



ENGINEERING ■ ARCHITECTURE ■ SURVEYING ■ PLANNING

Norman Ranch Development Traffic Impact Study

*Three Flags Lane & Norman Avenue
Summerset, SD*

JEO Project No. 231786.00

*Prepared for:
Vanocker Development*

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Table of Contents

1.0	Introduction	1
1.1	Objective	1
1.2	Project Description.....	1
1.3	Report Organization	1
2.0	Existing Conditions	3
2.1	Existing Street Network and Intersection Characteristics.....	3
2.1.1	I-90	3
2.1.2	Peaceful Pines Road	3
2.1.3	Norman Avenue/Infinity Drive	3
2.1.4	Three Flags Lane.....	3
2.1.5	Quaal Road	3
2.1.6	Intersection of I-90 southbound ramp terminal & Peaceful Pines Road	4
2.1.7	Intersection of I-90 northbound ramp terminal & Peaceful Pines Road	4
2.1.8	Intersection of Peaceful Pines Road & Norman Avenue/Infinity Drive	4
2.1.9	Intersection of Norman Ave & Three Flags Lane	4
2.1.10	Intersection of Norman Ave & Quaal Road.....	4
2.2	Crash History	6
2.3	Existing Traffic Volumes	6
2.4	Existing Conditions Capacity Analysis	8
3.0	Background Conditions	10
3.1	Year 2025 Background Conditions	10
3.1.1	Year 2025 Background Conditions Capacity Analysis.....	10
3.2	Year 2029 Background Conditions	12
3.2.1	Year 2029 Background Conditions Capacity Analysis.....	12
4.0	Site Trip Generation, Trip Distribution and Traffic Assignment.....	14
4.1	Site Trip Distribution	14
4.2	Phase 1 Buildout Site Trip Generation, Trip Distribution, and Traffic Assignment.....	14
4.3	Phase 2 Buildout Site Trip Generation, Trip Distribution, and Traffic Assignment.....	14
5.0	Site Buildout Conditions.....	21
5.1	Phase 1 (Year 2025) Site Buildout Conditions.....	21
5.1.1	Phase 1 (Year 2025) Site Buildout Conditions Capacity Analysis	21
5.2	Phases 1+2 (Year 2029) Site Buildout Conditions	21
5.2.1	Phases 1+2 (Year 2029) Site Buildout Conditions Capacity Analysis.....	21
6.0	20-Year Horizon (2045) Conditions	26

6.1 Background Traffic Volumes 26

 6.1.1 Horizon Year (2045) Background Conditions Capacity Analysis..... 26

6.2 Horizon Year 2045 Buildout Traffic Volumes 28

 6.2.1 Horizon Year (2045) Buildout Conditions Capacity Analysis 28

6.3 Turn Lane Warrant Analysis 31

6.4 Signal Warrant Analysis..... 33

7.0 Conclusions and Recommendations 34

List of Figures

Figure 1: Vicinity Map	2
Figure 2: Existing Intersection Lane Configurations and Traffic Control	5
Figure 3: Existing Peak Hour Traffic Volumes	7
Figure 4: Year 2025 Background Peak Hour Volumes.....	11
Figure 5: Year 2029 Background Peak Hour Volumes.....	13
Figure 6: Site Trip Distribution	15
Figure 7: Phase 1 Site Generated (New) Trips	17
Figure 8: Phase 2 Site Generated (New) Trips	19
Figure 9: Phase 1 + Phase 2 Site Generated (New) Trips	20
Figure 10: Phase 1 (Year 2025) Site Buildout Peak Hour Volumes	22
Figure 11: Phases 1+2 (Year 2029) Site Buildout Peak Hour Volumes.....	24
Figure 12: Horizon Year (2045) Background Peak Hour Volumes.....	27
Figure 13: Horizon Year (2045) Buildout Peak Hour Volumes	29

List of Tables

Table 1: Study Corridor Crashes.....	6
Table 2: Level of Service (LOS) Interpretation	8
Table 3: Existing Conditions Capacity Analysis Results	9
Table 4: Background 2025 Capacity Analysis Results	10
Table 5: Background 2029 Capacity Analysis Results	12
Table 6: Phase 1 Buildout AM & PM Peak Hour Site Trip Generation	16
Table 7: Phase 1 Buildout Site Generation	16
Table 8: Phase 2 Buildout AM & PM Peak Hour Site Trip Generation.....	18
Table 9: Phase 2 Buildout Site Generation	18
Table 10: Phase 1 (Year 2025) Site Buildout Capacity Analysis Results.....	23
Table 11: Phases 1+2 (Year 2029) Site Buildout Capacity Analysis Results	25
Table 12: Horizon Year (2045) Background Scenario Capacity Analysis Results	26
Table 13: Horizon Year (2045) Buildout Scenario Capacity Analysis Results.....	30
Table 14: Mainline Auxiliary Turn Lane Warrant Analysis ¹	32
Table 15: Signal Warrants	33

Appendices

Appendix A: Preliminary Site Plan

Appendix B: Study Intersection Crash Diagrams

Appendix C: Traffic Data Collection Sheets

Appendix D: Capacity Analysis Output Sheets – Existing Conditions

Appendix E: Capacity Analysis Output Sheets – Year 2025 Background Conditions

Appendix F: Capacity Analysis Output Sheets – Year 2029 Background Conditions

Appendix G: Site Trip Generation Reports – Phase 1

Appendix H: Site Trip Generation Reports – Phase 2

Appendix I: Capacity Analysis Output Sheets – Phase 1 (Year 2025) Site Buildout

Appendix J: Capacity Analysis Output Sheets – Phases 1+2 (Year 2029) Site Buildout

Appendix K: Capacity Analysis Output Sheets – Horizon Year (2045) Background Conditions

Appendix L: Capacity Analysis Output Sheets – Horizon Year (2045) Buildout Conditions

Appendix M: Turn Lane Warrant Analysis

Appendix N: Signal Warrant Analysis

1.0 Introduction

This report documents the results of the traffic impact study conducted for the proposed residential development, Norman Ranch, located east of Interstate 90 (I-90), along Norman Avenue, in Summerset, South Dakota. The scope and methodology of this study were developed by JEO Consulting Group in coordination with the City of Summerset, the South Dakota Department of Transportation (SDDOT) and Vanocker Development.

1.1 Objective

The primary objective of this traffic study was to evaluate impacts to the adjacent street network associated with the proposed site development located in Summerset, SD. The proposed site is adjacent to Norman Avenue and one mile north of the I-90 & Peaceful Pines Road interchange (Exit 52). This includes capacity and queue analyses for study area intersections impacted by the project; auxiliary turn lane analysis; and signal warrant analysis.

1.2 Project Description

The proposed residential development is proposed to be constructed in Summerset, SD, located east of I-90. Upon buildout of phase one, which is anticipated by year 2025, the site is expected to include 94 single-family detached residential units, 32 single-family attached residential units (townhomes), and 28 multifamily residential units (4-plexes). Full buildout of phase two, which is expected to be completed by the year 2029, includes an additional 307 single-family detached residential units, 38 single-family attached residential units (townhomes), and 16 multifamily residential units (4-plexes).

Upon buildout of phase one, two accesses to the site will be provided. The south access, called Joseph Street, will be constructed as the east leg of the existing intersection of Norman Avenue & Three Flags Lane. A second access is to be constructed approximately 0.25 miles north of the intersection. Upon buildout of phase two, in addition to those previously mentioned, a third access will be constructed as the east leg of the existing intersection of Norman Avenue & South Cliff Lane.

The site development area is illustrated in Figure 1. A preliminary site plan is provided in Appendix A.

1.3 Report Organization

The remainder of this report is organized as follows:

- 2.0 Existing Conditions
- 3.0 Background Conditions
- 4.0 Site Trip Generation, Trip Distribution and Traffic Assignment
- 5.0 Site Buildout Conditions
- 6.0 20-Year Horizon (2045) Conditions
- 7.0 Conclusion and Recommendations

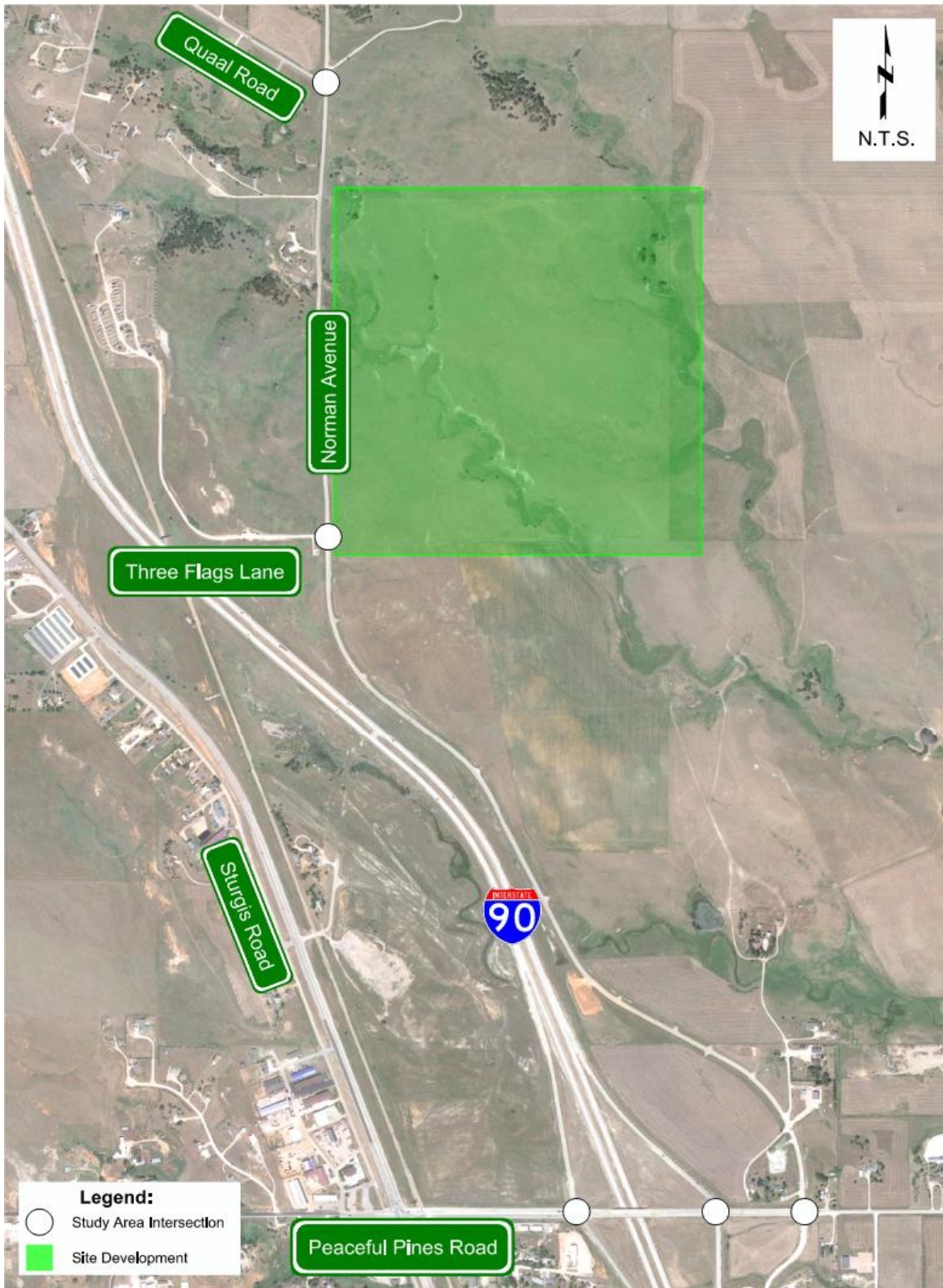


Figure 1: Vicinity Map

2.0 Existing Conditions

The following section summarizes existing study area conditions including current street and intersection geometrics, traffic volumes, and traffic operations and queue length analysis.

2.1 Existing Street Network and Intersection Characteristics

The study area includes I-90, Peaceful Pines Road, Norman Avenue/Infinity Drive, Three Flags Lane, and Quaal Road.

2.1.1 I-90

I-90 is a four-lane, east-west freeway throughout South Dakota and the continental United States. Within the vicinity of the proposed development, I-90 is oriented north-south and has a posted speed limit of 75mph.

2.1.2 Peaceful Pines Road

West of Exit 52, including its associated on- and off-ramp network, Peaceful Pines Road, also known as South Dakota Highway 231 (SD231), provides a connection to Sturgis Road, located approximately 0.3 miles west of I-90. West of I-90, Peaceful Pines Road is a four-lane, urban minor arterial (as per the State Functional Classification) with a painted median and has a posted speed limit of 45mph. Between the two ramp terminals, Peaceful Pines Road has one lane in each direction and left-turn lanes at both ramp intersections. East of Exit 52, Peaceful Pines Road is a two-lane, painted median-divided rural major collector with an eastbound auxiliary left-turn lane at the intersection with Norman Avenue/Infinity Drive. Peaceful Pines Road, east of Exit 52, has a posted speed limit of 45mph. The land use adjacent to Peaceful Pines Road is mostly residential with a small amount of commercial development.

2.1.3 Norman Avenue/Infinity Drive

From Peaceful Pines Road to Quaal Road, Norman Avenue is a two-lane local road with a posted speed limit of 45mph. Within the vicinity of the study area, Norman Avenue is abutted by agricultural and residential uses. Norman Avenue is classified as a collector road in the recently updated Meade County Master Transportation Plan. South of Peaceful Pines Road, Infinity Drive is an unmarked, paved local road with no posted speed limit. Infinity Drive is abutted by numerous commercial and service land uses, including a restaurant, golf cart dealership, indoor & outdoor playgrounds, an auto shop, and an engine conversion shop.

2.1.4 Three Flags Lane

West of Norman Avenue, Three Flags Lane is an unpaved road that provides access to Three Flags RV Park. As part of providing access to the proposed development, the intersection of Three Flags Lane with Norman Avenue will be inclusive of a paved east leg (Joseph Street). The speed limit of Three Flags Road is not posted.

2.1.5 Quaal Road

West of Norman Avenue, Quaal Road is an unmarked, paved local street that provides connectivity to other parts of the greater Summerset community. The street continues northwest from Norman Avenue, terminating at Stage Stop Road, which provides connections to I-90 at Exit 48. The posted speed limit of Three Flags Road is 35mph.

2.1.6 Intersection of I-90 southbound ramp terminal & Peaceful Pines Road

The intersection of Peaceful Pines Road with the I-90 southbound on- and off-ramps is unsignalized with stop sign control for the southbound movements. The eastbound approach consists of separate lanes for through and right-turning vehicles; the westbound approach consists of a single through lane and an approximate 420-ft auxiliary left-turn lane; and the southbound off-ramp consists of separate lanes for left-turning/through and right-turning vehicles. An auxiliary lane for right-turning vehicles starts approximately 430 feet north of the intersection. Within the influence area of the intersection, only paved shoulders along Peaceful Pines Road are available to accommodate pedestrians and bicyclists.

2.1.7 Intersection of I-90 northbound ramp terminal & Peaceful Pines Road

The intersection of Peaceful Pines Road with the I-90 northbound on- and off-ramps is unsignalized with stop sign control for the northbound movements. The eastbound approach consists of a single through lane and an approximate 420-ft auxiliary left-turn lane; the westbound approach consists of a single, shared through/right-turn lane; and the northbound off-ramp consists of separate lanes for left-turning/through and right-turning vehicles. An auxiliary lane for right-turning vehicles starts approximately 930 feet south of the intersection. Within the influence area of the intersection, only paved shoulders along Peaceful Pines Road are available to accommodate pedestrians and bicyclists. It should also be noted that the SDDOT 2020 Decennial Interstate Corridor Study documents future operations deficiencies at this intersection.

2.1.8 Intersection of Peaceful Pines Road & Norman Avenue/Infinity Drive

The intersection of Peaceful Pines Road with Norman Avenue/Infinity Drive is unsignalized with stop sign control for the northbound & southbound movements. Turn lanes are not provided on the southbound, westbound, or northbound approaches. The eastbound approach consists of a shared through/right-turn lane and an approximate 160-ft auxiliary left-turn lane. Within the influence area of the intersection, only paved shoulders along Peaceful Pines Road are available to accommodate pedestrians and bicyclists.

2.1.9 Intersection of Norman Ave & Three Flags Lane

The intersection of Norman Avenue with Three Flags Lane is unsignalized with stop sign control for the eastbound movements. Turn lanes are not provided on any of the approaches. There are no pedestrian accommodations within the influence area of the intersection.

2.1.10 Intersection of Norman Ave & Quaal Road

The intersection of Norman Avenue with Quaal Road is unsignalized with stop sign control for the eastbound movements. Turn lanes are not provided on any of the approaches. There are no pedestrian accommodations within the influence area of the intersection.

All existing lane configurations and traffic control at existing study intersections are illustrated in Figure 2.

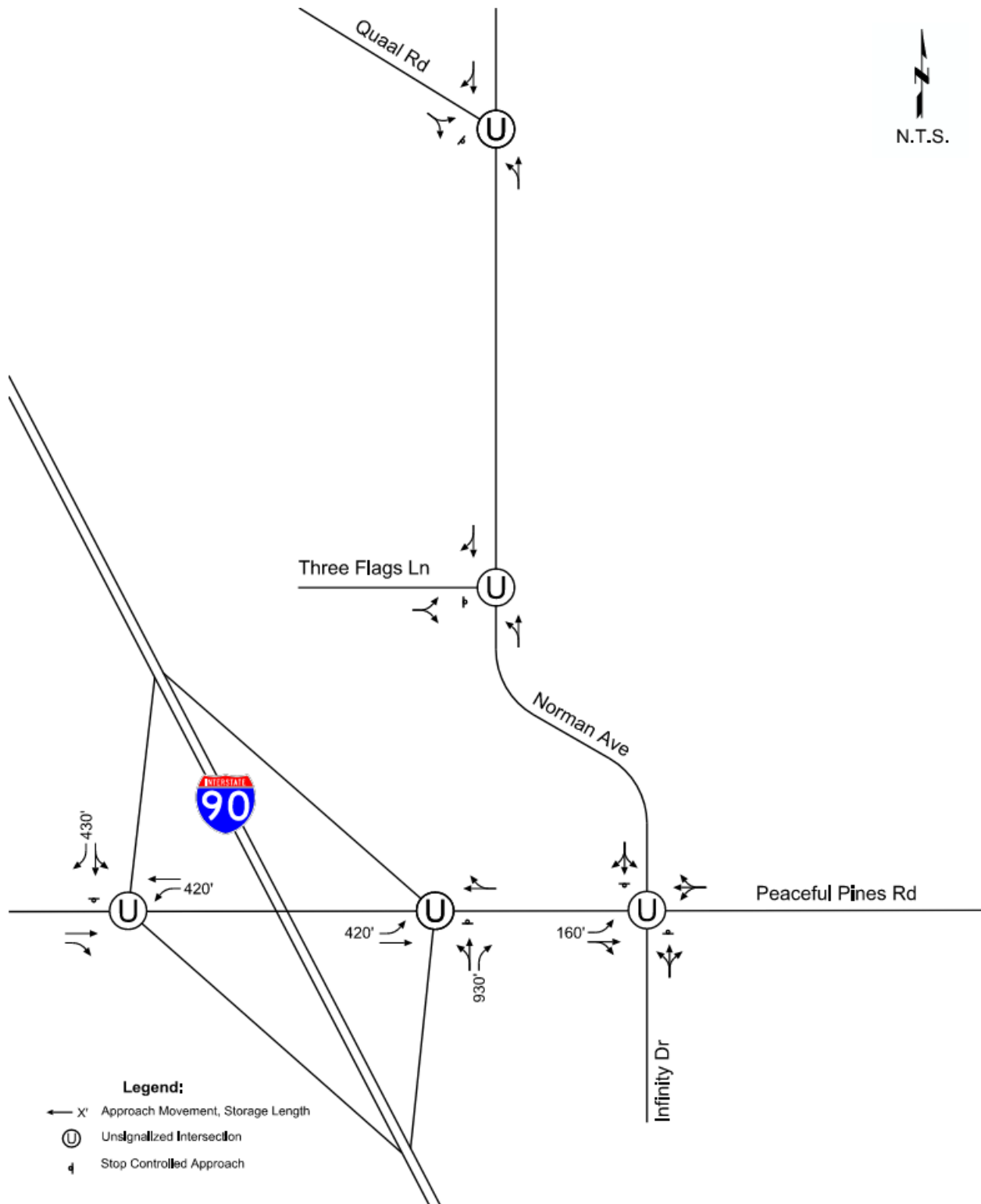


Figure 2: Existing Intersection Lane Configurations and Traffic Control

2.2 Crash History

The SDDOT Intersection Crash Diagram tool was used to extract crashes for a five-year period between July 1, 2018, to June 30, 2023. Crash diagram sheets for study intersections can be found in Appendix B. These crashes are summarized in Table 1.

Table 1: Study Corridor Crashes

Intersection	Number of Crashes			
	Fatal	Injury	PDO	Total
I-90 SB Ramps & Peaceful Pines Rd	0	1	5	6
I-90 NB Ramps & Peaceful Pines Rd	0	0	7	7
Peaceful Pines Rd & Norman Ave/Infinity Dr	0	0	1	1
Norman Ave & Three Flags Ln	0	0	0	0
Norman Ave & Quaal Rd	0	0	2	2

2.3 Existing Traffic Volumes

Twelve-hour turning movement volume data was collected by JEO at study intersections on Tuesday, November 7, 2023, through Wednesday, November 8, 2023. AM and PM peak hour time periods for the overall study area were determined as 7:00-8:00 a.m. and 4:30-5:30 p.m., respectively. Existing peak hour traffic volumes are shown in Figure 3. Traffic data collection sheets can be found in Appendix C.

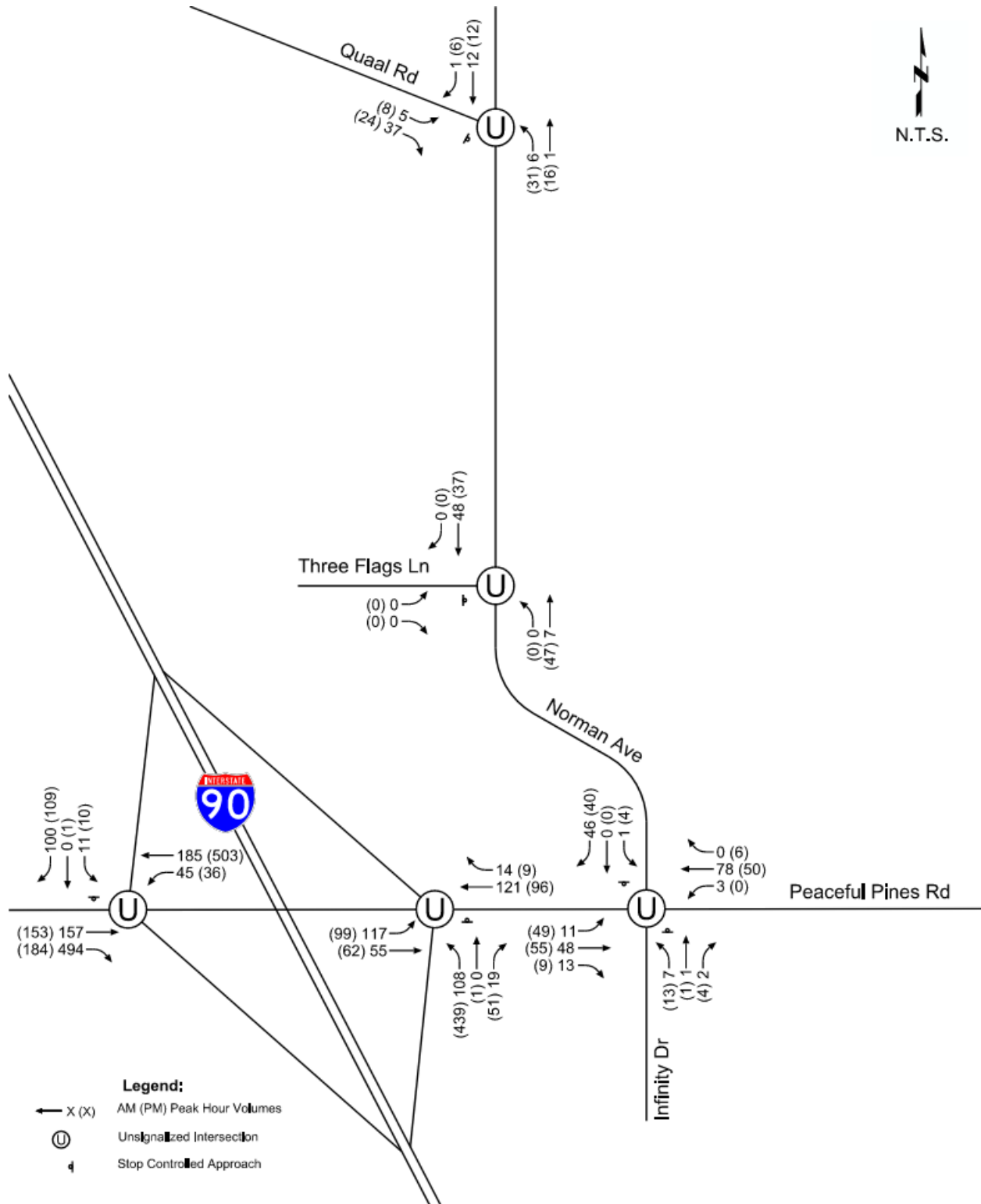


Figure 3: Existing Peak Hour Traffic Volumes

2.4 Existing Conditions Capacity Analysis

The peak hour volumes illustrated in Figure 3 were analyzed using the unsignalized intersection capacity analysis procedures outlined in the *Highway Capacity Manual* (HCM 7th edition). Level of Service (LOS), which indicates how well the intersection and/or its associated approaches and movements operate during peak hour time periods, is reported. LOS A represents free flow movement with very little to no delay, while LOS F represents congested flow at, or over the capacity of the intersection. Further details regarding the LOS methodology can be found in Table 2.

Table 2: Level of Service (LOS) Interpretation

Level of Service	Description	Stop-Controlled Intersection Delay (seconds per vehicle)
A	Free-flow operations. Vehicles are almost completely unimpeded in their ability to maneuver within the traffic stream.	< 10
B	Reasonably free flow. The ability to maneuver within the traffic stream is only slightly restricted.	>10 and < 15
C	At or near free flow. Freedom to maneuver within the traffic stream is noticeably restricted.	>15 and < 25
D	Speeds begin to decline slightly. Freedom to maneuver within the traffic stream is noticeably limited.	>25 and < 35
E	At capacity. Maneuverability within the traffic stream is extremely limited.	>35 and < 50
F	Breakdown. Vehicles are jammed. Generally, queues form behind the breakdown condition.	> 50

Source: *Highway Capacity Manual, 7th Edition, A Guide for Multimodal Mobility Analysis*, Transportation Research Board, Washington, D.C.

The existing weekday AM and PM peak hour traffic conditions were analyzed using the existing intersection lane configurations, traffic control and traffic volumes shown in Figure 2 and Figure 3. Capacity analysis results of existing conditions are summarized in Table 3.

Table 3: Existing Conditions Capacity Analysis Results

Intersection	Time Period	Control Type	LOS / Delay				
			Intersection ¹	NB	SB	EB	WB
I-90 SB Ramps & Peaceful Pines Rd	AM	Unsignalized (TWSC)	1.5	-	B / 10.3	-	A / 7.7 ²
	PM		1.9	-	B / 13.5	-	A / 7.6 ²
I-90 NB Ramps & Peaceful Pines Rd	AM	Unsignalized (TWSC)	6.0	B / 13.2	-	A / 7.8 ²	-
	PM		25.5	E / 37.8	-	A / 7.6 ²	-
Peaceful Pines Rd & Norman Ave/Infinity Dr	AM	Unsignalized (TWSC)	3.0	B / 10.5	A / 9.1	A / 7.5 ²	A / 7.4 ²
	PM		4.1	B / 10.2	A / 8.9	A / 7.4 ²	A / 7.3 ²
Norman Ave & Three Flags Ln	AM	Unsignalized (TWSC)	0.3	A / 0.0	-	A / 8.7	-
	PM		0.2	A / 0.0	-	A / 8.7	-
Norman Ave & Quaal Rd	AM	Unsignalized (TWSC)	6.6	A / 7.4 ²	-	A / 8.6	-
	PM		5.2	A / 7.3 ²	-	A / 8.7	-

¹Highway Capacity Manual (HCM) methodology does not report LOS for the entire intersection under TWSC conditions. Delay reported is the weighted delay for all movements.

²LOS/Delay reported is for left-turn movement only.

As tabulated, with the exception of the northbound approach at the I-90 northbound ramp terminal intersection during the PM peak time period, all approaches at each of the study intersections are expected to operate at LOS B or better. The northbound approach is anticipated to operate at LOS E during the PM peak time period. 95th percentile queue lengths were also calculated for study area auxiliary lanes and other critical movements. The reported 95th percentile queue length for the northbound left-turn/through lane at the I-90 northbound ramps intersection is estimated at 10 vehicles. Reported 95th percentile queue lengths for all other auxiliary turn lane movements are less than one vehicle which can be accommodated by the existing turn lane storage lengths. Analysis output sheets can be found in Appendix D.

3.0 Background Conditions

This section of the report presents the traffic volumes and capacity analysis results for two different background conditions associated with the Norman Ranch development.

3.1 Year 2025 Background Conditions

In coordination with the Rapid City Metropolitan Planning Organization, the City of Summerset, and the SDDOT, a growth percentage of 1% per year was applied to the existing volumes associated with the I-90 ramps and mainline Peaceful Pines Road. A growth percentage of 0.5% per year was applied to all remaining movements. These rates account for anticipated general population growth. The resulting 2025 background traffic volumes are shown in Figure 4.

3.1.1 Year 2025 Background Conditions Capacity Analysis

Year 2025 background conditions were analyzed using the existing intersection lane configurations and traffic control illustrated in Figure 2 and the background traffic volumes for year 2025 shown in Figure 4. Capacity analysis results for background 2025 conditions are summarized in Table 4.

Table 4: Background 2025 Capacity Analysis Results

Intersection	Time Period	Control Type	LOS / Delay				
			Intersection ¹	NB	SB	EB	WB
I-90 SB Ramps & Peaceful Pines Rd	AM	Unsignalized (TWSC)	1.5	-	B / 10.4	-	A / 7.7 ²
	PM		1.9	-	B / 13.7	-	A / 7.6 ²
I-90 NB Ramps & Peaceful Pines Rd	AM	Unsignalized (TWSC)	6.0	B / 13.4	-	A / 7.8 ²	-
	PM		28.1	E / 41.8	-	A / 7.6 ²	-
Peaceful Pines Rd & Norman Ave/Infinity Dr	AM	Unsignalized (TWSC)	3.0	B / 10.5	A / 9.1	A / 7.5 ²	A / 7.4 ²
	PM		4.0	B / 10.2	A / 8.9	A / 7.4 ²	A / 7.3 ²
Norman Ave & Three Flags Ln	AM	Unsignalized (TWSC)	0.3	A / 0.0	-	A / 8.7	-
	PM		0.2	A / 0.0	-	A / 8.7	-
Norman Ave & Quaal Rd	AM	Unsignalized (TWSC)	6.6	A / 7.4 ²	-	A / 8.6	-
	PM		5.2	A / 7.3 ²	-	A / 8.7	-

¹Highway Capacity Manual (HCM) methodology does not report LOS for the entire intersection under TWSC conditions. Delay reported is the weighted delay for all movements.

²LOS/Delay reported is for left-turn movement only.

As shown, all approaches at each of the study intersections are expected to operate at LOS B or better. The lone exception is the northbound approach at the I-90 northbound ramps intersection which is anticipated to operate at LOS E during the PM peak time period. 95th percentile queue lengths were also calculated for study area movements. The reported 95th percentile queue length for the northbound left-turn/through lane at the I-90 northbound ramps intersection is estimated at 10.8 vehicles. Reported queue lengths for all other auxiliary turn lane movements are less than one vehicle. Analysis output sheets can be found in Appendix E.

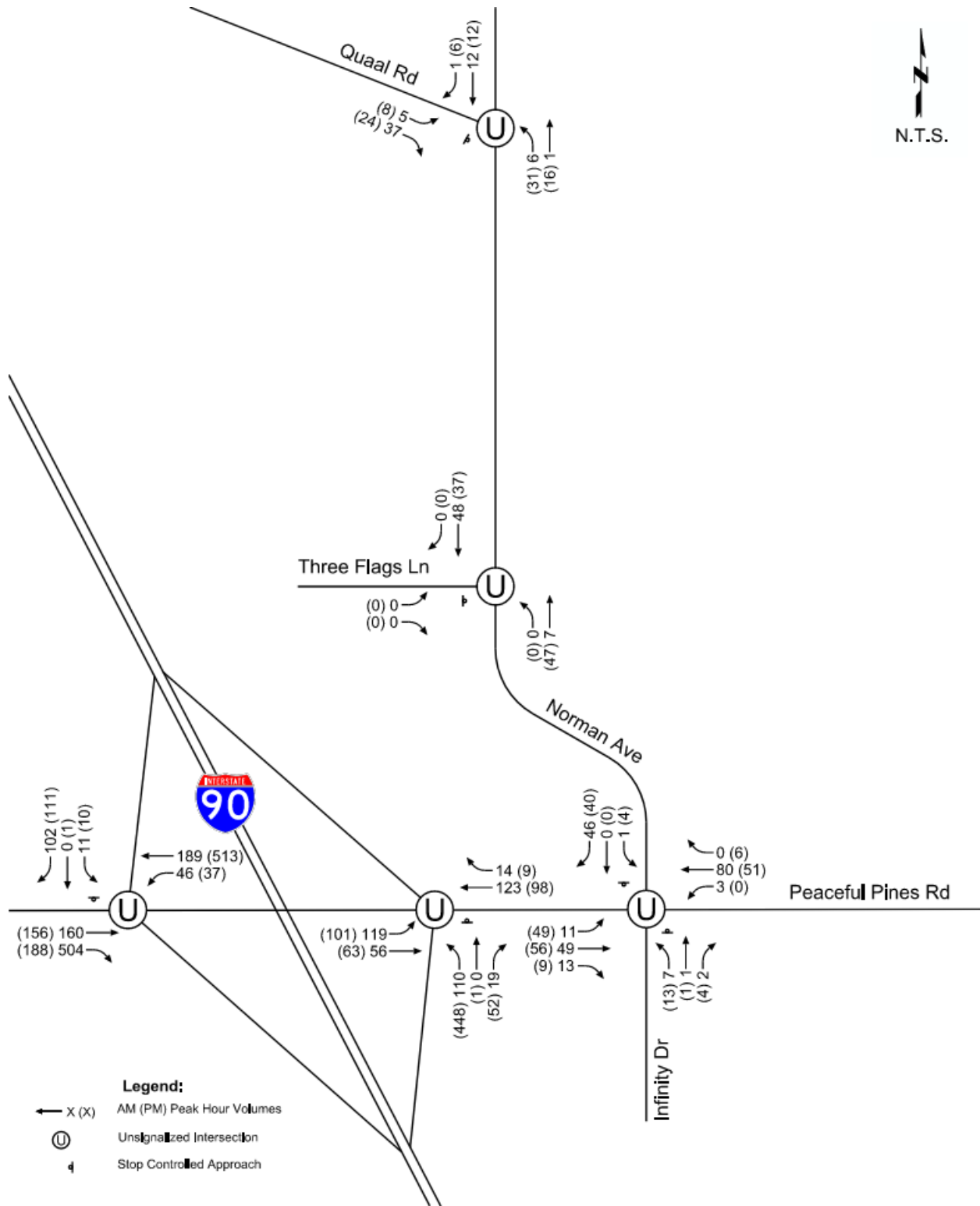


Figure 4: Year 2025 Background Peak Hour Volumes

3.2 Year 2029 Background Conditions

Growth rates were applied as mentioned in the previous section to derive 2029 background volumes and are shown in Figure 5.

3.2.1 Year 2029 Background Conditions Capacity Analysis

Year 2029 background conditions were analyzed using the existing intersection lane configurations and traffic control illustrated in Figure 2 and the background traffic volumes for 2029 shown in Figure 5. Capacity analysis results for background 2029 conditions are summarized in Table 5.

Table 5: Background 2029 Capacity Analysis Results

Intersection	Time Period	Control Type	LOS / Delay				
			Intersection ¹	NB	SB	EB	WB
I-90 SB Ramps & Peaceful Pines Rd	AM	Unsignalized (TWSC)	1.5	-	B / 10.5	-	A / 7.7 ²
	PM		2.0	-	B / 14.2	-	A / 7.6 ²
I-90 NB Ramps & Peaceful Pines Rd	AM	Unsignalized (TWSC)	6.2	B / 13.8	-	A / 7.9 ²	-
	PM		34.8	F / 52.2	-	A / 7.7 ²	-
Peaceful Pines Rd & Norman Ave/Infinity Dr	AM	Unsignalized (TWSC)	3.0	B / 10.6	A / 9.2	A / 7.5 ²	A / 7.4 ²
	PM		4.0	B / 10.3	A / 8.9	A / 7.4 ²	A / 7.3 ²
Norman Ave & Three Flags Ln	AM	Unsignalized (TWSC)	0.3	A / 0.0	-	A / 8.7	-
	PM		0.2	A / 0.0	-	A / 8.8	-
Norman Ave & Quaal Rd	AM	Unsignalized (TWSC)	6.6	A / 7.4 ²	-	A / 8.6	-
	PM		5.3	A / 7.3 ²	-	A / 8.7	-

¹Highway Capacity Manual (HCM) methodology does not report LOS for the entire intersection under TWSC conditions. Delay reported is the weighted delay for all movements.

²LOS/Delay reported is for left-turn movement only.

As shown, with the exception of the northbound approach at the I-90 northbound ramp intersection during the PM peak time period, all approaches at each of the study intersections are expected to operate at LOS B or better. As compared to year 2025 background conditions, the northbound approach LOS does decline from E to F during the PM peak time period. 95th percentile queue lengths were also calculated for study area auxiliary lanes and other critical movements. The reported 95th percentile queue length for the northbound left-turn/through lane at the I-90 northbound ramps intersection is estimated at 12.8 vehicles. Reported 95th percentile queue lengths for all other auxiliary turn lane movements are less than one vehicle which can be accommodated by the existing turn lane storage lengths. Analysis output sheets can be found in Appendix F.

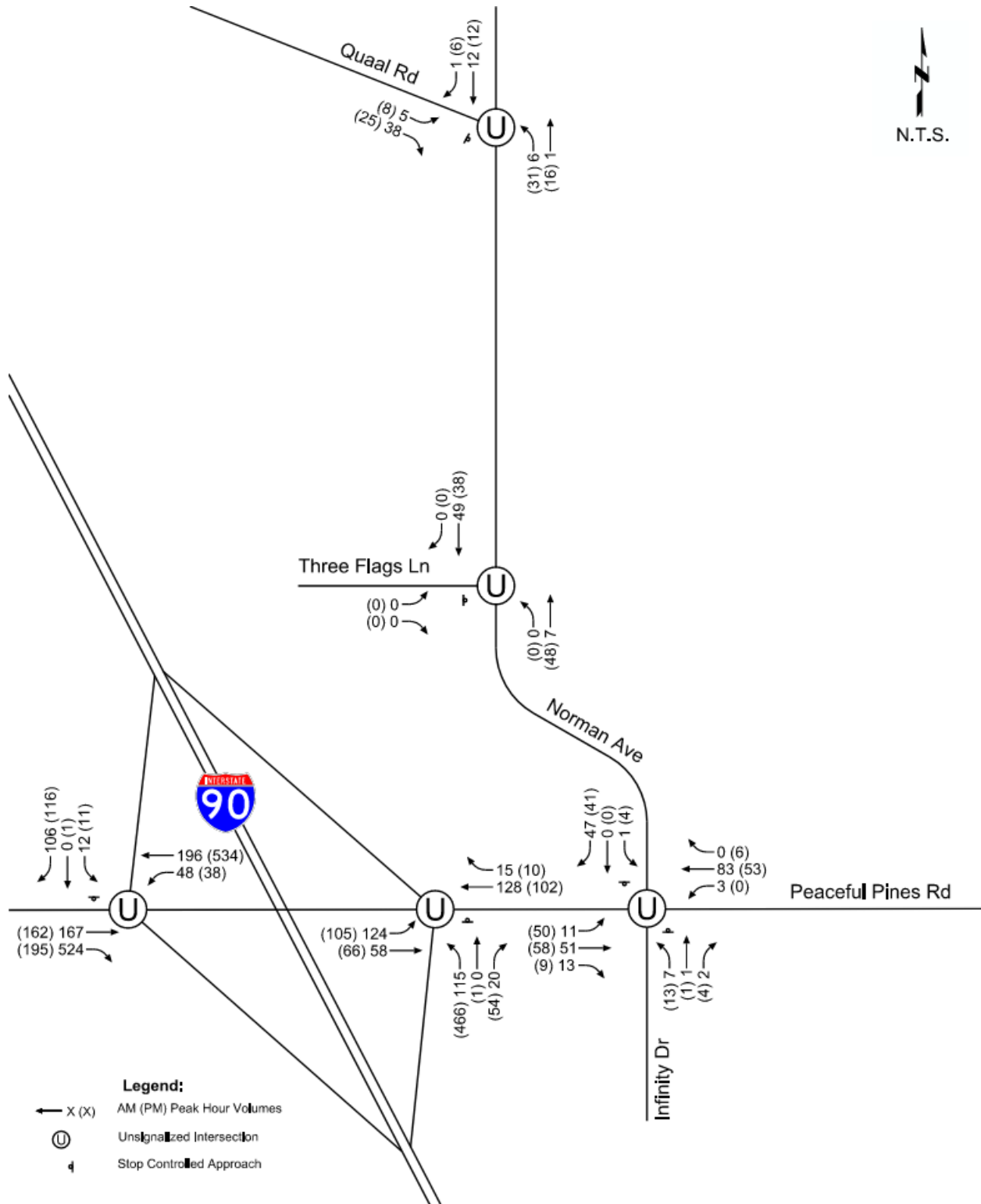


Figure 5: Year 2029 Background Peak Hour Volumes

4.0 Site Trip Generation, Trip Distribution and Traffic Assignment

This section of the report presents the projected trip generation, trip distribution, and traffic assignment, associated with the Norman Ranch development.

4.1 Site Trip Distribution

Existing traffic volumes were used to determine inbound and outbound site trip distribution percentages to/from the site. These percentages are illustrated in Figure 6.

4.2 Phase 1 Buildout Site Trip Generation, Trip Distribution, and Traffic Assignment

To analyze the proposed development's impacts on the adjacent street network, estimated trips entering and exiting the site were generated using methodology from the Institute of Transportation Engineers (ITE) *Trip Generation Manual* (TGM), 11th edition.

At buildout, Phase 1 of the proposed residential development is expected to include 94 single-family detached residential units, 32 single-family attached residential units, and 28 multifamily residential units. The estimated trips associated with this proposed land use are detailed in Table 6 and summarized in Table 7. Site trip generation reports are included in Appendix G.

Site trips were then assigned to the proposed street network using the results of the trip generation calculations summarized in Table 6 and the assumed trip distribution illustrated in Figure 6. Full access to the site is proposed to be at two locations. The south access, called Joseph Street, will be constructed as the east leg of the existing intersection of Norman Avenue & Three Flags Lane. An additional access will be constructed approximately 0.25 miles north of Three Flags Lane. The resulting site generated trips, for Phase 1 of the proposed development, are shown in Figure 7.

4.3 Phase 2 Buildout Site Trip Generation, Trip Distribution, and Traffic Assignment

At buildout, Phase 2 of the proposed residential development is expected to add an additional 307 single-family detached residential units, 38 single-family attached residential units, and 16 multifamily residential units. The estimated trips associated with Phase 2 are detailed in Table 8 and summarized in Table 9. Site trip generation reports are included in Appendix H.

Site trips were then assigned to the proposed street network using the results of the trip generation calculations summarized in Table 8 and the assumed trip distribution illustrated in Figure 6. Full access to the site is proposed to be at three locations. In addition to the accesses mentioned in Section 4.2, a third access will be constructed as the east leg of the existing intersection of Norman Avenue & South Cliff Lane. The resulting site generated trips, for Phase 2 of the proposed development are shown in Figure 8.

Total site trips generated by the full buildout of Phases 1 and 2, combined, are shown in Figure 9.

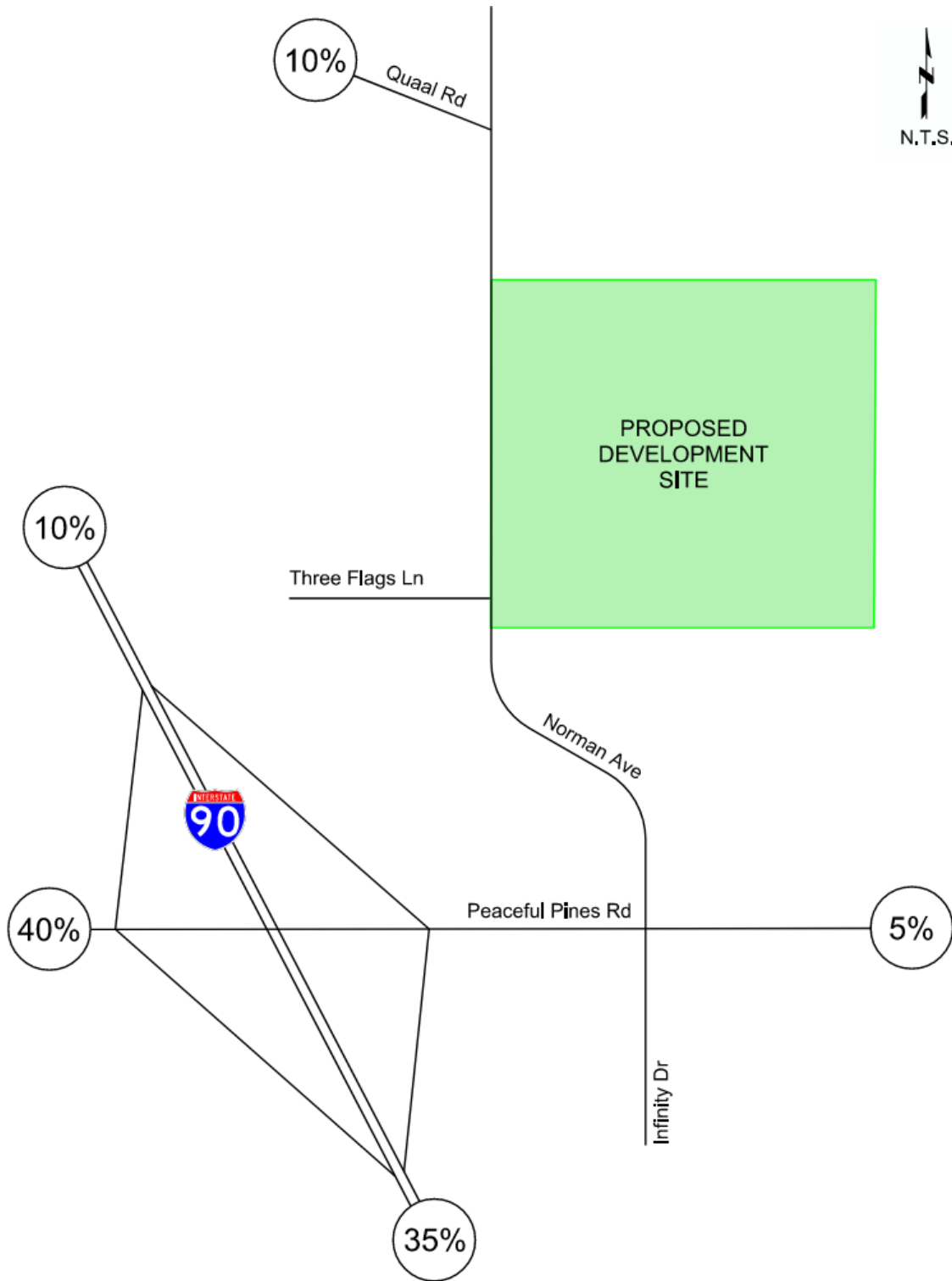


Figure 6: Site Trip Distribution

Table 6: Phase 1 Buildout AM & PM Peak Hour Site Trip Generation

ITE Land Use Code	Usage	Size	Trip Generation		Directional Distribution		AM Trips		
			Unit	Average Rate/Equation	In	Out	Total	Inbound	Outbound
210	Single-Family Detached Housing	94	1 Dwelling Unit	$\ln(T) = 0.91 \ln(X) + 0.12$	25%	75%	70	18	52
215	Single-Family Attached Housing	32	1 Dwelling Unit	$T = 0.52(X) - 5.70$	25%	75%	11	3	8
220	Multifamily Housing (Low-Rise)	28	1 Dwelling Unit	$T = 0.31(X) + 22.85$	24%	76%	32	8	24
Total:							113	29	84

ITE Land Use Code	Usage	Size	Trip Generation		Directional Distribution		PM Trips		
			Unit	Average Rate/Equation	In	Out	Total	Inbound	Outbound
210	Single-Family Detached Housing	94	1 Dwelling Unit	$\ln(T) = 0.94 \ln(X) + 0.27$	63%	37%	94	59	35
215	Single-Family Attached Housing	32	1 Dwelling Unit	$T = 0.60(X) - 3.93$	59%	41%	15	9	6
220	Multifamily Housing (Low-Rise)	28	1 Dwelling Unit	$T = 0.43(X) + 20.55$	63%	37%	33	21	12
Total:							142	89	53

Table 7: Phase 1 Buildout Site Generation

Time Period	All Vehicle Types		
	Entering	Exiting	Total
AM	29	84	113
PM	89	53	142

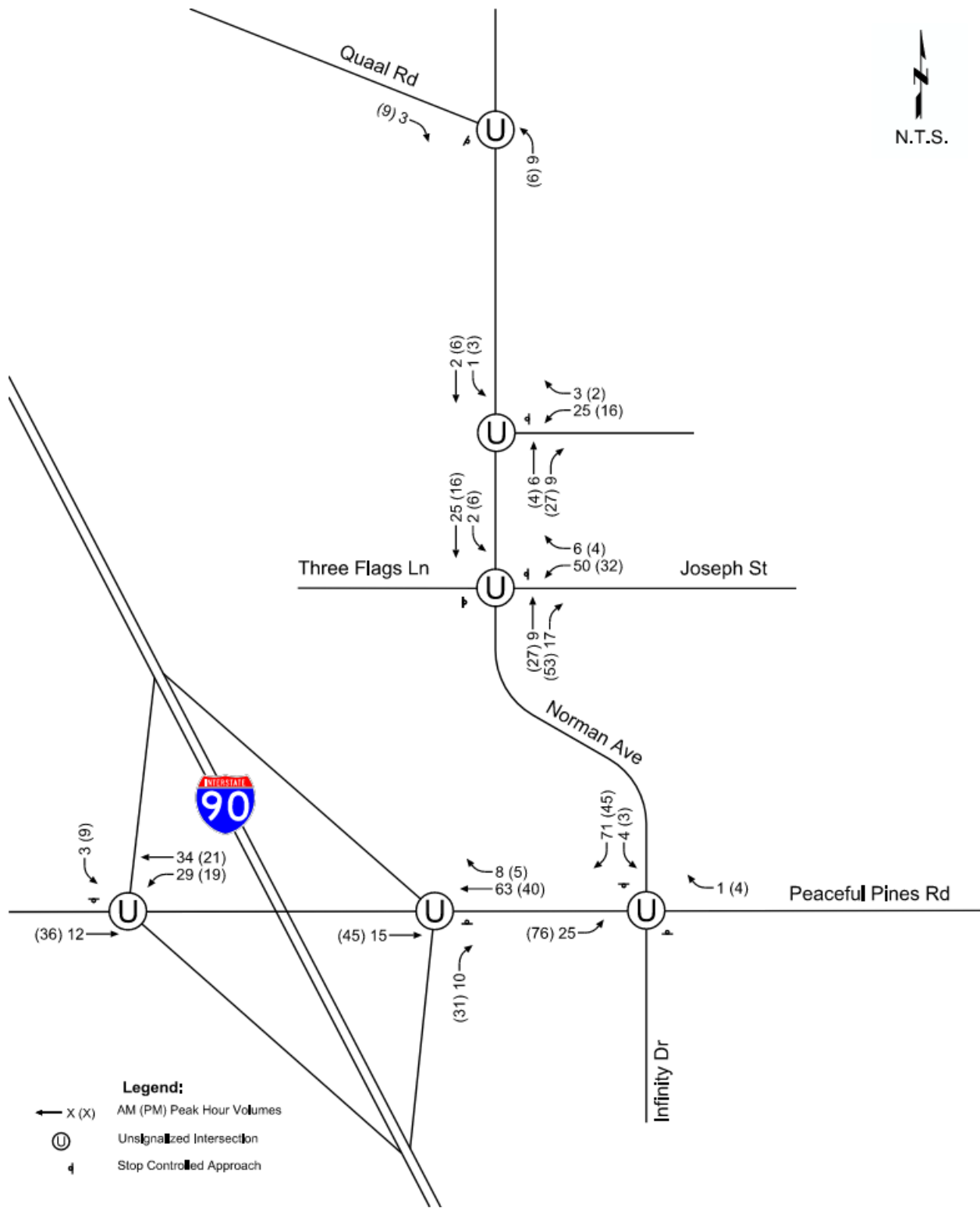


Figure 7: Phase 1 Site Generated (New) Trips

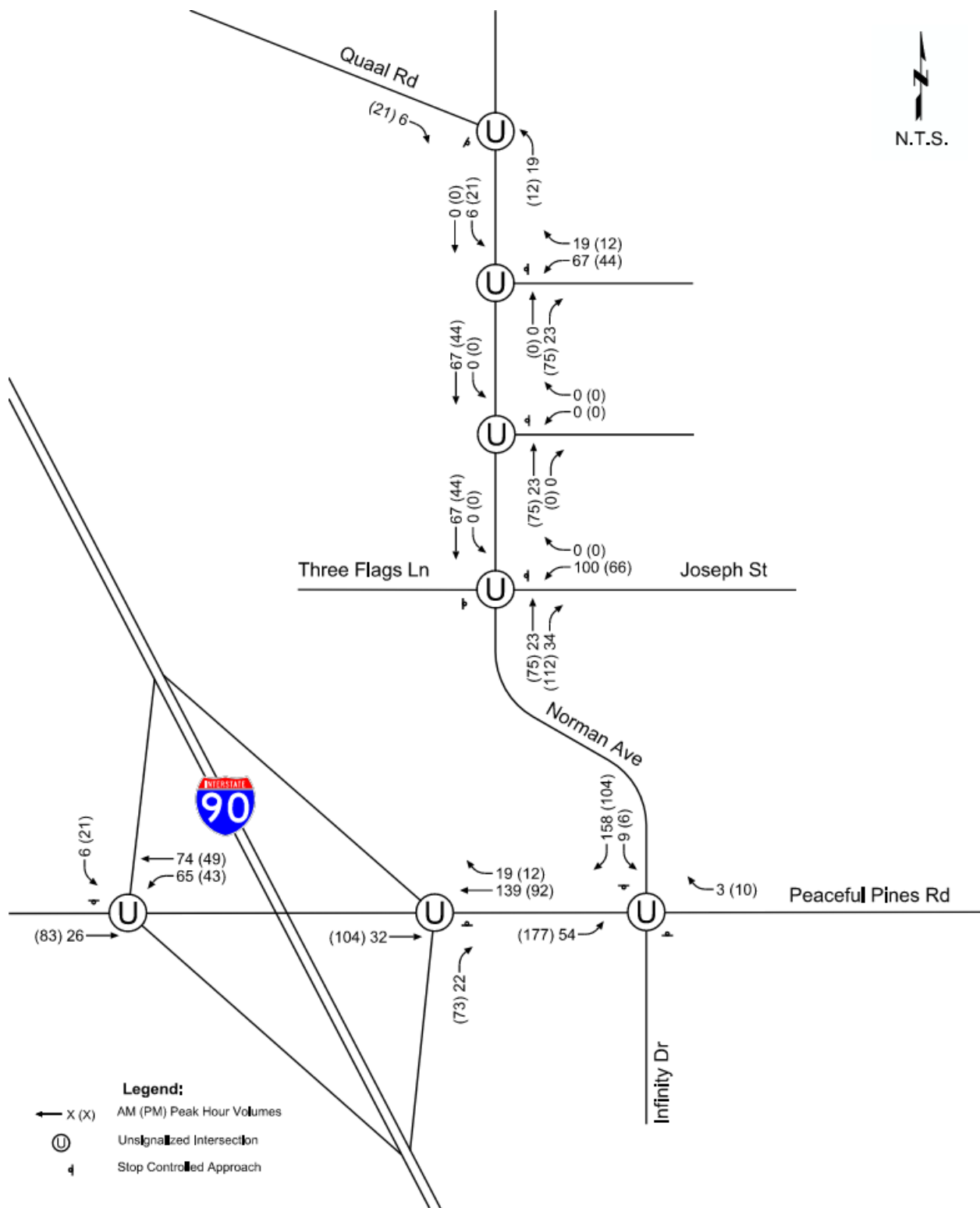
Table 8: Phase 2 Buildout AM & PM Peak Hour Site Trip Generation

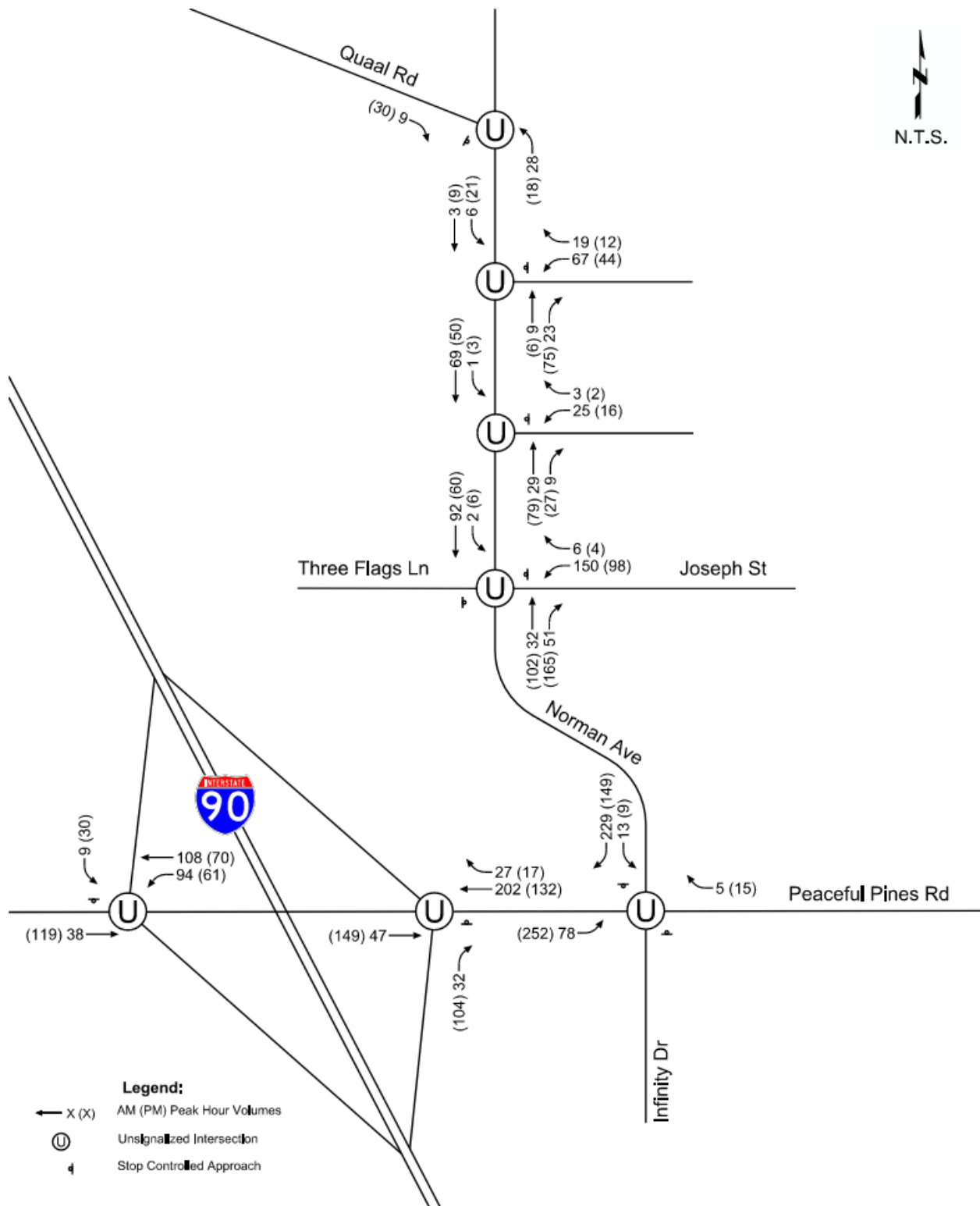
ITE Land Use Code	Usage	Size	Trip Generation		Directional Distribution		AM Trips		
			Unit	Average Rate/Equation	In	Out	Total	Inbound	Outbound
210	Single-Family Detached Housing	307	1 Dwelling Unit	$\ln(T) = 0.91 \ln(X) + 0.12$	25%	75%	207	52	155
215	Single-Family Attached Housing	38	1 Dwelling Unit	$T = 0.52(X) - 5.70$	25%	75%	14	4	10
220	Multifamily Housing (Low-Rise)	16	1 Dwelling Unit	$T = 0.31(X) + 22.85$	24%	76%	28	7	21
Total:							249	63	186

ITE Land Use Code	Usage	Size	Trip Generation		Directional Distribution		PM Trips		
			Unit	Average Rate/Equation	In	Out	Total	Inbound	Outbound
210	Single-Family Detached Housing	307	1 Dwelling Unit	$\ln(T) = 0.94 \ln(X) + 0.27$	63%	37%	285	180	105
215	Single-Family Attached Housing	38	1 Dwelling Unit	$T = 0.60(X) - 3.93$	59%	41%	19	11	8
220	Multifamily Housing (Low-Rise)	16	1 Dwelling Unit	$T = 0.43(X) + 20.55$	63%	37%	27	17	10
Total:							331	208	123

Table 9: Phase 2 Buildout Site Generation

Time Period	All Vehicle Types		
	Entering	Exiting	Total
AM	63	186	249
PM	331	123	331





5.0 Site Buildout Conditions

This section of the report presents the traffic volumes and capacity analysis results for two different site buildout scenarios associated with the Norman Ranch development.

5.1 Phase 1 (Year 2025) Site Buildout Conditions

The assigned site trips generated by buildout of Phase 1, as summarized in Figure 7, were added to 2025 background traffic volumes, as summarized in Figure 4, to derive year 2025 buildout traffic volumes. The projected 2025 buildout AM and PM peak period traffic volumes are shown in Figure 10.

5.1.1 Phase 1 (Year 2025) Site Buildout Conditions Capacity Analysis

Phase 1 site buildout conditions were analyzed using the existing intersection lane configurations and traffic control, illustrated in Figure 2, and the site buildout traffic volumes, shown in Figure 10. Capacity analysis results of anticipated Phase 1 conditions are summarized in Table 10.

As shown, with the exception of the northbound approach at the I-90 northbound ramp intersection during the PM peak time period, all approaches at each of the study intersections are expected to operate at LOS B or better. As compared to background 2025 conditions, the referenced northbound approach LOS does decline from E to F. 95th percentile queue lengths for auxiliary turn lanes were also calculated for study area auxiliary lanes and other critical movements. The reported 95th percentile queue length for the northbound left-turn/through lane at the I-90 northbound ramps intersection is estimated at 13.8 vehicles. Reported 95th percentile queue lengths for all other auxiliary turn lane movements are less than one vehicle which can be accommodated by the existing turn lane storage lengths. Analysis output sheets can be found in Appendix I.

5.2 Phases 1+2 (Year 2029) Site Buildout Conditions

The assigned site trips generated by the buildout of both Phases 1 and 2, as summarized in Figure 9, were added to 2029 background traffic volumes, as summarized in Figure 5, to derive year 2029 buildout traffic volumes. The projected 2029 buildout traffic volumes are shown in Figure 11.

5.2.1 Phases 1+2 (Year 2029) Site Buildout Conditions Capacity Analysis

Site buildout AM and PM peak hour traffic conditions, for Phases 1 and 2 combined, were analyzed using the existing intersection lane configurations and traffic control, as summarized in Figure 2, and the site buildout traffic volumes for 2029, shown in Figure 11. Capacity analysis results of Phases 1 and 2 site buildout conditions are summarized in Table 11.

As shown, with the exception of the northbound approach at the I-90 northbound ramp intersection during the PM peak time period, all approaches at each of the study intersections are expected to operate at LOS C or better. As compared to year 2029 background conditions, the northbound approach LOS remains at F during the PM peak time period, however, the calculated delay increases from 52.2 to 148.6 seconds per vehicle. 95th percentile queue lengths were also calculated for study area auxiliary lanes and other critical movements. The reported 95th percentile queue length for the northbound left-turn/through lane at the I-90 northbound ramps intersection is estimated at 24.5 vehicles. Reported 95th percentile queue lengths for all other auxiliary turn lane movements are less than two vehicles which can be accommodated by the existing turn lane storage lengths. Analysis output sheets can be found in Appendix J.

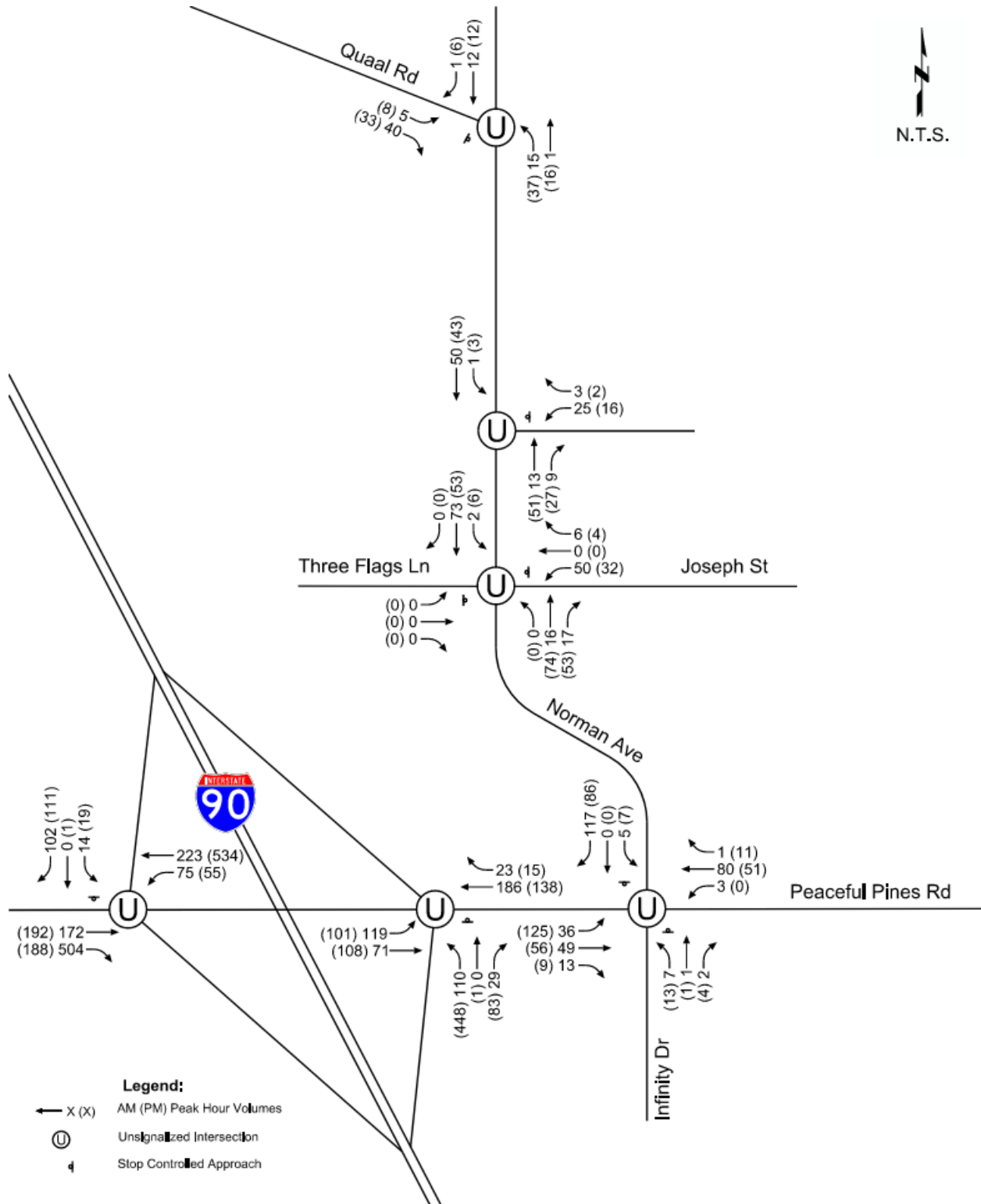


Figure 10: Phase 1 (Year 2025) Site Buildout Peak Hour Volumes

Table 10: Phase 1 (Year 2025) Site Buildout Capacity Analysis Results

Intersection	Time Period	Control Type	LOS / Delay				
			Intersection ¹	NB	SB	EB	WB
I-90 SB Ramps & Peaceful Pines Rd	AM	Unsignalized (TWSC)	1.7	-	B / 10.9	-	A / 7.8 ²
	PM		2.1	-	B / 14.3	-	A / 7.7 ²
I-90 NB Ramps & Peaceful Pines Rd	AM	Unsignalized (TWSC)	5.4	B / 14.0	-	A / 8.1 ²	-
	PM		36.3	F / 59.5	-	A / 7.8 ²	-
Peaceful Pines Rd & Norman Ave/Infinity Dr	AM	Unsignalized (TWSC)	5.1	B / 11.8	A / 9.7	A / 7.6 ²	A / 7.4 ²
	PM		5.6	B / 12.0	A / 9.3	A / 7.6 ²	A / 7.3 ²
Norman Ave & Three Flags Ln/Joseph St	AM	Unsignalized (TWSC)	3.4	A / 0.0	A / 7.3 ²	A / 8.9	A / 9.4
	PM		1.9	A / 0.0	A / 7.5 ²	A / 9.1	A / 9.8
Norman Ave & Norman Ranch North Access	AM	Unsignalized (TWSC)	2.6	-	A / 7.3 ²	-	A / 9.0
	PM		1.3	-	A / 7.4 ²	-	A / 9.2
Norman Ave & Quaal Rd	AM	Unsignalized (TWSC)	6.8	A / 7.4 ²	-	A / 8.7	-
	PM		5.6	A / 7.3 ²	-	A / 8.7	-

¹Highway Capacity Manual (HCM) methodology does not report LOS for the entire intersection under TWSC conditions. Delay reported is the weighted delay for all movements.

²LOS/Delay reported is for left-turn movement only.

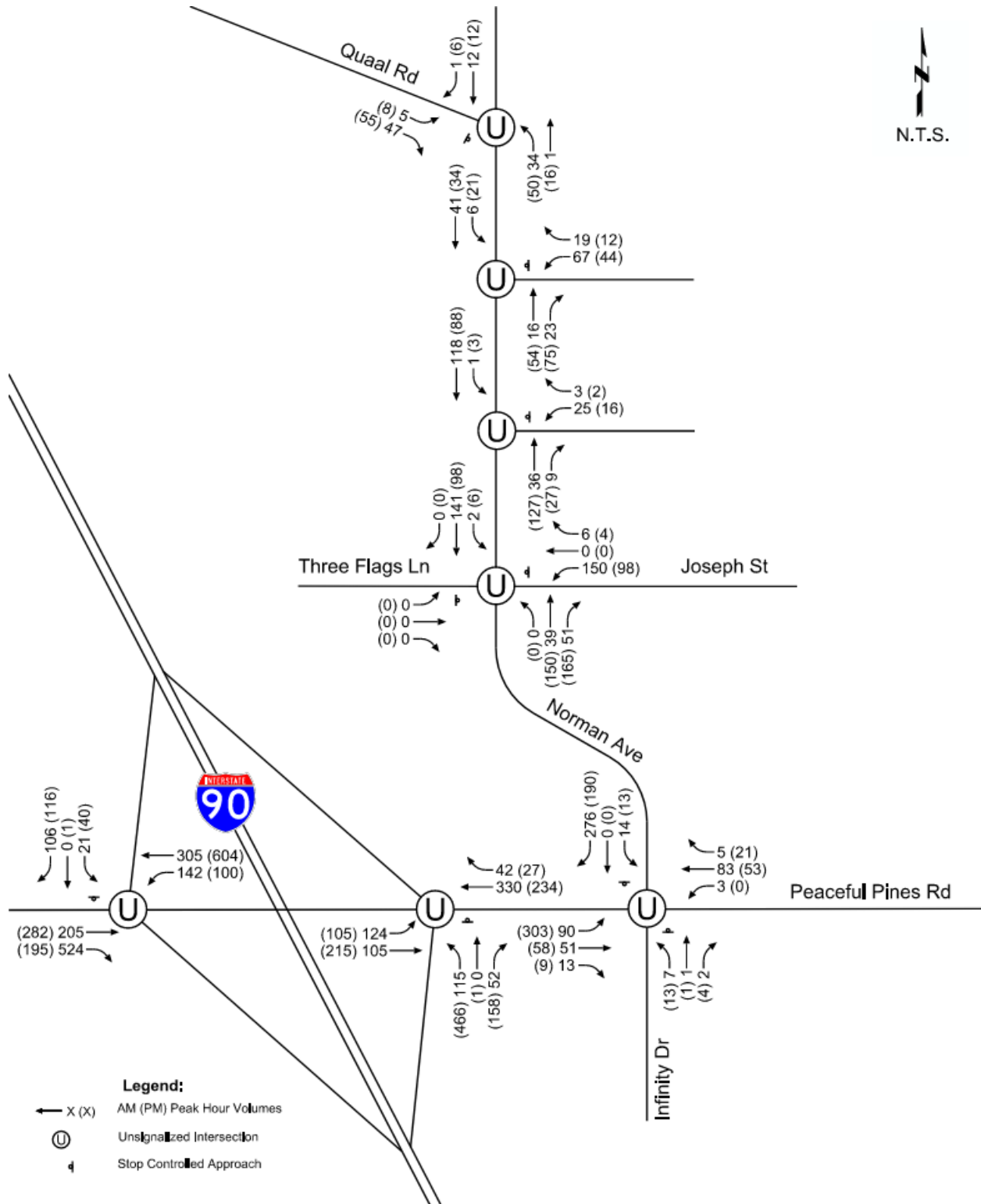


Figure 11: Phases 1+2 (Year 2029) Site Buildout Peak Hour Volumes

Table 11: Phases 1+2 (Year 2029) Site Buildout Capacity Analysis Results

Intersection	Time Period	Control Type	LOS / Delay				
			Intersection ¹	NB	SB	EB	WB
I-90 SB Ramps & Peaceful Pines Rd	AM	Unsignalized (TWSC)	2.1	-	B / 12.7	-	A / 8.0 ²
	PM		2.6	-	C / 17.4	-	A / 8.1 ²
I-90 NB Ramps & Peaceful Pines Rd	AM	Unsignalized (TWSC)	5.0	C / 16.7	-	A / 8.6 ²	-
	PM		77.7	F / 148.6	-	A / 8.1 ²	-
Peaceful Pines Rd & Norman Ave/Infinity Dr	AM	Unsignalized (TWSC)	8.0	C / 17.6	B / 11.9	A / 7.7 ²	A / 7.4 ²
	PM		7.6	C / 20.8	B / 10.9	A / 8.1 ²	A / 7.3 ²
Norman Ave & Three Flags Ln/ Joseph St	AM	Unsignalized (TWSC)	4.6	A / 7.5 ²	A / 7.4 ²	A / 9.5	B / 11.4
	PM		2.6	A / 7.4 ²	A / 8.0 ²	B / 10.0	B / 12.6
Norman Ave & Norman Ranch North Access	AM	Unsignalized (TWSC)	1.4	-	A / 7.3 ²	-	A / 9.5
	PM		0.8	-	A / 7.6 ²	-	A / 9.9
Norman Ave & Norman Ranch Far North Access	AM	Unsignalized (TWSC)	4.9	-	A / 7.3 ²	-	A / 9.3
	PM		2.9	-	A / 7.5 ²	-	A / 9.7
Norman Ave & Quaal Rd	AM	Unsignalized (TWSC)	7.1	A / 7.5 ²	-	A / 8.7	-
	PM		6.3	A / 7.3 ²	-	A / 8.8	-

¹Highway Capacity Manual (HCM) methodology does not report LOS for the entire intersection under TWSC conditions. Delay reported is the weighted delay for all movements.

²LOS/Delay reported is for left-turn movement only.

6.0 20-Year Horizon (2045) Conditions

This section of the report presents the projected traffic volumes and capacity analysis results for a horizon year scenario 20 years after the buildout of Phase 1, or year 2045.

6.1 Background Traffic Volumes

Growth rates, as summarized in Section 3.0, were applied to existing traffic volumes to achieve year 2045 background volumes. The resulting background traffic volumes are shown in Figure 12.

6.1.1 Horizon Year (2045) Background Conditions Capacity Analysis

Year 2045 Background AM and PM peak hour traffic conditions were analyzed using the existing intersection lane configurations and traffic control illustrated in Figure 2 and the background traffic volumes for year 2045 illustrated in Figure 12. Capacity analysis results for background 2045 conditions are summarized in Table 12.

Table 12: Horizon Year (2045) Background Scenario Capacity Analysis Results

Intersection	Time Period	Control Type	LOS / Delay				
			Intersection ¹	NB	SB	EB	WB
I-90 SB Ramps & Peaceful Pines Rd	AM	Unsignalized (TWSC)	1.6	-	B / 11.0	-	A / 7.8 ²
	PM		2.3	-	C / 16.9	-	A / 7.7 ²
I-90 NB Ramps & Peaceful Pines Rd	AM	Unsignalized (TWSC)	6.7	C / 15.4	-	A / 8.0 ²	-
	PM		73.2	F / 111.2	-	A / 7.7 ²	-
Peaceful Pines Rd & Norman Ave/Infinity Dr	AM	Unsignalized (TWSC)	2.8	B / 10.5	A / 9.1	A / 7.5 ²	A / 7.4 ²
	PM		3.9	B / 10.4	A / 9.0	A / 7.4 ²	A / 7.4 ²
Norman Ave & Three Flags Ln	AM	Unsignalized (TWSC)	0.3	A / 0.0	-	A / 8.7	-
	PM		0.2	A / 0.0	-	A / 8.7	-
Norman Ave & Quaal Rd	AM	Unsignalized (TWSC)	6.6	A / 7.4 ²	-	A / 8.6	-
	PM		5.2	A / 7.3 ²	-	A / 8.7	-

¹Highway Capacity Manual (HCM) methodology does not report LOS for the entire intersection under TWSC conditions. Delay reported is the weighted delay for all movements.

²LOS/Delay reported is for left-turn movement only.

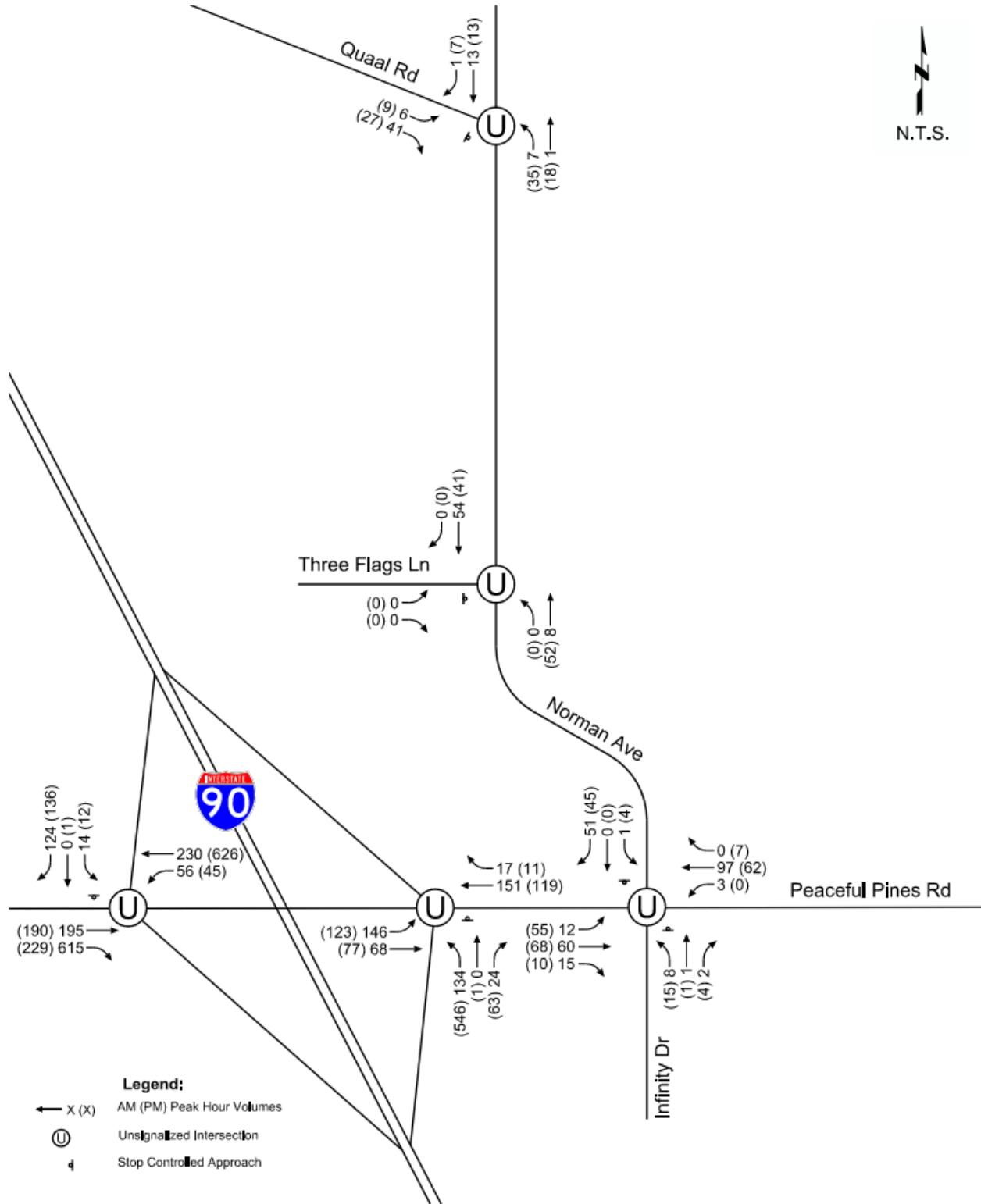


Figure 12: Horizon Year (2045) Background Peak Hour Volumes

As shown, with the exception of the northbound approach at the I-90 northbound ramp terminal intersection, all movements at each of the study intersections are expected to operate at LOS C or better. The northbound approach at the I-90 ramp terminal intersection is anticipated to operate at LOS F during the PM peak time period. 95th percentile queue lengths were also calculated for study area auxiliary lanes and other critical movements. The reported 95th percentile queue length for the northbound left-turn/through lane at the I-90 northbound ramps intersection is estimated at 21.3 vehicles. Reported 95th percentile queue lengths for all other auxiliary turn lane movements are less than two vehicles which can be accommodated by the existing turn lane storage lengths. Analysis output sheets can be found in Appendix K.

6.2 Horizon Year 2045 Buildout Traffic Volumes

The assigned site trips generated by the buildout of both Phases 1 and 2, as summarized in Figure 9, were added to year 2045 background traffic volumes, as illustrated in Figure 12, to derive horizon year buildout traffic volumes. The projected 2045 buildout AM and PM peak period traffic volumes are shown in Figure 13.

6.2.1 Horizon Year (2045) Buildout Conditions Capacity Analysis

Horizon year 2045 AM and PM peak hour traffic conditions were analyzed using the existing intersection lane configurations and traffic control, illustrated in Figure 2, and the horizon year traffic volumes for 2045, shown in Figure 13. Capacity analysis results of horizon year 2045 conditions are summarized in Table 13.

As shown, with the exception of the northbound approaches at the I-90 northbound ramp terminal intersection, all movements at each of the study intersections are expected to operate at LOS C or better. The northbound approach at the I-90 ramp terminal intersection is anticipated to operate at LOS F during the PM peak time period. 95th percentile queue lengths were also calculated for study area auxiliary lanes and other critical movements. The reported 95th percentile queue length for the northbound left-turn/through lane at the I-90 northbound ramps intersection is estimated at 34.6 vehicles. Reported 95th percentile queue lengths for all other auxiliary turn lane movements are less than three vehicles which can be accommodated by the existing turn lane storage lengths. Analysis output sheets can be found in Appendix L.

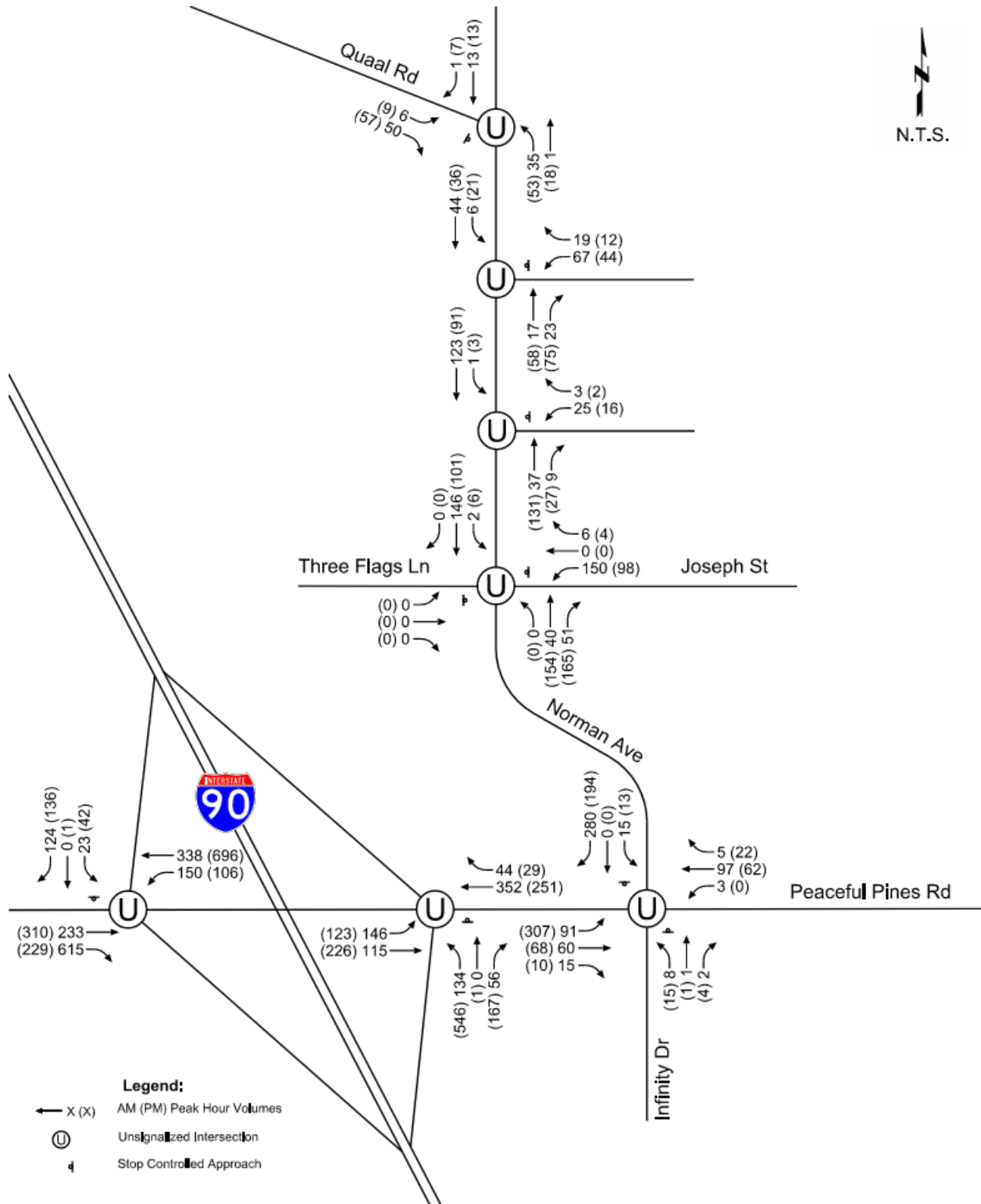


Table 13: Horizon Year (2045) Buildout Scenario Capacity Analysis Results

Intersection	Time Period	Control Type	LOS / Delay				
			Intersection ¹	NB	SB	EB	WB
I-90 SB Ramps & Peaceful Pines Rd	AM	Unsignalized (TWSC)	2.2	-	B / 13.4	-	A / 8.1 ²
	PM		3.1	-	C / 21.2	-	A / 8.2 ²
I-90 NB Ramps & Peaceful Pines Rd	AM	Unsignalized (TWSC)	5.9	C / 19.6	-	A / 8.8 ²	-
	PM		129.6	F / 242.4	-	A / 8.2 ²	-
Peaceful Pines Rd & Norman Ave/Infinity Dr	AM	Unsignalized (TWSC)	7.2	C / 15.3	B / 11.1	A / 7.7 ²	A / 7.4 ²
	PM		7.3	C / 20.1	B / 10.7	A / 8.0 ²	A / 7.4 ²
Norman Ave & Three Flags Ln/Joseph St	AM	Unsignalized (TWSC)	4.6	A / 7.5 ²	A / 7.4 ²	A / 9.6	B / 11.5
	PM		2.6	A / 7.4 ²	A / 8.0 ²	B / 10.1	B / 12.7
Norman Ave & Norman Ranch North Access	AM	Unsignalized (TWSC)	1.4	-	A / 7.3 ²	-	A / 9.5
	PM		0.8	-	A / 7.6 ²	-	A / 10.0
Norman Ave & Norman Ranch Far North Access	AM	Unsignalized (TWSC)	4.8	-	A / 7.3 ²	-	A / 9.3
	PM		2.9	-	A / 7.5 ²	-	A / 9.8
Norman Ave & Quaal Rd	AM	Unsignalized (TWSC)	7.1	A / 7.4 ²	-	A / 8.7	-
	PM		6.2	a / 7.3 ²	-	A / 8.8	-

¹Highway Capacity Manual (HCM) methodology does not report LOS for the entire intersection under TWSC conditions. Delay reported is the weighted delay for all movements.

²LOS/Delay reported is for left-turn movement only.

6.3 Turn Lane Warrant Analysis

Where turn lanes are not already provided on mainline Peaceful Pines Road and mainline Norman Avenue, the need for auxiliary turn lanes at study area intersections was analyzed using the methodology from Report 457 of the National Cooperative Highway Research Program (NCHRP 457). The analysis was completed for all scenarios at each study intersection and is summarized in Table 14. Auxiliary lane warrant analysis sheets can be found in Appendix M.

Based on these results, aside from those already in existence, only a northbound right-turn lane at the intersection of Norman Avenue & Three Flags Lane/Joseph Street is warranted for 2029 & 2045 Buildout conditions.

Table 14: Mainline Auxiliary Turn Lane Warrant Analysis¹

Intersection	NB Left-turn	NB Right-turn	SB Left-turn	SB Right-turn	EB Left-turn	EB right-turn	WB Left-turn	WB Right-turn
I-90 SB Ramps & Peaceful Pines Rd	-	-	-	Existing	-	Existing	Existing	-
I-90 NB Ramps & Peaceful Pines Rd	-	Existing	-	-	Existing	-	-	Not warranted
Peaceful Pines Rd & Norman Ave/Infinity Dr	-	-	-	-	Existing	Not warranted	Not warranted	Not warranted
Norman Ave & Three Flags Ln/Joseph St	Not warranted	Warranted Buildout 2029 & 2045	Not warranted	Not warranted	-	-	-	-
Norman Ave & Norman Ranch North Access	-	Not warranted	Not warranted	-	-	-	-	-
Norman Ave & Norman Ranch Far North Access	-	Not warranted	Not warranted	-	-	-	-	-
Norman Ave & Quaal Rd	Not warranted	-	-	Not warranted	-	-	-	-

¹Minor street approaches were not analyzed as part of the auxiliary turn lane warrant analysis.

6.4 Signal Warrant Analysis

A review was performed to determine if signal warrant criteria are satisfied for the implementation of traffic signal control at either of the two existing unsignalized intersections at the Exit 52 interchange. For the purposes of this evaluation, *Manual on Uniform Traffic Control Devices (MUTCD)* Warrant 1 (Eight-hour Vehicular Volume), Warrant 2 (Four-hour Vehicular Volume), and Warrant 3 (Peak Hour) were considered. It should be noted that Warrant 3 (Peak Hour) should be applied only in unusual cases, such as office complexes, manufacturing plants, industrial complexes, or high-occupancy vehicle facilities that attract or discharge large numbers of vehicles over a short time period. However, since eight hours of data is not available for buildout conditions (i.e., trip generation only applies to the AM and PM peak hours), Warrant 3 was included for illustrative purposes. Table 15 summarizes the results of this evaluation.

Table 15: Signal Warrants

Intersection	Scenario	MUTCD Warrant 1 (8-hour)	MUTCD Warrant 2 (4-hour)	MUTCD Warrant 3 (Peak Hour)
Peaceful Pines Rd & Exit 52 – SB Ramps	Existing	Not warranted	Not warranted	Not warranted
	Background 2025			
	Background 2029			
	Background 2045		Warranted w/o right-turn (RT) volume reduction ²	
	Buildout 2025	- ¹		Not warranted
	Buildout 2029			
	Buildout 2045			Warranted w/o RT reduction
Peaceful Pines Rd & Exit 52 – NB Ramps	Existing	Not warranted	Not warranted	Warranted w/ RT Reduction
	Background 2025			
	Background 2029			
	Background 2045			
	Buildout 2025	- ¹		
	Buildout 2029			
	Buildout 2045			

¹Insufficient data to evaluate warrant criteria.

²Right-turn volume reduction performed in accordance with NCHRP report 457.

Based on the results of this signal warrant evaluation, formal traffic signal control warrant criteria are satisfied at both intersections. Signals are warranted for the peak hour at the I-90 southbound ramps intersection for the background 2045 and 2029 & 2045 buildout scenarios. In addition, the four-hour warrant is satisfied for the background 2045 scenario. Criteria for the peak hour warrant are satisfied for the I-90 northbound ramps intersection under all scenarios. Signal warrant analysis output sheets can be found in Appendix N.

7.0 Conclusions and Recommendations

Based on the results of the traffic study analyses, the following conclusions and recommendations are provided:

Conclusions

1. The AM peak hour for the study area network was determined to be 7:00-8:00 a.m. and the PM peak hour was 4:30-5:30 p.m.
2. Under existing (2023) conditions, all approaches at each of the study intersections operate at LOS B, or better, during both peak time periods, with the exception of the northbound approach at the northbound ramp terminal intersection which is expected to operate at LOS E during the PM peak time period. The calculated 95th percentile vehicle queue length of the shared left-turn/through lane on this approach is 10 vehicles. (It should also be noted that the SDDOT 2020 Decennial Interstate Corridor Study documents future operations deficiencies at this intersection.)
3. Under background (2025) conditions, all approaches at each of the study intersections are expected to operate at LOS B, or better, with the exception of the northbound approach at the northbound ramp terminal intersection which is expected to operate at LOS E during the PM peak time period. The calculated 95th percentile vehicle queue length of the shared left-turn/through lane on this approach is 10.8 vehicles.
4. Under background (2029) conditions, all approaches at each of the study intersections are expected to operate at LOS B, or better, with the exception of the northbound approach at the northbound ramp terminal intersection which is expected to operate at LOS F during the PM peak time period. The calculated 95th percentile vehicle queue length of the shared left-turn/through lane on this approach is 12.8 vehicles.
5. Using methodology from the Institute of Transportation Engineers (ITE) *Trip Generation Manual* (TGM), 11th edition, it is estimated that Phase 1 of the proposed residential development will generate 113 vehicle trips during the AM peak time period and 142 vehicle trips during the PM peak time period. After buildout of Phase 2, the development is estimated to generate an additional 249 vehicle trips during the AM peak time period and an additional 331 vehicle trips during the PM peak time period.
6. Under Phase 1 (2025) site buildout conditions, all approaches at each of the study intersections are expected to operate at LOS B, or better, with the exception of the northbound approach at the northbound ramp terminal intersection. This movement is expected to operate at LOS F during the PM peak time period. The calculated 95th percentile vehicle queue length of the shared left-turn/through lane on this approach is 13.8 vehicles.
7. Under site buildout conditions for Phases 1 and 2 combined (2029), all approaches at each of the study intersections are expected to operate at LOS C, or better, with the exception of the northbound approach at the northbound ramp terminal intersection. The calculated 95th percentile vehicle queue length of the shared left-turn/through lane on this approach is 24.5 vehicles.

8. Under background (2045) conditions, all approaches at each of the study intersections are expected to operate at LOS C, or better, with the exception of the northbound approach at the northbound ramp terminal intersection which is expected to operate at LOS F during the PM peak time period. The calculated 95th percentile vehicle queue length of the shared left-turn/through lane on this approach is 21.3 vehicles.
9. Under horizon year 2045 buildout conditions, including trips associated with Phases 1 and 2, all approaches at each of the study intersections are expected to operate at LOS C, or better, with the exception of the northbound approach at the northbound ramp terminal intersection which is expected to operate at LOS F during the PM peak time period. The calculated 95th percentile vehicle queue length of the shared left-turn/through lane on this approach is 34.6 vehicles.
10. Under Buildout 2029 & 2045 conditions, a northbound right-turn lane at the intersection of Norman Avenue & Three Flags Lane/Joseph Street is warranted. No additional turn lanes are warranted aside from those already in existence.
11. Formal traffic signal control warrant criteria are satisfied at both of the Exit 52 ramp terminal intersections. The southbound ramp intersection satisfies signal warrant criteria after year 2029 for background conditions and at year 2029 for buildout conditions. The northbound ramp intersection satisfies signal warrant criteria under existing conditions. It should be noted, however, that the majority of the satisfied warrant criteria apply to Warrant 3 (Peak Hour) which may not be applicable to this location and associated surrounding land use.

Recommendations

Based on the analyses documented herein, the following recommendations are offered to mitigate anticipated traffic operations deficiencies associated with existing and/or future conditions.

1. Due to existing and anticipated future vehicle delays, operating the Exit 52 northbound ramp terminal intersection under traffic signal control should be considered. Ongoing monitoring and evaluation of this intersection should be performed to determine when signal warrant criteria, other than that associated with Warrant 3 (Peak Hour), are satisfied. Unless more significant changes are implemented for the entire interchange (i.e., reconfiguration), signalization is likely the best strategy to mitigate vehicle delay and queuing on the northbound ramp approach.
2. As part of Phase 2 buildout of the proposed development, installing a northbound right-turn lane at the intersection of Norman Avenue & Joseph Street will likely improve traffic operations and safety at this intersection.
3. When approaching Norman Avenue, all new streets constructed as part of the proposed development should be stop sign controlled.

