 hours on Thursday March 22, 2018. These counts were supplemented by counts provided by Hamilton County and ODOT for the Black Friday analysis.

For the Black Friday peak scenarios, a ratio of the existing volumes to the ODOT provided counts at Kenwood Road and Montgomery Road was calculated and used to project volumes at intersections 1-4 and 7. Count information is included in **Appendix 1. Table 1** shows the peak hours of the intersections that were studied.

ODOT provided a 3.0% annual linear growth rate to grow the collected traffic volumes to 2020 and 2040. The studied traffic volumes for 2020 and 2040 background are shown in **Appendix 3** (Figures C, D, I, and J).

Table 1: Studied Intersections Peak Periods

Intersection	AM Peak Period	Midday Peak Period	PM Peak Period	Saturday Peak Period
1. Kenwood Road and Galbraith Road	7:45-8:45 AM	12:45–1:45 PM	4:45-5:45 PM	1:30-2:30 PM
2. Kenwood Road and Kenwood Mall/Hospital Driveway	7:45-8:45 AM	12:45–1:45 PM	4:30-5:30 PM	2:15-3:15 PM
3. Kenwood Road and Happiness Way	7:45-8:45 AM	11:30 AM–12:30 PM	4:30-5:30 PM	1:30-2:30 PM
4. Kenwood Road and Kenwood Place/Towne Center	7:45-8:45 AM	12:45–1:45 PM	4:45-5:45 PM	3:00-4:00 PM
5. Kenwood Road and Orchard Lane	7:45-8:45 AM	12:15–1:15 PM	4:30-5:30 PM	1:30-2:30 PM
6. Kenwood Road and Montgomery Road (US 22/SR 3)	7:45-8:45 AM	12:00-1:00 PM	4:45-5:45 PM	1:30-2:30 PM
7. Happiness Way and Site Access 1/Hospital Driveway	9:00–10:00 AM	12:30-1:30 PM	4:30-5:30 PM	1:15-2:15 PM

SECTION 4 – PROPOSED DEVELOPMENT

Development Description

Capital Investment Group plans to redevelop the existing with a proposed hotel, retail and restaurant space, office space, and low-rise multifamily housing. Parking will be provided for the site and for employees of the Jewish Hospital – Mercy Health. The development is planned to open in Year 2020.

Access to the site is planned off both Kenwood Road and Happiness Way (to the north). Two access drives off Happiness are proposed, one to the main parking area and a western drive into a parking garage. A right-in/right-out entrance is proposed directly from Kenwood Road. A southern access drive will connect to the adjacent Kenwood Place development, routing traffic through the parking lot to an existing traffic signal on Kenwood Road. See **Figure 2** for the proposed site plan.

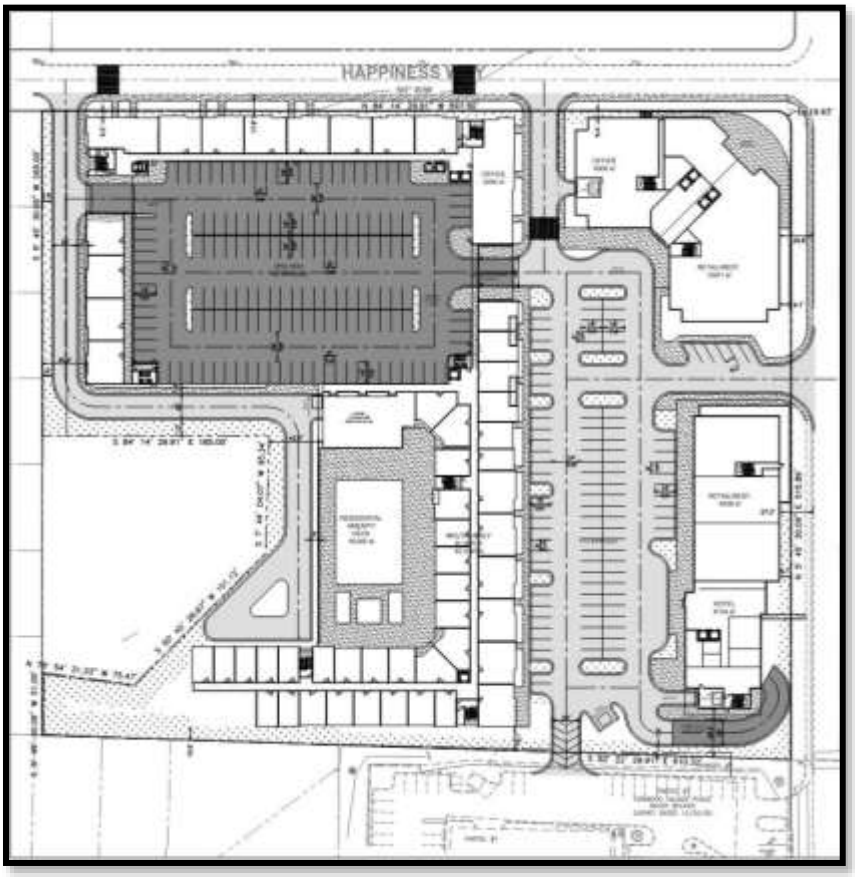

Figure 2: Proposed Site Plan

Trip Generation

Trip Generation was calculated using the ITE Trip Generation Manual, 10th Edition for the proposed Kenwood Road Development. The provided site plan included 259 units of Multifamily Housing (ITE Land Use Code 220), a 120-room hotel (ITE Land Use Code 310), a 108,000 SF multi-level office (ITE Land Use Code 710), 19,122 SF of restaurant space (ITE Land Use Code 932), and 3,250 SF of retail space (ITE Land Use Code 814, shown as Office on site plan). The site plan indicated that a portion of the restaurant space would be fast casual. However, the ITE Trip Generation Manual provides limited data for this land use type. Therefore, the fast-casual space was grouped with the other restaurant space and assumed to be high-turnover sit-down. Because the development is mixed-use, internal capture trip reductions were considered for trips beginning and ending within the development. The PM internal capture rate was utilized for the Midday and Saturday peak hours.

Trip generation was performed for the site in the Weekday AM, Midday, PM, and Saturday peak hours. The ITE Trip Generation Manual provides data for the Weekday AM, PM, and Saturday peak hours. To calculate the Midday peak hour site trips, a time-of-day distribution was applied to the overall weekday trips for each land use. The pass-by percentage and directional distribution for the Saturday peak hour was utilized for the Midday peak hour.

The Kenwood area has a concentration of retail uses, with a large Black Friday/Christmas holiday traffic peak. The ITE Trip Generation Manual does not provide data for holiday peak hours and ODOT's seasonal adjustment factors are not applicable to peak hour traffic, so separate holiday trips were not calculated. Since the AM peak hour site trips are higher than the Midday peak hour trips, the AM peak hour trips were added to the background counts for the Black Friday Midday scenario. The PM peak hour site trips were added to background counts for the Black Friday PM scenario.

The site currently has 24 multi-family housing building (4 units per building). Existing counts showed similar characteristics to ITE Trip Generation data, therefore the existing number of units (96 total) were subtracted from the proposed 259 units, yielding 163 new units for trip generation purposed.

A number parking spaces for Jewish Hospital staff are currently provided across the street, at the Kenwood Towne Center. The volume of hospital employees using the Kenwood Towne Center for parking was approximated using pedestrian counts across the Kenwood Road. Using engineering judgement, it was assumed that the pedestrian counts on the northbound leg at Galbraith Road accounted for approximately 60% of the hospital employee trips in each peak hour, with the remaining 40% at midblock locations and not captured in the counts. This assumption was verified by spot checks in the field on April 2, 2018.

The anticipated site trips for the Weekday AM, Midday, PM, and Saturday peak hours are summarized in **Table 2**. The relocated hospital employee parking trips for the Weekday AM, Midday, PM, and Saturday peak hours are shown in **Table 3**. Calculations for the trip generation are included in **Appendix 2.**

Table 2: Proposed Kenwood Road Development Trip Generation

Land Use Description	ITE Land Use Code	Unit	Site Trips											
			AM Peak Hour			MID Peak Hour			PM Peak Hour			SAT Peak Hour		
			Total	In	Out	Total	In	Out	Total	In	Out	Total	In	Out
Multifamily Housing (Low-Rise)	220	163 Units	76	18	58	65	41	24	91	57	34	143	90	53
Hotel	310	120 Rooms	55	32	23	45	25	20	64	33	31	87	49	38
General Office Building	710	108,000 SF	128	110	18	119	64	55	122	20	102	57	31	26
Variety Store	814	3,250 SF	10	6	4	18	9	9	22	11	11	22	11	11
High-Turnover (Sit-Down) Restaurant	932	19,122 SF	190	104	86	262	134	128	187	116	71	214	109	105
Total Site Trips			**459**	**270**	**189**	**509**	**273**	**236**	**486**	**237**	**249**	**523**	**290**	**233**
Total Internal Capture			**101**	**59**	**42**	**107**	**57**	**50**	**102**	**50**	**52**	**109**	**61**	**49**
Total Site Trips (Driveway)			**358**	**211**	**147**	**402**	**216**	**186**	**384**	**187**	**197**	**414**	**229**	**184**
Total Pass-By Trips			**0**	**0**	**0**	**118**	**59**	**59**	**87**	**43**	**44**	**100**	**50**	**50**
Total Primary Site Trips			**358**	**211**	**147**	**284**	**157**	**127**	**297**	**144**	**153**	**314**	**179**	**134**

Table 3: Hospital Employee Parking Site Trips

Rerouted Trips	AM Peak Hour			MID Peak Hour			PM Peak Hour			SAT Peak Hour		
	Total	In	Out	Total	In	Out	Total	In	Out	Total	In	Out
Hospital Employee Parking (Pedestrians)	47	24	23	14	7	7	29	15	14	0	0	0

Directional Distribution

An analysis of the turning movement counts and population distribution was considered in determining the directional distribution. The percentages are shown in **Table 4** and are broken down by roads within the study area. The limits of distributions were based upon the exterior boundary of the counts taken.

Table 4: Directional Distribution Analysis

Road (To/From Direction)	Distributions by Existing Traffic
Galbraith Road (West)	10%
Galbraith Road (East)	12%
Kenwood Road (North)	20%
Montgomery Road (West)	18%
Montgomery Road (East)	18%
Kenwood Road (South)	22%
Total Percentage	**100%**

Based on the directional distribution shown within **Table 4**, the proposed development's trip generation shown in **Tables 2 and 3** was distributed to the adjacent roadway network and shown in **Appendix 3** (Figures E and F).

An analysis of the turning movement counts and population distribution was considered in determining the directional distribution. The percentages are shown in **Table 4** and are broken down by roads within the study area. The limits of distributions were based upon the exterior boundary of the counts taken.

Opening Year Traffic Volumes

The proposed development's calculated trip generation traffic volumes shown in **Appendix 3** (Figures E and F) were added to the 2020 Background traffic volumes shown in **Appendix 3** (Figures C and D) to develop the 2020 Opening Year Build traffic volumes shown in **Appendix 3** (Figures G and H).

Horizon Year Traffic Volumes

The proposed development's calculated trip generation traffic volumes shown in **Appendix 3** (Figures E and F) were added to the 2040 Background traffic volumes shown in **Appendix 3** (Figures I and J) to develop the 2040 Horizon Year Build traffic volumes shown in **Appendix 3** (Figures K and L).

Signal Warrant Analysis

Initial analyses of Build scenarios with the Happiness Way/Kenwood Road (Intersection #3) as unsignalized showed unacceptable delays for eastbound (Happiness) traffic.

Signal warrant analysis was completed for the intersection of Kenwood Road and Happiness Way (Intersection #3). The PM peak hour volumes for the studied intersection were distributed based upon the hourly profile from the existing 24 hour count taken at the studied intersection. Warrants #1 (Eight Hour Volume) and #2 (Four Hour Volume) were analyzed. The signal is warranted in the 2020 Build and 2040 Build scenarios. The Signal Warrants can be found in **Appendix 4**.

Due to excessive delays experienced without applying a traffic signal on the side streets the build analysis included a traffic signal in the capacity analysis. Installing a traffic signal in this location is not optimal spacing but if coordinated with the corridor signal the progression along Kenwood Road will operate efficiently. The signal will also help mitigate cut through traffic through the adjacent neighborhood that has been a concern.

Turn Lane Analysis

Turn lane warrant analysis was completed at the unsignalized intersections according to the ODOT State Highway Access Management Manual. The results of the peak hour turn lane warrants indicate that at Kenwood Road and Kenwood Mall/Hospital Driveway (Intersection #2), a northbound right turn lane is warranted in the 2040 PM background scenario and a southbound right turn lane is warranted in the 2040 AM background and build scenarios. The turn lane Warrants may be found in **Appendix 5**.

Turn lane queuing analysis was also completed and is included in **Appendix 5**. Storage turn lane lengths were determined by comparing the Synchro 95th Percentile Queue Length and the ODOT Location and Design Manual calculated turn lane length for the AM, Midday, PM, and Saturday time periods. The 95th percentile queue is the queue length that has only a 5-percent probability of being exceeded during the analysis time period. The findings are summarized below in **Table 5** and **Table 6**. The tables show lengths based on the peak volume period for the particular movement to ensure conservative lengths are being considered. The detailed results for all periods are shown in **Appendix 6**. The turn lane lengths include a 50-foot taper.

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Table 5: Opening Year (2020) Queuing Analysis

Movement	Existing Turn Lane Length (Ft.)	Peak Volume Period	Background		Build	
			ODOT Calculated Length (Ft.)	Synchro 95th %tile Queue Length (Ft.)	ODOT Calculated Length (Ft.)	Synchro 95th %tile Queue Length (Ft.)
1. Kenwood Road and Galbraith Road						
EBL	310	PM	593	124	609	124
EBT	-	PM		276		273
EBR	-	MID	394	191	400	208
WBL	250	MID	458	82	457	95
WBT	-	PM		250		248
WBR	540	PM	426	132	448	135
NBL	355	MID	413	116	441	129
NBTR	-	PM	-	313	-	335
SBL	435	AM	494	179	516	175
SBTR	-	PM	-	284	-	300
2. Kenwood Road and Kenwood Mall / Hospital Driveway						
NBL	145	SAT	100		100	
NBTR	-	-	-		-	
SBL	140	SAT	100		100	
SBTR	-	AM	-		-	
3. Kenwood Road and Happiness Way						
EBLR	-	PM	-		-	101
NBL	170	PM	100		525	55
NBT	-	PM	-		-	127
SBT	-	PM				170
SBTR	-	-	-		-	
4. Kenwood Road and Kenwood Plaza / Towne Center						
EBL	-	PM	100	44	150	60
EBTR	-	MID	-	34	-	42
NBL	100	MID	545	17	582	39
NBTR	-	PM	-	336	-	361
SBL	250	SAT	545	36	372	36
SBTR	-	PM	-	302	-	344
5. Kenwood Road and Orchard Lane						
NBL	115	MID	626	m6	667	m5
NBT	-	SAT		32		31
SBTR	-	PM	-	144	-	164
6. Kenwood Road and Montgomery Road (US 22/SR 3)						
EBL	270	PM	528	246	565	#322
EBT	-	PM	-	#535	-	#486
EBR	-	MID	-		-	
WBL	350	PM	515	#397	515	#451
WBT	-	MID		280		280
WBR	550	MID	503	167	515	217
NBL	420	MID	550	#262	581	#293
NBT	-	MID		#513		#554
NBR	-	MID	-		-	
SBL	220	MID	459	#349	482	#404
SBT	-	AM		431		471
SBR	-	MID	-		-	

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Table 6: Horizon Year (2040) Queuing Analysis

Movement	Existing Turn Lane Length (Ft.)	Peak Volume Period	Background		Background W/ Imp	Build		Recommended Length (Ft.) NC = No Change
			ODOT Calculated Length (Ft.)	Synchro 95th %tile Queue Length (Ft.)	Synchro 95th %tile Queue Length (Ft.)	ODOT Calculated Length (Ft.)	Synchro 95th %tile Queue Length (Ft.)	
1. Kenwood Road and Galbraith Road								
EBL	310	PM	885	370	370	901	367	NC
EBT	-	PM		595	595		593	-
EBR	-	MID	606	403	403	605	#444	-
WBL	250	MID	668	#205	#205	667	#247	NC
WBT	-	PM		#526	#526		#524	-
WBR	540	PM	636	357	357	647	371	NC
NBL	355	MID	625	#434	#434	639	#500	NC
NBTR	-	PM	-	#680	#680	-	#686	-
SBL	435	AM	751	#746	#746	772	#755	NC
SBTR	-	PM	-	564	564	-	589	-
2. Kenwood Road and Kenwood Mall / Hospital Driveway								
NBL	145	SAT	100			100		NC
NBTR	-	-	-			-		-
SBL	140	SAT	150			150		NC
SBTR	-	AM	100			100		-
3. Kenwood Road and Happiness Way								
EBLR	-	PM	-			-	200	-
NBL	170	PM	100			804	#92	300
NBT	-	PM	-			-	339	-
SBT	-	PM					486	-
SBTR	-	-	-			-		-
4. Kenwood Road and Kenwood Plaza / Towne Center								
EBL	-	PM	150	79	79	200	96	-
EBTR	-	MID	-	52	52	-	58	-
NBL	100	MID	833	23	23	859	44	100
NBTR	-	PM	-	#801	#801	-	#837	-
SBL	250	SAT	498	57	57	527	57	NC
SBTR	-	PM	-	628	628	-	#763	-
5. Kenwood Road and Orchard Lane								
NBL	115	MID	941	m40	m#126	990	m#159	NC
NBT	-	SAT		m430	458		582	-
SBTR	-	PM	-	477	477	-	549	-
6. Kenwood Road and Montgomery Road (US 22/SR 3)								
EBL	270	PM	805	#741	#299	758	#320	375/375
EBT	-	PM	-	#1052	#651	-	#631	-
EBR	-	MID	745		222	758	208	760
WBL	350	PM	715	#762	#329	665	#320	350/350
WBT	-	MID		#538	#495		454	-
WBR	550	MID	765	453	398	765	421	NC
NBL	420	MID	843	#693	#267	862	#267	420/420
NBT	-	MID		#1060	328		362	-
NBR	-	MID	785		428	800	460	800
SBL	220	MID	669	#628	#236	710	#257	220/220
SBT	-	AM		#830	382		376	-
SBR	-	MID	726		237	749	275	300

The results of the peak hour turn lane queuing and ODOT calculated lengths contained within **Tables 5** and **Table 6** on the previous pages indicate the following:

1. At Kenwood Road and Galbraith Road (Intersection #1), the ODOT calculate lengths for the eastbound, westbound, and northbound left turn length exceeded the existing storage length in all scenarios. It is not recommended to improve these turn lanes since all three turn lanes are back to back with downstream turn lanes, and are not physically able to be lengthened. The southbound left turn length queue exceeds the existing 310 feet turn lane length in all scenarios. It is not recommended to improve this turn lane since the roadway geometrics begin to taper at the end of the current turn lane.

2. At Kenwood Road and Hospital Driveway North/Town Center North (Intersection #2), the ODOT Calculated Length for the southbound left turn length is 150 feet exceeding the available space of 140 feet for the 2040 Background and Build scenarios. It is not recommended to improve this turn lane since the turn lane is back to back with the northbound left turn lane for Intersection #1 and is not physically able to be lengthened.

3. At Kenwood Road and Happiness Way (Intersection #3), the ODOT calculated length for the northbound left turn length exceeds the available space in the 2020 and 2040 Build scenarios. It is recommended to stripe the turn lane length to 300 feet, including a 50 foot taper. It is not recommended to improve this turn lane since this turn lane is constrained by the southbound left turn lane at Intersection #4.

4. At Kenwood Road and Kenwood Place/Towne Center (Intersection #4), the ODOT calculated lengths for the northbound and southbound left turn lengths exceed the available space in all scenarios. It is not recommended to improve these turn lanes since both turn lanes are back to back with downstream turn lanes and the 95th percentile queue length for both turn lanes are less than 60 feet in all scenarios.

5. At Kenwood Road and Orchard Lane (Intersection #5), the ODOT calculated length for the northbound left turn length exceeded the existing 115 foot turn lane length in all scenarios. It is not recommended to improve this turn lane since the turn lane is back to back with the southbound left turn lane for Intersection #6 and is not physically able to be lengthened.

6. At Kenwood Road and Montgomery Road (US 22/SR 3) (Intersection #6), the ODOT calculated lengths for the westbound, northbound, and southbound left turn lengths exceeded the existing turn lane length in the 2040 Background and Build scenarios. All three turn lanes are back to back with downstream turn lanes, and are not physically able to be lengthened. Adding another turn lane to create dual left turn lanes as applied in the 2040 Background scenario with improvements mitigates the excessive queue lengths reported by Synchro. The ODOT calculated length for the eastbound left turn length exceeds the existing 270 foot turn lane length in the 2040 Background and Build scenarios. It is recommended to extend the turn lane length to 375 feet the maximum allowable length as constrained by the driveway access points to the west. In the 2040 Background and Build scenarios it is recommended to construct a right turn lane for the eastbound, northbound, and southbound approaches. The ODOT calculated lengths for the recommended right turn lanes are 760 feet for the eastbound right turn lane, 800 feet for the northbound right turn lane, and 750 feet for the southbound right turn lane. It is recommended to construct he eastbound and northbound approaches based on the ODOT calculated length, but to consider, reviewing access management for upstream driveway access points that align within the recommended right turn lane. It is recommended to extend southbound right turn lane length to only 300 feet, the maximum allowable length as constrained by Orchard Lane to the north, instead of the ODOT calculated length of 750 feet.

All other turn lanes are sized sufficiently for the analyzed peak hours.

Capacity Analysis

Capacity of an intersection is quantified by the Level of Service (LOS), which is based upon the amount of delay a vehicle experiences while at a particular intersection. The criterion for both signalized and unsignalized intersections is shown in **Tables 7 and 8**, respectively, as defined in Chapter 18, 19 and 20 of the Highway Capacity Manual (HCM 2010). Based upon the analysis performed, recommendations will be developed (if needed) to mitigate any traffic impacts that the Kenwood Road Development may have on the adjacent street network. Based upon the analysis performed, recommendations will be developed (if needed) to mitigate any traffic impacts that the Proposed Development may have on the adjacent street network. Recommendations will be presented to meet an overall intersection Level of Service C or better, unless the existing Level of Service is D.

Table 7: Signalized LOS Criteria

Level of Service	Control Delay (seconds/vehicle)
A	*0-10*
B	*>10-20*
C	*>20-35*
D	*>35-55*
E	*>55-80*
F	*>80*

Table 8: Unsignalized LOS Criteria

Level of Service	Control Delay (seconds/vehicle)
A	*<10*
B	*>10-15*
C	*>15-25*
D	*>25-35*
E	*>35-50*
F	*>50*

Capacity analyses were performed for the ten (10) intersections within the study area during the AM, Midday, PM, Saturday, Black Friday Midday, and Black Friday PM peak hours for all studied traffic scenarios, utilizing the corresponding traffic volumes shown in **Appendix 2.** The AM, Midday, PM, Saturday, Black Friday Midday, and Black Friday PM peak hour capacity analyses findings are shown in **Table 9** through **Table 14,** respectively. The Synchro capacity analysis summary sheets are contained in the following appendices: 2020 Background Capacity Analysis Sheets (**Appendix 7**), 2020 Build Capacity Analysis Sheets (**Appendix 8**), 2040 Background Capacity Analysis Sheets (**Appendix 9**), and 2040 Build Capacity Analysis Sheets (**Appendix 10**).

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Table 9: AM Peak Hour Capacity Analysis

Direction	Approach	AM Peak Hour Capacity Analysis				
		Opening Year (2020)		Horizon Year (2040)		
		Background	Build	Background	Background W/ Imp	Build
1. Kenwood Road and Galbraith Road						
Galbraith Road	EB	30.4-C	30.1-C	36.9-D	36.9-D	36.7-D
	WB	28.1-C	27.9-C	32.8-C	32.8-C	34.4-C
Kenwood Road	NB	17.6-B	18-B	40.9-D	40.9-D	54.3-D
	SB	15.7-B	16.8-B	49.5-D	49.5-D	53-D
Intersection Total		**20.3-C**	**20.8-C**	**42.9-D**	**42.9-D**	**48.1-D**
2. Kenwood Road and Kenwood Mall / Hospital Driveway						
Hospital Driveway	EB	29-D	35.5-E	0-A	0-A	0-A
Kenwood Mall	WB	38.9-E	53.5-F	$ 444.3-F	$ 444.3-F	$ 626.1-F
Kenwood Road	NB	0.8-A	0.8-A	1.2-A	1.2-A	1.2-A
	SB	0.2-A	0.1-A	0.2-A	0.2-A	0.2-A
Intersection Total		**1-A**	**1-A**	**4.8-A**	**4.8-A**	**5.1-A**
3. Kenwood Road and Happiness Way						
Happiness Way	EB	17.4-C	20.8-C	43.6-E	43.6-E	35.2-D
Kenwood Road	NB	0.1-A	4.4-A	0.1-A	0.1-A	4.6-A
	SB	0-A	4.7-A	0-A	0-A	5.1-A
Intersection Total		**0.2-A**	**5.7-A**	**0.5-A**	**0.5-A**	**6.3-A**
4. Kenwood Road and Kenwood Plaza / Towne Center						
Kenwood Plaza	EB	33.3-C	33.6-C	33.9-C	33.9-C	33.9-C
Towne Center	WB	31.2-C	31.5-C	30.4-C	30.4-C	31.3-C
Kenwood Road	NB	9-A	11-B	12.5-B	12.5-B	15.3-B
	SB	9.2-A	14.3-B	13.4-B	13.4-B	23.5-C
Intersection Total		**9.5-A**	**13.4-B**	**13.3-B**	**13.3-B**	**20-C**
5. Kenwood Road and Orchard Lane						
Orchard Lane	EB	55.8-E	55.8-E	56-E	56-E	56-E
Kenwood Road	NB	0.2-A	0.3-A	0.1-A	0.6-A	0.7-A
	SB	3.9-A	4-A	6.5-A	6.5-A	6.7-A
Intersection Total		**5-A**	**4.7-A**	**6.2-A**	**6.4-A**	**6.3-A**
6. Kenwood Road and Montgomery Road (US 22/SR 3)						
Montgomery Road	EB	49.9-D	49.3-D	55.7-E	53.4-D	54-D
	WB	43.7-D	45.7-D	38.8-D	47.2-D	47.9-D
Kenwood Road	NB	22.1-C	23.5-C	98.4-F	30.6-C	31.4-C
	SB	37.8-D	38.8-D	89.2-F	43.6-D	44-D
Intersection Total		**36.7-D**	**37.7-D**	**75.9-E**	**42.4-D**	**43-D**
7. Happiness Way and Site Access 1 / Hospital Drive						
Happiness Way	EB	0.7-A	0.3-A	0.7-A	0.7-A	0.4-A
	WB	0-A	5.5-A	0-A	0-A	5.2-A
Site Access 1	NB	N/A	8.9-A	N/A	N/A	9-A
Hospital Drive	SB	8.6-A	10.9-B	8.7-A	8.7-A	11.3-B
Intersection Total		**1.4-A**	**5.8-A**	**1.4-A**	**1.4-A**	**5.6-A**
8. Happiness Way and Site Access 2						
Happiness Way	EB	N/A	0-A	N/A	N/A	0-A
	WB	N/A	4.3-A	N/A	N/A	3.4-A
Site Access 2	NB	N/A	8.5-A	N/A	N/A	8.6-A
Intersection Total		N/A	**4.4-A**	N/A	N/A	**3.4-A**
9. Kenwood Road and Site Access 3 (RIRO)						
Site Access 3 (RIRO)	EB	N/A	12.5-B	N/A	N/A	16.9-C
Kenwood Road	NB	N/A	0-A	N/A	N/A	0-A
	SB	N/A	0-A	N/A	N/A	0-A
Intersection Total		N/A	**0.1-A**	N/A	N/A	**0.1-A**
10. Site Access 4 and Kenwood Place Drive						
Kenwood Place Drive	EB	N/A	0-A	N/A	N/A	0-A
Site Access 10	SB	N/A	8.9-A	N/A	N/A	8.9-A
Intersection Total		N/A	**3.1-A**	N/A	N/A	**3.1-A**

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Table 10: Midday Peak Hour Capacity Analysis

Direction	Approach	MIDDAY Peak Hour Capacity Analysis				
		Opening Year (2020)		Horizon Year (2040)		
		Background	Build	Background	Background W/ Imp	Build
1. Kenwood Road and Galbraith Road						
Galbraith Road	EB	27.8-C	28.1-C	32.3-C	32.3-C	32.9-C
	WB	26.7-C	26.7-C	30.8-C	30.8-C	32.6-C
Kenwood Road	NB	16.9-B	17.7-B	44.9-D	44.9-D	56.6-E
	SB	16.9-B	18.3-B	28.1-C	28.1-C	30.9-C
Intersection Total		**20.9-C**	**21.6-C**	**35-D**	**35-D**	**40.2-D**
2. Kenwood Road and Kenwood Mall / Hospital Driveway						
Hospital Driveway	EB	26.1-D	30.2-D	299.6-F	299.6-F	439.2-F
Kenwood Mall	WB	21.6-C	22.9-C	277.2-F	277.2-F	291.6-F
Kenwood Road	NB	0.3-A	0.3-A	0.5-A	0.5-A	0.5-A
	SB	0.8-A	0.8-A	1.1-A	1.1-A	1.1-A
Intersection Total		**2.4-A**	**2.4-A**	**24.6-C**	**24.6-C**	**25.7-C**
3. Kenwood Road and Happiness Way						
Happiness Way	EB	19-C	19.6-B	58.3-F	58.3-F	36.2-D
Kenwood Road	NB	0.1-A	4.7-A	0.1-A	0.1-A	5.2-A
	SB	0-A	5-A	0-A	0-A	5.6-A
Intersection Total		**0.3-A**	**6.1-A**	**0.8-A**	**0.8-A**	**7.2-A**
4. Kenwood Road and Kenwood Plaza / Towne Center						
Kenwood Plaza	EB	35.4-D	36.3-D	40.2-D	40.2-D	43-D
Towne Center	WB	29.4-C	30-C	47.1-D	47.1-D	57.6-E
Kenwood Road	NB	19.2-B	19.4-B	33.4-C	33.4-C	34-C
	SB	16.5-B	18.8-B	21.1-C	21.1-C	23.2-C
Intersection Total		**19.8-B**	**21-C**	**30.3-C**	**30.3-C**	**32.6-C**
5. Kenwood Road and Orchard Lane						
Orchard Lane	EB	55.6-E	55.6-E	55.9-E	55.9-E	55.9-E
Kenwood Road	NB	0.3-A	0.3-A	0.5-A	1.4-A	1.5-A
	SB	4.1-A	4.3-A	7-A	7-A	7.3-A
Intersection Total		**4.8-A**	**4.6-A**	**6.2-A**	**6.6-A**	**6.6-A**
6. Kenwood Road and Montgomery Road (US 22/SR 3)						
Montgomery Road	EB	53.9-D	53.7-D	165-F	67.9-E	52.3-D
	WB	38.9-D	40.2-D	100.3-F	51.6-D	48.6-D
Kenwood Road	NB	50-D	53.8-D	314.7-F	48.2-D	54.8-D
	SB	50-D	56.9-E	148-F	52.2-D	54.4-D
Intersection Total		**48-D**	**51-D**	**185.5-F**	**54.6-D**	**52.5-D**
7. Happiness Way and Site Access 1 / Hospital Drive						
Happiness Way	EB	1.6-A	1-A	1.6-A	1.6-A	1.1-A
	WB	0-A	6.2-A	0-A	0-A	5.8-A
Site Access 1	NB	N/A	9-A	N/A	N/A	9.2-A
Hospital Drive	SB	8.7-A	12.8-B	8.8-A	8.8-A	13.1-B
Intersection Total		**1.7-A**	**7-A**	**1.8-A**	**1.8-A**	**6.8-A**
8. Happiness Way and Site Access 2						
Happiness Way	EB	N/A	0-A	N/A	N/A	0-A
	WB	N/A	1.7-A	N/A	N/A	1.2-A
Site Access 2	NB	N/A	8.4-A	N/A	N/A	8.5-A
Intersection Total		N/A	**2.1-A**	N/A	N/A	**1.5-A**
9. Kenwood Road and Site Access 3 (RIRO)						
Site Access 3 (RIRO)	EB	N/A	12.5-B	N/A	N/A	16.9-C
Kenwood Road	NB	N/A	0-A	N/A	N/A	0-A
	SB	N/A	0-A	N/A	N/A	0-A
Intersection Total		N/A	**0.2-A**	N/A	N/A	**0.2-A**
10. Site Access 4 and Kenwood Place Drive						
Kenwood Place Drive	EB	N/A	0-A	N/A	N/A	0-A
Site Access 10	SB	N/A	8.8-A	N/A	N/A	8.8-A
Intersection Total		N/A	**3.4-A**	N/A	N/A	**3.4-A**

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Table 11: PM Peak Hour Capacity Analysis

Direction	Approach	PM Peak Hour Capacity Analysis				
		Opening Year (2020)		Horizon Year (2040)		
		Background	Build	Background	Background W/ Imp	Build
1. Kenwood Road and Galbraith Road						
Galbraith Road	EB	28.7-C	28.8-C	52.3-D	52.3-D	48.4-D
	WB	29.8-C	29.7-C	45.7-D	45.7-D	46.6-D
Kenwood Road	NB	19.7-B	19.9-B	60.5-E	60.5-E	66.2-E
	SB	18.1-B	19-B	44.8-D	44.8-D	53.5-D
Intersection Total		**23-C**	**23.3-C**	**50.9-D**	**50.9-D**	**54.8-D**
2. Kenwood Road and Kenwood Mall / Hospital Driveway						
Hospital Driveway	EB	30.9-D	36.3-E	912.2-F	912.2-F	1284-F
Kenwood Mall	WB	44.5-E	54.1-F	1283.4-F	1283.4-F	$ 1697.1-F
Kenwood Road	NB	0.1-A	0.1-A	0.2-A	0.2-A	0.2-A
	SB	0.7-A	0.7-A	1.1-A	1.1-A	1.1-A
Intersection Total		**3.8-A**	**4.2-A**	**100.7-F**	**100.7-F**	**127.3-F**
3. Kenwood Road and Happiness Way						
Happiness Way	EB	23.2-C	22-C	130.5-F	130.5-F	50.8-D
Kenwood Road	NB	0.2-A	5-A	0.3-A	0.3-A	6.2-A
	SB	0-A	5.1-A	0-A	0-A	6.2-A
Intersection Total		**0.4-A**	**6.4-A**	**1.6-A**	**1.6-A**	**8.6-A**
4. Kenwood Road and Kenwood Plaza / Towne Center						
Kenwood Plaza	EB	34.9-C	35.7-D	43.5-D	43.5-D	46.7-D
Towne Center	WB	29.6-C	29.9-C	56.6-E	56.6-E	72.7-E
Kenwood Road	NB	20-C	20.4-C	37.8-D	37.8-D	38.6-D
	SB	17.3-B	20.1-C	25.7-C	25.7-C	30.4-C
Intersection Total		**20.2-C**	**21.8-C**	**34.5-C**	**34.5-C**	**38.3-D**
5. Kenwood Road and Orchard Lane						
Orchard Lane	EB	55.2-E	55.2-E	55.6-E	55.6-E	55.6-E
Kenwood Road	NB	0.3-A	0.3-A	1.9-A	3.6-A	11.6-B
	SB	4.2-A	4.4-A	7.2-A	7.2-A	7.4-A
Intersection Total		**4.4-A**	**4.3-A**	**6.6-A**	**7.4-A**	**11.3-B**
6. Kenwood Road and Montgomery Road (US 22/SR 3)						
Montgomery Road	EB	62.3-E	54-D	259.5-F	53.8-D	59.6-E
	WB	41.1-D	52.6-D	111.7-F	48.8-D	50.8-D
Kenwood Road	NB	54.7-D	53.5-D	233-F	53-D	51.5-D
	SB	59.7-E	59-E	190.7-F	61.2-E	45.2-D
Intersection Total		**54.8-D**	**54.9-D**	**200.8-F**	**54.3-D**	**51.9-D**
7. Happiness Way and Site Access 1 / Hospital Drive						
Happiness Way	EB	0-A	0-A	0-A	0-A	0-A
	WB	0-A	5.2-A	0-A	0-A	4.6-A
Site Access 1	NB	N/A	9-A	N/A	N/A	9.1-A
Hospital Drive	SB	8.8-A	13.2-B	9-A	9-A	13.9-B
Intersection Total		**1.7-A**	**6.5-A**	**1.7-A**	**1.7-A**	**6.2-A**
8. Happiness Way and Site Access 2						
Happiness Way	EB	N/A	0-A	N/A	N/A	0-A
	WB	N/A	2-A	N/A	N/A	1.4-A
Site Access 2	NB	N/A	8.4-A	N/A	N/A	8.5-A
Intersection Total		N/A	**2.8-A**	N/A	N/A	**2.1-A**
9. Kenwood Road and Site Access 3 (RIRO)						
Site Access 3 (RIRO)	EB	N/A	13.1-B	N/A	N/A	18.5-C
Kenwood Road	NB	N/A	0-A	N/A	N/A	0-A
	SB	N/A	0-A	N/A	N/A	0-A
Intersection Total		N/A	**0.2-A**	N/A	N/A	**0.2-A**
10. Site Access 4 and Kenwood Place Drive						
Kenwood Place Drive	EB	N/A	0-A	N/A	N/A	0-A
Site Access 10	SB	N/A	8.8-A	N/A	N/A	8.8-A
Intersection Total		N/A	**3.9-A**	N/A	N/A	**3.9-A**

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Table 12: SAT Peak Hour Capacity Analysis

Direction	Approach	SAT Peak Hour Capacity Analysis				
		Opening Year (2020)		Horizon Year (2040)		
		Background	Build	Background	Background W/ Imp	Build
1. Kenwood Road and Galbraith Road						
Galbraith Road	EB	26.6-C	26.8-C	28.7-C	28.7-C	28.5-C
	WB	25.6-C	25.4-C	27.1-C	27.1-C	27-C
Kenwood Road	NB	13.1-B	13.4-B	18.5-B	18.5-B	19-B
	SB	12.4-B	12.9-B	16.5-B	16.5-B	17.6-B
Intersection Total		**17-B**	**17.3-B**	**20.9-C**	**20.9-C**	**21.3-C**
2. Kenwood Road and Kenwood Mall / Hospital Driveway						
Hospital Driveway	EB	15.5-C	17.4-C	49.8-E	49.8-E	0-A
Kenwood Mall	WB	19-C	22.3-C	176.5-F	176.5-F	243.2-F
Kenwood Road	NB	0.2-A	0.2-A	0.2-A	0.2-A	0.2-A
	SB	1.1-A	1-A	1.3-A	1.3-A	1.3-A
Intersection Total		**3.9-A**	**4-A**	**30.1-A**	**30.1-D**	**38.8-C**
3. Kenwood Road and Happiness Way						
Happiness Way	EB	11.5-B	17.1-B	15.8-C	15.8-C	21.9-C
Kenwood Road	NB	0.2-A	4.7-A	0.2-A	0.2-A	4.7-A
	SB	0-A	4.6-A	0-A	0-A	4.5-A
Intersection Total		**0.2-A**	**5.8-A**	**0.3-A**	**0.3-A**	**5.8-A**
4. Kenwood Road and Kenwood Plaza / Towne Center						
Kenwood Plaza	EB	36-D	36.6-D	36.9-D	36.9-D	37.9-D
Towne Center	WB	33.2-C	34.2-C	92.7-F	92.7-F	108.3-F
Kenwood Road	NB	18.4-B	18.5-B	22.6-C	22.6-C	23-C
	SB	14.9-B	17.4-B	17.7-B	17.7-B	20-C
Intersection Total		**20.7-C**	**21.8-C**	**34.9-C**	**34.9-C**	**37.9-D**
5. Kenwood Road and Orchard Lane						
Orchard Lane	EB	55.5-E	55.5-E	55.7-E	55.7-E	55.7-E
Kenwood Road	NB	0.3-A	0.3-A	0.1-A	0.7-A	0.8-A
	SB	3.5-A	3.6-A	5.3-A	5.3-A	5.5-A
Intersection Total		**4.8-A**	**4.5-A**	**5.4-A**	**5.7-A**	**5.7-A**
6. Kenwood Road and Montgomery Road (US 22/SR 3)						
Montgomery Road	EB	49.4-D	49-D	67.4-E	52.6-D	51.7-D
	WB	40.5-D	41.9-D	50.4-D	65.1-E	47.7-D
Kenwood Road	NB	30.5-C	32.5-C	180.6-F	38-D	48.2-D
	SB	36.2-D	38.1-D	112.2-F	52.5-D	46.9-D
Intersection Total		**38.6-D**	**39.9-D**	**106.8-F**	**51.4-D**	**48.6-D**
7. Happiness Way and Site Access 1 / Hospital Drive						
Happiness Way	EB	0.8-A	0.7-A	1-A	1-A	0.9-A
	WB	0-A	6.7-A	0-A	0-A	6.3-A
Site Access 1	NB	N/A	8.9-A	N/A	N/A	9-A
Hospital Drive	SB	0-A	0-A	0-A	0-A	0-A
Intersection Total		**0.3-A**	**7.4-A**	**0.4-A**	**0.4-A**	**7.1-A**
8. Happiness Way and Site Access 2						
Happiness Way	EB	N/A	0-A	N/A	N/A	0-A
	WB	N/A	0-A	N/A	N/A	0-A
Site Access 2	NB	N/A	0-A	N/A	N/A	0-A
Intersection Total		N/A	**0-A**	N/A	N/A	**0-A**
9. Kenwood Road and Site Access 3 (RIRO)						
Site Access 3 (RIRO)	EB	N/A	10.6-B	N/A	N/A	12.3-B
Kenwood Road	NB	N/A	0-A	N/A	N/A	0-A
	SB	N/A	0-A	N/A	N/A	0-A
Intersection Total		N/A	**0.3-A**	N/A	N/A	**0.2-A**
10. Site Access 4 and Kenwood Place Drive						
Kenwood Place Drive	EB	N/A	0-A	N/A	N/A	0-A
Site Access 10	SB	N/A	8.8-A	N/A	N/A	8.8-A
Intersection Total		N/A	**3.1-A**	N/A	N/A	**3.1-A**

The results of the AM, Midday, PM, and Saturday peak hour capacity analysis shown within **Table 9** through **Table 12** on the previous pages indicates:

2020 Background

During the 2020 PM Background scenario, all intersection total LOS operated at an acceptable level in the Background scenario with the existing infrastructure.

2020 Build

During the 2020 PM Build scenario the intersection of Kenwood Road and Happiness Way (Intersection #3) warrants a signal that was implemented in the Build scenario, capacity remains at an overall intersection LOS A. Without the signal in the PM peak hour the LOS would be a D. Then eastbound approach LOS would be a F with 357.7 seconds of delay. This approach would serve as the main access point to the proposed development and would cause major backups on Happiness Wat.

All other intersection total LOS were maintained at an acceptable level from the Background to Build scenarios with the existing infrastructure.

2040 Background

During the 2040 PM Background scenario, the intersection of Kenwood Road and Kenwood Mall/Hospital Driveway (Intersection #2) degrades to a LOS F. This intersection is un-signalized with the stop controlled minor approaches. The main approaches (Kenwood Road) operate at a LOS A and do not have any upstream or downstream queueing. The minor approaches (Kenwood Mall and Hospital Drive) both have alternative driveways at other signalized locations. There are no recommendations to improve this intersection but the City should monitor this intersection for safety and a possible need for access control.

During the 2040 PM Background scenario, the intersection of Kenwood Road and Montgomery Road (Intersection #6) degrades to a LOS F. To improve the LOS from a F to a D the following improvements were needed:

- Construct a right turn lane for the eastbound, northbound, and southbound approaches.
- Add right turn overlap to the right turns.
- Provide a second left turn lane for all four approaches.
- Provide a third northbound and southbound through lane.

All other intersection total LOS were maintained at an acceptable level in the Background scenario with the existing infrastructure.

2040 Build

At the intersection of Kenwood Road and Montgomery Road (Intersection #6), optimizing the cycle length will maintain the Background LOS D in the Build scenario.

All other intersection total LOS were maintained at an acceptable level from the Background to Build scenarios with the background improvements listed in the 2040 Background section above.

Table 13: Black Friday Midday Peak Hour Capacity Analysis

Direction	Approach	BF MID Peak Hour Capacity Analysis					
		Opening Year (2020)			Horizon Year (2040)		
		Background	Background W/ Imp	Build	Background	Background W/ Imp	Build
1. Kenwood Road and Galbraith Road							
Galbraith Road	EB	37-D	37-D	36.9-D	84.3-F	45.6-D	45.4-D
	WB	33.1-C	33.1-C	34.9-C	113.8-F	49.6-D	48.4-D
Kenwood Road	NB	42.6-D	42.6-D	56.4-E	205.6-F	45.2-D	46.9-D
	SB	51.7-D	51.7-D	55.3-E	357.2-F	46.6-D	51.9-D
Intersection Total		**44.4-D**	**44.4-D**	**49.8-D**	**239.6-F**	**46.5-D**	**49-D**
2. Kenwood Road and Kenwood Mall / Hospital Driveway							
Hospital Driveway	EB	0-A	0-A	0-A	35.3-E	35.3-E	*
Kenwood Mall	WB	$ 496.8-F	$ 496.8-F	$ 654.3-F	$ 10443-F	$ 10443-F	*
Kenwood Road	NB	1.2-A	1.2-A	1.3-A	7.1-A	7.1-A	8.7-A
	SB	0.2-A	0.2-A	0.2-A	0.3-A	0.3-A	0.3-A
Intersection Total		**5.8-A**	**5.8-A**	**5.8-A**	**110.5-F**	**110.5-F**	*
3. Kenwood Road and Happiness Way							
Happiness Way	EB	45.7-E	45.7-E	36.1-D	$ 1397.6-F	$ 1397.6-F	59.5-E
Kenwood Road	NB	0.1-A	0.1-A	4.6-A	0.3-A	0.3-A	14.1-B
	SB	0-A	0-A	5-A	0-A	0-A	16.4-B
Intersection Total		**0.5-A**	**0.5-A**	**6.3-A**	**12.7-A**	**12.7-A**	**16.9-B**
4. Kenwood Road and Kenwood Plaza / Towne Center							
Kenwood Plaza	EB	33.3-C	33.3-C	36.4-D	45.9-D	59.1-E	45.2-D
Towne Center	WB	88.5-F	88.5-F	114-F	335.4-F	67.8-E	58.5-E
Kenwood Road	NB	23.8-C	23.8-C	25.6-C	159.7-F	34.9-C	27.7-C
	SB	18.2-B	18.2-B	20.5-C	61.2-E	30.4-C	47.6-D
Intersection Total		**32.8-C**	**32.8-C**	**37.9-D**	**147.2-F**	**39.5-D**	**40.9-D**
5. Kenwood Road and Orchard Lane							
Orchard Lane	EB	61.6-E	61.6-E	61.6-E	77.1-E	77.1-E	66.5-E
Kenwood Road	NB	0.4-A	0.8-A	0.7-A	28.2-C	22.6-C	58.6-E
	SB	5.8-A	5.8-A	5.9-A	11.7-B	8.7-A	9-A
Intersection Total		**6.1-A**	**6.3-A**	**6.1-A**	**24.5-C**	**20.3-C**	**39.5-D**
6. Kenwood Road and Montgomery Road (US 22/SR 3)							
Montgomery Road	EB	72.5-E	67.2-E	59.4-E	308.8-F	55-E	43.7-D
	WB	49.5-D	48.9-D	51.5-D	165.9-F	54.5-D	51.6-D
Kenwood Road	NB	86.8-F	40.8-D	48.1-D	324.2-F	49.9-D	58.6-E
	SB	70-E	62.3-E	51.3-D	241.5-F	55.3-E	45.1-D
Intersection Total		**70.1-E**	**54.1-D**	**52.3-D**	**261.3-F**	**53.5-D**	**50.1-D**
7. Happiness Way and Site Access 1 / Hospital Drive							
Happiness Way	EB	0.9-A	0.9-A	0.5-A	0.8-A	0.8-A	0.6-A
	WB	0-A	0-A	5.2-A	0-A	0-A	4.8-A
Site Access 1	NB	N/A	N/A	9-A	N/A	N/A	9.1-A
Hospital Drive	SB	8.7-A	8.7-A	11-B	8.9-A	8.9-A	11.5-B
Intersection Total		**1.6-A**	**1.6-A**	**5.6-A**	**1.5-A**	**1.5-A**	**5.2-A**
8. Happiness Way and Site Access 2							
Happiness Way	EB	N/A	N/A	0-A	N/A	N/A	0-A
	WB	N/A	N/A	3.4-A	N/A	N/A	2.6-A
Site Access 2	NB	N/A	N/A	8.6-A	N/A	N/A	8.7-A
Intersection Total		N/A	N/A	**3.4-A**	N/A	N/A	**2.6-A**
9. Kenwood Road and Site Access 3 (RIRO)							
Site Access 3 (RIRO)	EB	N/A	N/A	17-C	N/A	N/A	31.4-D
Kenwood Road	NB	N/A	N/A	0-A	N/A	N/A	0-A
	SB	N/A	N/A	0-A	N/A	N/A	0-A
Intersection Total		N/A	N/A	**0.2-A**	N/A	N/A	**0.2-A**
10. Site Access 4 and Kenwood Place Drive							
Kenwood Place Drive	EB	N/A	N/A	0-A	N/A	N/A	0-A
Site Access 10	SB	N/A	N/A	8.9-A	N/A	N/A	8.9-A
Intersection Total		N/A	N/A	**3.1-A**	N/A	N/A	**3.1-A**

*Computations for Delay and LOS are beyond Synchro computational capacity

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Table 14: Black Friday PM Peak Hour Capacity Analysis

Direction	Approach	BF PM Peak Hour Capacity Analysis					
		Opening Year (2020)			Horizon Year (2040)		
		Background	Background W/ Imp	Build	Background	Background W/ Imp	Build
1. Kenwood Road and Galbraith Road							
Galbraith Road	EB	44-D	44-D	45.9-D	171.1-F	62-E	59.8-E
	WB	46-D	46-D	52.6-D	204.5-F	74.9-E	47.1-D
Kenwood Road	NB	60.3-E	60.3-E	70.5-E	292.4-F	50.8-D	54.6-D
	SB	44.4-D	44.4-D	46.5-D	198.8-F	41.8-D	45.1-D
Intersection Total		**49.2-D**	**49.2-D**	**54.6-D**	**221.3-F**	**54.9-D**	**51.1-D**
2. Kenwood Road and Kenwood Mall / Hospital Driveway							
Hospital Driveway	EB	1061.5-F	1061.5-F	1416.5-F	*	*	*
Kenwood Mall	WB	$ 1142.1-F	$ 1142.1-F	$ 1440.1-F	*	*	*
Kenwood Road	NB	0.2-A	0.2-A	0.2-A	0.4-A	0.4-A	0.4-A
	SB	1.1-A	1.1-A	1.1-A	6.6-A	6.6-A	7.7-A
Intersection Total		**93.1-F**	**93.1-F**	**112.5-F**	*	*	*
3. Kenwood Road and Happiness Way							
Happiness Way	EB	146.2-F	146.2-F	52.2-D	$ 10675-F	$ 10675-F	52-D
Kenwood Road	NB	0.3-A	0.3-A	6.3-A	0.8-A	0.8-A	39.9-D
	SB	0-A	0-A	6.4-A	0-A	0-A	45.4-D
Intersection Total		**1.8-A**	**1.8-A**	**8.8-A**	**120.8-F**	**120.8-F**	**43.2-D**
4. Kenwood Road and Kenwood Plaza / Towne Center							
Kenwood Plaza	EB	37.1-D	37.1-D	38.6-D	50-D	58.3-E	46.4-D
Towne Center	WB	124.8-F	124.8-F	147.7-F	597.3-F	110.5-F	129.6-F
Kenwood Road	NB	24.4-C	24.4-C	25.3-C	106.7-F	38.9-D	24.9-C
	SB	19.9-B	19.9-B	22.2-C	47-D	36.7-D	35.2-D
Intersection Total		**41.1-D**	**41.1-D**	**45.2-D**	**167.5-F**	**51.6-D**	**47.9-D**
5. Kenwood Road and Orchard Lane							
Orchard Lane	EB	60.6-E	60.6-E	60.6-E	70.9-E	70.9-E	60.5-E
Kenwood Road	NB	0.5-A	0.7-A	0.8-A	25-C	12.4-B	26.1-C
	SB	5.5-A	5.5-A	5.7-A	11.8-B	8-A	8.4-A
Intersection Total		**6.1-A**	**6.2-A**	**6.1-A**	**21.2-C**	**13.4-B**	**19.5-B**
6. Kenwood Road and Montgomery Road (US 22/SR 3)							
Montgomery Road	EB	79-E	53.8-D	52.6-D	302.7-F	55.6-E	44.9-D
	WB	56.8-E	55.7-E	61.3-E	143.4-F	49.5-D	51.3-D
Kenwood Road	NB	64.7-E	45.6-D	44.2-D	267.2-F	54.6-D	57.4-E
	SB	78.6-E	63.6-E	58.1-E	263-F	59.9-E	47.7-D
Intersection Total		**69.9-E**	**54.9-D**	**54.1-D**	**244.6-F**	**55.1-E**	**50.4-D**
7. Happiness Way and Site Access 1 / Hospital Drive							
Happiness Way	EB	0-A	0-A	0-A	0-A	0-A	0-A
	WB	0-A	0-A	4.6-A	0-A	0-A	3.9-A
Site Access 1	NB	N/A	N/A	9.2-A	N/A	N/A	9.3-A
Hospital Drive	SB	9-A	9-A	13.9-B	9.3-A	9.3-A	15.2-C
Intersection Total		**1.6-A**	**1.6-A**	**6.2-A**	**1.7-A**	**1.7-A**	**5.8-A**
8. Happiness Way and Site Access 2							
Happiness Way	EB	N/A	N/A	0-A	N/A	N/A	0-A
	WB	N/A	N/A	1.4-A	N/A	N/A	0.9-A
Site Access 2	NB	N/A	N/A	8.5-A	N/A	N/A	8.5-A
Intersection Total		N/A	N/A	**2.1-A**	N/A	N/A	**1.4-A**
9. Kenwood Road and Site Access 3 (RIRO)							
Site Access 3 (RIRO)	EB	N/A	N/A	18.7-C	N/A	N/A	39.3-E
Kenwood Road	NB	N/A	N/A	0-A	N/A	N/A	0-A
	SB	N/A	N/A	0-A	N/A	N/A	0-A
Intersection Total		N/A	N/A	**0.2-A**	N/A	N/A	**0.3-A**
10. Site Access 4 and Kenwood Place Drive							
Kenwood Place Drive	EB	N/A	N/A	0-A	N/A	N/A	0-A
Site Access 10	SB	N/A	N/A	8.8-A	N/A	N/A	8.8-A
Intersection Total		N/A	N/A	**3.9-A**	N/A	N/A	**3.9-A**

*Computations for Delay and LOS are beyond Synchro computational capacity

The results of the Black Friday Midday and PM peak hour capacity analysis shown within **Table 13** and **Table 14** on the previous pages indicates:

2020 Background Black Friday Midday and PM Peak Hour

During the 2020 Black Friday Midday and PM Background scenario, the intersection of Kenwood Road and Kenwood Mall/Hospital Driveway (Intersection #2) degrades to a LOS F with the background traffic. This intersection is unsignalized with the stop controlled minor approaches. The main approaches (Kenwood Road) operate at a LOS A and do not have any upstream or downstream queueing. The minor approaches (Kenwood Mall and Hospital Drive) both have alternative driveways at other signalized locations. There are no recommendations to improve this intersection but the City should monitor this intersection for safety and a possible need for access control.

The intersection of Kenwood Road and Montgomery Road (Intersection #6) degrades to a LOS F with the background traffic. To improve the LOS from a F to a D the following improvements were needed:

- Construct a right turn lane for the northbound approach.
- Add right turn overlap to the right turns.

All other intersection total LOS operated at an acceptable level in the Background scenario with the existing infrastructure.

2020 Build Black Friday Midday and PM Peak Hour

During the 2020 Black Friday Midday and PM Build scenario, the intersection of Kenwood Road and Happiness Way (Intersection #3) warrants a signal that was implemented in the Build scenario, capacity remains at an overall intersection LOS A. Without the signal the LOS would be a F.

The intersection of Kenwood Road and Montgomery Road (Intersection #6) degrades to a LOS F with the background traffic. To improve the LOS from a F to a D the following improvements were needed:

- Construct a right turn lane for the southbound approach.
- Add right turn overlap to the right turns.

All other intersection total LOS were maintained at an acceptable level from the Background to Build scenarios with the existing infrastructure.

2040 Background Black Friday Midday and PM Peak Hour

During the 2040 Black Friday Midday and PM Background scenario, the intersection of Kenwood Road and Galbraith Road (Intersection #1) degrades to a LOS F with the background traffic. To improve the LOS from a F to a D the following improvements were needed:

- Construct a right turn lane for the northbound and southbound approaches.
- Add right turn overlap to the right turns.
- Provide a second left turn lane for the westbound approach.
- Provide a third southbound through lane.

The intersection of Kenwood Road and Kenwood Place/Towne Center (Intersection #4) degrades to a LOS F with the background traffic. To improve the LOS from a F to a D the following improvements were needed:

- Construct a right turn lane for the northbound and southbound approaches.
- Add right turn overlap to the northbound and southbound right turns.
- Provide a second left turn lane for the westbound approach.
- Provide a third southbound through lane.

The intersection of Kenwood Road and Orchard Lane (Intersection #5) operates at an acceptable LOS but with the third southbound through lane at intersections #4 and #6 this lane could be continued on Kenwood Road.

The intersection of Kenwood Road and Montgomery Road (Intersection #6) degrades to a LOS F with the background traffic. To improve the LOS from a F to a D the following improvements were needed:

- Construct a right turn lane for the eastbound, northbound, and southbound approaches.
- Add right turn overlap to the right turns.
- Provide a second left turn lane for all four approaches.
- Provide a third eastbound, westbound, northbound and southbound through lane.
- Provide a second westbound right turn lane.

All other intersection total LOS were maintained at an acceptable level in the Background scenario with the existing infrastructure during the 2040 Background study year.

2040 Build Black Friday Midday and PM Peak Hour

During the 2040 Black Friday PM Build scenario, the intersection of Kenwood Road and Galbraith Road (Intersection #1) degrades to a LOS F with the build traffic. To improve the LOS from a F to a D the following improvements were needed:

- Provide a second westbound right turn lane.

All other intersection total LOS were maintained at an acceptable level from the Background to Build scenario with the background improvements listed in the 2040 Background section above.

SECTION 6 – CONCLUSIONS

Recommendations

Based on the results of the capacity and queuing analysis, the following improvements are recommended to address the impacts expected on the surrounding roadway network for each applicable scenario. Improvements in 2040 include recommendations from 2020. All turn lane lengths include a 50 foot taper within the recommendations unless stated otherwise.

2020 Background

- No improvements necessary.

2020 Build

- **Intersection 3: Kenwood Road and Happiness Way**
  - Signalize intersection
- **Intersection 7: Happiness Way and Site Access 1/Hospital Driveway**
  - Construct a northbound access driveway with one ingress lane and one egress lane. Align opposite the existing Hospital drive.
- **Intersection 8: Happiness Way and Site Access 2**
  - Construct a northbound access driveway with one ingress lane and one egress lane
- **Intersection 9: Kenwood Road and Site Access 3 (RIRO)**
  - Construct an eastbound access driveway with one right turn only ingress lane and one right turn only egress lane
- **Intersection 10: Site Access 4 and Kenwood Place Drive**
  - Construct a southbound access driveway with one ingress lane and one egress lane to connect with the adjacent development access to Kenwood Road (signalized).

2040 Background

- **Intersection 6: Kenwood Road and Montgomery Road (US 22/SR 3)**
  - Construct a 760 foot right turn lane for the eastbound approach, an 800 foot right turn lane for the northbound approach, and a 300 foot right turn lane for the southbound approach
  - Extend the eastbound left turn lane length to 375 feet
  - Add right turn overlap for all right turn lanes
  - Construct a second left turn lane on all four approaches (375 feet for eastbound, 350 feet for westbound, 420 feet for northbound and 220 feet for southbound)
  - Construct a third northbound and southbound through lane

*Note: These improvements would require a significant amount of right-of-way beyond the control of the developer. These apply without the development of the proposed site.

2040 Build

(2040 Background improvements apply)

- **Intersection 3: Kenwood Road and Happiness Way**
  - Extend the northbound left turn lane length to 300 feet
- **Intersection 6: Kenwood Road and Montgomery Road (US 22/SR 3)**
  - Optimize cycle length

Adjust corridor coordinated timings.

Based on the results of the capacity and queuing analysis for the Black Friday scenarios, the following improvements would be necessary to address the impacts expected on the surrounding roadway network. These improvements are in addition to normal operation. Improvements in 2040 include recommendations from 2020.

2020 Background Black Friday

- **Intersection 6: Kenwood Road and Montgomery Road (US 22/SR 3)**
  - Construct a right turn lane for the northbound approach

2020 Build Black Friday

(2020 Background Black Friday improvements apply)

- **Intersection 3: Kenwood Road and Happiness Way**
  - Signalize intersection
- **Intersection 6: Kenwood Road and Montgomery Road (US 22/SR 3)**
  - Construct a right turn lane for the southbound approach

2040 Background Black Friday

- **Intersection 1: Kenwood Road and Galbraith Road**
  - Construct a right turn lane for the northbound approach and a right turn lane for the southbound approach
  - Provide a second left turn lane for the westbound approach
  - Provide a third southbound through lane
- **Intersection 4: Kenwood Road and Kenwood Place/Towne Center**
  - Construct a right turn lane for the northbound and southbound approaches
  - Provide a second left turn lane for the westbound approach
  - Provide a third through lane for the southbound approach
- **Intersection 5: Kenwood Road and Orchard Lane**
  - Provide a third southbound through lane
- **Intersection 6: Kenwood Road and Montgomery Road (US 22/SR 3)**
  - Construct right turn lanes for the eastbound and southbound approaches
  - Provide a second left turn lane for all approaches
  - Provide a third through lane for all approaches
  - Provide a second westbound right turn lane

2040 Build Black Friday

(2040 Background Black Friday improvements apply)

- **Intersection 1: Kenwood Road and Galbraith Road**
  - Provide a second westbound right turn lane
- **Intersection 3: Kenwood Road and Happiness Way**
  - Extend the northbound left turn lane length