STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

MICHAEL F. EASLEY
GOVERNOR

1534 MAIL SERVICE CENTER, RALEIGH, N.C. 27699-1534

W. LYNDO TIPPETT
SECRETARY

June 20, 2002

MEMORANDUM TO: Mr. Douglas J. Galyon, Member, Board of Transportation
Mr. Mike Mills, P.E., Division Engineer, Division 7
Mr. David King
Mr. Calvin Leggett, P.E.
Mr. Troy Peoples, P.E. (3) Attention: Jim Dunlop, P.E.
Mr. John Williamson
Mr. Bill Gilmore, P.E. (2)
Ms. Deborah Barbour, P.E.
Mr. Jay Bennett, P.E.
Mr. Blake Norwood, P.E.
Mr. A. L. Avant
Mr. Van Argabright, P.E.
Mr. Doug Lane
Mr. Burt Tasaico, P.E., Attention: Omar S. Sultan
Mr. Terry M. Snow, P.E., Neel-Schaffer, Inc

FROM: Mr. Derrick W. Lewis, P.E.
Feasibility Studies Unit

SUBJECT: Feasibility Study FS-9907E; Eckerson Road (SR 2970)/US 29 Interchange modifications, Greensboro, Guilford County.

Our staff has completed a cursory review of the FS-9907E feasibility study prepared by the private engineering firm of Neel Schaffer, Inc.. This brief analysis suggests improvements that would be logical if the project were to be funded. A copy of this report and a summary of the anticipated cost are attached for your information.

DWL/dl

Attachment

cc: Mr. Len Hill, P.E.
Mr. Len Sanderson, P.E.

PHONE 919-733-2039 FAX 919-733-3585

Anticipated Feasibility Study Cost Estimates

		Right of way Cost	Construction Cost	Total Alternative Cost
Recommended	**Revised US 29/Eckerson Road (SR 2970) Interchange**, and also includes widening of US 29 to a four lane divided freeway with a 70 foot median and Eckerson Road from US 29 to the intersection with Reedy Fork Avenue. It does not include the service road opposite the US 29 northbound ramps. No relocations anticipated.	$2,500,000	$13,900,000.00	$16,400,000
	Proposed US 29/Brown Summit Avenue SPUI. Includes widening of US 29 to a four lane freeway with a 70 foot median and the Summit Avenue, Brown Summit Road, and Brown Summit Avenue. One residential relocation resulting from the proposed interchange.	$1,900,000	$16,000,000	$17,900,000
	Asymmetrical widening of US 29 between the interchanges to a four-lane divided freeway with a 46 foot median. Includes providing an auxilary lane between the ramp terminals of the Eckerson Road and Brown Summit Avenue interchanges. No relocations anticipated.	$300,000.00	$4,500,000.00	$4,800,000.00
	Future widening of US 29 to a six-lane freeway with a 46 foot median. Includes both interchanges and the section of US 29 between the interchanges. Right of way is incorporated in other abovementioned sections.	$0.00	$2,200,000.00	$2,200,000.00
	Total Cost	$4,700,000.00	$36,600,000.00	$41,300,000

Note: These cost reflect the recommendations shown in the attached feasibility study. A cost estimate breakdown of the proposed US 29/Eckerson Road interchange revisions is provided in Appendex A.

FEASIBILITY STUDY & FUNCTIONAL DESIGNS

ECKERSON ROAD/US 29 INTERCHANGE MODIFICATION
&
BROWN SUMMIT AVENUE EXTENSION/US 29 INTERCHANGE
Greensboro, North Carolina

prepared for:

STARMOUNT COMPANY
P.O. Box 10349
Greensboro, North Carolina 27404

and

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
P.O. Box 25201
Raleigh, North Carolina 27611

prepared by:

NEEL-SCHAFFER, INC.
ENGINEERS • PLANNERS
2302 W. Meadowview Road, Suite 130
Greensboro, NC 27407
Ph: (336) 851-1006

June 18, 2002
REVISED

(N/S Project No. 3-2-3812-02)

NORTH CAROLINA PROFESSIONAL SEAL ENGINEER TERRY M. SNOW 6/21/02

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INTERCHANGES FEASIBILITY STUDY

1. PURPOSE OF STUDY

An interchange feasibility study was conducted to provide general functional designs for the proposed interchange modifications at US 29/Eckerson Road and the proposed new interchange at US 29/Brown Summit Avenue Extension. The locations of the existing and proposed interchanges are illustrated on Figure 1.

The purpose of this study was to analyze the projected 2025 design year traffic in order to determine the optimal interchange and intersection geometrics that will adequately accommodate the expected traffic in the area.

2. PROJECT HISTORY

The stimulus for the aforementioned interchange modification and new interchange is the development of Reedy Fork Ranch, a mixed-use 1800-acre development that is located along the east and west sides of US 29, north of the US 29/Eckerson Road interchange. The Greensboro City Council approved this large development in early 2000. A Traffic Impact Analysis (TIA), dated January 11, 2000 was prepared by Neel-Schaffer, Inc. This TIA indicated that upgrades to the existing US 29/Eckerson Road interchange would be needed in the future to accommodate normal traffic growth in the area and to accommodate the projected Reedy Fork Ranch development traffic. The Conceptual Site Plan, prepared by Evans Engineering, Inc., is shown in Figure 2.

On July 27, 2000, a meeting was held at the North Carolina Department of Transportation to discuss the proposed interchange modification and the proposed new interchange. The meeting was attended by representatives from the Federal Highway Administration (FHWA), the North Carolina Department of Transportation (NCDOT), City of Greensboro Department of Transportation (GDOT), Starmount Company, and Neel-Schaffer. Inc. At this meeting, Neel-Schaffer, Inc. presented two conceptual design alternatives for US 29/Eckerson Road interchange and the proposed interchange at US 29/Brown Summit Avenue. The two interchanges alternatives were as follows:

Alternative 3A:	Single Point Urban Interchange at US 29/Brown Summit Road ½ Clover Interchange at US 29/Eckerson Road
Alternative 3B:	½ Clover Interchange at US 29/Brown Summit Road ½ Diamond Interchange at US 29/Eckerson Road

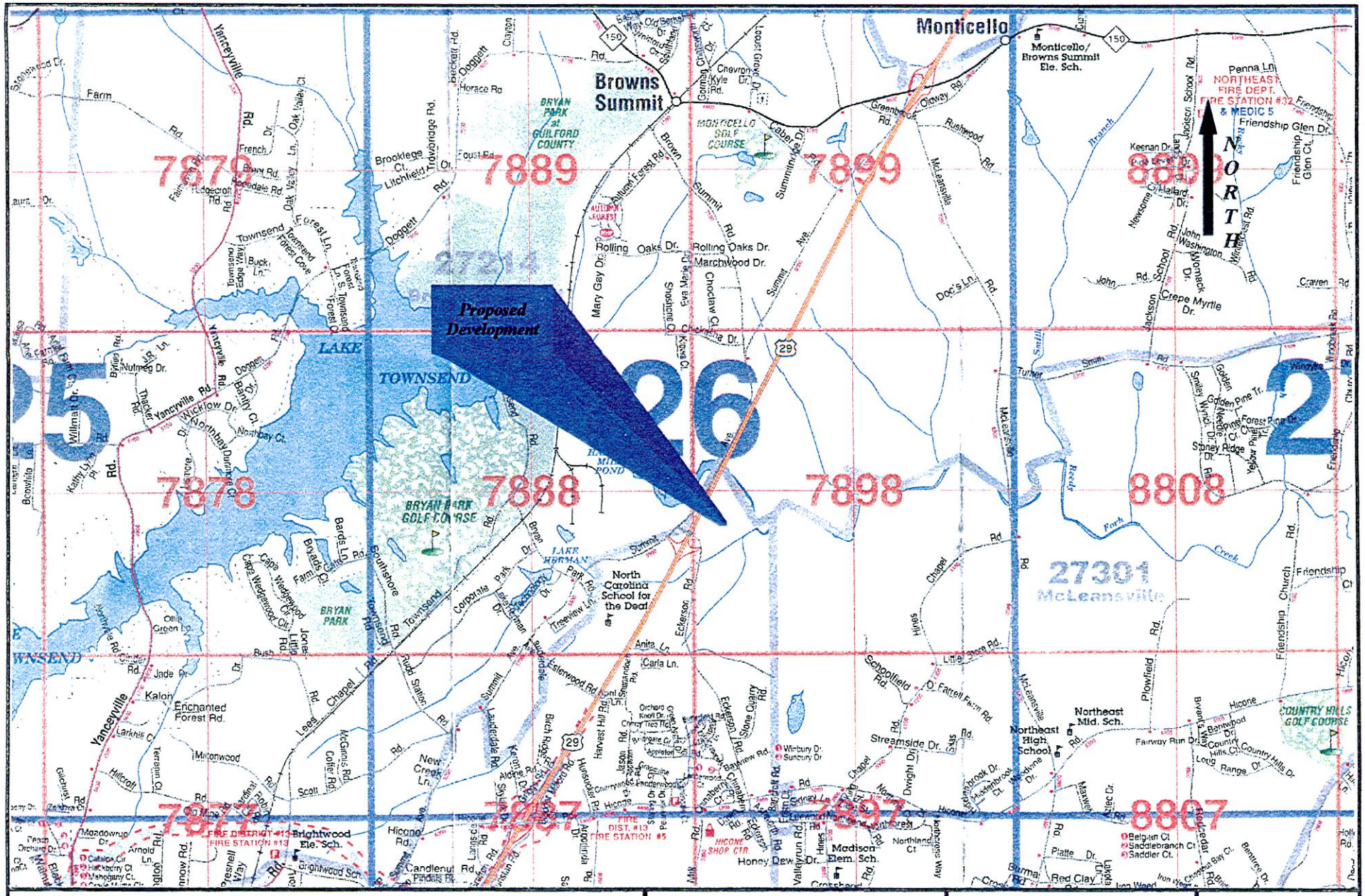
Based on comments provided by FHWA, NCDOT, and GDOT, it was decided that the preferred interchange configurations at the two locations would be as follows:

- US 29/Brown Summit Road: Single Point Urban Interchange
- US 29/Eckerson Road: ½ Clover Interchange

During these meetings, questions were raised regarding the projected traffic in the study area. NCDOT agreed to provide an updated traffic model by October 15, 2000. Upon receipt of the updated 2025 traffic projections, Neel-Schaffer, Inc. would modify the conceptual designs and develop functional designs for the two aforementioned interchanges.

Due to heavy project workloads, the updated traffic projections were not completed until December 2000. The development of site plans for the Reedy Fork Ranch development north east of the US 29/Eckerson Road interchange was being undertaken by Evans Engineering, Inc., consultants of Starmount Company. This site plan included the realignment of Eckerson Road to tie into the proposed Reedy Fork Avenue. Because the exact location of this realignment has not been approved by NCDOT, the development of the functional designs was delayed until July 2001.

The following sections summarize the traffic capacity projections and the recommended configurations of the proposed US 29/Eckerson Road interchange modification and the proposed new US 29/Brown Summit Road interchange.



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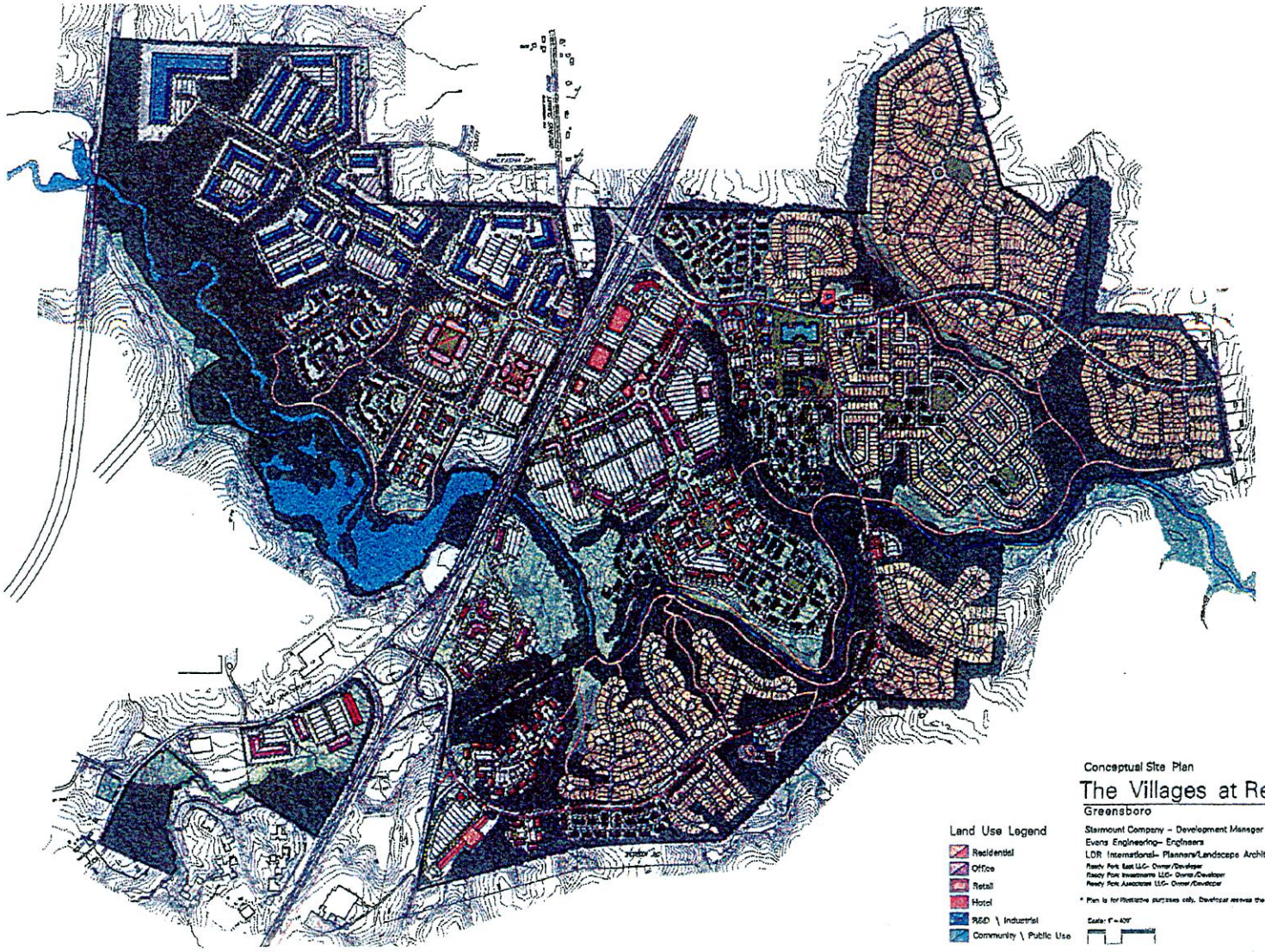
PROPOSED DEVELOPMENT
REEDY FORK RANCH
GREENSBORO, NORTH CAROLINA

SITE LOCATION

FIGURE: 1

SCALE: NONE

2-3812-02



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PROPOSED DEVELOPMENT
REEDY FORK RANCH
GREENSBORO, NORTH CAROLINA

PROPOSED SKETCH PLAN

FIGURE: 2

SCALE: NONE

2-3812-02

3. TRAFFIC CAPACITY ANALYSIS

A traffic capacity analysis was conducted to determine and examine future capacity levels for the two interchange locations using the projected 2025 average daily traffic (ADT) provided by NCDOT (see Appendix A). The projected 2025 ADT volumes provided by NCDOT indicate that 8,100 vehicles per day (vpd) are projected to travel on Reedy Fork Avenue, north of Eckerson Road. This projected ADT appears to be underestimated. Over 3,700 single family residences and a retail shopping center have been approved for development in this area. The approved single family residences alone should generate over 37,000 trips per day.

Although the traffic appears to be underestimated for Reedy Fork Avenue, the traffic capacity analysis performed used the 2025 ADT as provided by NCDOT.

LEVEL OF SERVICE CRITERIA

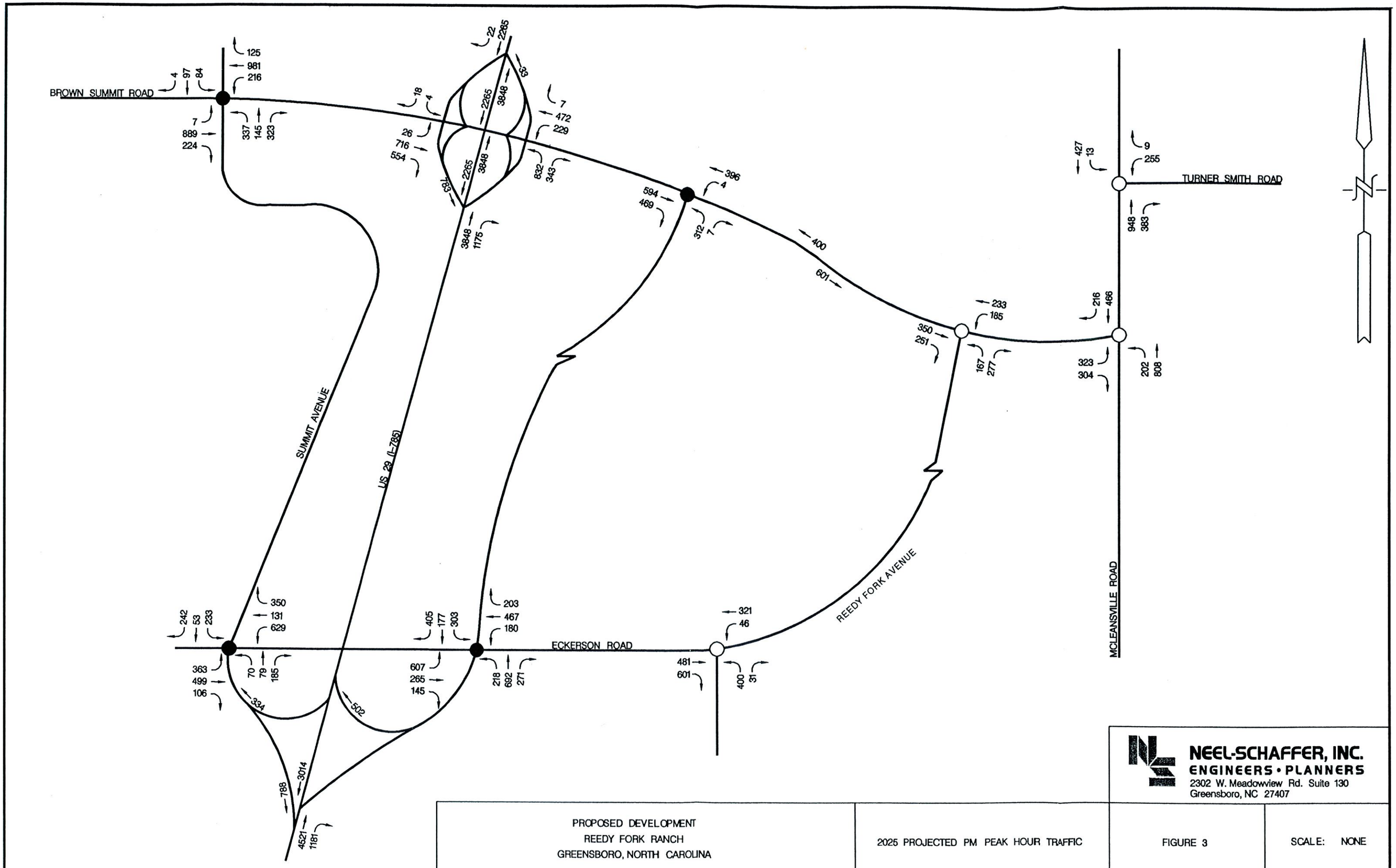
The interchange ramp intersections, all major at grade intersections within the vicinity of each interchange, and the ramp-to-ramp weaving between the interchanges were analyzed using the methods outlined in the ***Highway Capacity Manual***[1] and ***Synchro***[2], Version 5. The manual defines capacity as the maximum rate of flow at which persons or vehicles can be reasonably expected to traverse a point or uniform section of a lane or roadway during a specified time period under prevailing roadway, traffic, and control conditions, usually expressed as vehicles per hour or persons per hour. The capacity analyses were performed for the projected year 2025 peak hour traffic conditions.

Level of service (LOS) is a term used to represent different traffic conditions, and is defined as a "qualitative measure describing operational conditions within a traffic stream, and their perception by motorist/or passengers". Level of Service varies from Level A, representing free flow to Level F where traffic breakdown conditions are evident. Level B represents good progression with minimal congestion. At Level C, the number of vehicles stopping is significant, although many still pass through the intersection without stopping. Level D represents more congestion, but the overall operations are acceptable. At Level E, freedom to maneuver within the traffic stream is extremely difficult with driver frustration being generally high.

For signalized intersections, service levels pertain to each approach as well as an overall value. For unsignalized intersections service levels pertain to each movement that yields the right-of-way. Generally, Level D is acceptable in suburban areas during peak periods. It should be noted that actual operating conditions might be better than the calculated level of service due to an aggressive driver population.

Table 1 presents criteria of each level of service as indicated in the ***Highway Capacity Manual***[1].

Appendix B includes the specific capacity analysis worksheets for each intersection analyzed as well as merge / diverge analysis for the ramps for the projected 2025 peak hour traffic.



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PROPOSED DEVELOPMENT REEDY FORK RANCH GREENSBORO, NORTH CAROLINA	2025 PROJECTED PM PEAK HOUR TRAFFIC	FIGURE 3	SCALE: NONE

2-3812-02

TABLE 1
LEVEL OF SERVICE CRITERIA

SIGNALIZED INTERSECTIONS

Level of Service	Stopped Delay Per Vehicle (sec)
A	≤10.0
B	>10.0 and ≤20.0
C	>20.0 and ≤35.0
D	>35.0 and ≤55.0
E	>55.0 and ≤80.0
F	>80.0

UNSIGNALIZED INTERSECTIONS

Level of Service	Average Total Delay (sec/veh)
A	≤10
B	>10 and ≤15
C	>15 and ≤25
D	>25 and ≤35
E	>35 and ≤50
F	>50

Source: *Highway Capacity Manual*[1], Special Report 209, Transportation Research Board, National Research Council, Washington, D.C., 1998.

ANALYSIS OF 2025 BUILD CONDITIONS

To determine the capacity of each intersection, year 2025 average daily traffic (ADT) provided by NCDOT was used to analyze the capacity during the peak hour. See Appendix A for 2025 ADT volumes provided by NCDOT. Refer to Figure 3 for the projected 2025 peak hour traffic volumes within the study area.

All of the 2025 analyses assume that NC 29 is a 6-lane divided facility.

The results of the 2025 capacity analyses show that the level of service (LOS) of all intersections will vary from a LOS B to a LOS F during the peak hours. The unsignalized intersections are predicted to operate at an LOS F during the peak hours. It may be necessary to consider signalizing these intersections to improve the overall level of service. Table 2 represents a summary of traffic capacity analyses for the study area intersections analyzed.

TABLE 2
Eckerson Road & Brown Summit Avenue Extension
Traffic Capacity Summary

Intersection	2025 Build Conditions (Unsignalized) LOS(Delay)	2025 Build Conditions (Signalized) LOS(Delay)
	Peak Hour Analysis	Peak Hour Analysis
♦ Brown Summit Rd/Summit Ave	N/A	C (23.7)
♦ Brown Summit Rd/US 29	N/A	C (20.9)
♦ Brown Summit Rd/N-S Connector	N/A	B (13.5)
♦ Eckerson Rd/US 29	N/A	B (16.2)
♦ Eckerson Rd/N-S Connector	N/A	E (78.6)
♦ Eckerson Rd/Summit Ave	N/A	D (45.8)
♦ Brown Summit Rd/Eckerson Rd	#(14.2) *E (42.6) NB	B (18.1)
♦ Brown Summit Rd/McLeansville Rd	#(1396.2) *F (5160.6) EB	A (9.3)
♦ Turner Smith Rd/McLeansville Rd	#(48.4) *F (336.1) WB	B (11.5)

no letter value assigned by Synchro, only overall intersection delay
* LOS & delay for a specific movement, not the overall intersection

The ramp-to-ramp weaving analysis indicates the weaving between the proposed ramps at the two aforementioned interchanges are predicted to operate at an adequate level of service (LOS C or better) during the 2025 peak hour. The weaving distance between the ramps of the two proposed interchanges is approximately 3,500 feet, which is more than adequate to safely and efficiently serve vehicle weaving maneuvers.

Capacity analysis for interchange ramps differ from at grade intersection analysis in that density is used as a measure of effectiveness instead of delay. For merge / diverge ramps, LOS A through E assume stable, nonbreakdown operations and LOS F represents breakdown, or unstable operations.

Table 3 presents criteria of each level of service as indicated in the ***Highway Capacity Manual***[1].

TABLE 3
Level of Service Criteria
Ramp-Freeway Junction Areas of Influence

Level of Service	Maximum Density (Primary Measure) (pc/mi/ln)	Minimum Speed (Secondary Measure) (MPH)
A	10	58
B	20	56
C	28	52
D	35	46
E	>35	42
F	*	*

**Demand flows exceed limits*

Table 4 represents a summary of merge / diverge capacity analyses for the study area intersections analyzed.

The results of the 2025 capacity analyses show that the level of service (LOS) of all ramp intersections will vary from a LOS B to a LOS D during the peak hours.

TABLE 4
Eckerson Road & Brown Summit Avenue Extension
Merge / Diverge Capacity Summary

Intersection	2025 Build Conditions *(Upstream Adjacent Ramp)* LOS / Density (pc/mi/ln)	2025 Build Conditions *(Downstream Adjacent Ramp)* LOS / Density (pc/mi/ln)
	Peak Hour Analysis	Peak Hour Analysis
(1) US 29 SB SPUI Off Ramp	N/A	B (15)
(2) US 29 SB SPUI On Ramp	C (20)	B (17)
(3) US 29 NB SPUI Off Ramp	C (26)	C (26)
(4) US 29 NB SPUI On Ramp	C (20)	N/A
(5) US 29 SB ½ Clover Off Ramp	B (17)	B (17)
(6) US 29 SB ½ Clover On Ramp	C (23)	N/A
(7) US 29 NB ½ Clover Off Ramp	N/A	D (29)
(8) US 29 NB ½ Clover On Ramp	D (28)	D (28)

4. PROJECT COST ESTIMATES

Based on 2002 dollars, the total project cost of the interchange improvements including the Eckerson Road section and US 29 improvements is estimated to be approximately:

Construction Costs	$13,900,000
Right-of-Way Costs	$ 2,500,000
TOTAL	$16,400,000

A detailed breakdown of the project cost estimates is included in the appendix.

5. RECOMMENDATIONS

In order for the subject interchanges to function at acceptable levels of service in year 2025, the following lane configurations/cross-sections are recommended for area roadways and interchanges:

- US 29 (Future I-785) – 6 lane divided freeway with 46′ depressed median
- US 29/Brown Summit Road Interchange – Single Point Urban Interchange
- US 29/Eckerson Road Interchange – ½ Clover Interchange
- Reedy Fork Avenue -6 lanes from Summit Avenue to Eckerson Road intersection
  -3 lanes east of Eckerson Road intersection
- Brown Summit Road – basic 5 lanes section

The recommended lane configurations for study area roadways and interchanges are illustrated in Figure 4.

Figure 5 represents a functional design for the reconstruction of the US 29/Eckerson Road interchange. This requires relocating the Eckerson Road bridge approximately 350-500 feet to the south. This alternative will result in improved interchange geometrics and traffic operations. Figure 5 illustrates the new interchange teeing directly to the proposed Reedy Fork Avenue as designed by Evans Engineering, Inc. This will require stream relocations or the piping of the existing stream in the southeast quadrant of the interchange.

Figure 5.1 represents functional designs for US 29 between the US 29 / Eckerson Road and US 29 / Brown Summit Road interchanges.

Figure 5.2 represents the functional designs for the proposed US 29/Brown Summit Road single point urban interchange.

Figure 5.3 represents the northern part of US 29 / Brown Summit Road single point urban interchange and Figure 5.4 represents the southern part of US 29 / Brown Summit Road single point urban interchange.

6. CONCLUSIONS

The exact locations and configurations of the aforementioned interchanges cannot be definitively determined at this time. An Environmental Impact Statement (EIS) or other environmental documents as well as preliminary interchange design will need to be completed and approved in conformance with the requirements of the National Environmental Protection Act (NEPA) before final decisions can be made.

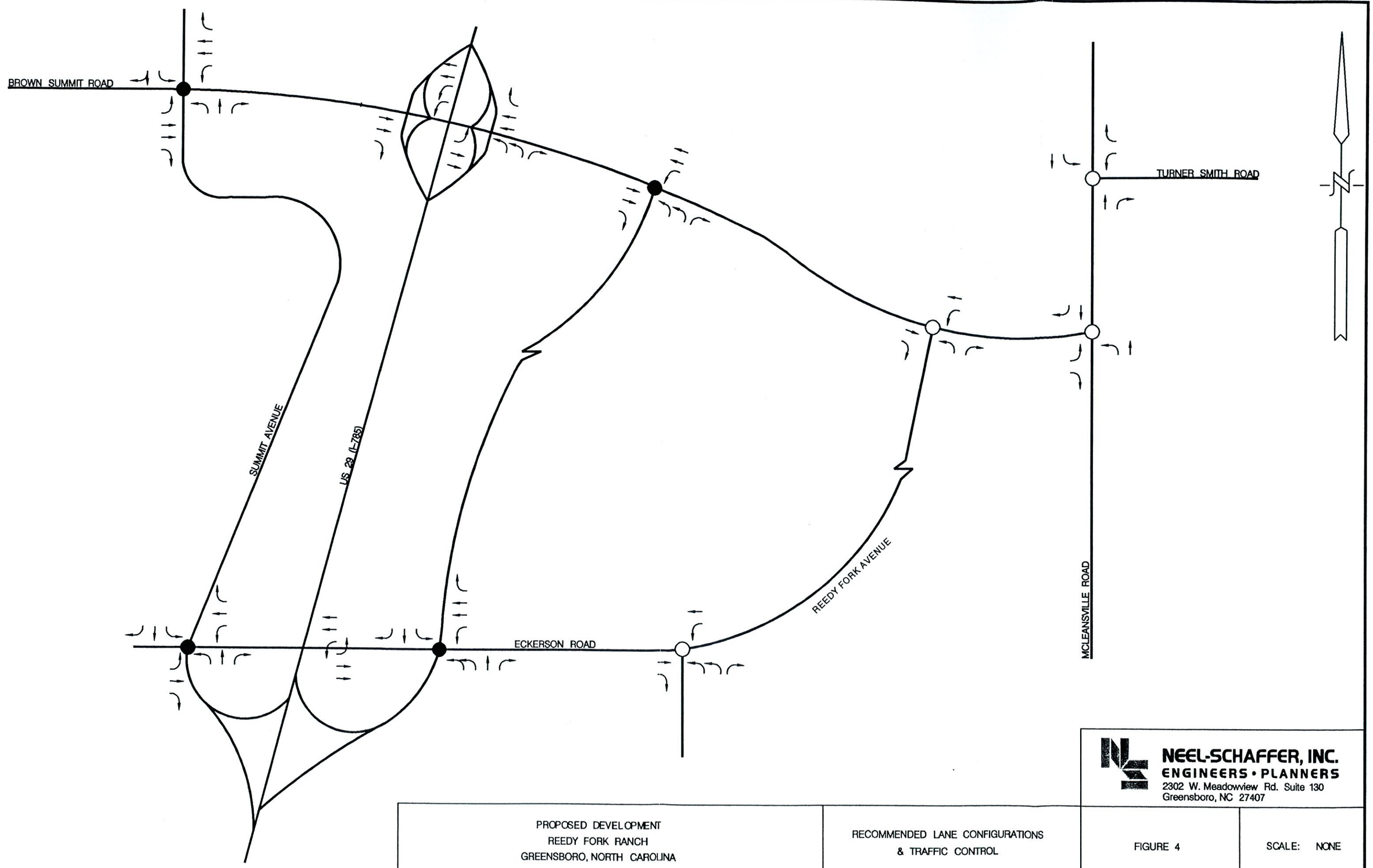
The functional designs presented as part of this feasibility study indicate the proposed single point urban interchange at Brown Summit Road/US 29 is a prudent and feasible alternative. The proposed interchange modifications at the Eckerson Road/US 29 interchange are more challenging due to existing streams, floodways, and other environmental concerns. However, functional designs for various options have been developed that indicate the modifications at the subject interchange are also prudent and feasible. Final decisions on the preferred design will be based on results of a future EIS and preliminary design.

7. REFERENCES

[1]***Highway Capacity Manual,*** Special Report 209, Transportation Research Board, National Research Council, Washington, D.C., 1998.

[2]***Synchro Version 6,*** Trafficware, 2001.

FS-99072E



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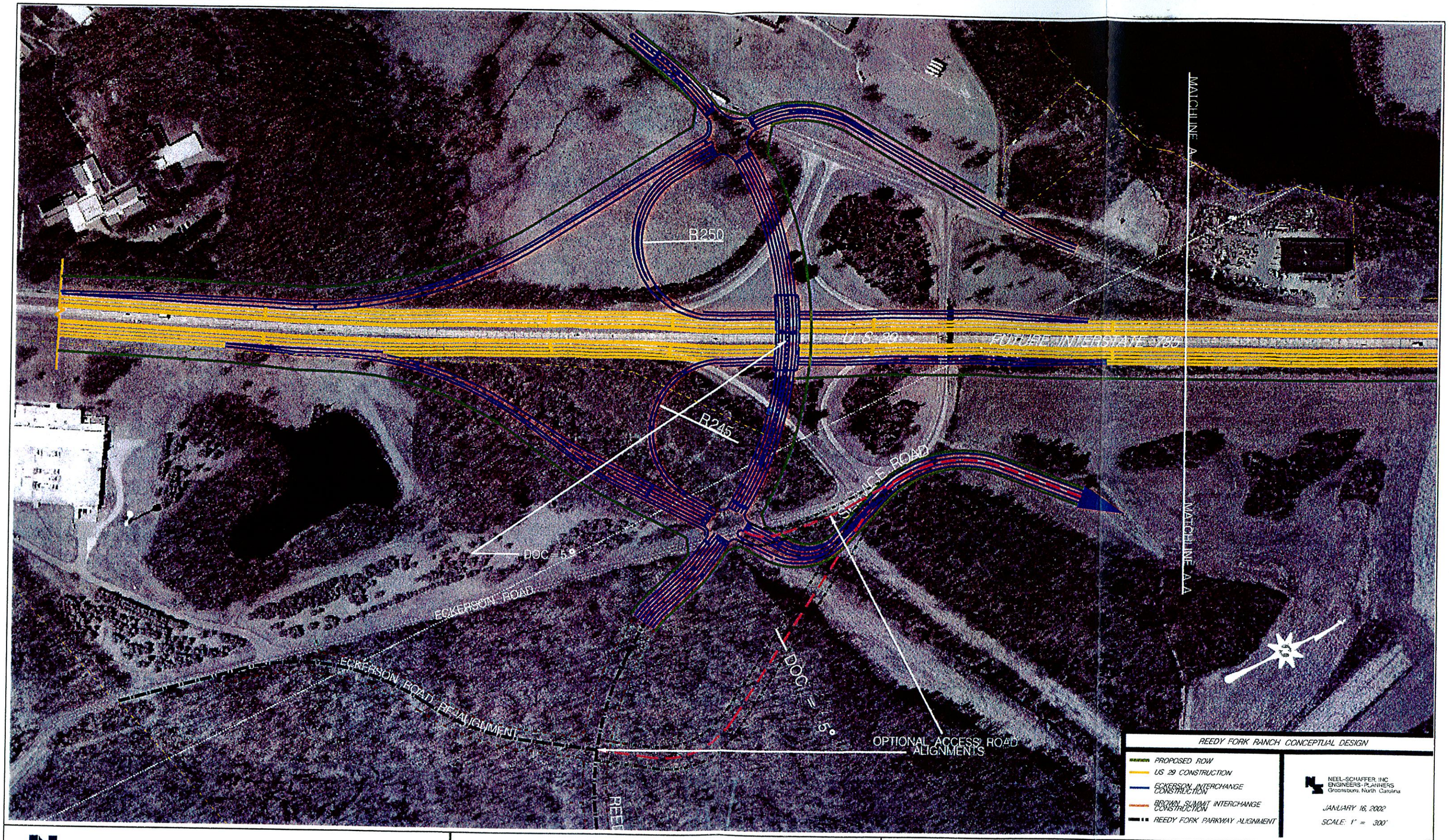
PROPOSED DEVELOPMENT REEDY FORK RANCH GREENSBORO, NORTH CAROLINA	RECOMMENDED LANE CONFIGURATIONS & TRAFFIC CONTROL	FIGURE 4	SCALE: NONE

2-3812-02



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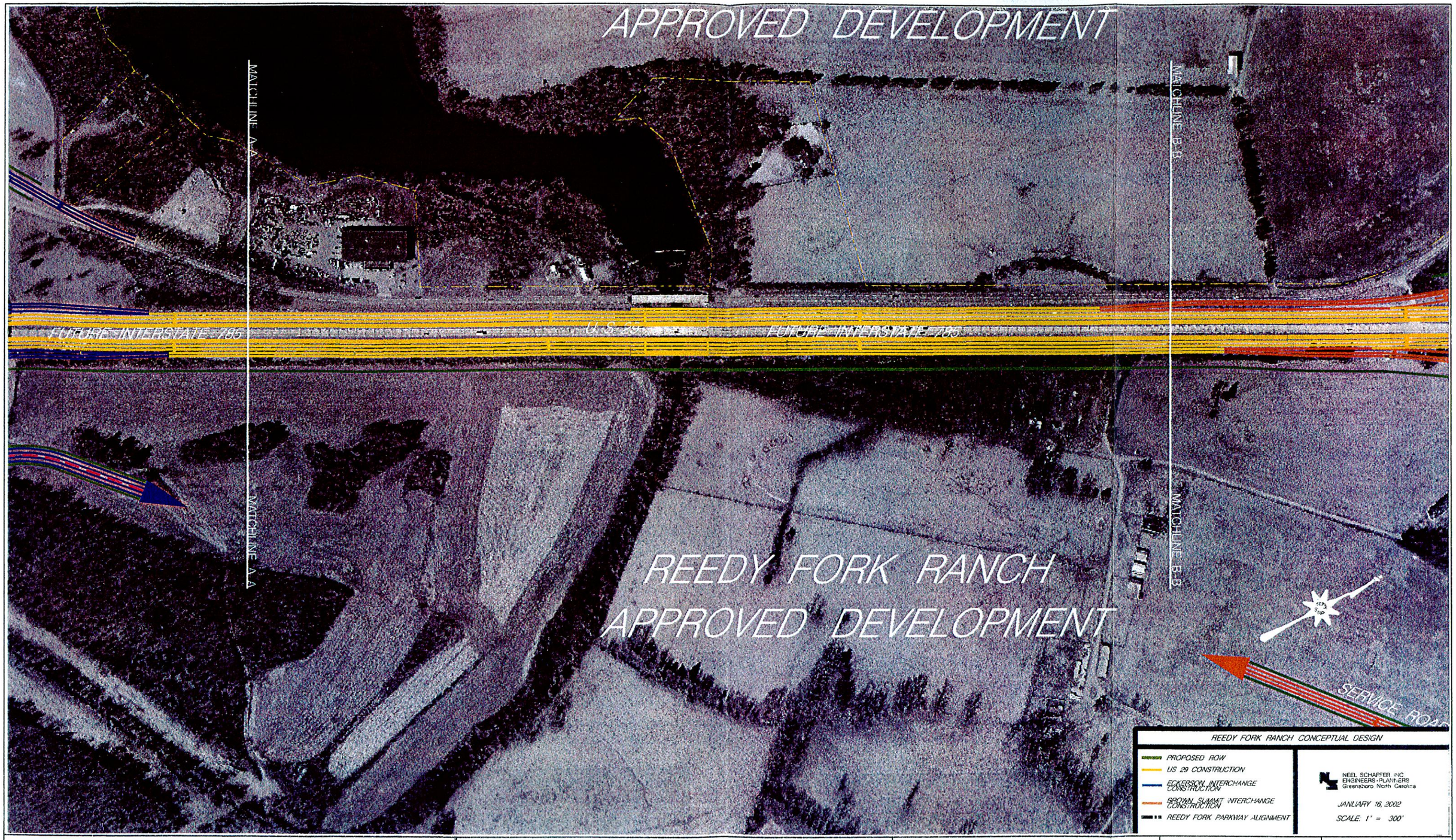
ECKERSON ROAD & BROWN SUMMIT AVENUE
INTERCHANGES FEASIBILITY STUDY

US 29 / ECKERSON ROAD / BROWN SUMMIT
FUNCTIONAL DESIGNS

FIGURE 5

SCALE: 300

2-3812-02



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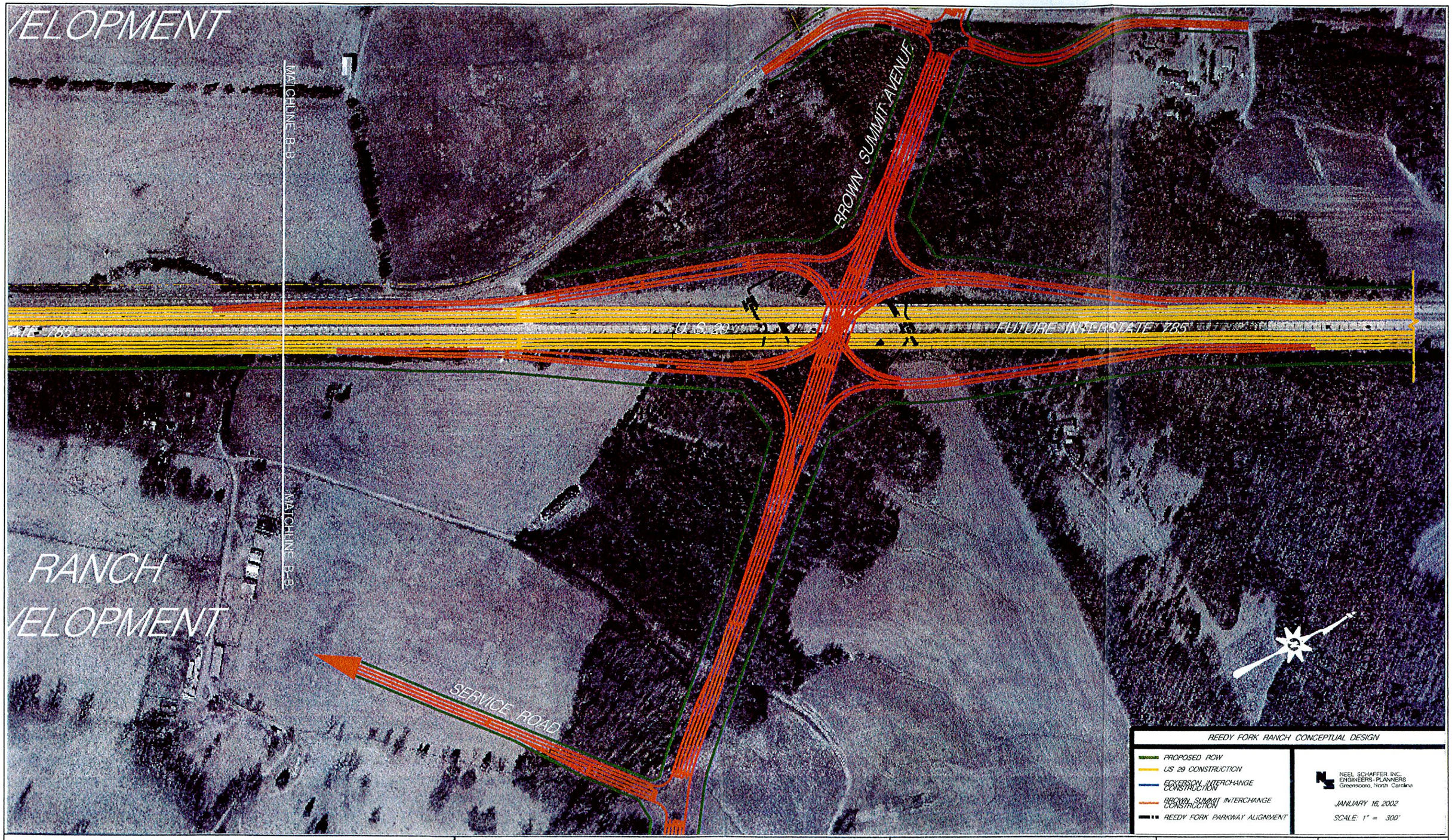
ECKERSON ROAD & BROWN SUMMIT AVENUE
INTERCHANGES FEASIBILITY STUDY

US 29 / ECKERSON ROAD / BROWN SUMMIT
FUNCTIONAL DESIGNS

FIGURE 5.1

SCALE: 300

2-3812-02



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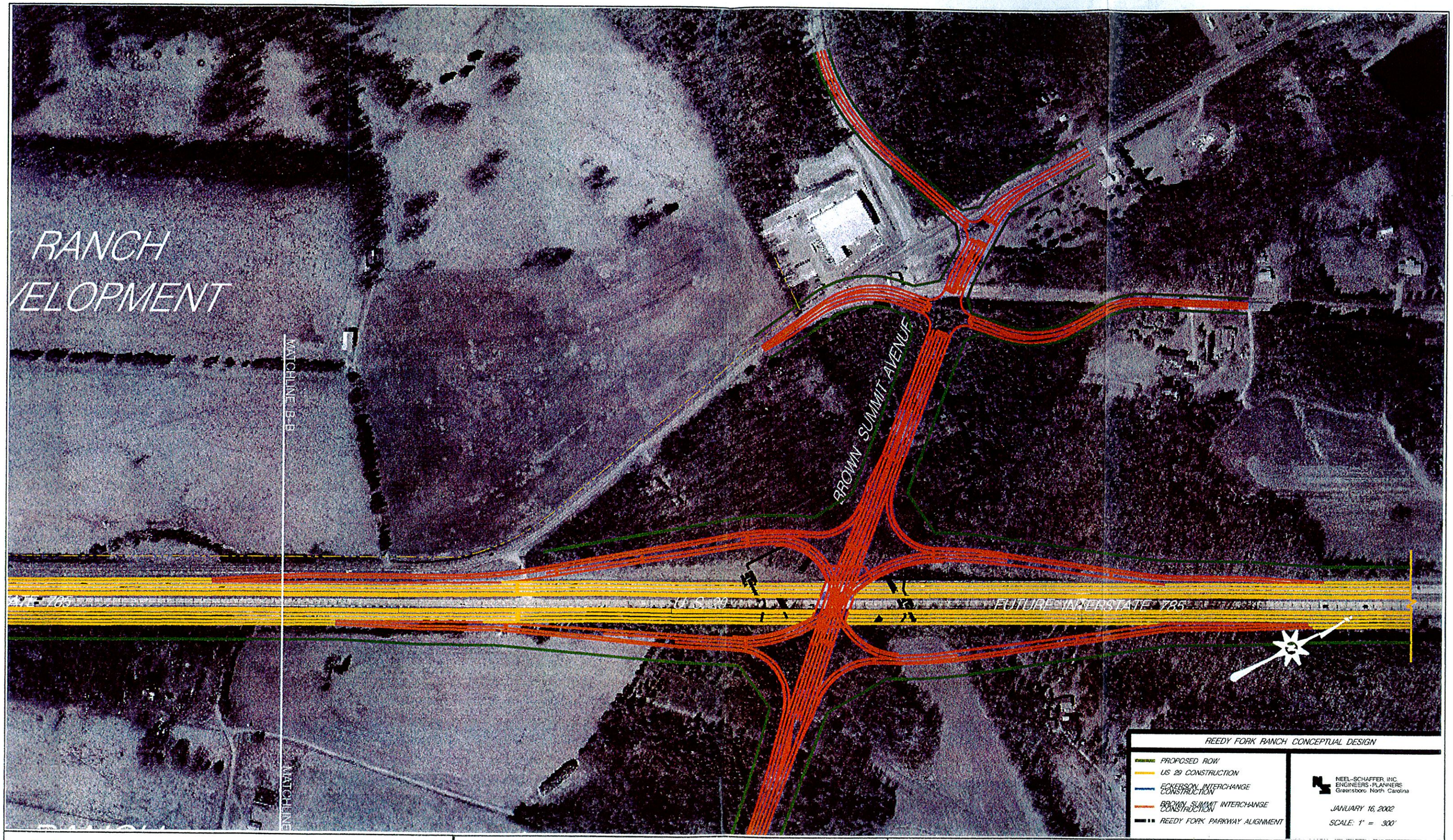
ECKERSON ROAD & BROWN SUMMIT AVENUE
INTERCHANGES FEASIBILITY STUDY

US 29 / ECKERSON ROAD / BROWN SUMMIT
FUNCTIONAL DESIGNS

FIGURE 5.2

SCALE: 300

2-3812-02



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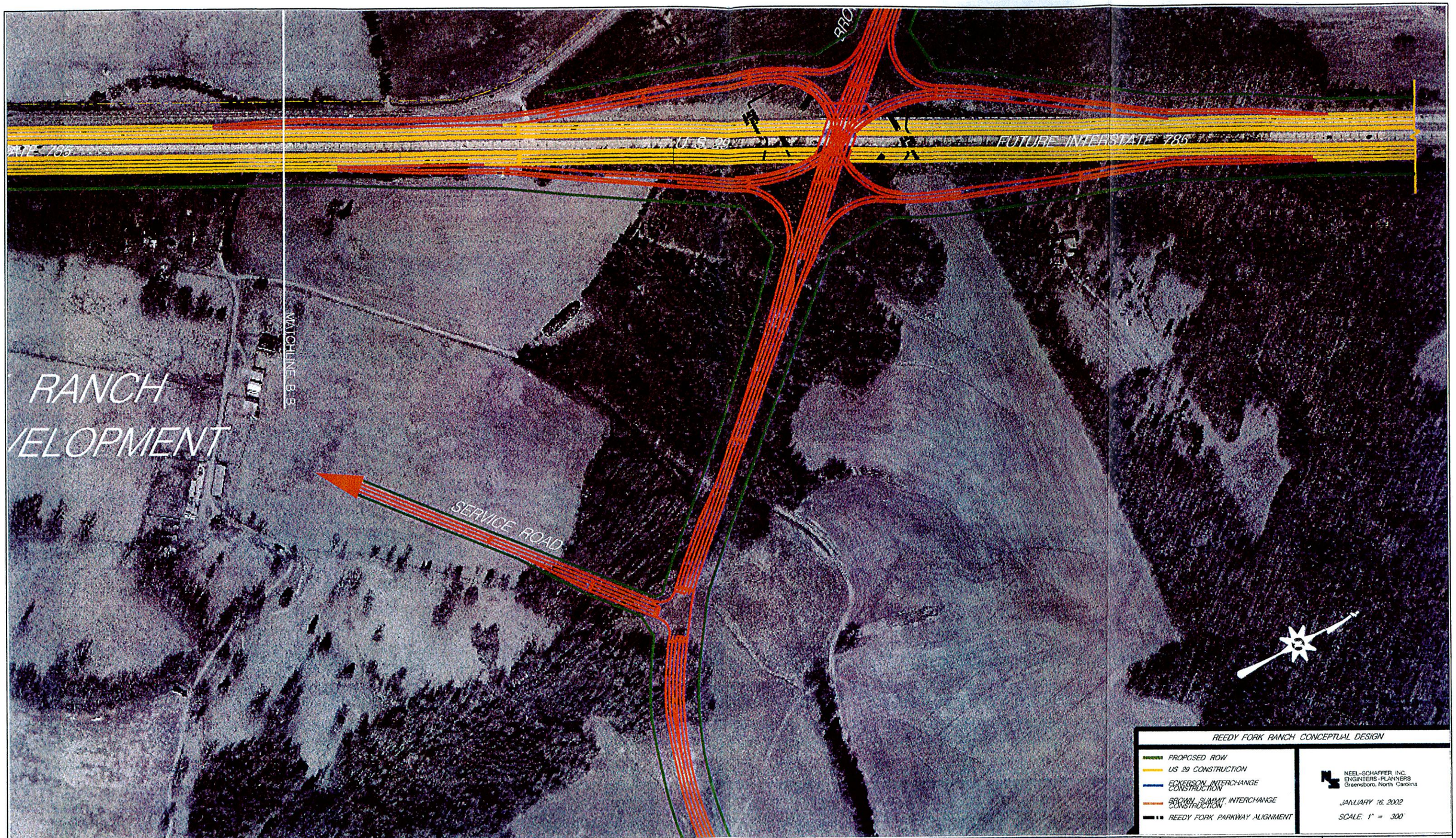
ECKERSON ROAD & BROWN SUMMIT AVENUE
INTERCHANGES FEASIBILITY STUDY

US 29 / ECKERSON ROAD / BROWN SUMMIT
FUNCTIONAL DESIGNS

FIGURE 5.3

SCALE: 300

2-3812-02



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ECKERSON ROAD & BROWN SUMMIT AVENUE
INTERCHANGES FEASIBILITY STUDY

US 29 / ECKERSON ROAD / BROWN SUMMIT
FUNCTIONAL DESIGNS

FIGURE 5.4

SCALE: 300

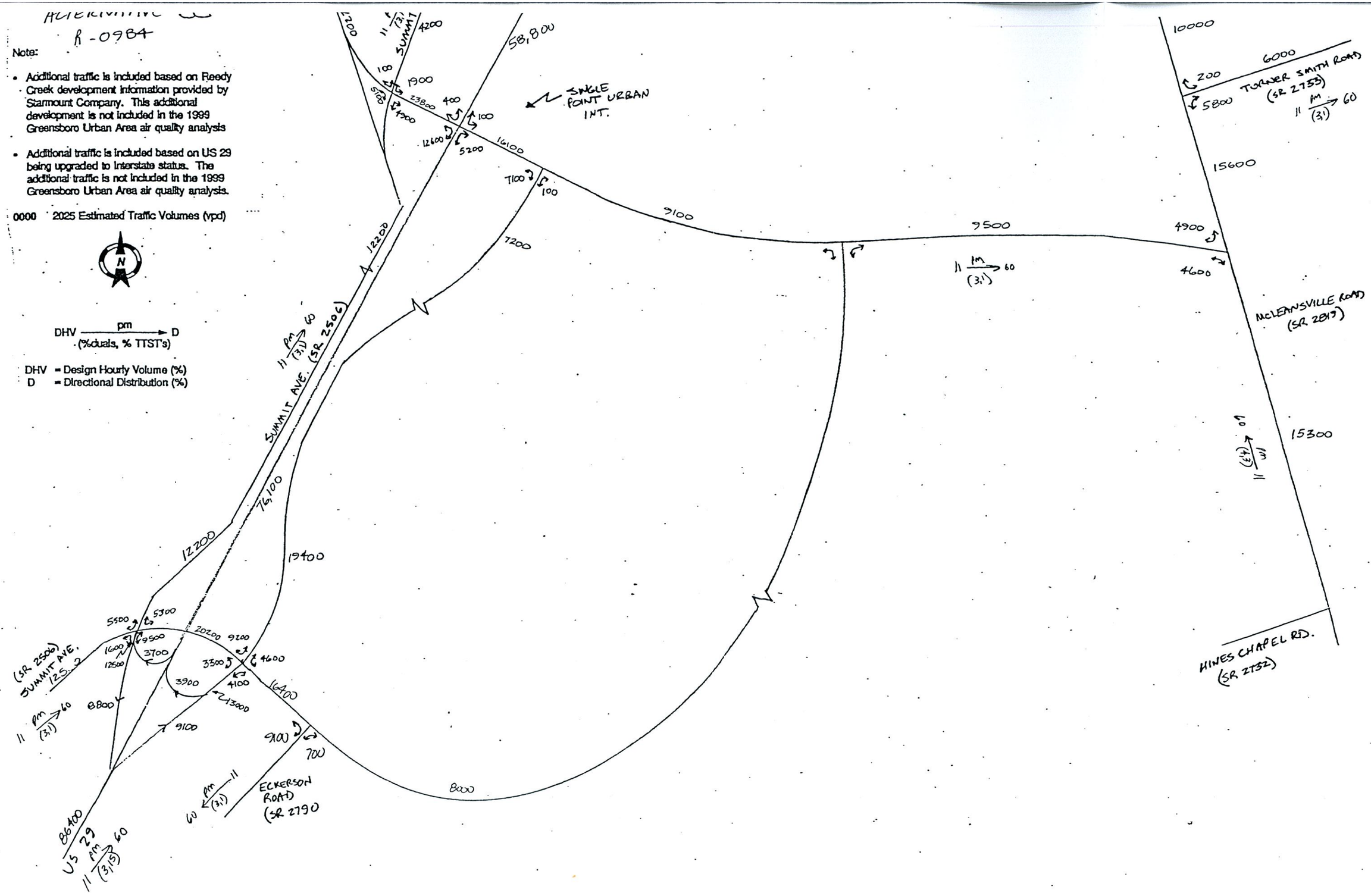
2-3812-02

ALTERNATIVE
R-0984

Note:

- Additional traffic is included based on Reedy Creek development information provided by Starmount Company. This additional development is not included in the 1999 Greensboro Urban Area air quality analysis
- Additional traffic is included based on US 29 being upgraded to Interstate status. The additional traffic is not included in the 1999 Greensboro Urban Area air quality analysis.

0000 2025 Estimated Traffic Volumes (vpd)



Appendix A: 2025 Average Daily Traffic
Cost Estimates

A

Deniece Swinton

From: "Terry Snow, PE" <tsnow@neel-schaffer.com>
To: "Deniece Swinton" <dswinton@neel-schaffer.com>
Sent: Monday, June 17, 2002 8:13 AM
Subject: Fw: US 29/Eckerson Road (REEDY FORK RANCH)

Please modify the Feasbility Study to include these construction and right-of-way cost estimates. Make a new section in the study entitled Project Cost Estimates. Refer to Lake Jeanette for guidance.

thanks,

Terry
---- Original Message ----
From: Derrick W. Lewis PE
To: Terry Snow, PE
Sent: Monday, June 17, 2002 7:58 AM
Subject: Re: US 29/Eckerson Road (REEDY FORK RANCH)

Terry

The cost of the Eckerson Road interchange without the US 29 improvements or the 1000 foot section of relocated Eckerson Road is as follows

Construction $11,000,000
Right of way $2,400,000
Total $13,500,000

This proposed interchange also includes a 1000 foot section of the relocated Eckerson Road between the US 29 Northbound Ramp terminal and Reedy Fork Avenue. The proposed cross section on this section is a four lane divided narrow median curb and gutter section on 100 feet of right of way. The anticipated cost of this section of Relocated Eckerson Road is approximately

Construction $1,100,000
Right of way $ 100,000
Total $1,200,000.

The cost of widening US 29 to a four lane divided freeway with a 70-foot median is approximately $1.8 million in construction cost. Considering that the right of way needed to cover the proposed ramp improvements greatly overshadows the right of way for the US 29 widening, I did not separate the right of way estimate.

The total cost of the interchange improvements including the Eckerson Road section and US 29 improvements:

Construction $13,900,000
Right of way $ 2,500,000

Total $16,400,000

The Remaining cost estimates have not changed and are included in the letter I sent to you previously.

Please note that the dual left turns and six lane structure is the only thing that I added to the cost estimate that is not already in his document.

I hope this answers your questions.

Thanks

Derrick

"Terry Snow, PE" wrote:

> Derrick, I spoke with Calvin on Thursday. He indicated that all we needed to do, at this time, was to add in the cost estimates in the Feasibility Study. We will complete this task today and forward the feasibiltiy studies to you. Please provide your latest construction and right-of-way cost estimates to me and Deniece Swinton so we can finalize the study. thanks in advance for your assistance. Terry Snow

Appendix B: Capacity Analysis Output

B

Synchro Output

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (ft)	50	50	50	50	50		50	50		50	50	
Trailing Detector (ft)	0	0	0	0	0		0	0		0	0	
Turning Speed (mph)	15		9	15		9	15		9	15		9
Lane Util. Factor	0.95	0.95	1.00	1.00	0.95	0.95	1.00	1.00	1.00	1.00	1.00	1.00
Frt			0.850		0.983			0.897			0.994	
Flt Protected				0.950			0.950			0.950		
Satd. Flow (prot)	0	3539	1583	1770	3479	0	1770	1671	0	1770	1852	0
Flt Permitted		0.940		0.129			0.687			0.195		
Satd. Flow (perm)	0	3327	1583	240	3479	0	1280	1671	0	363	1852	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			243		25			138			2	
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Link Speed (mph)		45			45			45			45	
Link Distance (ft)		1776			4224			3067			2697	
Travel Time (s)		26.9			52.9			46.5			40.9	
Volume (vph)	7	889	224	216	981	125	337	145	323	84	97	4
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	8	966	243	235	1066	136	366	158	351	91	105	4
Lane Group Flow (vph)	0	974	243	235	1202	0	366	509	0	91	109	0
Turn Type	Perm		Perm	pm+pt			Perm			Perm		
Protected Phases		4		3	8			2			6	
Permitted Phases	4		4	8			2			6		
Detector Phases	4	4	4	3	8		2	2		6	6	
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Minimum Split (s)	22.0	22.0	22.0	10.0	22.0		22.0	22.0		22.0	22.0	
Total Split (s)	31.0	31.0	31.0	23.0	54.0	0.0	36.0	36.0	0.0	36.0	36.0	0.0
Total Split (%)	34%	34%	34%	26%	60%	0%	40%	40%	0%	40%	40%	0%
Maximum Green (s)	25.0	25.0	25.0	17.0	48.0		30.0	30.0		30.0	30.0	
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag	Lag	Lag	Lag	Lead								
Lead-Lag Optimize?	Yes	Yes	Yes	Yes								
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None	None	None	None		Coord	Coord		Coord	Coord	
Walk Time (s)	5.0	5.0	5.0		5.0		5.0	5.0		5.0	5.0	
Flash Dont Walk (s)	11.0	11.0	11.0		11.0		11.0	11.0		11.0	11.0	
Pedestrian Calls (#/hr)	0	0	0		0		0	0		0	0	
Act Effct Green (s)		27.0	27.0	45.0	45.0		37.0	37.0		37.0	37.0	
Actuated g/C Ratio		0.30	0.30	0.50	0.50		0.41	0.41		0.41	0.41	
v/c Ratio		0.98	0.38	0.66	0.69		0.70	0.66		0.61	0.14	
Uniform Delay, d1		31.1	0.0	12.9	16.7		21.8	15.0		20.8	16.2	
Delay		49.6	3.5	22.5	11.7		22.8	11.4		38.9	17.8	
LOS		D	A	C	B		C	B		D	B	
Approach Delay		40.4			13.5			16.2			27.4	
Approach LOS		D			B			B			C	
Queue Length 50th (ft)		286	0	73	143		168	62		39	37	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Queue Length 95th (ft)		#421	52	141	164		m#327	91		#127	75	
Internal Link Dist (ft)		1696			4144			2987			2617	
50th Up Block Time (%)												
95th Up Block Time (%)												
Turn Bay Length (ft)												
50th Bay Block Time %												
95th Bay Block Time %												
Queuing Penalty (veh)												

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 90
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green
Natural Cycle: 55
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.98
Intersection Signal Delay: 23.7 Intersection LOS: C
Intersection Capacity Utilization 109.0% ICU Level of Service F
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 3: Brown Summit Rd & Summit Avenue

ø2	ø3	ø4
36 s	23 s	31 s
ø6	ø8	
36 s	54 s	

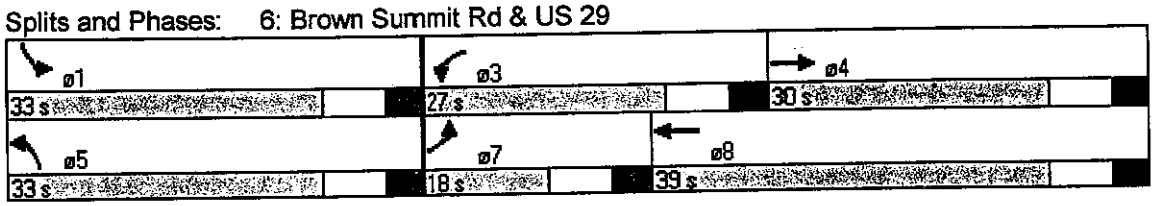
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (ft)	50	50		50	50		50			50		
Trailing Detector (ft)	0	0		0	0		0			0		
Turning Speed (mph)	15		9	15		9	15		9	15		9
Lane Util. Factor	1.00	0.95	1.00	0.97	0.95	1.00	0.97	1.00	1.00	0.97	1.00	1.00
Frt												
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1770	3539	0	3433	3539	0	3433	0	0	3433	0	0
Flt Permitted	0.463			0.950			0.950			0.950		
Satd. Flow (perm)	862	3539	0	3433	3539	0	3433	0	0	3433	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Link Speed (mph)		45			45			55			55	
Link Distance (ft)		4224			4334			3074			1664	
Travel Time (s)		64.0			65.7			38.1			20.6	
Volume (vph)	26	716	0	229	472	0	832	0	0	4	0	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	28	778	0	249	513	0	904	0	0	4	0	0
Lane Group Flow (vph)	28	778	0	249	513	0	904	0	0	4	0	0
Turn Type	pm+pt			Prot			custom			custom		
Protected Phases	7	4		3	8		5			1		
Permitted Phases	4						5			1		
Detector Phases	7	4		3	8		5			1		
Minimum Initial (s)	4.0	4.0		4.0	4.0		4.0			4.0		
Minimum Split (s)	12.0	24.0		12.0	24.0		12.0			12.0		
Total Split (s)	18.0	30.0	0.0	27.0	39.0	0.0	33.0	0.0	0.0	33.0	0.0	0.0
Total Split (%)	20%	33%	0%	30%	43%	0%	37%	0%	0%	37%	0%	0%
Maximum Green (s)	10.0	22.0		19.0	31.0		25.0			25.0		
Yellow Time (s)	5.0	5.0		5.0	5.0		5.0			5.0		
All-Red Time (s)	3.0	3.0		3.0	3.0		3.0			3.0		
Lead/Lag	Lead	Lag		Lead	Lag							
Lead-Lag Optimize?	Yes	Yes		Yes	Yes							
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0			3.0		
Recall Mode	None	None		None	None		None			None		
Walk Time (s)		5.0			5.0							
Flash Dont Walk (s)		11.0			11.0							
Pedestrian Calls (#/hr)		0			0							
Act Effct Green (s)	35.4	25.6		15.2	39.2		37.2			37.2		
Actuated g/C Ratio	0.39	0.28		0.17	0.44		0.41			0.41		
v/c Ratio	0.06	0.77		0.43	0.33		0.64			0.00		
Uniform Delay, d1	10.1	25.3		33.5	16.8		25.0			18.5		
Delay	6.0	21.3		30.8	14.5		22.0			17.2		
LOS	A	C		C	B		C			B		
Approach Delay		20.8			19.8							
Approach LOS		C			B							
Queue Length 50th (ft)	1	214		71	97		205			0		

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Queue Length 95th (ft)	m4	m247		107	136		293			4		
Internal Link Dist (ft)		4144			4254			2994			1584	
50th Up Block Time (%)												
95th Up Block Time (%)												
Turn Bay Length (ft)												
50th Bay Block Time %												
95th Bay Block Time %												
Queuing Penalty (veh)												

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 90
Offset: 0 (0%), Referenced to phase 2: and 6:, Start of Green
Natural Cycle: 60
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.77
Intersection Signal Delay: 20.9 Intersection LOS: C
Intersection Capacity Utilization 64.4% ICU Level of Service B
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 6: Brown Summit Rd & US 29



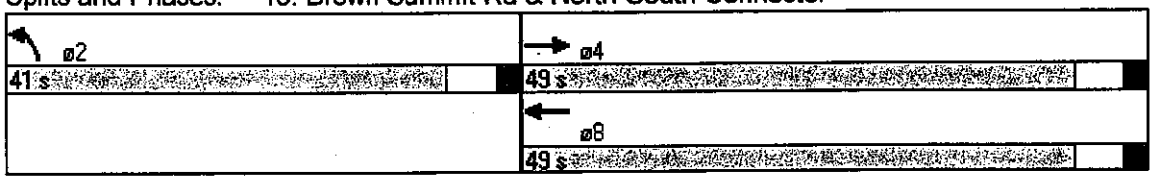
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (ft)	50	50	50	50	50	
Trailing Detector (ft)	0	0	0	0	0	
Turning Speed (mph)		9	15		15	9
Lane Util. Factor	0.95	1.00	0.95	0.95	0.97	0.95
Frt		0.850			0.997	
Flt Protected					0.953	
Satd. Flow (prot)	3539	1583	0	3539	3434	0
Flt Permitted				0.950	0.953	
Satd. Flow (perm)	3539	1583	0	3362	3434	0
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)		510			3	
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00
Link Speed (mph)	45			45	45	
Link Distance (ft)	4334			4420	3080	
Travel Time (s)	65.7			67.0	46.7	
Volume (vph)	594	469	4	396	312	7
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	646	510	4	430	339	8
Lane Group Flow (vph)	646	510	0	434	347	0
Turn Type		Perm	Perm			
Protected Phases	4			8	2	
Permitted Phases		4	8			
Detector Phases	4	4	8	8	2	
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	
Minimum Split (s)	22.0	22.0	22.0	22.0	22.0	
Total Split (s)	49.0	49.0	49.0	49.0	41.0	0.0
Total Split (%)	54%	54%	54%	54%	46%	0%
Maximum Green (s)	43.0	43.0	43.0	43.0	35.0	
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	
Lead/Lag						
Lead-Lag Optimize?						
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	
Recall Mode	None	None	None	None	Coord	
Walk Time (s)	5.0	5.0	5.0	5.0	5.0	
Flash Dont Walk (s)	11.0	11.0	11.0	11.0	11.0	
Pedestrian Calls (#/hr)	0	0	0	0	0	
Act Effct Green (s)	26.5	26.5		26.5	55.5	
Actuated g/C Ratio	0.29	0.29		0.29	0.62	
v/c Ratio	0.62	0.62		0.44	0.16	
Uniform Delay, d1	27.4	0.0		25.7	7.3	
Delay	15.9	6.7		24.7	4.9	
LOS	B	A		C	A	
Approach Delay	11.9			24.7	4.9	
Approach LOS	B			C	A	
Queue Length 50th (ft)	197	195		105	19	

Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Queue Length 95th (ft)	187	m295		123	m36	
Internal Link Dist (ft)	4254			4340	3000	
50th Up Block Time (%)						
95th Up Block Time (%)						
Turn Bay Length (ft)						
50th Bay Block Time %						
95th Bay Block Time %						
Queuing Penalty (veh)						

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 90
Offset: 0 (0%), Referenced to phase 2:NBL and 6:, Start of Green
Natural Cycle: 45
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.62
Intersection Signal Delay: 13.5 Intersection LOS: B
Intersection Capacity Utilization 50.3% ICU Level of Service A
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 13: Brown Summit Rd & North-South Connector



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (ft)	50	50	50	50	50	50	50	50	50	50	50	50
Trailing Detector (ft)	0	0	0	0	0	0	0	0	0	0	0	0
Turning Speed (mph)	15		9	15		9	15		9	15		9
Lane Util. Factor	1.00	1.00	1.00	0.97	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt			0.850			0.850			0.850			0.850
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1770	1863	1583	3433	1863	1583	1770	1863	1583	1770	1863	1583
Flt Permitted	0.666			0.950			0.719			0.574		
Satd. Flow (perm)	1241	1863	1583	3433	1863	1583	1339	1863	1583	1069	1863	1583
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			115			380			201			263
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Link Speed (mph)		30			30			45			45	
Link Distance (ft)		1736			4224			1928			3067	
Travel Time (s)		39.5			96.0			29.2			46.5	
Volume (vph)	363	499	106	629	131	350	70	79	185	233	53	242
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	395	542	115	684	142	380	76	86	201	253	58	263
Lane Group Flow (vph)	395	542	115	684	142	380	76	86	201	253	58	263
Turn Type	pm+pt		Perm	Prot		Perm	pm+pt		Perm	pm+pt		Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4		4			8	2		2	6		6
Detector Phases	7	4	4	3	8	8	5	2	2	1	6	6
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	10.0	22.0	22.0	10.0	22.0	22.0	10.0	22.0	22.0	10.0	22.0	22.0
Total Split (s)	19.0	22.0	22.0	30.0	33.0	33.0	10.0	22.0	22.0	16.0	28.0	28.0
Total Split (%)	21%	24%	24%	33%	37%	37%	11%	24%	24%	18%	31%	31%
Maximum Green (s)	13.0	16.0	16.0	24.0	27.0	27.0	4.0	16.0	16.0	10.0	22.0	22.0
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lead/Lag	Lead	Lag	Lag	Lead	Lag	Lag	Lead	Lag	Lag	Lead	Lag	Lag
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Recall Mode	None	None	None	None	None	None	None	Coord	Coord	None	Coord	Coord
Walk Time (s)		5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0
Flash Dont Walk (s)		11.0	11.0		11.0	11.0		11.0	11.0		11.0	11.0
Pedestrian Calls (#/hr)		0	0		0	0		0	0		0	0
Act Effct Green (s)	33.0	18.0	18.0	23.8	26.7	26.7	26.5	20.5	20.5	36.3	28.3	28.3
Actuated g/C Ratio	0.37	0.20	0.20	0.26	0.30	0.30	0.29	0.23	0.23	0.40	0.31	0.31
v/c Ratio	0.73	1.45	0.28	0.75	0.26	0.51	0.18	0.20	0.39	0.48	0.10	0.39
Uniform Delay, d1	15.3	36.0	0.0	30.4	24.0	0.0	17.4	28.1	0.0	18.7	22.8	0.0
Delay	17.3	187.7	6.5	30.3	23.6	2.7	18.7	30.1	5.0	18.2	22.8	3.5
LOS	B	F	A	C	C	A	B	C	A	B	C	A
Approach Delay		103.9			20.8			13.8			11.9	
Approach LOS		F			C			B			B	
Queue Length 50th (ft)	129	~425	0	178	59	0	27	41	0	98	26	0

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Queue Length 95th (ft)	196	#621	43	238	105	61	57	82	50	145	m48	45
Internal Link Dist (ft)		1656			4144			1848			2987	
50th Up Block Time (%)												
95th Up Block Time (%)												
Turn Bay Length (ft)												
50th Bay Block Time %												
95th Bay Block Time %												
Queuing Penalty (veh)												

Intersection Summary

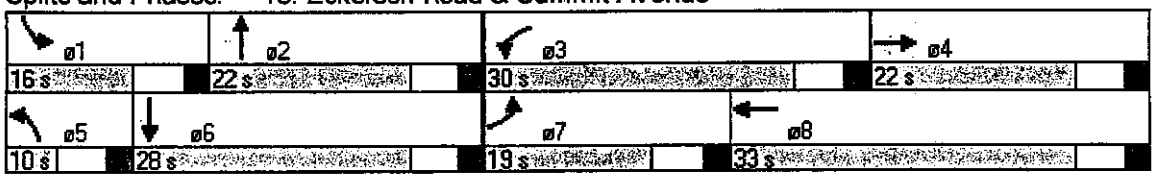
Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 90
Offset: 10 (11%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green
Natural Cycle: 90
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 1.45
Intersection Signal Delay: 45.8 Intersection LOS: D
Intersection Capacity Utilization 78.7% ICU Level of Service C

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 18: Eckerson Road & Summit Avenue



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (ft)	50	50	50	50	50	50	50	50	50	50	50	50
Trailing Detector (ft)	0	0	0	0	0	0	0	0	0	0	0	0
Turning Speed (mph)	15		9	15		9	15		9	15		9
Lane Util. Factor	1.00	1.00	1.00	1.00	0.95	1.00	0.97	1.00	1.00	1.00	1.00	1.00
Frt			0.850			0.850			0.850			0.850
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1770	1863	1583	1770	3539	1583	3433	1863	1583	1770	1863	1583
Flt Permitted	0.200			0.461			0.950			0.154		
Satd. Flow (perm)	373	1863	1583	859	3539	1583	3433	1863	1583	287	1863	1583
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			158			166			228			440
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Link Speed (mph)		30			30			45			45	
Link Distance (ft)		4332			2718			2060			3080	
Travel Time (s)		98.5			61.8			31.2			46.7	
Volume (vph)	607	265	145	180	467	203	218	692	271	303	177	405
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	660	288	158	196	508	221	237	752	295	329	192	440
Lane Group Flow (vph)	660	288	158	196	508	221	237	752	295	329	192	440
Turn Type	pm+pt		Perm	pm+pt		Perm	Prot		Perm	pm+pt		Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4		4	8		8			2	6		6
Detector Phases	7	4	4	3	8	8	5	2	2	1	6	6
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	10.0	22.0	22.0	10.0	22.0	22.0	10.0	22.0	22.0	10.0	22.0	22.0
Total Split (s)	25.0	27.0	27.0	20.0	22.0	22.0	11.0	26.0	26.0	17.0	32.0	32.0
Total Split (%)	28%	30%	30%	22%	24%	24%	12%	29%	29%	19%	36%	36%
Maximum Green (s)	19.0	21.0	21.0	14.0	16.0	16.0	5.0	20.0	20.0	11.0	26.0	26.0
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lead/Lag	Lead	Lag	Lag	Lead	Lag	Lag	Lead	Lag	Lag	Lead	Lag	Lag
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Recall Mode	None	None	None	None	None	None	None	Coord	Coord	None	Coord	Coord
Walk Time (s)		5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0
Flash Dont Walk (s)		11.0	11.0		11.0	11.0		11.0	11.0		11.0	11.0
Pedestrian Calls (#/hr)		0	0		0	0		0	0		0	0
Act Effct Green (s)	42.5	24.6	24.6	31.3	17.5	17.5	7.0	22.5	22.5	39.5	28.5	28.5
Actuated g/C Ratio	0.47	0.27	0.27	0.35	0.19	0.19	0.08	0.25	0.25	0.44	0.32	0.32
v/c Ratio	1.31	0.56	0.29	0.45	0.74	0.50	0.89	1.61	0.52	0.96	0.32	0.55
Uniform Delay, d1	22.3	28.1	0.0	15.0	34.1	7.6	41.1	33.8	6.0	20.2	23.4	0.0
Delay	146.3	29.2	4.8	19.2	39.5	17.9	63.8	217.6	8.0	55.5	16.8	0.5
LOS	F	C	A	B	D	B	E	F	A	E	B	A
Approach Delay		95.6			30.0			141.0			22.6	
Approach LOS		F			C			F			C	
Queue Length 50th (ft)	~435	142	0	63	118	23	70	~627	21	109	70	2

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Queue Length 95th (ft)	#648	229	46	162	215	127	#137	#843	105	#298	110	3
Internal Link Dist (ft)		4252			2638			1980			3000	
50th Up Block Time (%)												
95th Up Block Time (%)												
Turn Bay Length (ft)												
50th Bay Block Time %												
95th Bay Block Time %												
Queuing Penalty (veh)												

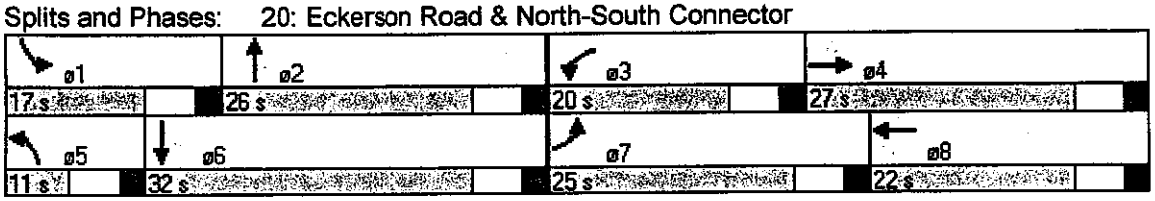
Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 90
Offset: 10 (11%), Referenced to phase 2:NBT and 6:SBTL, Start of Green
Natural Cycle: 100
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 1.61
Intersection Signal Delay: 78.6 Intersection LOS: E
Intersection Capacity Utilization 121.8% ICU Level of Service H

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 20: Eckerson Road & North-South Connector

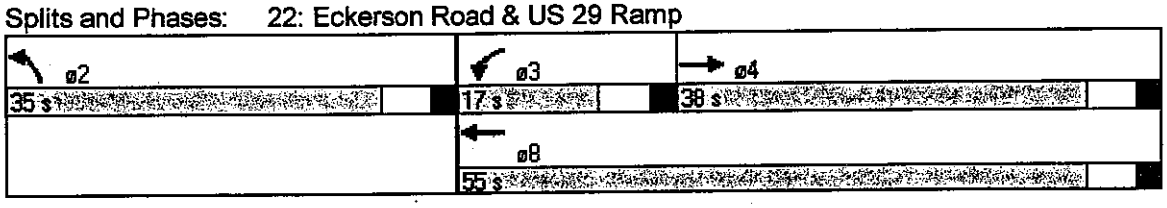


Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Queue Length 95th (ft)	m301	m0	52	252	131	19
Internal Link Dist (ft)	737			659	2369	
50th Up Block Time (%)						
95th Up Block Time (%)						
Turn Bay Length (ft)						
50th Bay Block Time %						
95th Bay Block Time %						
Queuing Penalty (veh)						

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 90
Offset: 0 (0%), Referenced to phase 2:NBL and 6:, Start of Green
Natural Cycle: 60
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.85
Intersection Signal Delay: 16.2 Intersection LOS: B
Intersection Capacity Utilization 50.4% ICU Level of Service A
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 22: Eckerson Road & US 29 Ramp



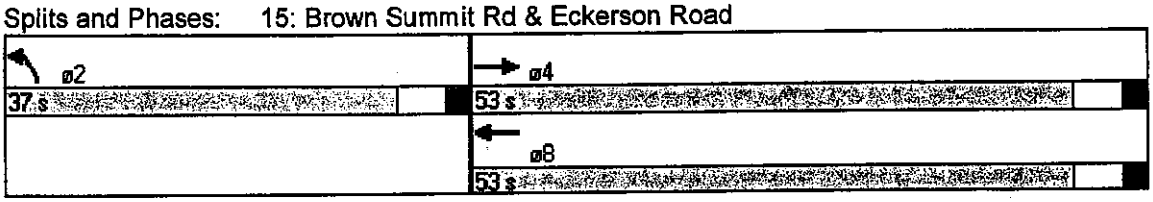
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑	↱	↰	↑	↰	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (ft)	50	50	50	50	50	50
Trailing Detector (ft)	0	0	0	0	0	0
Turning Speed (mph)		9	15		15	9
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.850				0.850
Flt Protected			0.950		0.950	
Satd. Flow (prot)	1863	1583	1770	1863	1770	1583
Flt Permitted			0.460		0.950	
Satd. Flow (perm)	1863	1583	857	1863	1770	1583
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)		273				301
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00
Link Speed (mph)	45			45	30	
Link Distance (ft)	4420			2046	2382	
Travel Time (s)	67.0			31.0	54.1	
Volume (vph)	350	251	185	233	167	277
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	380	273	201	253	182	301
Lane Group Flow (vph)	380	273	201	253	182	301
Turn Type		Perm	Perm			Perm
Protected Phases	4			8	2	
Permitted Phases		4	8			2
Detector Phases	4	4	8	8	2	2
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	22.0	22.0	22.0	22.0	22.0	22.0
Total Split (s)	53.0	53.0	53.0	53.0	37.0	37.0
Total Split (%)	59%	59%	59%	59%	41%	41%
Maximum Green (s)	47.0	47.0	47.0	47.0	31.0	31.0
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0
Lead/Lag						
Lead-Lag Optimize?						
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Recall Mode	None	None	None	None	Coord	Coord
Walk Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Flash Dont Walk (s)	11.0	11.0	11.0	11.0	11.0	11.0
Pedestrian Calls (#/hr)	0	0	0	0	0	0
Act Effct Green (s)	30.9	30.9	30.9	30.9	51.1	51.1
Actuated g/C Ratio	0.34	0.34	0.34	0.34	0.57	0.57
v/c Ratio	0.59	0.38	0.68	0.40	0.18	0.29
Uniform Delay, d1	24.4	0.0	25.3	22.4	9.4	0.0
Delay	19.9	13.4	19.5	16.7	26.3	15.7
LOS	B	B	B	B	C	B
Approach Delay	17.1			17.9	19.7	
Approach LOS	B			B	B	
Queue Length 50th (ft)	236	136	85	81	97	100

Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Queue Length 95th (ft)	325	207	132	101	m148	m172
Internal Link Dist (ft)	4340			1966	2302	
50th Up Block Time (%)						
95th Up Block Time (%)						
Turn Bay Length (ft)						
50th Bay Block Time %						
95th Bay Block Time %						
Queuing Penalty (veh)						

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 90
Offset: 0 (0%), Referenced to phase 2:NBL and 6:, Start of Green
Natural Cycle: 45
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.68
Intersection Signal Delay: 18.1 Intersection LOS: B
Intersection Capacity Utilization 51.2% ICU Level of Service A
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 15: Brown Summit Rd & Eckerson Road



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	323	304	202	808	466	216
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (veh/h)	351	330	220	878	507	235
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
vC, conflicting volume	1824	507	741			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	0	42	75			
cM capacity (veh/h)	63	566	866			

Direction, Lane #	EB 1	EB 2	NB 1	NB 2	SB 1	SB 2
Volume Total	351	330	220	878	507	235
Volume Left	351	0	220	0	0	0
Volume Right	0	330	0	0	0	235
cSH	63	566	866	1700	1700	1700
Volume to Capacity	5.55	0.58	0.25	0.52	0.30	0.14
Queue Length (ft)	Err	93	25	0	0	0
Control Delay (s)	Err	19.9	10.6	0.0	0.0	0.0
Lane LOS	F	C	B			
Approach Delay (s)	5160.6		2.1		0.0	
Approach LOS	F					

Intersection Summary			
Average Delay	1396.2		
Intersection Capacity Utilization	72.3%	ICU Level of Service	C

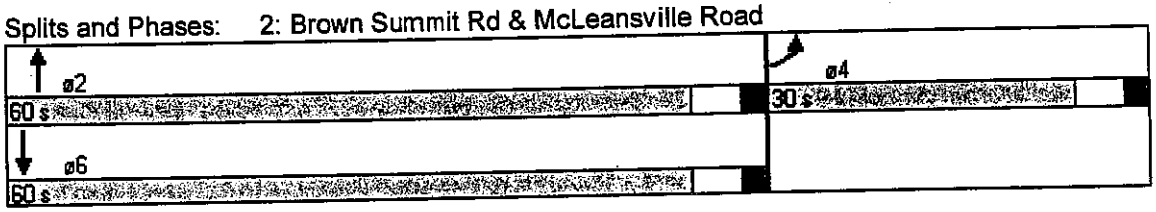
Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (ft)	50	50	50	50	50	50
Trailing Detector (ft)	0	0	0	0	0	0
Turning Speed (mph)	15	9	15			9
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.850				0.850
Flt Protected	0.950		0.950			
Satd. Flow (prot)	1770	1583	1770	1863	1863	1583
Flt Permitted	0.950		0.398			
Satd. Flow (perm)	1770	1583	741	1863	1863	1583
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)		330				235
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00
Link Speed (mph)	45			45	45	
Link Distance (ft)	2046			5040	2980	
Travel Time (s)	31.0			76.4	45.2	
Volume (vph)	323	304	202	808	466	216
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	351	330	220	878	507	235
Lane Group Flow (vph)	351	330	220	878	507	235
Turn Type		Perm	Perm			Perm
Protected Phases	4			2	6	
Permitted Phases		4	2			6
Detector Phases	4	4	2	2	6	6
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	22.0	22.0	22.0	22.0	22.0	22.0
Total Split (s)	30.0	30.0	60.0	60.0	60.0	60.0
Total Split (%)	33%	33%	67%	67%	67%	67%
Maximum Green (s)	24.0	24.0	54.0	54.0	54.0	54.0
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0
Lead/Lag						
Lead-Lag Optimize?						
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Recall Mode	None	None	Coord	Coord	Coord	Coord
Walk Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Flash Dont Walk (s)	11.0	11.0	11.0	11.0	11.0	11.0
Pedestrian Calls (#/hr)	0	0	0	0	0	0
Act Effct Green (s)	26.0	26.0	56.0	56.0	56.0	56.0
Actuated g/C Ratio	0.29	0.29	0.62	0.62	0.62	0.62
v/c Ratio	0.69	0.48	0.48	0.76	0.44	0.22
Uniform Delay, d1	28.4	0.0	9.1	12.1	8.8	0.0
Delay	16.5	2.8	9.9	12.9	6.0	0.8
LOS	B	A	A	B	A	A
Approach Delay	9.9			12.3	4.4	
Approach LOS	A			B	A	
Queue Length 50th (ft)	63	4	61	324	75	0

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Queue Length 95th (ft)	170	51	120	486	155	4
Internal Link Dist (ft)	1966			4960	2900	
50th Up Block Time (%)						
95th Up Block Time (%)						
Turn Bay Length (ft)						
50th Bay Block Time %						
95th Bay Block Time %						
Queuing Penalty (veh)						

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 90
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBT, Start of Green
Natural Cycle: 60
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.76
Intersection Signal Delay: 9.3 — Intersection LOS: A
Intersection Capacity Utilization 72.3% — ICU Level of Service C

Splits and Phases: 2: Brown Summit Rd & McLeansville Road



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	255	9	748	383	13	427
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (veh/h)	277	10	813	416	14	464
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
vC, conflicting volume	1305	813			1229	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	0	97			98	
cM capacity (veh/h)	172	378			567	

Direction, Lane #	WB 1	WB 2	NB 1	NB 2	SB 1	SB 2
Volume Total	277	10	813	416	14	464
Volume Left	277	0	0	0	14	0
Volume Right	0	10	0	416	0	0
cSH	172	378	1700	1700	567	1700
Volume to Capacity	1.61	0.03	0.48	0.24	0.02	0.27
Queue Length (ft)	467	2	0	0	2	0
Control Delay (s)	347.5	14.8	0.0	0.0	11.5	0.0
Lane LOS	F	B			B	
Approach Delay (s)	336.1		0.0		0.3	
Approach LOS	F					

Intersection Summary			
Average Delay	48.4		
Intersection Capacity Utilization	64.8%	ICU Level of Service	B

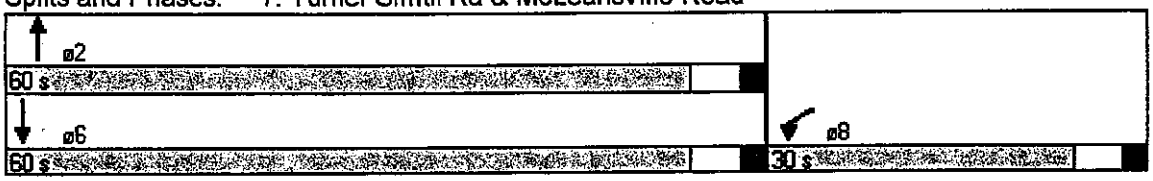
Lane Group	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (ft)	50	50	50	50	50	50
Trailing Detector (ft)	0	0	0	0	0	0
Turning Speed (mph)	15	9		9	15	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.850		0.850		
Flt Protected	0.950				0.950	
Satd. Flow (prot)	1770	1583	1863	1583	1770	1863
Flt Permitted	0.950				0.205	
Satd. Flow (perm)	1770	1583	1863	1583	382	1863
Right Turn on Red		Yes		Yes		
Satd. Flow (RTOR)		10		416		
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00
Link Speed (mph)	45		45			45
Link Distance (ft)	2160		2980			815
Travel Time (s)	32.7		45.2			12.3
Volume (vph)	255	9	748	383	13	427
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	277	10	813	416	14	464
Lane Group Flow (vph)	277	10	813	416	14	464
Turn Type		Perm		Perm	Perm	
Protected Phases	8		2			6
Permitted Phases		8		2	6	
Detector Phases	8	8	2	2	6	6
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	22.0	22.0	22.0	22.0	22.0	22.0
Total Split (s)	30.0	30.0	60.0	60.0	60.0	60.0
Total Split (%)	33%	33%	67%	67%	67%	67%
Maximum Green (s)	24.0	24.0	54.0	54.0	54.0	54.0
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0
Lead/Lag						
Lead-Lag Optimize?						
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Recall Mode	None	None	Coord	Coord	Coord	Coord
Walk Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Flash Dont Walk (s)	11.0	11.0	11.0	11.0	11.0	11.0
Pedestrian Calls (#/hr)	0	0	0	0	0	0
Act Effct Green (s)	20.4	20.4	61.6	61.6	61.6	61.6
Actuated g/C Ratio	0.23	0.23	0.68	0.68	0.68	0.68
v/c Ratio	0.69	0.03	0.64	0.34	0.05	0.36
Uniform Delay, d1	31.9	0.0	7.9	0.0	4.6	6.0
Delay	31.3	12.9	12.1	2.4	6.3	6.9
LOS	C	B	B	A	A	A
Approach Delay	30.7		8.8			6.8
Approach LOS	C		A			A
Queue Length 50th (ft)	144	0	261	23	2	98

Lane Group	WBL	WBR	NBT	NBR	SBL	SBT
Queue Length 95th (ft)	212	12	453	m56	11	180
Internal Link Dist (ft)	2080		2900			735
50th Up Block Time (%)						
95th Up Block Time (%)						
Turn Bay Length (ft)						
50th Bay Block Time %						
95th Bay Block Time %						
Queuing Penalty (veh)						

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 90
Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBTL, Start of Green
Natural Cycle: 60
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.69
Intersection Signal Delay: 11.5 Intersection LOS: B
Intersection Capacity Utilization 64.8% ICU Level of Service B
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 7: Turner Smith Rd & McLeansville Road



HCS Ramp Capacity Output

HCS: Ramps and Ramp Junctions Release 3.2

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DIVERGE ANALYSIS

Location: US 29 SB SPUI Off Ramp
Analyst: DDS-CAG
Analysis Time Period: 2025 Peak Hour
Date Performed: 10/1/2001

FREEWAY-RAMP COMPONENTS AND CHARACTERISTICS

Type of Analysis	Diverge	
Freeway Data:		
Number of Lanes in Freeway	3	
Free-Flow Speed on Freeway	55.0	mph
Volume on Freeway	2265	vph
Off Ramp Data:		
Side of Freeway	Right	
Number of Lanes in Ramp	1	
Free-Flow Speed on Ramp	35.0	mph
Volume on Ramp	22	vph
Length of First Accel/Decel Lane	550	ft
Length of Second Accel/Decel Lane	500	ft
Adjacent Ramp Data if one exists:		
Does adjacent ramp exist?	Yes	
Volume on Adjacent Ramp	783	vph
Position of Adjacent Ramp	Downstream	
Type of Adjacent Ramp	On	
Distance to Adjacent Ramp	2400	ft

VOLUME ADJUSTMENT

Junction Components	Freeway	Ramp	Adjacent Ramp	
Terrain Type	Rolling	Rolling	Rolling	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Volume, V (vph)	2265	22	783	vph
Peak-Hour Factor, PHF	0.95	0.95	0.95	
Peak 15-min Volume, v15	596	6	206	v
Trucks and Buses	4	4	4	%
Trucks and Buses PCE, ET	3.0	3.0	3.0	
Recreational Vehicles	0	0	0	%
Recreational Vehicle PCE, ER	2.0	2.0	2.0	
Heavy Vehicle Adjustment, fHV	0.926	0.926	0.926	
Driver Population Adjustment, fP	1.00	1.00	1.00	
Adjusted Flow Rate, vp	2575	25	890	pcph

ANALYSIS and RESULTS of DIVERGE AREAS

Estimation of Flow entering Lanes 1 and 2:
Proportion of Freeway Vehicles

in Lanes 1 and 2, P_{FD} = 0.694 Using Equation 7

Flow in Lanes 1 and 2, $v_{12} = v_R + (v_F - v_R) P_{FD}$ = 1796 pcph

Capacity Checks:

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	2575	6750	No
v_{12}	1796	4400	No
$v_{FO} = v_F - v_R$	2550	6750	No
v_R	25	2000	No

Level of Service Operation (if not LOS F):

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 15- pc/mi/ln

Level of Service for Ramp-Freeway Junction Areas of Influence B

Speed in Ramp Influence Area, S_R 49 mph

HCS: Ramps and Ramp Junctions Release 3.2

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MERGE ANALYSIS

Location: US 29 SB SPUI On Ramp
Analyst: DDS-CAG
Analysis Time Period: 2025 Peak Hour
Date Performed: 10/1/2001

FREEWAY-RAMP COMPONENTS AND CHARACTERISTICS

Type of Analysis	Merge	
Freeway Data:		
Number of Lanes in Freeway	3	
Free-Flow Speed on Freeway	55.0	mph
Volume on Freeway	2265	vph
On Ramp Data:		
Side of Freeway	Right	
Number of Lanes in Ramp	1	
Free-Flow Speed on Ramp	35.0	mph
Volume on Ramp	783	vph
Length of First Accel/Decel Lane	965	ft
Length of Second Accel/Decel Lane		ft
Adjacent Ramp Data if one exists:		
Does adjacent ramp exist?	Yes	
Volume on Adjacent Ramp	22	vph
Position of Adjacent Ramp	Upstream	
Type of Adjacent Ramp	Off	
Distance to Adjacent Ramp	2400	ft

VOLUME ADJUSTMENT

Junction Components	Freeway	Ramp	Adjacent Ramp	
Terrain Type	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Volume, V (vph)	2265	783	22	vph
Peak-Hour Factor, PHF	0.95	0.95	0.95	
Peak 15-min Volume, v15	596	206	6	v
Trucks and Buses	4	4	4	%
Trucks and Buses PCE, ET	3.0	3.0	3.0	
Recreational Vehicles	0	0	0	%
Recreational Vehicle PCE, ER	2.0	2.0	2.0	
Heavy Vehicle Adjustment, fHV	0.926	0.926	0.926	
Driver Population Adjustment, fP	1.00	1.00	1.00	
Adjusted Flow Rate, vp	2575	890	25	pcph

ANALYSIS and RESULTS of MERGE AREAS

Estimation of Flow entering Lanes 1 and 2:
Proportion of Freeway Vehicles

in Lanes 1 and 2, P_{FM} = 0.718 Using Equation 3

Flow in Lanes 1 and 2, $v_{12} = v_F (P_{FM})$ = 1849 pcph

Capacity Checks:

	Actual	Maximum	LOS F?
v_{FO}	3465	6750	No
v_{R12}	2739	4600	No

Level of Service Operation (if not LOS F):

Density, $D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 20+ pc/mi/ln

Level of Service for Ramp-Freeway Junction Areas of Influence C

Speed in Ramp Influence Area, S_R 50.9 mph

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MERGE ANALYSIS

Location: US 29 SB SPUI On Ramp
Analyst: DDS-CAG
Analysis Time Period: 2025 Peak Hour
Date Performed: 10/1/2001

FREEWAY-RAMP COMPONENTS AND CHARACTERISTICS

Type of Analysis	Merge	
Freeway Data:		
Number of Lanes in Freeway	3	
Free-Flow Speed on Freeway	55.0	mph
Volume on Freeway	2265	vph
On Ramp Data:		
Side of Freeway	Right	
Number of Lanes in Ramp	1	
Free-Flow Speed on Ramp	35.0	mph
Volume on Ramp	783	vph
Length of First Accel/Decel Lane	965	ft
Length of Second Accel/Decel Lane		ft
Adjacent Ramp Data if one exists:		
Does adjacent ramp exist?	Yes	
Volume on Adjacent Ramp	334	vph
Position of Adjacent Ramp	Downstream	
Type of Adjacent Ramp	Off	
Distance to Adjacent Ramp	4800	ft

VOLUME ADJUSTMENT

Junction Components	Freeway	Ramp	Adjacent Ramp	
Terrain Type	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Volume, V (vph)	2265	783	334	vph
Peak-Hour Factor, PHF	0.95	0.95	0.95	
Peak 15-min Volume, v15	596	206	88	v
Trucks and Buses	4	4	4	%
Trucks and Buses PCE, ET	3.0	3.0	3.0	
Recreational Vehicles	0	0	0	%
Recreational Vehicle PCE, ER	2.0	2.0	2.0	
Heavy Vehicle Adjustment, fHV	0.926	0.926	0.926	
Driver Population Adjustment, fP	1.00	1.00	1.00	
Adjusted Flow Rate, vp	2575	890	380	pcph

ANALYSIS and RESULTS of MERGE AREAS

Estimation of Flow entering Lanes 1 and 2:
Proportion of Freeway Vehicles

in Lanes 1 and 2, P_{FM} = 0.570 Using Equation 4

Flow in Lanes 1 and 2, $v_{12} = v_F (P_{FM})$ = 1466 pcph

Capacity Checks:

	Actual	Maximum	LOS F?
v_{FO}	3465	6750	No
v_{R12}	2356	4600	No

Level of Service Operation (if not LOS F):

Density, $D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 17+ pc/mi/ln

Level of Service for Ramp-Freeway Junction Areas of Influence B

Speed in Ramp Influence Area, S_R 51.2 mph

HCS: Ramps and Ramp Junctions Release 3.2

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DIVERGE ANALYSIS

Location: US 29 NB SPUI Off Ramp
Analyst: DDS-CAG
Analysis Time Period: 2025 Peak Hour
Date Performed: 10/1/2001

FREEWAY-RAMP COMPONENTS AND CHARACTERISTICS

Type of Analysis	Diverge	
Freeway Data:		
Number of Lanes in Freeway	3	
Free-Flow Speed on Freeway	55.0	mph
Volume on Freeway	3848	vph
Off Ramp Data:		
Side of Freeway	Right	
Number of Lanes in Ramp	1	
Free-Flow Speed on Ramp	35.0	mph
Volume on Ramp	1175	vph
Length of First Accel/Decel Lane	550	ft
Length of Second Accel/Decel Lane	500	ft
Adjacent Ramp Data if one exists:		
Does adjacent ramp exist?	Yes	
Volume on Adjacent Ramp	502	vph
Position of Adjacent Ramp	Upstream	
Type of Adjacent Ramp	On	
Distance to Adjacent Ramp	4500	ft

VOLUME ADJUSTMENT

Junction Components	Freeway	Ramp	Adjacent Ramp	
Terrain Type	Rolling	Rolling	Rolling	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Volume, V (vph)	3848	1175	502	vph
Peak-Hour Factor, PHF	0.95	0.95	0.95	
Peak 15-min Volume, v15	1013	309	132	v
Trucks and Buses	4	4	4	%
Trucks and Buses PCE, ET	3.0	3.0	3.0	
Recreational Vehicles	0	0	0	%
Recreational Vehicle PCE, ER	2.0	2.0	2.0	
Heavy Vehicle Adjustment, fHV	0.926	0.926	0.926	
Driver Population Adjustment, fP	1.00	1.00	1.00	
Adjusted Flow Rate, vp	4375	1336	571	pcph

ANALYSIS and RESULTS of DIVERGE AREAS

Estimation of Flow entering Lanes 1 and 2:
Proportion of Freeway Vehicles

in Lanes 1 and 2, P_{FD} = 0.589 Using Equation 7

Flow in Lanes 1 and 2, $v_{12} = v_R + (v_F - v_R) P_{FD}$ = 3126 pcph

Capacity Checks:

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	4375	6750	No
v_{12}	3126	4400	No
$v_{FO} = v_F - v_R$	3039	6750	No
v_R	1336	2000	No

Level of Service Operation (if not LOS F):

Density, $D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ = 26+ pc/mi/ln

Level of Service for Ramp-Freeway Junction Areas of Influence C

Speed in Ramp Influence Area, S_R 48 mph

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DIVERGE ANALYSIS

Location: US 29 NB SPUI Off Ramp
Analyst: DDS-CAG
Analysis Time Period: 2025 Peak Hour
Date Performed: 10/1/2001

FREEWAY-RAMP COMPONENTS AND CHARACTERISTICS

Type of Analysis	Diverge	
Freeway Data:		
Number of Lanes in Freeway	3	
Free-Flow Speed on Freeway	55.0	mph
Volume on Freeway	3848	vph
Off Ramp Data:		
Side of Freeway	Right	
Number of Lanes in Ramp	1	
Free-Flow Speed on Ramp	35.0	mph
Volume on Ramp	1175	vph
Length of First Accel/Decel Lane	550	ft
Length of Second Accel/Decel Lane	500	ft
Adjacent Ramp Data if one exists:		
Does adjacent ramp exist?	Yes	
Volume on Adjacent Ramp	33	vph
Position of Adjacent Ramp	Downstream	
Type of Adjacent Ramp	On	
Distance to Adjacent Ramp	2400	ft

VOLUME ADJUSTMENT

Junction Components	Freeway	Ramp	Adjacent Ramp	
Terrain Type	Rolling	Rolling	Rolling	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Volume, V (vph)	3848	1175	33	vph
Peak-Hour Factor, PHF	0.95	0.95	0.95	
Peak 15-min Volume, v15	1013	309	9	v
Trucks and Buses	4	4	4	%
Trucks and Buses PCE, ET	3.0	3.0	3.0	
Recreational Vehicles	0	0	0	%
Recreational Vehicle PCE, ER	2.0	2.0	2.0	
Heavy Vehicle Adjustment, fHV	0.926	0.926	0.926	
Driver Population Adjustment, fP	1.00	1.00	1.00	
Adjusted Flow Rate, vp	4375	1336	38	pcph

ANALYSIS and RESULTS of DIVERGE AREAS

Estimation of Flow entering Lanes 1 and 2:
Proportion of Freeway Vehicles

in Lanes 1 and 2, P_{FD} = 0.589 Using Equation 7

Flow in Lanes 1 and 2, $v_{12} = v_R + (v_F - v_R) P_{FD}$ = 3126 pcph

Capacity Checks:

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	4375	6750	No
v_{12}	3126	4400	No
$v_{FO} = v_F - v_R$	3039	6750	No
v_R	1336	2000	No

Level of Service Operation (if not LOS F):

Density, $D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ = 26+ pc/mi/ln

Level of Service for Ramp-Freeway Junction Areas of Influence C

Speed in Ramp Influence Area, S_R 48 mph

HCS: Ramps and Ramp Junctions Release 3.2

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MERGE ANALYSIS

Location: US 29 NB SPUI On Ramp
Analyst: DDS-CAG
Analysis Time Period: 2025 Peak Hour
Date Performed: 10/1/2001

FREEWAY-RAMP COMPONENTS AND CHARACTERISTICS

Type of Analysis	Merge	
Freeway Data:		
Number of Lanes in Freeway	3	
Free-Flow Speed on Freeway	55.0	mph
Volume on Freeway	3848	vph
On Ramp Data:		
Side of Freeway	Right	
Number of Lanes in Ramp	1	
Free-Flow Speed on Ramp	35.0	mph
Volume on Ramp	33	vph
Length of First Accel/Decel Lane	990	ft
Length of Second Accel/Decel Lane		ft
Adjacent Ramp Data if one exists:		
Does adjacent ramp exist?	Yes	
Volume on Adjacent Ramp	1175	vph
Position of Adjacent Ramp	Upstream	
Type of Adjacent Ramp	Off	
Distance to Adjacent Ramp	2400	ft

VOLUME ADJUSTMENT

Junction Components	Freeway	Ramp	Adjacent Ramp	
Terrain Type	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Volume, V (vph)	3848	33	1175	vph
Peak-Hour Factor, PHF	0.95	0.95	0.95	
Peak 15-min Volume, v15	1013	9	309	v
Trucks and Buses	4	4	4	%
Trucks and Buses PCE, ET	3.0	3.0	3.0	
Recreational Vehicles	0	0	0	%
Recreational Vehicle PCE, ER	2.0	2.0	2.0	
Heavy Vehicle Adjustment, fHV	0.926	0.926	0.926	
Driver Population Adjustment, fP	1.00	1.00	1.00	
Adjusted Flow Rate, vp	4375	38	1336	pcph

ANALYSIS and RESULTS of MERGE AREAS

Estimation of Flow entering Lanes 1 and 2:
Proportion of Freeway Vehicles

in Lanes 1 and 2, P_{FM} = 0.605 Using Equation 2

Flow in Lanes 1 and 2, $v_{12} = v_F (P_{FM})$ = 2648 pcph

Capacity Checks:

	Actual	Maximum	LOS F?
v_{FO}	4413	6750	No
v_{R12}	2686	4600	No

Level of Service Operation (if not LOS F):

Density, $D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 20+ pc/mi/ln

Level of Service for Ramp-Freeway Junction Areas of Influence C

Speed in Ramp Influence Area, S_R 51.0 mph

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DIVERGE ANALYSIS

Location: US 29 SB Off Ramp
Analyst: DDS-CAG
Analysis Time Period: 2025 Peak Hour
Date Performed: 10/1/2001

FREEWAY-RAMP COMPONENTS AND CHARACTERISTICS

Type of Analysis	Diverge	
Freeway Data:		
Number of Lanes in Freeway	3	
Free-Flow Speed on Freeway	55.0	mph
Volume on Freeway	3014	vph
Off Ramp Data:		
Side of Freeway	Right	
Number of Lanes in Ramp	1	
Free-Flow Speed on Ramp	35.0	mph
Volume on Ramp	334	vph
Length of First Accel/Decel Lane	810	ft
Length of Second Accel/Decel Lane	500	ft
Adjacent Ramp Data if one exists:		
Does adjacent ramp exist?	Yes	
Volume on Adjacent Ramp	783	vph
Position of Adjacent Ramp	Upstream	
Type of Adjacent Ramp	On	
Distance to Adjacent Ramp	4800	ft

VOLUME ADJUSTMENT

Junction Components	Freeway	Ramp	Adjacent Ramp	
Terrain Type	Rolling	Rolling	Rolling	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Volume, V (vph)	3014	334	783	vph
Peak-Hour Factor, PHF	0.95	0.95	0.95	
Peak 15-min Volume, v15	793	88	206	v
Trucks and Buses	4	4	4	%
Trucks and Buses PCE, ET	3.0	3.0	3.0	
Recreational Vehicles	0	0	0	%
Recreational Vehicle PCE, ER	2.0	2.0	2.0	
Heavy Vehicle Adjustment, fHV	0.926	0.926	0.926	
Driver Population Adjustment, fP	1.00	1.00	1.00	
Adjusted Flow Rate, vp	3426	380	890	pcph

ANALYSIS and RESULTS of DIVERGE AREAS

Estimation of Flow entering Lanes 1 and 2:
Proportion of Freeway Vehicles

in Lanes 1 and 2, P_{FD} = 0.657 Using Equation 7

Flow in Lanes 1 and 2, $v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2381 pcph

Capacity Checks:

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	3426	6750	No
v_{12}	2381	4400	No
$v_{FO} = v_F - v_R$	3046	6750	No
v_R	380	2000	No

Level of Service Operation (if not LOS F):

Density, $D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ = 17+ pc/mi/ln

Level of Service for Ramp-Freeway Junction Areas of Influence B

Speed in Ramp Influence Area, S_R 49 mph

HCS: Ramps and Ramp Junctions Release 3.2

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DIVERGE ANALYSIS

Location: US 29 SB Off Ramp
Analyst: DDS-CAG
Analysis Time Period: 2025 Peak Hour
Date Performed: 10/1/2001

FREEWAY-RAMP COMPONENTS AND CHARACTERISTICS

Type of Analysis	Diverge	
Freeway Data:		
Number of Lanes in Freeway	3	
Free-Flow Speed on Freeway	55.0	mph
Volume on Freeway	3014	vph
Off Ramp Data:		
Side of Freeway	Right	
Number of Lanes in Ramp	1	
Free-Flow Speed on Ramp	35.0	mph
Volume on Ramp	334	vph
Length of First Accel/Decel Lane	810	ft
Length of Second Accel/Decel Lane	500	ft
Adjacent Ramp Data if one exists:		
Does adjacent ramp exist?	Yes	
Volume on Adjacent Ramp	788	vph
Position of Adjacent Ramp	Downstream	
Type of Adjacent Ramp	On	
Distance to Adjacent Ramp	800	ft

VOLUME ADJUSTMENT

Junction Components	Freeway	Ramp	Adjacent Ramp	
Terrain Type	Rolling	Rolling	Rolling	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Volume, V (vph)	3014	334	788	vph
Peak-Hour Factor, PHF	0.95	0.95	0.95	
Peak 15-min Volume, v15	793	88	207	v
Trucks and Buses	4	4	4	%
Trucks and Buses PCE, ET	3.0	3.0	3.0	
Recreational Vehicles	0	0	0	%
Recreational Vehicle PCE, ER	2.0	2.0	2.0	
Heavy Vehicle Adjustment, fHV	0.926	0.926	0.926	
Driver Population Adjustment, fP	1.00	1.00	1.00	
Adjusted Flow Rate, vp	3426	380	896	pcph

ANALYSIS and RESULTS of DIVERGE AREAS

Estimation of Flow entering Lanes 1 and 2:
Proportion of Freeway Vehicles

in Lanes 1 and 2, P_{FD} = 0.657 Using Equation 7

Flow in Lanes 1 and 2, $v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2381 pcph

Capacity Checks:

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	3426	6750	No
v_{12}	2381	4400	No
$v_{FO} = v_F - v_R$	3046	6750	No
v_R	380	2000	No

Level of Service Operation (if not LOS F):

Density, $D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ = 17+ pc/mi/ln

Level of Service for Ramp-Freeway Junction Areas of Influence B

Speed in Ramp Influence Area, S_R 49 mph

HCS: Ramps and Ramp Junctions Release 3.2

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MERGE ANALYSIS

Location: US 29 SB On Ramp
Analyst: DDS-CAG
Analysis Time Period: 2025 Peak Hour
Date Performed: 10/1/2001

FREEWAY-RAMP COMPONENTS AND CHARACTERISTICS

Type of Analysis	Merge	
Freeway Data:		
Number of Lanes in Freeway	3	
Free-Flow Speed on Freeway	55.0	mph
Volume on Freeway	3014	vph
On Ramp Data:		
Side of Freeway	Right	
Number of Lanes in Ramp	1	
Free-Flow Speed on Ramp	35.0	mph
Volume on Ramp	788	vph
Length of First Accel/Decel Lane	760	ft
Length of Second Accel/Decel Lane		ft
Adjacent Ramp Data if one exists:		
Does adjacent ramp exist?	Yes	
Volume on Adjacent Ramp	334	vph
Position of Adjacent Ramp	Upstream	
Type of Adjacent Ramp	Off	
Distance to Adjacent Ramp	800	ft

VOLUME ADJUSTMENT

Junction Components	Freeway	Ramp	Adjacent Ramp	
Terrain Type	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Volume, V (vph)	3014	788	334	vph
Peak-Hour Factor, PHF	0.95	0.95	0.95	
Peak 15-min Volume, v15	793	207	88	v
Trucks and Buses	4	4	4	%
Trucks and Buses PCE, ET	3.0	3.0	3.0	
Recreational Vehicles	0	0	0	%
Recreational Vehicle PCE, ER	2.0	2.0	2.0	
Heavy Vehicle Adjustment, fHV	0.926	0.926	0.926	
Driver Population Adjustment, fP	1.00	1.00	1.00	
Adjusted Flow Rate, vp	3426	896	380	pcph

ANALYSIS and RESULTS of MERGE AREAS

Estimation of Flow entering Lanes 1 and 2:
Proportion of Freeway Vehicles

in Lanes 1 and 2, P_{FM} = 0.606 Using Equation 3

Flow in Lanes 1 and 2, $v_{12} = v_F (P_{FM})$ = 2075 pcph

Capacity Checks:

	Actual	Maximum	LOS F?
v_{FO}	4322	6750	No
v_{R12}	2971	4600	No

Level of Service Operation (if not LOS F):

Density, $D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 23+ pc/mi/ln

Level of Service for Ramp-Freeway Junction Areas of Influence C

Speed in Ramp Influence Area, S_R 50.5 mph

HCS: Ramps and Ramp Junctions Release 3.2

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DIVERGE ANALYSIS

Location: US 29 NB Off Ramp
Analyst: DDS-CAG
Analysis Time Period: 2025 Peak Hour
Date Performed: 10/1/2001

FREEWAY-RAMP COMPONENTS AND CHARACTERISTICS

Type of Analysis	Diverge	
Freeway Data:		
Number of Lanes in Freeway	3	
Free-Flow Speed on Freeway	55.0	mph
Volume on Freeway	4521	vph
Off Ramp Data:		
Side of Freeway	Right	
Number of Lanes in Ramp	1	
Free-Flow Speed on Ramp	35.0	mph
Volume on Ramp	1181	vph
Length of First Accel/Decel Lane	800	ft
Length of Second Accel/Decel Lane	500	ft
Adjacent Ramp Data if one exists:		
Does adjacent ramp exist?	Yes	
Volume on Adjacent Ramp	502	vph
Position of Adjacent Ramp	Downstream	
Type of Adjacent Ramp	On	
Distance to Adjacent Ramp	950	ft

VOLUME ADJUSTMENT

Junction Components	Freeway	Ramp	Adjacent Ramp	
Terrain Type	Rolling	Rolling	Rolling	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Volume, V (vph)	4521	1181	502	vph
Peak-Hour Factor, PHF	0.90	0.90	0.95	
Peak 15-min Volume, v15	1256	328	132	v
Trucks and Buses	4	4	4	%
Trucks and Buses PCE, ET	3.0	3.0	3.0	
Recreational Vehicles	0	0	0	%
Recreational Vehicle PCE, ER	2.0	2.0	2.0	
Heavy Vehicle Adjustment, fHV	0.926	0.926	0.926	
Driver Population Adjustment, fP	1.00	1.00	1.00	
Adjusted Flow Rate, vp	5425	1417	571	pcph

ANALYSIS and RESULTS of DIVERGE AREAS

Estimation of Flow entering Lanes 1 and 2:
Proportion of Freeway Vehicles

in Lanes 1 and 2, P_{FD} = 0.559 Using Equation 7

Flow in Lanes 1 and 2, $v_{12} = v_R + (v_F - v_R) P_{FD}$ = 3658 pcph

Capacity Checks:

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	5425	6750	No
v_{12}	3658	4400	No
$v_{FO} = v_F - v_R$	4008	6750	No
v_R	1417	2000	No

Level of Service Operation (if not LOS F):

Density, $D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ = 29- pc/mi/ln

Level of Service for Ramp-Freeway Junction Areas of Influence D

Speed in Ramp Influence Area, S_R 48 mph

HCS: Ramps and Ramp Junctions Release 3.2

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MERGE ANALYSIS

Location: US 29 NB - On Ramp
Analyst: DDS-CAG
Analysis Time Period: 2025 Peak Hour
Date Performed: 10/1/2001

FREEWAY-RAMP COMPONENTS AND CHARACTERISTICS

Type of Analysis	Merge	
Freeway Data:		
Number of Lanes in Freeway	3	
Free-Flow Speed on Freeway	55.0	mph
Volume on Freeway	4521	vph
On Ramp Data:		
Side of Freeway	Right	
Number of Lanes in Ramp	1	
Free-Flow Speed on Ramp	35.0	mph
Volume on Ramp	502	vph
Length of First Accel/Decel Lane	840	ft
Length of Second Accel/Decel Lane		ft
Adjacent Ramp Data if one exists:		
Does adjacent ramp exist?	Yes	
Volume on Adjacent Ramp	1181	vph
Position of Adjacent Ramp	Upstream	
Type of Adjacent Ramp	Off	
Distance to Adjacent Ramp	950	ft

VOLUME ADJUSTMENT

Junction Components	Freeway	Ramp	Adjacent Ramp	
Terrain Type	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Volume, V (vph)	4521	502	1181	vph
Peak-Hour Factor, PHF	0.95	0.95	0.95	
Peak 15-min Volume, v15	1190	132	311	v
Trucks and Buses	4	4	4	%
Trucks and Buses PCE, ET	3.0	3.0	3.0	
Recreational Vehicles	0	0	0	%
Recreational Vehicle PCE, ER	2.0	2.0	2.0	
Heavy Vehicle Adjustment, fHV	0.926	0.926	0.926	
Driver Population Adjustment, fP	1.00	1.00	1.00	
Adjusted Flow Rate, vp	5140	571	1343	pcph

ANALYSIS and RESULTS of MERGE AREAS

Estimation of Flow entering Lanes 1 and 2:
Proportion of Freeway Vehicles

in Lanes 1 and 2, P_{FM} = 0.596 Using Equation 3

Flow in Lanes 1 and 2, $v_{12} = v_F (P_{FM})$ = 3065 pcph

Capacity Checks:

	Actual	Maximum	LOS F?
v_{FO}	5711	6750	No
v_{R12}	3636	4600	No

Level of Service Operation (if not LOS F):

Density, $D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 28+ pc/mi/ln

Level of Service for Ramp-Freeway Junction Areas of Influence D

Speed in Ramp Influence Area, S_R 49.7 mph

HCS: Ramps and Ramp Junctions Release 3.2

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MERGE ANALYSIS

Location: US 29 NB - On Ramp
Analyst: DDS-CAG
Analysis Time Period: 2025 Peak Hour
Date Performed: 10/1/2001

FREEWAY-RAMP COMPONENTS AND CHARACTERISTICS

Type of Analysis	Merge	
Freeway Data:		
Number of Lanes in Freeway	3	
Free-Flow Speed on Freeway	55.0	mph
Volume on Freeway	4521	vph
On Ramp Data:		
Side of Freeway	Right	
Number of Lanes in Ramp	1	
Free-Flow Speed on Ramp	35.0	mph
Volume on Ramp	502	vph
Length of First Accel/Decel Lane	840	ft
Length of Second Accel/Decel Lane		ft
Adjacent Ramp Data if one exists:		
Does adjacent ramp exist?	Yes	
Volume on Adjacent Ramp	1175	vph
Position of Adjacent Ramp	Downstream	
Type of Adjacent Ramp	Off	
Distance to Adjacent Ramp	4500	ft

VOLUME ADJUSTMENT

Junction Components	Freeway	Ramp	Adjacent Ramp	
Terrain Type	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Volume, V (vph)	4521	502	1175	vph
Peak-Hour Factor, PHF	0.95	0.95	0.95	
Peak 15-min Volume, v15	1190	132	309	v
Trucks and Buses	4	4	4	%
Trucks and Buses PCE, ET	3.0	3.0	3.0	
Recreational Vehicles	0	0	0	%
Recreational Vehicle PCE, ER	2.0	2.0	2.0	
Heavy Vehicle Adjustment, fHV	0.926	0.926	0.926	
Driver Population Adjustment, fP	1.00	1.00	1.00	
Adjusted Flow Rate, vp	5140	571	1336	pcph

ANALYSIS and RESULTS of MERGE AREAS

Estimation of Flow entering Lanes 1 and 2:
Proportion of Freeway Vehicles

in Lanes 1 and 2, P_{FM} = 0.601 Using Equation 2

Flow in Lanes 1 and 2, v_{12} = v_F (P_{FM}) = 3089 pcph

Capacity Checks:

	Actual	Maximum	LOS F?
v_{FO}	5711	6750	No
v_{R12}	3660	4600	No

Level of Service Operation (if not LOS F):

Density, $D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 28+ pc/mi/ln

Level of Service for Ramp-Freeway Junction Areas of Influence D

Speed in Ramp Influence Area, S_R 49.6 mph