Traffic Impact Analysis

Sieg Property

Albemarle County, Virginia

September 2023



Prepared for:

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Introduction

Riverbend Development is proposing to construct a mixed-use center in the southwest quadrant of the I-64 at U.S. 29 interchange. The original Traffic Impact Analysis (TIA) was submitted in February 2022, and addenda were submitted on June 21, 2022 and February 7, 2023. VDOT issued review comments on the February 7 TIA addendum and Signal Justification Report (SJR) on March 23, 2023. Following are those comments and a response to each:

District Traffic Engineering

1. Page 3 – Can you please explain how the trips for the "Congregate Care Facility" (LU 253) were generated? The ITE Trip Gen Manual lists the variable as "number of dwelling units" and not "beds".

    - Table 5 has been updated to refer to the number of dwelling units instead of beds. The trip calculation is correct.

2. Pages 128 and 138 – Given that a conventional signal is a recommendation per the Developer / Engineer, why was an R-CUT configuration with the Site Driveway / Route 29 intersection signalized not analyzed? The aforementioned configuration would have better v/c ratios than as analyzed in the report.

    - The proposed site driveway was assumed to be unsignalized because we thought VDOT would be opposed to adding a second partial traffic signal on U.S. 29. The R-Cut analysis has been updated to include signalization of the proposed site driveway – see Table 6.

3. Page 141 – Signalizing the main intersection would provide gaps and minimize the potential for the "high-volume weaving area". Lengthening the left turn lane to the main intersection would also help minimize the potential for the "high-volume weaving area".

    - The R-Cut analysis has been updated to include signalization of the proposed site driveway intersection and extending the southbound U-turn lane on U.S. 29 from the U-turn point back to the proposed site driveway – see Table 6.

4. SJR Page 3 – in our review, signalizing the main intersection of the RCUT resulted in lower V/C ratios than presented. Lengthening the left turn lane to the main intersection would also help minimize the potential for "hundreds of outbound drivers per hour to weave across U.S. 29 to the U-turn point". The location of the U-turn point could be further investigated to minimize the impact, if any, for ROW acquisition.

    - The R-Cut analysis has been updated to include signalization of the proposed site driveway intersection and extending the southbound U-turn lane on U.S. 29 from the U-turn point back to the proposed site driveway – see Table 6. The location of the U-turn point is constrained by several factors. It needs to be far enough away from the proposed driveway to allow enough room for outbound drivers to complete the weave maneuver, and also fit within the existing ROW without encroaching into the Moores Creek floodplain on the southeast side of U.S. 29.

5. a) Because US 29 is on the Arterial Preservation Network, should the District Traffic Engineer and District Engineer approve the SJR, the SJR must then be reviewed by the VDOT Central Office.

    - Understood

    b) Treatment of heavy vehicles is inconsistent throughout the TIA and SJR. Synchro defaults are used in some cases but not others; the non-Synchro defaults do not match the 10% shown on the VJuST input sheet.

    - The heavy vehicle percentage on U.S. 29 was increased from 2% to 5% based on the traffic counts. VDOT asked us to assume 10% in the VJuST input sheet in the last review cycle to be conservative. The heavy vehicle percentage has a very small impact on the overall analysis.

c) The VJuST analysis is for an unsignalized RCUT. The maximum V/C ratio appears to be 0.72 for a signalized RCUT.

- The VJuST output has been revised to include comparison with a signalized R-Cut.

d) The SJR should discuss the comparative safety of the options considered (conventional T-intersection, continuous green T intersection, RCUT, and Roundabout).

- A safety comparison has been added to Table 7.

e) In light of the 55 mph speed limit on US 29 and the projected PM peak hour opposing SB thru / NB left volumes (110 vs 1,136 in 2030, 11 vs 1,204 in 2036), permissive phasing for the NB left turn movement at the site entrance would not be allowed. Assume protected-only phasing for the conventional signal option.

- Understood – the results with permitted-only and protected-permitted phasing have been removed from Table 6.

f) Please update the SJR to specifically cite the response to the comment under review as opposed to the generic "See the TIA".

- Done

Scope of the Traffic Impact Analysis

To be consistent with the February 2022 TIA, the study area includes the following intersections:

- U.S. 29 (Monacan Trail) at I-64 Westbound On-Ramp
- U.S. 29 (Monacan Trail) at I-64 Eastbound On-Ramp
- U.S. 29 (Monacan Trail) at Gold Eagle Drive / Teel Lane
- U.S. 29 (Monacan Trail) at Proposed Site Driveway

The site location and study intersections are shown in Figure 1 and Figure 2 shows the revised site plan.

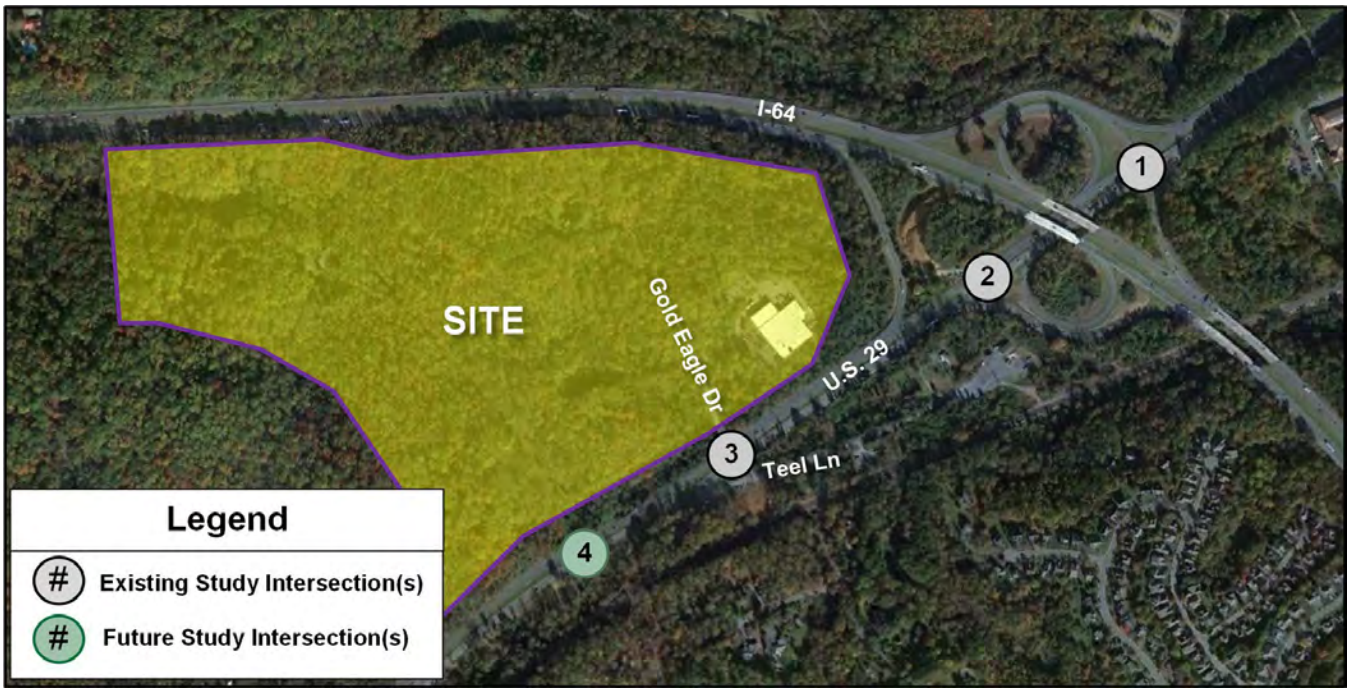


Figure 1: Site Location and Study Intersections



Figure 2: Conceptual Site Plan

Existing (2021) Conditions

Existing Roadway Network

The original TIA dated February 2022 provides a detailed overview of the existing roadway network including speed limits, functional classifications and ADT's. The information from that TIA is repeated in Table 1 below.

Table 1: Existing Roadway Network

Roadway	RTE #	VDOT Classification	Legal/Design Speed Limit (mph)	AADT (vpd)
Interstate 64	I-64	Interstate	65	55,000
Moncan Trail	U.S. 29	Principal Arterial	55	18,000
Teel Lane	1106	Local	25	480
Gold Eagle Drive	F0178	Local	25	360

Note that the speed limit on U.S. 29 is 60 mph southwest of Shepards Hill Road.

Existing (2021) Intersection Capacity Analysis

Capacity analysis was performed at the study intersections during the weekday AM and PM peak hour under the existing conditions. The results from the February 2022 TIA were revised to utilize Highway Capacity Manual (HCM) methodology at the signalized study intersections, the results of which are shown in Table 2. HCM 6th Edition methodology is unable to analyze U-turns and nonconventional NEMA phasing. Therefore, HCM 2000 Signalized methodology was used for signalized intersection analysis. HCM 2000 was also used at the I-64 westbound on-ramp to capture two-stage left-turning vehicle movements. SimTraffic results were used to report queue lengths at all study intersections. *Synchro, Version 10.*3 was used to analyze the study intersections and includes level of service (LOS), delay and queue length comparisons for the turning movements analyzed. Synchro and SimTraffic outputs for the existing (2021) conditions are located in the Appendix. SimTraffic results are from the maximum queue length based on an average of 10 microsimulation runs. Figure 4 from the February 2022 TIA shows the existing (2021) peak hour traffic volumes.

Table 2: Existing (2021) Intersection Capacity Analysis Results

Intersection	Lane Group	Lane Storage (ft.)	AM Peak Hour				PM Peak Hour			
			LOS	Delay (sec)	SimTraffic Queue (ft.)	Overall LOS	LOS	Delay (sec)	SimTraffic Queue (ft.)	Overall LOS
U.S. 29 at I-64 Westbound Ramp	NBL NBT SBT	275 - -	B - -	14.1 - -	86 94 4	N/A	F - -	90.8 - -	360 635 661	N/A
U.S. 29 at I-64 Eastbound Ramp	NBT NBR SBU/L SBT	- 675 350 -	B B B A	13.0 12.2 18.8 0.1	205 104 253 153	B (12.4 Sec)	C C B A	24.2 26.1 17.4 0.3	241 78 302 31	B (13.1 Sec)
U.S. 29 at Gold Eagle Drive / Teel Lane	EBL/T/R WBL/T/R NBU/L NBT/R SBU/L SBT SBR	- - 100 - 100 - 175	E D A - C - -	43.1 27.9 9.4 - 21.1 - -	28 221 14 - 34 - -	N/A	F B B - A - -	56.3 14.4 14.3 - 9.8 - -	52 43 8 - 38 - -	N/A

VDOT SmartScale Improvements

VDOT is planning to close the median break on U.S. 29 at the I-64 westbound on-ramp, and construct a U-turn lane at the U.S. 29 at Fontaine Avenue interchange by 2030. The U-turn point was assumed to be in place for no-build conditions to provide a direct comparison for build conditions. It was assumed that all northbound left-turns at the U.S. 29 at I-64 westbound on-ramp will be rerouted as U-turns at Fontaine Avenue, and then turn right onto the I-64 westbound on-ramp.

Under 2030 no-build conditions, the U-turn volume is projected to be 31 vehicles during the AM peak hour and 37 vehicles during the PM peak hour. The Sieg Property is expected to add 41 vehicles to this movement during the AM peak hour and 61 vehicles during the PM peak hour. Table 3 shows the estimated impact of site trips on this U-turn movement.

Table 3: Projected Peak Hour Traffic on Fontaine Avenue U-Turn

Scenario	U-Turn Volume	
	AM Peak Hour	PM Peak Hour
No-Build (2030)	31	37
No-Build (2036)	33	39
Site Trips	41	61
% Impact in 2030	132%	165%
% Impact in 2036	124%	156%
Build (2030)	72	98
Build (2036)	74	100

The U-turn movement will be unsignalized with the interchange reconfiguration, but there will be a signal immediately to the east where the Fontaine Avenue through lanes cross each other. This signal will create regular gaps in the traffic on Fontaine Avenue that will allow drivers to easily make the U-turn movement. Assuming the signal has a cycle length of 90 seconds (40 cycles per hour), then this project will add just 1 vehicle per cycle in the AM peak hour, and just 1.5 vehicles per cycle in the PM peak hour, which is a minimal impact.

No-Build (2030) Conditions

No-Build (2030) Traffic Volumes

The proposed mixed-use center is expected to be complete by 2030. Regional growth was added to the existing traffic volumes to estimate the no-build (2030) traffic volumes. The results from the February 2022 TIA were updated based on HCM 6th methodology. No-Build (2030) traffic volumes can be viewed on Figure 9 in the February 2022 TIA.

Regional Growth

No-build traffic volumes were estimated by increasing the existing traffic volumes to the build-out year using an annual background growth rate of 1.0% applied to all turning movements in the February 2022 TIA.

Approved Developments

Based on discussion with the County and VDOT, no approved developments were included in the traffic projections, as stated in the February 2022 TIA.

No-Build (2030) Intersection Capacity Analysis

Capacity analysis was performed at the study intersections during the weekday AM and PM peak hour under the no-build conditions. Capacity analysis results utilizing HCM 6th Edition and 2000 methodology, where applicable, are summarized in Table 4. The Synchro and SimTraffic output reports are included in the Appendix.

Table 4: No-Build (2030) Intersection Capacity Analysis Results

Intersection	Lane Group	Lane Storage (ft.)	AM Peak Hour				PM Peak Hour			
			LOS	Delay (sec)	SimTraffic Queue (ft.)	Overall LOS	LOS	Delay (sec)	SimTraffic Queue (ft.)	Overall LOS
U.S. 29 at I-64 Eastbound Ramp	NBT NBR SBU/L SBT	- 675 350 -	B B C A	14.4 13.6 21.1 0.1	226 125 267 194	B (13.8 Sec)	C C B A	27.5 32.0 19.2 0.3	171 102 308 0	B (14.8 Sec)
U.S. 29 at Gold Eagle Drive / Teel Lane	EBR WBL/R NBT/R SBU/L SBT SBR	- - - 100 - 175	A C - C - -	9.7 21.7 - 16.4 - -	21 54 - 34 - -	N/A	B B - B - -	13.6 13.4 - 10.5 - -	35 37 - 48 - -	N/A

All study intersections are expected to operate with acceptable LOS during the no-build conditions.

Build (2030) Conditions

The original site plan from the February 2022 TIA included 475 apartments and 290,000 s.f. of general office space, among several other uses. In the updated site plan, these land uses have been modified:

- Single-Family Detached Housing – Added 60 lots
- Single-Family Attached Housing – Added 240 townhomes
- Multifamily Housing (Mid-Rise) – Increased by 125 apartments
- General Office Space – Decreased by 50,000 s.f.

Site Generated Volumes

The February 2022 TIA estimated the trip potential of the proposed mixed-use center based on the Institute of Transportation Engineers (ITE) *Trip Generation Manual*, 11th Edition. Table 5 shows the trip generation potential of the updated site plan based on the changes previously described.

Table 5: Site Trip Generation – Typical Weekday – 11th Edition

Land Use (ITE Land Use Code)	Size	Average Daily Traffic (vpd)		AM Peak Hour (vph)		PM Peak Hour (vph)	
		Enter	Exit	Enter	Exit	Enter	Exit
Single-Family Detached Housing (210)	60 lots	316	316	12	35	38	23
Single-Family Attached Housing (215)	240 townhomes	889	889	37	82	80	60
Multifamily Housing (Mid-Rise) (221)	600 apartments	1,408	1,408	58	194	143	91
Congregate Care Facility (253)	200 dwelling units	222	222	10	7	18	18
General Office Space (710)	240,000 s.f.	1,301	1,301	321	44	59	287
Strip Retail Plaza (< 40 ksf) (822)	30,000 s.f.	817	817	42	29	99	99
Fast-Casual Restaurants (930)	20,000 s.f.	972	972	14	15	189	154
Convenience Store / Gas Station (4.0 – 5.5 ksf) (945)	5,000 s.f. 12 f.p.	1,543	1,543	162	162	136	137
Brewery Tap Room (971)	5,000 s.f.	154	154	3	0	29	20
Subtotal		7,622	7,622	659	568	791	889
ITE Internal Capture – 3% AM / 10% PM		-495	-495	-18	-18	-84	-84
Driveway Volumes		7,127	7,127	641	550	707	805
ITE Pass-By Trips: Strip Retail Plaza – 34% Fast Casual Restaurant – 43% Brewery – 43% Convenience Store – 76%		 -259 -390 -61 -1,096	 -259 -390 -61 -1,096	 -11 -6 -0 -119	 -11 -6 -0 -119	 -30 -66 -9 -93	 -30 -66 -9 -93
Total Primary Trips		5,321	5,321	505	414	509	607
February 2022 Plan		4,653	4,653	540	285	416	608
Percentage Difference in Primary Trips		**+11%**		**+11%**		**+9%**	

As shown in Table 5, the proposed mixed-use center is anticipated to generate 11% more daily trips than the February 2022 TIA, but the overall LOS results are similar.

Site Trip Distribution

The primary site trip distribution for the proposed mixed-use center is based on existing traffic patterns, surrounding land uses, engineering judgement and input from the County and VDOT. The site trip distribution assumed in the February 2022 TIA is restated below:

- 45% to / from the north on U.S. 29
- 35% to / from the east on I-64
- 10% to / from the west on I-64
- 10% to / from the south on U.S. 29

The pass-by distribution was based on ADT's and existing traffic volumes, and is restated below from the February 2022 TIA:

- AM Peak – 30% southbound / 70% northbound
- PM Peak – 70% southbound / 30% northbound

The primary and pass-by trip distribution are shown in Figure 3 and Figure 4, respectively. The primary and pass-by site trip assignments are shown in Figure 5 and Figure 6, respectively. The total site trips are shown in Figure 7.

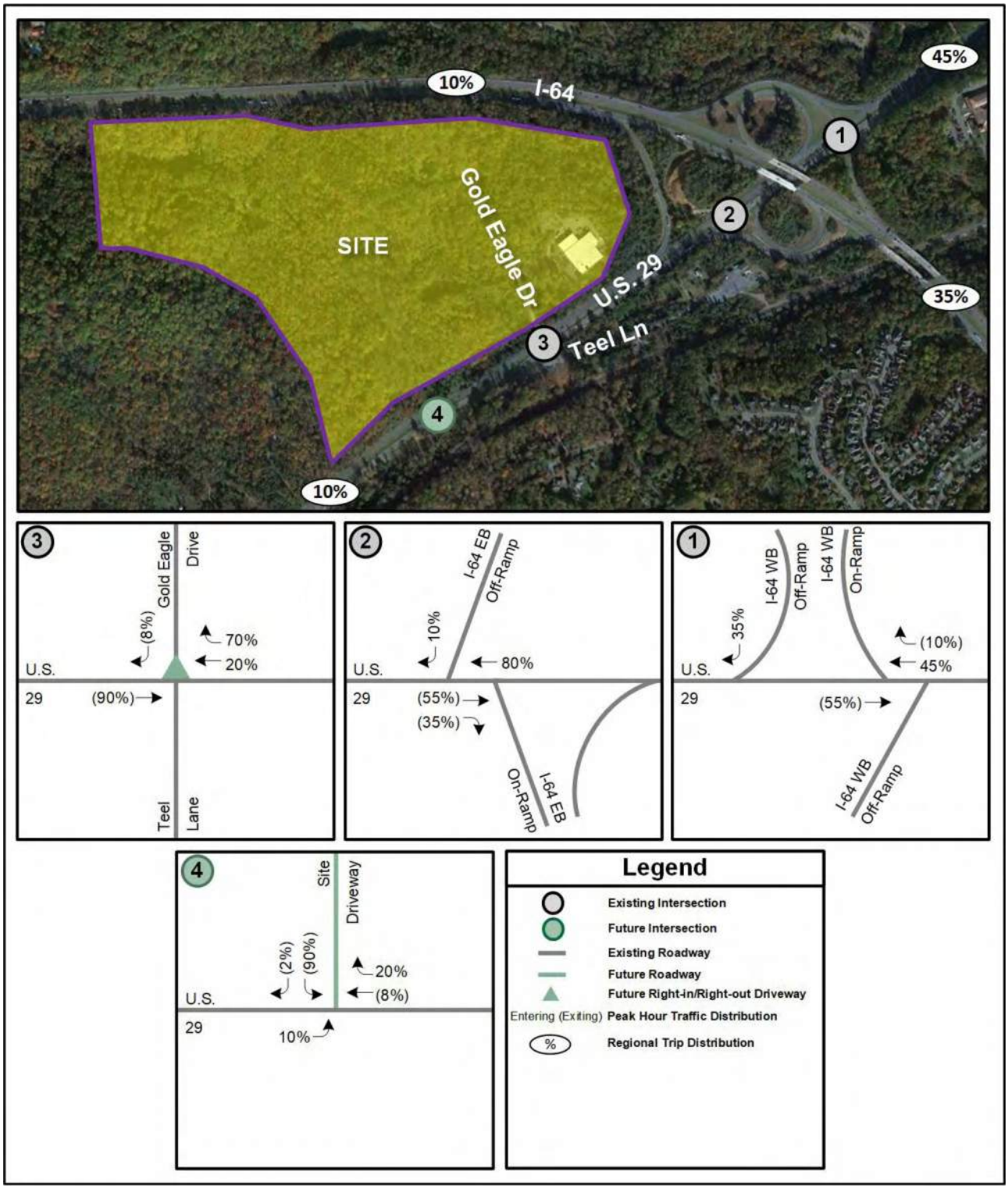


Figure 3: Primary Site Trip Distribution

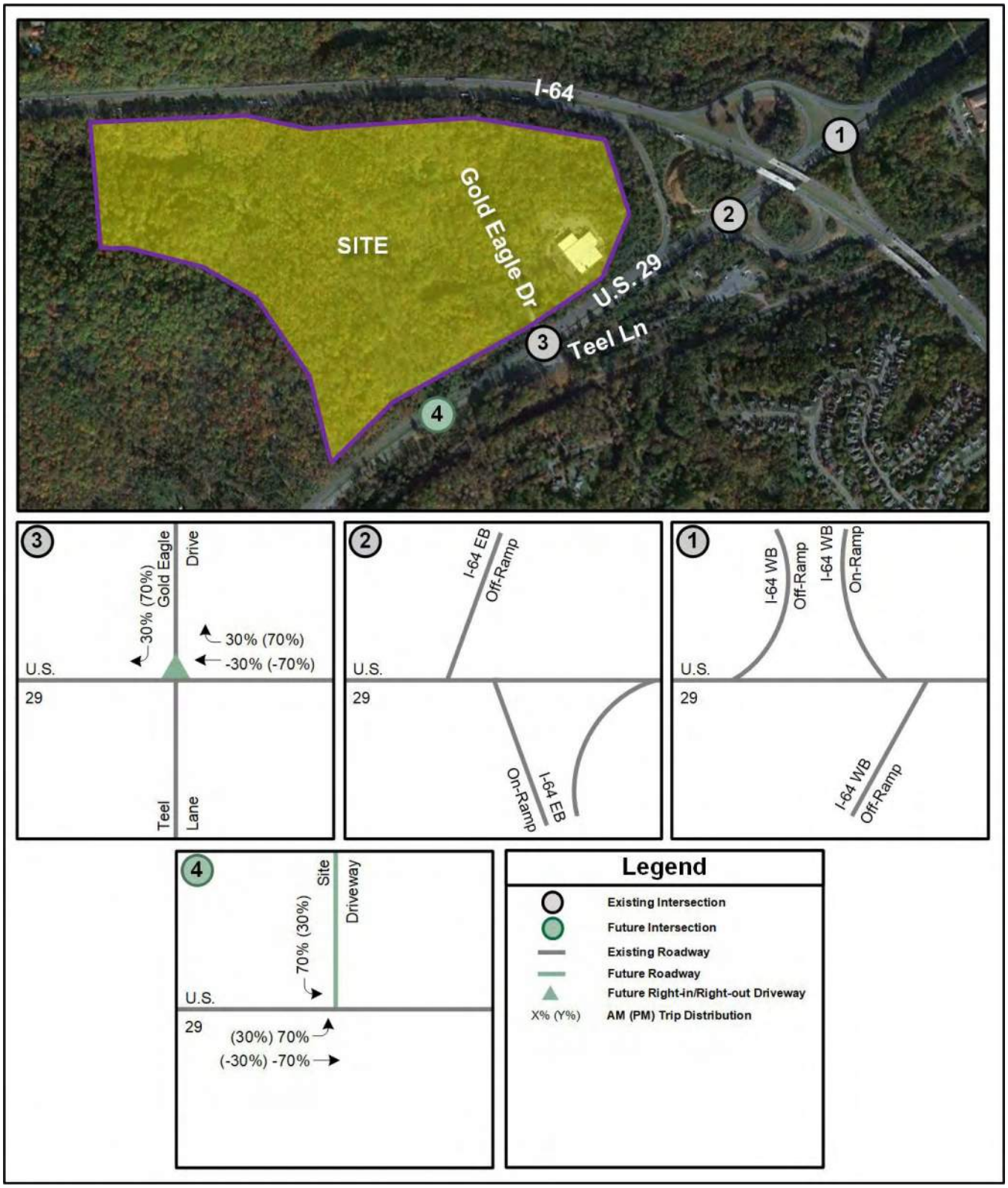


Figure 4: Pass-By Site Trip Distribution

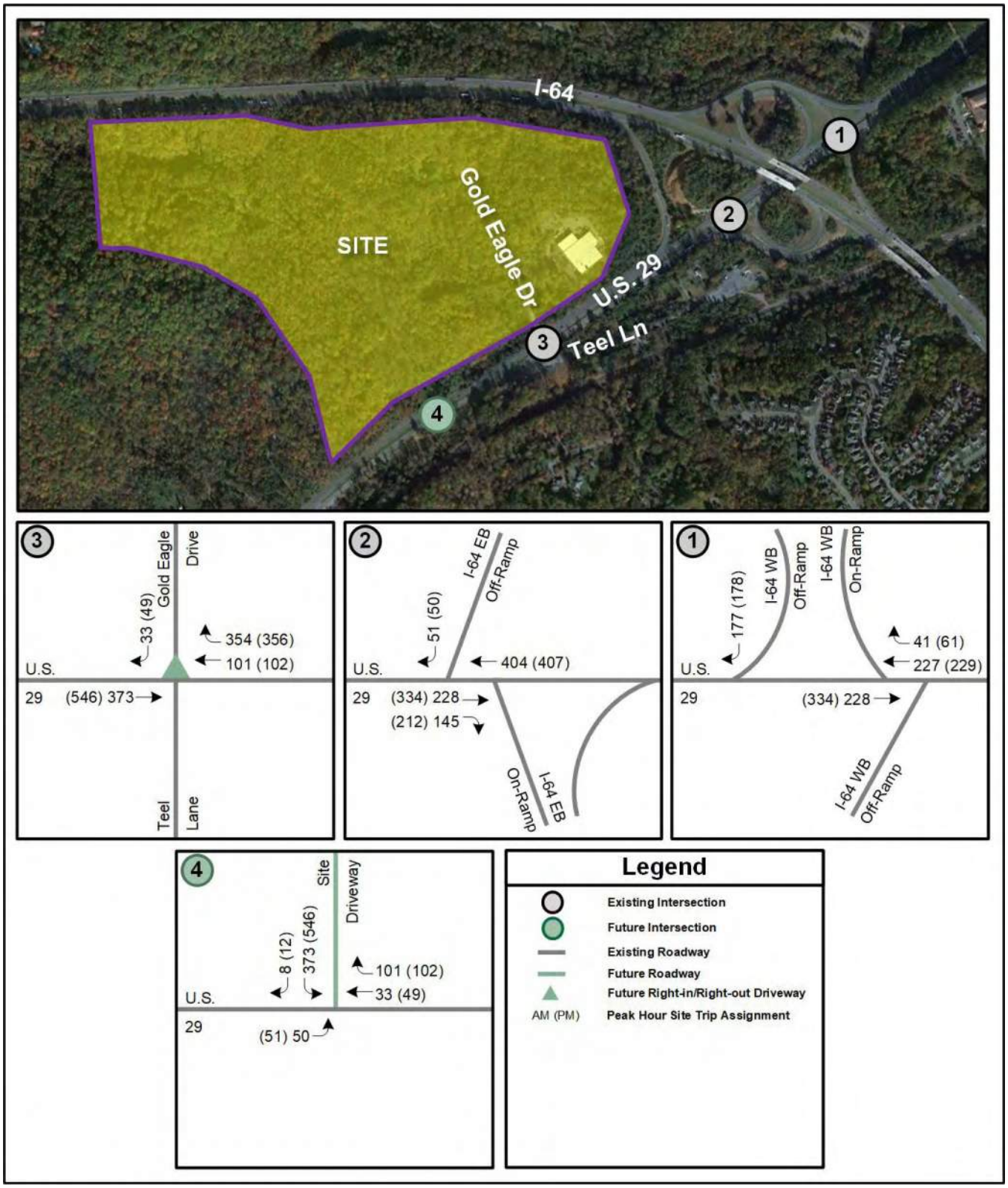


Figure 5: Primary Site Trip Assignment

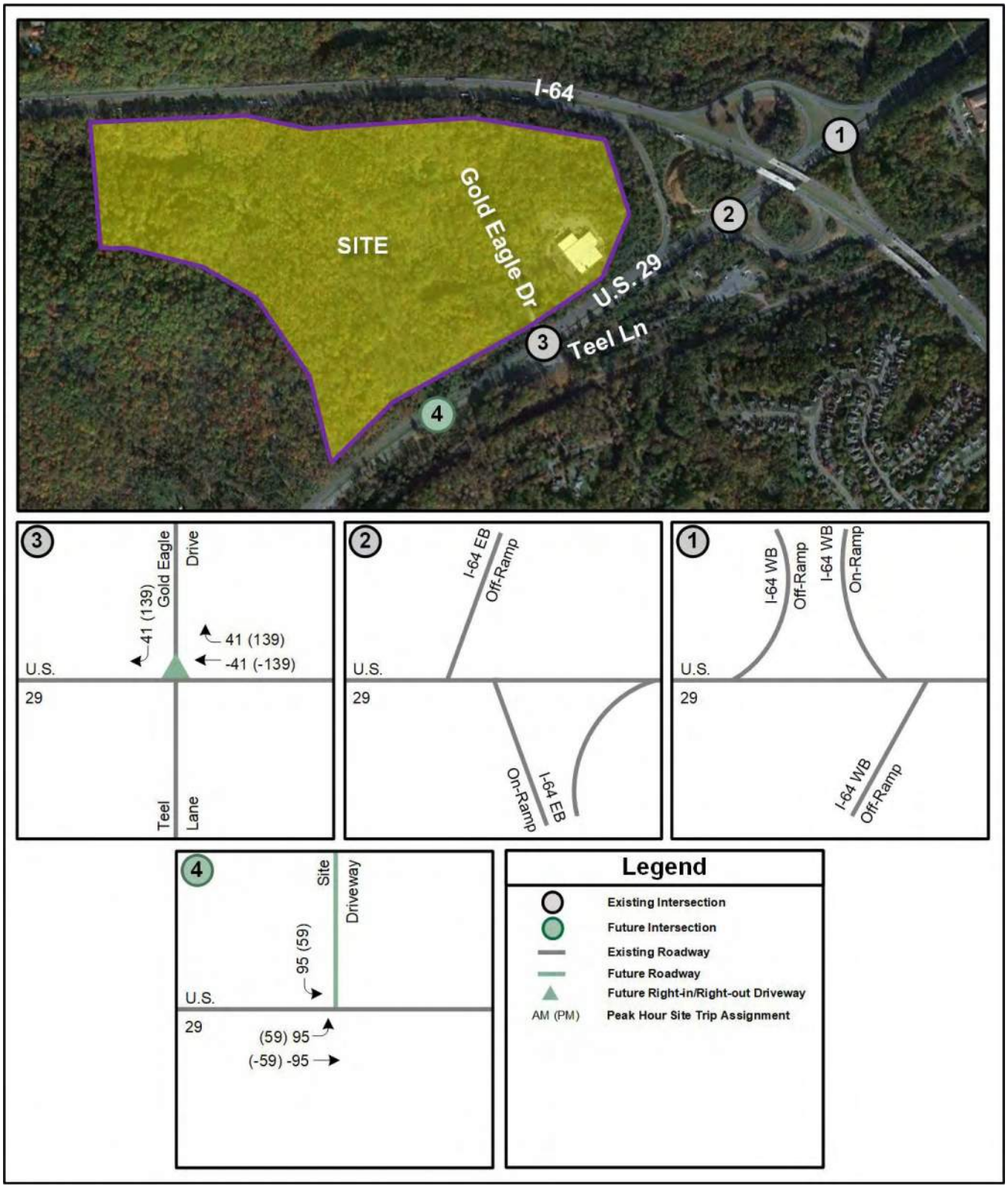


Figure 6: Pass-By Site Trip Assignment

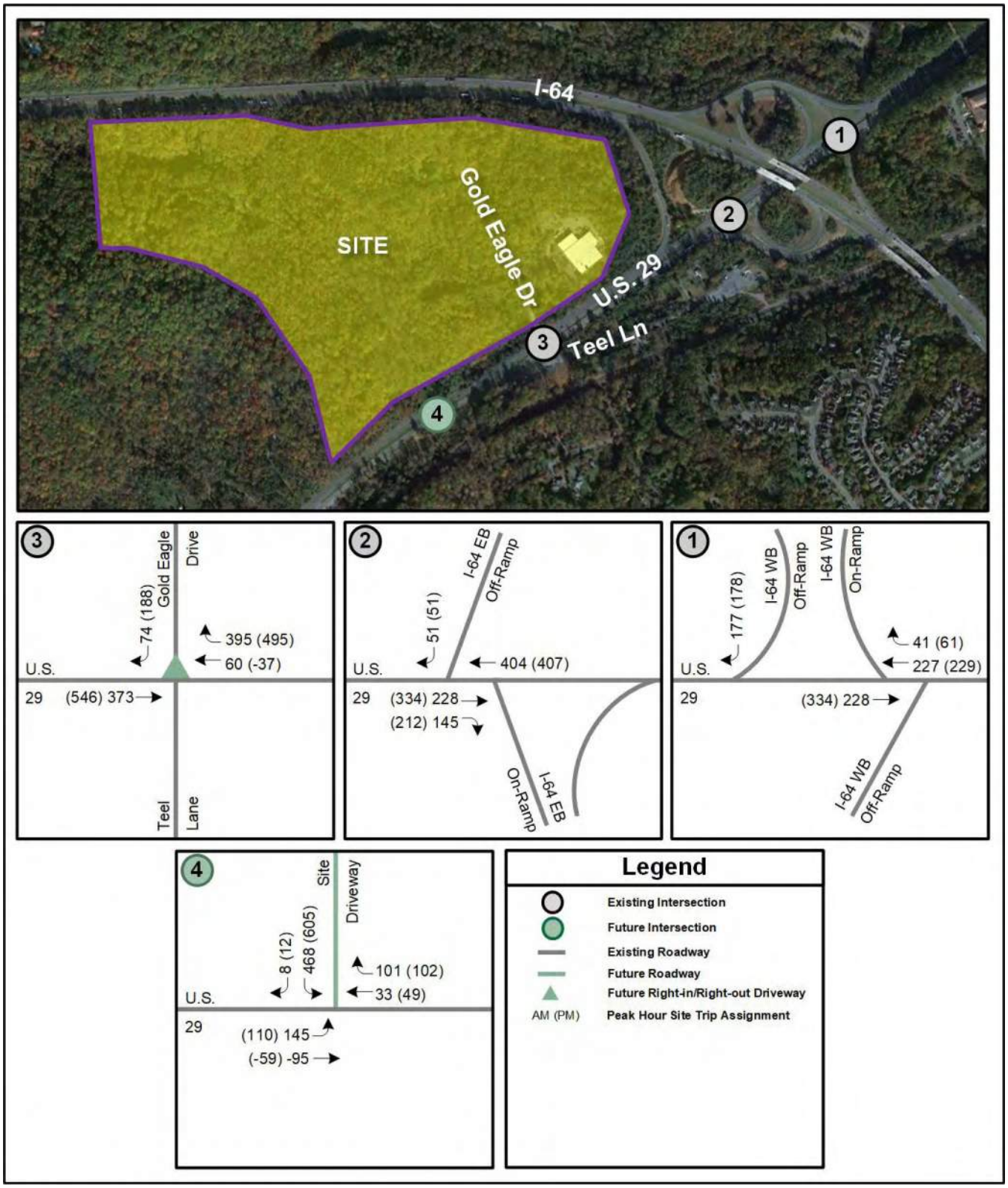


Figure 7: Total Site Trips

Build (2030) Peak Hour Traffic Volumes

The proposed site trips (Figure 7) were added to the no-build 2030 traffic volumes with redirected trips (Figure 9 from the February 2022 TIA) to estimate the build 2030 traffic volumes. The build (2030) peak hour traffic volumes are shown in Figure 8.

Build (2036) Peak Hour Traffic Volumes

The proposed site trips (Figure 7) were added to the no-build traffic 2036 volumes with redirected trips (Figure 10 from the February 2022 TIA) to estimate the build 2036 traffic volumes. The build (2030) peak hour traffic volumes are shown in Figure 9.

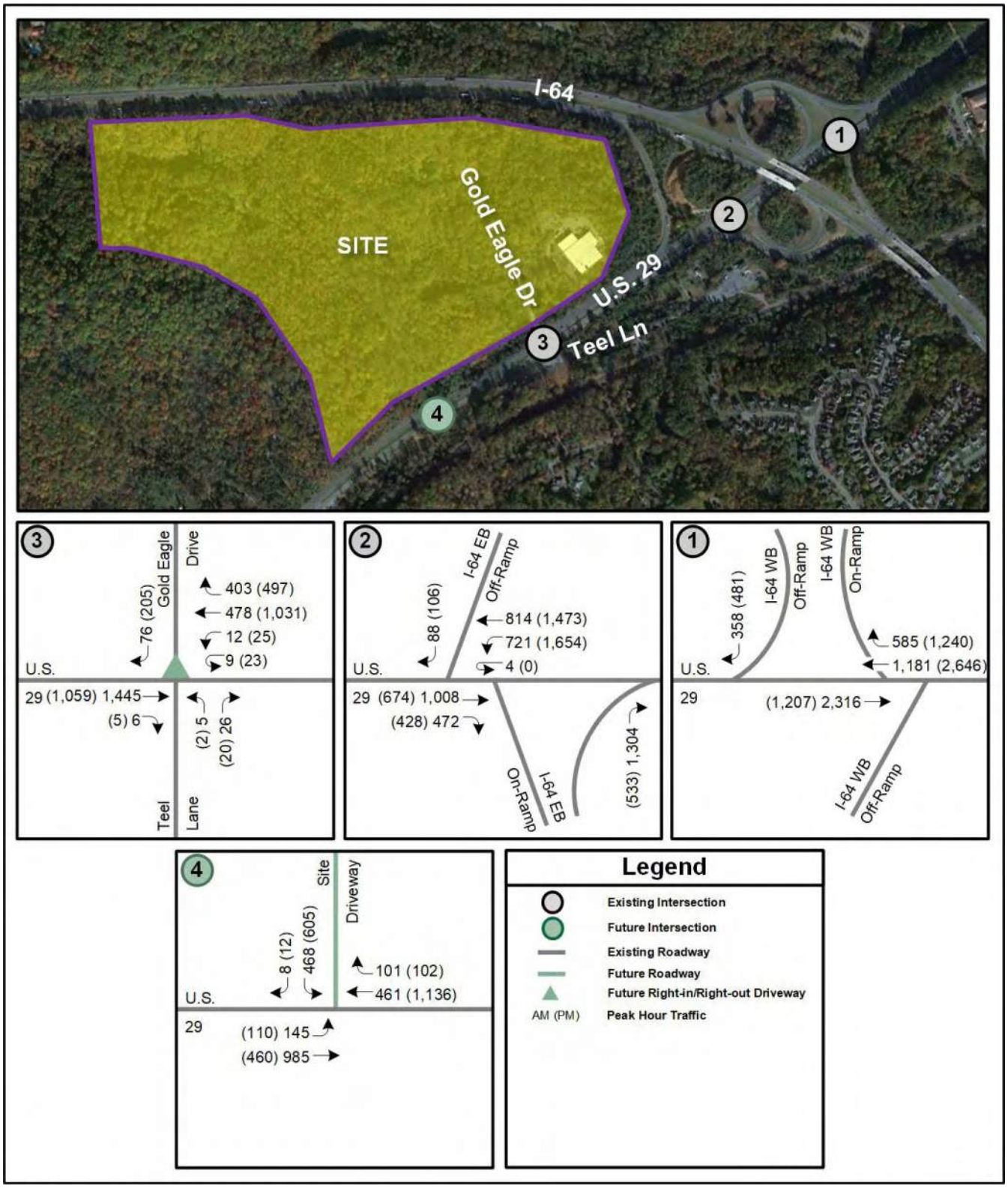


Figure 8: Build (2030) Peak Hour Traffic Volumes

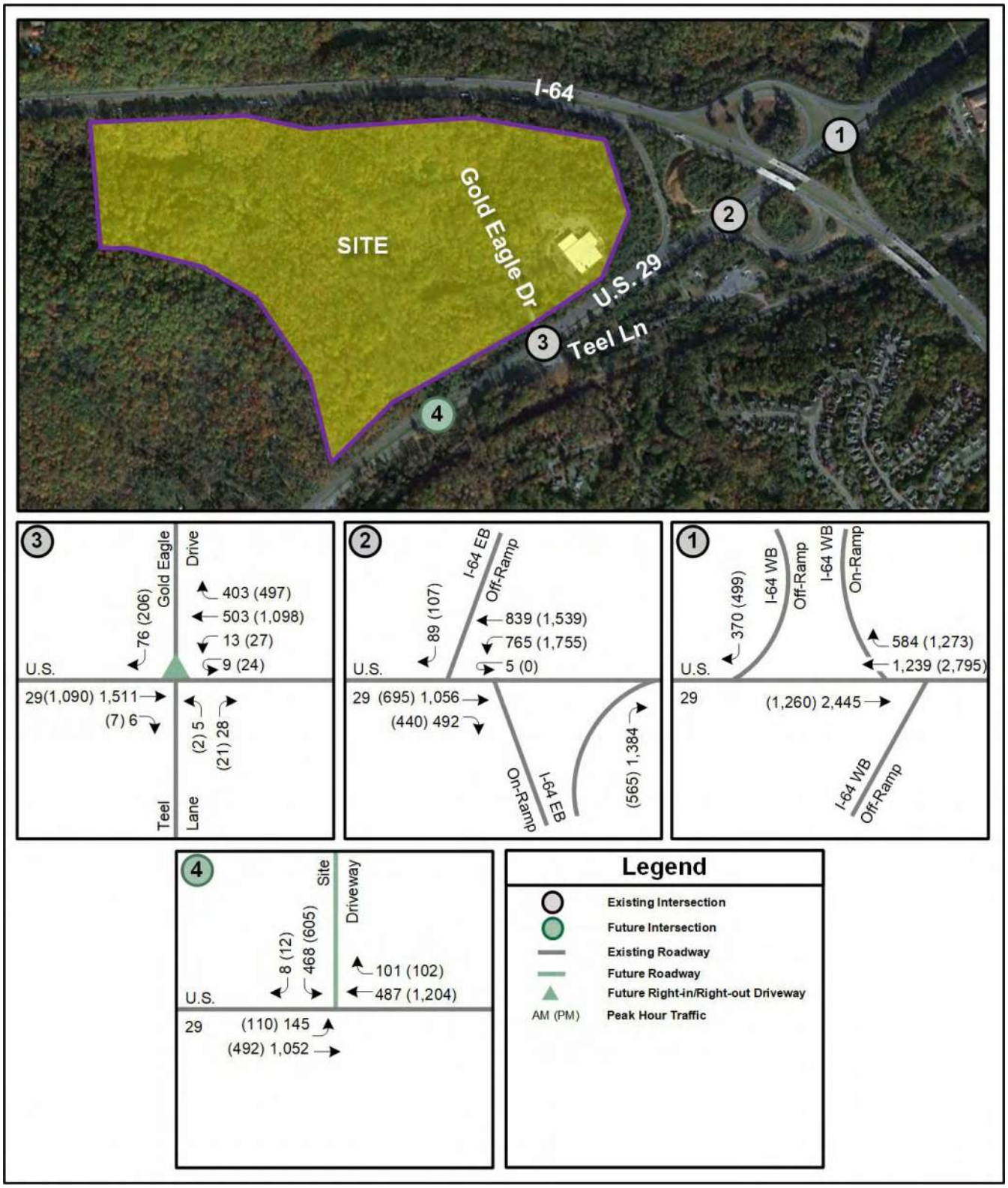


Figure 9: Build (2036) Peak Hour Traffic Volumes

Build (2030) Intersection Capacity Analysis

Capacity analysis was performed at the study intersections during the weekday AM and PM peak hour under build (2030) conditions. SimTraffic queue lengths provided are based on an average of 10 microsimulation runs, except where the intersection was evaluated as a roundabout, where Sidra queues are reported. Those results are summarized in Table 6. The Synchro, SimTraffic and Sidra output reports are included in the Appendix.

Table 6: Build (2030) Intersection Capacity Analysis Results

Intersection	Lane Group	Lane Storage (ft.)	AM Peak Hour				PM Peak Hour			
			LOS	Delay (sec)	SimTraffic Queue (ft.)	Overall LOS	LOS	Delay (sec)	SimTraffic Queue (ft.)	Overall LOS
U.S. 29 at I-64 Eastbound Ramp	NBT NBR SBU/L SBT	- / - 675 350 / 350 - / -	B B D A	16.4 17.6 45.4 0.2	297 148 280 323	B (19.2 Sec)	C E D A	35.0 62.1 37.1 0.4	248 135 320 231	C (26.5 Sec)
U.S. 29 at Gold Eagle Drive / Teel Lane ***(Teel Lane RIRO)***	EBR WBR NBT/R SBT SBR	- - - / - - / - 175	B C - - -	10.8 20.5 - - -	66 76 - - -	N/A	C C - - -	20.0 15.0 - - -	325 49 - - -	N/A
U.S. 29 at Gold Eagle Drive / Teel Lane ***(Teel Lane Full-Movement)***	EBR WBL/R NBT/R SBL/U SBT SBR	- - - / - 100 - / - 175	B E - D - -	10.6 44.7 - 25.8 - -	63 65 - 34 - -	N/A	C D - C - -	19.0 28.9 - 16.5 - -	275 54 - 58 - -	N/A
U.S. 29 at Site Driveway ***Unsignalized***	EBL EBR NBL NBT SBT SBR	- - 200 - / - - / - 200	F A A - - -	1,616.3 9.9 9.5 - - -	935 930 88 - - -	N/A	F B B - - -	4,697.8 13.6 14.3 - - -	1,417 1,428 117 - - -	N/A
U.S. 29 at Site Driveway ***Conventional Signal (Northbound Left Protected Only)***	EBL EBR NBL NBT SBT SBR	- / - 200 200 - / - - / - 200	C B C A B A	24.4 18.3 25.6 8.7 17.6 6.6	198 28 150 154 132 66	B (15.1 Sec)	D C D A C A	41.1 26.4 49.7 7.4 23.4 4.2	283 59 153 127 274 107	C (25.2 Sec)
U.S. 29 at Site Driveway ***Signalized R-Cut***	EBR NBL NBT SBT SBR	- 200 - / - - / - 200	C A A B B	21.1 10.0 0.3 13.0 11.0	320 114 0 152 60	A (7.2 Sec)	D B A C B	44.3 16.8 0.2 30.7 16.0	675 110 0 314 177	C (21.7 Sec)
U.S. 29 at Site Driveway ***Roundabout***	EBL EBR NBL/T NBT SBT SBT/R	- - - - - -	B A C C A A	11.3 6.9 19.8 18.8 5.9 5.8	93 2 218 222 43 43	B (14.0 Sec)	F B B B A A	76.8 10.5 12.9 12.4 10.4 10.3	664 3 91 94 133 133	D (27.5 Sec)
U.S. 29 at Site Driveway ***Signalized Green T***	EBL EBR NBL NBT SBT SBR	- - 200 - / - - / - 200	D B E A C A	46.4 13.2 58.5 0.2 29.0 5.0	506 32 208 112 223 74	C (20.4 Sec)	E B F A E A	76.5 10.8 82.4 0.1 69.4 3.7	756 414 166 0 415 300	D (54.8 Sec)
U.S. 29 at Western Median Break ***Signalized R-Cut***	NBT SBU SBT	- / - - - / -	B C A	17.5 25.9 0.1	0 54 5	B (15.5 Sec)	C C A	22.2 28.7 0.1	0 70 0	B (13.1 Sec)

The intersection of U.S. 29 at I-64 Eastbound Ramp is expected to operate at LOS B during the AM peak hour and LOS C during the PM peak hour at build-out of the site.

The design team has located the proposed driveway on U.S. 29 as far away from the I-64 interchange as possible. There are critical slopes on the northwest side of U.S. 29 between the proposed driveway location and Shepard's Hill Road that prevent the driveway from shifting any further south. The critical slopes are shown in light brown in Figure 10.



Figure 10: Critical Slopes on Northwest Side of U.S. 29

The projected traffic volumes at this intersection will clearly meet all MUTCD traffic signal warrants at build-out of the site. The traffic signal warrant methodology and results are detailed later in this report. The intersection of U.S. 29 at Site Driveway was evaluated with five configurations.

- If unsignalized, the movements out of the site would experience excessive delay and queueing during both peak hours
- With a conventional traffic signal, this intersection is expected to operate at LOS B during the AM peak hour and LOS C during the PM peak hour if the northbound left-turn movement on U.S. 29 is protected-only.

  If the U.S. 29 northbound left-turn movement is protected-only, the average delay for the U.S. 29 southbound through movement would be 17.6 seconds in the AM peak hour and 23.4 seconds in the PM peak hour.

  The proposed conventional traffic signal on U.S. 29 will be coordinated with the existing traffic signal at the I-64 eastbound on-ramp. The proposed signal will not interrupt progression on northbound U.S. 29 because the existing traffic signal at the I-64 eastbound on-ramp restricts northbound U.S. 29 more than the proposed traffic signal. At the I-64 eastbound on-ramp, northbound U.S. 29 receives only **57%** of the green time in the AM peak hour and **38%** of the green time in the PM peak hour because the U.S. 29 southbound left-turn is the dominant movement. At the proposed conventional traffic signal, northbound U.S. 29 will receive **67%** of the green time in the AM peak hour and **69%** of the green time in the PM peak hour, which is a much wider green band than the I-64 eastbound on-ramp.

  The conventional traffic signal is the recommended alternative because it allows Teel Lane to remain full-movement at the existing median break – preserving access to the residents and the VDOT maintenance facility, and it will minimize disruption to U.S. 29 traffic.

  The applicant understands the importance of considering safety when installing a new traffic signal on this segment of U.S. 29. If requested by VDOT, the applicant will install advance signage, rumble strips, flashing beacons, or other appropriate treatment on U.S. 29 to alert drivers to the new traffic signal. The applicant is focused on providing safe and efficient access for the people who will live and work at the site, as well as commuters and travelers driving by on U.S. 29.

- With a two-lane roundabout, the intersection would be expected to operate at an overall LOS B during the AM peak hour and LOS D during the PM peak hour. However, a roundabout is not recommended in this case for several reasons. For more information, refer to the FHWA's National Cooperative Highway Research Program (NCHRP) Report 672 – Roundabouts: An Informational Guide:
    - Roundabouts are generally constructed on local roads, collector roads, neighborhood roads, and shopping centers – not high-speed principal arterials.
    - Section 2.2.3.2 of NCHRP Report 672 says *"Roundabouts tend to treat all movements at an intersection equally, with no priority provided to major movements over minor movements."* In this case, the traffic volumes on U.S. 29 are much higher than the proposed site driveway. The traffic on U.S. 29 is also very directional – 70% northbound in the AM peak hour and 70% southbound in the PM peak hour, which would reduce the efficiency of a roundabout.
    - Section 2.2.8 of NCHRP Report 672 says one of the primary application of roundabouts is as a traffic calming measure to address speeding and cut-through issues. U.S. 29 is a high-speed principal arterial designed for long-range travel, so traffic calming measures are not appropriate
    - A roundabout on U.S. 29 would violate driver expectancy. U.S. 29 is posted 55 mph across the property frontage, and posted 60 mph south of the property. Drivers would have to decelerate to 15 to 20 mph to enter the roundabout, which will create an unnecessary safety hazard.
- With a Green-T traffic signal, this intersection would operate at LOS C during the AM peak hour and LOS D during the PM peak hour. The Green-T configuration is not recommended in this case for the following reasons:
    - The median acceleration lane on U.S. 29 northbound would require the median break at Teel Lane to be closed, thereby restricting Teel Lane to right-in / right-out operation.
    - U.S. 29 southbound would operate at LOS C during the AM peak hour and LOS E during the PM peak hour because this configuration allows only one outbound left-turn lane. With the conventional traffic signal and outbound dual lefts, U.S. 29 southbound will operate at LOS B during the AM peak hour and LOS C during the PM peak hour.
- With an R-Cut configuration, the outbound right-turn movement would operate at LOS C during the AM peak hour and LOS D during the PM peak hour if signalized. It would also require outbound drivers to weave across U.S. 29 southbound to make a U-turn, which would have to be signalized. The R-Cut configuration is not recommended in this case for the following reasons:
    - The U-turn point would require a large bulb-out with a radius of approximately 70 feet to accommodate truck U-turns. The existing beverage distributorship on Gold Eagle Lane will remain in operation, and they generate several loaded trucks each day that would have to U-turn on U.S. 29. Two of the proposed uses – the convenience store and brewery / tap room – will also generate some level of truck traffic that would have to U-turn on U.S. 29.
    - Due to the Moores Creek floodplain boundary on the south side of U.S. 29, the U-turn point would only be 500 feet southwest of the proposed site driveway. VDOT typically requires the U-turn point to be at least 800 feet from the main intersection to separate the conflict points and provide drivers with enough room to complete the U-turn. Therefore, an R-Cut with just 500 feet of separation would be unusually compact, and would likely require a VDOT design waiver.
    - VDOT recommends considering R-Cut design for intersections with heavy through traffic volume on the major street, and low left-turn traffic volume on the side street:

      See website – https://virginiadot.org/info/innovative_intersections_and_interchanges/rcut.asp

If 90% of the outbound trips have to make a U-turn to U.S. 29 northbound, that will be 468 vehicles in the AM peak hour (1 every 8 seconds), and 605 vehicles in the PM peak hour (1 every 6 seconds). This is a very heavy side street left-turn movement, which runs counter to VDOT's guidance on when to install an R-Cut.

- Even with a traffic signal, the outbound queue on the site driveway is projected to be over 600 feet (24 cars) in the PM peak hour, which would lead to driver frustration.
- The U-turn movement would create unnecessary delay for outbound drivers. First, the projected outbound delay in the PM peak hour is 44 seconds, then approximately 12 seconds to reach the U-turn point (assuming the U-turn point is 500 feet away and an average speed of 35 mph), plus the U-turn delay of 29 seconds, then another 12 seconds to reach the site driveway in the northbound direction. Therefore, it will take drivers approximately 97 seconds to accomplish the U-turn movement, which would lead to driver frustration.

Table 7 summarizes the key performance metrics of the intersection configurations that were considered.

Table 7: U.S. 29 at Proposed Site Driveway – Evaluation of Intersection Configurations

Intersection Configuration	AM LOS	PM LOS	US 29 Northbound AM LOS	US 29 Northbound PM LOS	US 29 Southbound AM LOS	US 29 Southbound PM LOS	Preserve the US 29 southbound left onto Teel Lane?	Off-site Constraints	Conflict Points
U.S. 29 at Site Driveway ***Conventional Signal Northbound Left Protected Only***	B	C	B	B	B	C	Yes	No	12
U.S. 29 at Site Driveway ***Signalized Green T***	C	D	A	B	C	E	No	Merge point at Teel Lane	12
U.S. 29 at Site Driveway ***Signalized R-Cut***	A	C	A	A	B	C	Yes	No	7
U.S. 29 at Western Median Break ***Signalized R-Cut***	B	B	B	C	A	A	Yes	Yes for U-turn bulbout	

Based on a thorough evaluation of the key performance metrics for all alternatives, the conventional traffic signal is clearly the best overall option because it:

- Preserves full-movement access for the residents and VDOT maintenance facility on Teel Lane
- Will have the smallest impact to through traffic on U.S. 29 because it will accommodate dual outbound left-turn lanes, which will maximize green time for U.S. 29
- Will meet driver expectancy, and provide safe and efficient access to the property
- Based on construction costs for similar projects in the region, the conventional traffic signal and turn lanes will likely cost approximately $1.5 million. The R-Cut configuration would likely cost approximately $3.0 million due to the additional grading, paving and retaining wall associated with the U-turn bulb-out, and the additional traffic signal equipment required.

Build (2036) Intersection Capacity Analysis

Capacity analysis was performed at the study intersections during the weekday AM and PM peak hour under build (2036) conditions with the recommended lane configuration only. Those results are summarized in Table 8. The Synchro and SimTraffic output reports are included in the Appendix.

Table 8: Build (2036) Intersection Capacity Analysis Results

Intersection	Lane Group	Lane Storage (ft.)	AM Peak Hour				PM Peak Hour			
			LOS	Delay (sec)	SimTraffic Queue (ft.)	Overall LOS	LOS	Delay (sec)	SimTraffic Queue (ft.)	Overall LOS
U.S. 29 at I-64 Eastbound Ramp	NBT	-	B	18.0	325	C (20.1 Sec)	D	37.0	277	C (34.1 Sec)
	NBR	675	B	19.4	170		E	69.9	141	
	SBU/L	350	D	45.0	280		D	53.5	320	
	SBT	-	A	0.2	317		A	0.5	238	
U.S. 29 at Gold Eagle Drive / Teel Lane **(Teel Lane Full-Movement)**	EBR	-	B	10.8	68	N/A	C	20.5	332	N/A
	WBL/R	-	F	60.4	66		D	32.2	56	
	NBT/R	- / -	-	-	-		-	-	-	
	SBL/U	100	D	28.2	49		C	17.2	66	
	SBT	- / -	-	-	-		-	-	-	
	SBR	175	-	-	-		-	-	-	
U.S. 29 at Site Driveway ***Conventional Signal Northbound Left Protected Only***	EBL	- / -	C	22.8	180	B (15.3 Sec)	D	44.3	316	C (25.6 Sec)
	EBR	200	B	17.7	28		C	27.0	59	
	NBL	200	C	30.3	160		D	46.7	165	
	NBT	- / -	A	9.7	174		A	7.4	132	
	SBT	- / -	B	17.4	144		C	23.6	284	
	SBR	200	A	6.0	66		A	4.4	82	

Under build conditions in 2036, the intersection of U.S. 29 at I-64 Eastbound Ramp is expected to operate at LOS C during the AM and PM peak hours.

With a conventional traffic signal at the site driveway, the intersection is expected to operate at LOS B during the AM peak hour and LOS C during the PM peak hour with all movements operating at LOS D or better.

Access Management Standards

VDOT classifies U.S. 29 as Principal Arterial, part of the Arterial Preservation Network (APN). The intersection spacing standards from Table 2-2 of VDOT's *Road Design Manual*, Appendix F are shown in Table 9.

Table 9: Minimum Spacing Standards for Accesses Near Interchange Areas on Multilane Crossroads

Minimum Spacing Standards for Accesses Near Interchange Areas on Multilane Crossroads		
X (Right-in/Right-out)	M (Directional Median Crossover)	Y (Four-legged Intersection)
750'	990'	1320'

TABLE 2-3 MINIMUM SPACING STANDARDS FOR ACCESSES NEAR INTERCHANGE AREAS ON MULTI LANE CROSSROADS*

Source: *Access Control Design on Highway Interchanges, 2008.*

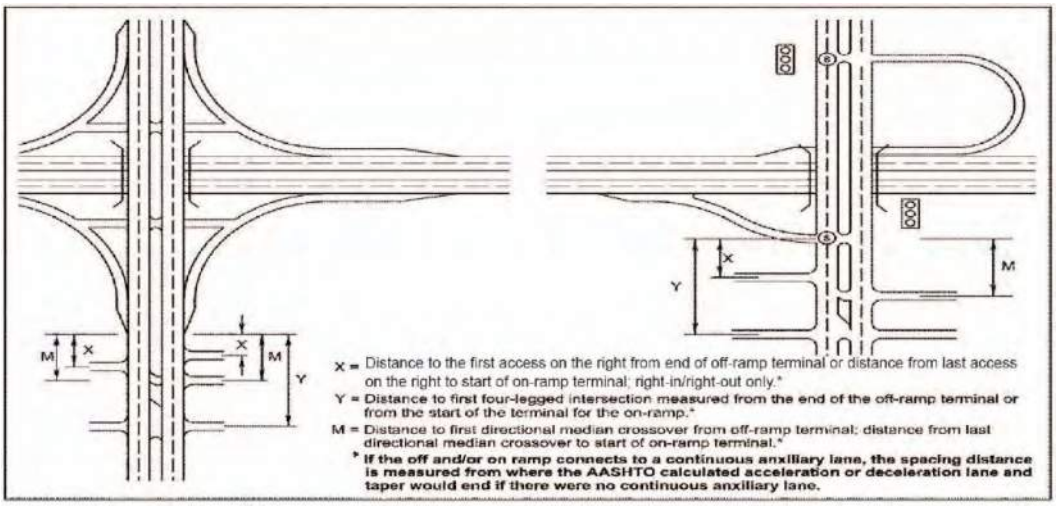


FIGURE 2-9 ACCESS CONTROL ON MULTILANE CROSSROADS AT INTERCHANGES

The proposed full-movement driveway is approximately 875 feet south of Gold Eagle Lane, which is approximately 290 feet south of the I-64 eastbound off-ramp merge point. VDOT requires at least 990 feet between the merge point and a median crossover. The proposed site driveway is 1,165 feet south of the merge point, which exceeds the minimum spacing. The applicant is also proposing to restrict Gold Eagle Lane to right-in / right-out operation to eliminate vehicle conflict points on this segment of U.S. 29.

The design team has located the proposed driveway on U.S. 29 as far away from the I-64 interchange as possible. There are critical slopes on the northwest side of U.S. 29 between the proposed driveway location and Shepard's Hill Road that prevent the driveway from shifting any further south.

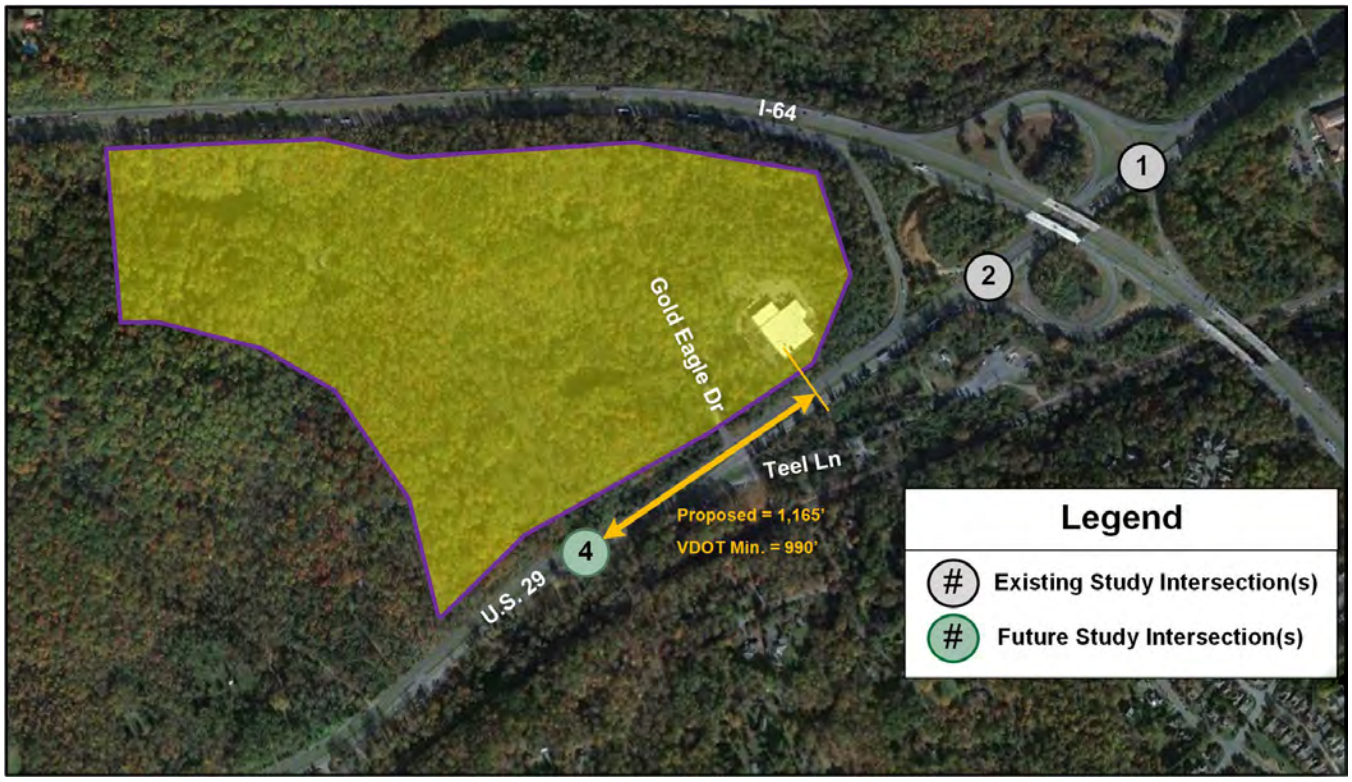


Figure 11: Proposed Intersection Spacing

Traffic Signal Warrant Analysis

A signal warrant analysis was performed at the intersection of U.S. 29 at Site Driveway under Build (2030) conditions. Signal warrant thresholds include five traffic signal warrants based on traffic volume that are published by the Federal Highway Administration (FHWA):

- Warrant 1A – Eight-Hour Vehicular Volume – Minimum Vehicular Volume
- Warrant 1B – Eight-Hour Vehicular Volume – Interruption of Continuous Traffic Flow
- Warrant 1C – Eight-Hour Vehicular Volume – Combination Warrant
- Warrant 2 – Four-Hour Vehicular Volume
- Warrant 3 – Peak-Hour Vehicular Volume

The results of the signal warrant analysis are shown in Table 10 and the detailed signal warrant calculations are included in the appendix. Note that all right-turn volumes were excluded from the analysis to be conservative.

Table 10: Traffic Signal Warrant Analysis – U.S. 29 at Site Driveway

Start Time	Traffic Volume		Warrants					
	Major Street (vph)	Minor Street (vph)	1A 600 Maj 150 Min	1B 900 Maj 75 Min	Combination 1A 480 Maj 120 Min	Combination 1B 720 Maj 60 Min	2	3
6:00 AM	1,127	193	Yes	Yes	Yes	Yes	Yes	No
7:00 AM	1,440	379	Yes	Yes	Yes	Yes	Yes	Yes
8:00 AM	1,639	455	Yes	Yes	Yes	Yes	Yes	Yes
9:00 AM	1,195	310	Yes	Yes	Yes	Yes	Yes	Yes
10:00 AM	872	300	Yes	No	Yes	Yes	Yes	No
11:00 AM	942	407	Yes	Yes	Yes	Yes	Yes	Yes
12:00 PM	1,172	478	Yes	Yes	Yes	Yes	Yes	Yes
1:00 PM	1,051	405	Yes	Yes	Yes	Yes	Yes	Yes
2:00 PM	1,051	397	Yes	Yes	Yes	Yes	Yes	Yes
3:00 PM	1,395	409	Yes	Yes	Yes	Yes	Yes	Yes
4:00 PM	1,805	540	Yes	Yes	Yes	Yes	Yes	Yes
5:00 PM	1,810	608	Yes	Yes	Yes	Yes	Yes	Yes
6:00 PM	1,307	341	Yes	Yes	Yes	Yes	Yes	Yes
7:00 PM	1,060	243	Yes	Yes	Yes	Yes	Yes	No
Hours Needed to Meet Warrant			8	8	8	8	4	1
Total Hours Met			14	13	14	14	14	11
Warranted?			Satisfied	Satisfied	Satisfied		Satisfied	Satisfied

Based on the *Manual on Uniform Traffic Control Devices* (MUTCD) low-speed thresholds, all traffic signal warrants are expected to be met at build-out of the site. U.S. 29 is posted 55 mph, but the low-speed (< 40 mph) thresholds were applied to be conservative. The first 8-hour vehicular volume signal warrant will be satisfied when the proposed site is approximately 20% complete.

Recommendations

Based on the traffic capacity analysis, and the evaluation of all five access alternatives, the conventional traffic signal is clearly the best overall option for the proposed site driveway on U.S. 29 because it preserves full-movement access for Teel Lane, and all movements on U.S. 29 will operate at LOS C or better.

The following off-site roadway improvements are recommended:

U.S. 29 at Gold Eagle Drive / Teel Lane:

- Restrict Gold Eagle Drive to right-in / right-out operation, but maintain full-movement access for Teel Lane

U.S. 29 at Proposed Site Driveway:

- Construct the site driveway with one ingress lane and three egress lanes – dual lefts and one right-turn lane
- Construct one northbound left-turn lane on U.S. 29 with 200 feet of storage
- Construct one southbound right-turn lane on U.S. 29 with 200 feet of storage
- Install a conventional traffic signal

With a conventional traffic signal, this intersection is expected to operate at LOS B during the AM peak hour and LOS C during the PM peak hour if the northbound left-turn movement on U.S. 29 is protected-only.

If the U.S. 29 northbound left-turn movement is protected-only, the average delay for the U.S. 29 southbound through movement would be 17.6 seconds in the AM peak hour and 23.4 seconds in the PM peak hour.

The proposed conventional traffic signal on U.S. 29 will be coordinated with the existing traffic signal at the I-64 eastbound on-ramp. The proposed signal will not interrupt progression on northbound U.S. 29 because the existing traffic signal at the I-64 eastbound on-ramp restricts northbound U.S. 29 more than the proposed traffic signal. At the I-64 eastbound on-ramp, northbound U.S. 29 receives only **57%** of the green time in the AM peak hour and **38%** of the green time in the PM peak hour because the U.S. 29 southbound left-turn is the dominant movement. At the proposed conventional traffic signal, northbound U.S. 29 will receive **67%** of the green time in the AM peak hour and **69%** of the green time in the PM peak hour, which is a much wider green band than the I-64 eastbound on-ramp.

The conventional traffic signal is the recommended alternative because it allows Teel Lane to remain full-movement at the existing median break – preserving access to the residents and the VDOT maintenance facility, and it will minimize disruption to U.S. 29 traffic.

The applicant understands the importance of considering safety when installing a new traffic signal on this segment of U.S. 29. If requested by VDOT, the applicant will install advance signage, rumble strips, flashing beacons, or other appropriate treatment on U.S. 29 to alert drivers to the new traffic signal. The applicant is focused on providing safe and efficient access for the people who will live and work at the site, as well as commuters and travelers driving by on U.S. 29.

Based on a thorough evaluation of the key performance metrics for all alternatives, the conventional traffic signal is clearly the best overall option because it:

- Preserves full-movement access for the residents and VDOT maintenance facility on Teel Lane
- Will have the smallest impact to through traffic on U.S. 29 because it will accommodate dual outbound left-turn lanes, which will maximize green time for U.S. 29
- Will meet driver expectancy, and provide safe and efficient access to the property
- Based on construction costs for similar projects in the region, the conventional traffic signal and turn lanes will likely cost approximately $1.5 million. The R-Cut configuration would likely cost approximately $3.0 million due to the additional grading, paving and retaining wall associated with the U-turn bulb-out, and the additional traffic signal equipment required.

Figure 12 shows the recommended roadway improvements for build-out.

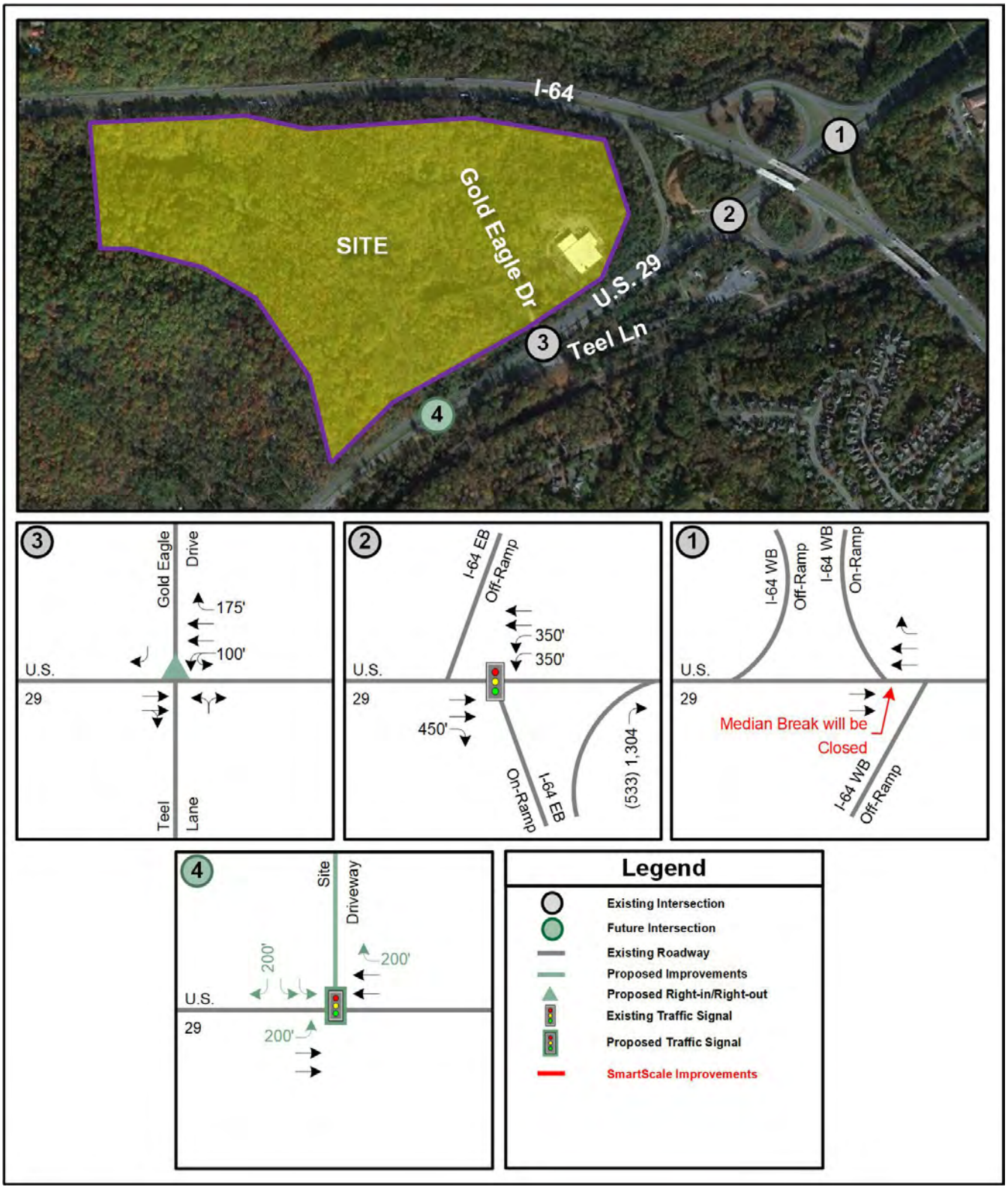


Figure 12: Recommended Lane Configuration