FUTURE NC 540 GRADE SEPARATION & INTERCHANGE TECHNICAL ASSESSMENT

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Table of Contents

EXECUTIVE SUMMARY **ES-1**

Interchange Locations, Grade Separations, & Other Crossings **ES-1**

Interchange Types at Holly Springs Road **ES-7**

Interchange Types at Other NC 540 Interchanges **ES-8**

1.0 INTRODUCTION **1**

1.1 Project Goals **1**

1.2 Study Area **1**

1.3 Project Assumptions **2**

2.0 LOCAL TRANSPORTATION PLANS **3**

2.1 NCDOT and NCTA **3**

2.1.1 NC 540 Traffic Forecasts 3

2.1.2 NC 540 Interchange Layouts 4

2.2 NC Capital Area MPO **5**

2.2.1 2040 Metropolitan Transportation Plan 5

2.2.2 Southwest Area Study 5

2.3 Wake County Plans **6**

2.4 Town of Apex Plans **6**

2.5 Town of Holly Springs Plans **7**

2.6 Town of Cary Plans **7**

2.7 Town of Fuquay-Varina Plans **8**

2.8 Town of Garner Plans **8**

3.0 IDENTIFICATION OF INTERCHANGE LOCATIONS & GRADE SEPARATIONS **9**

3.1 Interchange Locations **9**

3.1.1 Lake Wheeler Road Interchange Review 9

3.2 Grade Separations along NC 540 ..... **10**

3.2.1 Roadway Crossings Requiring Grade Separation 10

3.2.2 Roadway Crossings Not Requiring Grade Separation 11

3.2.3 Greenway Crossings 11

3.3 Cross Sections at Grade Separations **12**

3.4 Other Local Roadway Network Connections **13**

4.0 INTERCHANGE NEEDS WITH NC 540 16

4.1 Methodology 17
4.1.1 FHWA CAP-X Software 17
4.1.2 Synchro Software 17
4.1.3 Traffic Volumes 18

4.2 NC 55 Bypass Interchange 18

4.3 Holly Springs Road Interchange 18
4.3.1 Traffic Operations Review 18
4.3.2 Criteria for Interchange Comparison at Holly Springs Road 20
4.3.3 Interchange Review and Comparison at Holly Springs Road 21
4.3.4 Interchange Recommendations at Holly Springs Road 25
4.3.5 Local Network Connections Required at Holly Springs Road 25

4.4 Bells Lake Road Interchange 26
4.4.1 Traffic Operations Review 26
4.4.2 Interchange Type at Bells Lake Road 27
4.4.3 Local Network Connections Required at Bells Lake Road 28

4.5 US 401 Fayetteville Road Interchange 29
4.5.1 Traffic Operations Review 29
4.5.2 Interchange Type at US 401 Fayetteville Road 30
4.5.3 Local Network Connections Required at US 401 Fayetteville Rd 31

4.6 Old Stage Road Interchange 32
4.6.1 Traffic Operations Review 32
4.6.2 Interchange Type at Old Stage Road 33
4.6.3 Local Network Connections Required at Old Stage Road 33

4.7 NC 50 Benson Road Interchange 34
4.7.1 Traffic Operations Review 34
4.7.2 Interchange Type at NC 50 Benson Road 35
4.7.3 Local Network Connections Required at NC 50 Benson Road 36

List of Figures

Figure 1. Map of Recommended Interchanges, Grade Separations, and Other NC 540 Crossings 2
Figure 2. Concept 4: Diverging Diamond Interchange at Holly Springs Road 23
Figure 3. Concept 5: Half Clover Interchange at Holly Springs Road 23
Figure 4. Concept 6: Half Clover Interchange with 2 Ramps at Holly Springs Road 23
Figure 5. Concept 10: Split Diamond at Kildaire Farm Road and Holly Springs Road .. 24
Figure 6. Concept 11: Split Diamond at Sunset Lake Road and Holly Springs Road 25
Figure 7. Bells Lake Road Interchange Concept 28
Figure 8. US 401 Fayetteville Road Interchange Concept 30
Figure 9. Old Stage Road Interchange Concept 34
Figure 10. NC 50 Benson Road Interchange Concept 36

List of Tables

Table 1. Grade Separation and Cross Section Recommendations 5
Table 2. Summary of Interchange Layouts 8
Table 3. Summary of Greenway Crossings 12
Table 4. Other Proposed Local Roadway Connections 14
Table 5. Summary of Interchange Layouts 16
Table 6. Critical Lane Methodology Thresholds 17
Table 7. CAP-X Interchange Review at Holly Spring Road 19
Table 8. HCM Average Delay Thresholds for Traffic Signal Level of Service 20
Table 9. Comparison of Interchange Concepts at Holly Springs Interchange Location . 22
Table 10. CAP-X Interchange Review at Bells Lake Road 27
Table 11. CAP-X Interchange Review at US 401 Fayetteville Road 29
Table 12. CAP-X Interchange Review at Old Stage Road 32
Table 13. CAP-X Interchange Review at NC 50 Benson Road 35

List of Appendices

Appendix A – Holly Springs Interchange Layouts

Appendix B – Interchange Layouts at Bells Lake Road, US 401 Fayetteville Road, Old Stage Road, and NC 50 Benson Road

Appendix C – Traffic Analysis

Appendix D – CAMPO Typical Sections

Executive Summary

The proposed NC 540 Southern Wake Expressway is planned as a major freeway connection in southern Wake County. Recognizing that this project will revise traffic patterns and impact regional roads, the North Carolina Capital Area Metropolitan Planning Organization (NC Capital Area MPO) developed this study to identify, evaluate, and prepare recommendations for grade crossings and interchanges along the NC 540 corridor. This study is independent of the North Carolina Department of Transportation's (NCDOT's) Environmental Impact Statement (EIS) process.

Interchange Locations, Grade Separations, & Other Crossings

This study examines the Orange line alignment of NC 540 which follows the protected corridor identified by NCDOT in the 1990s. The study focuses on the NC 540 corridor between the recently opened interchange at the NC 55 Bypass to I-40 south of Raleigh. The recommendation for grade crossings and other roadway and greenway elements are illustrated in a map format in Figure 1 and summarized in Table 1. Key recommendations include:

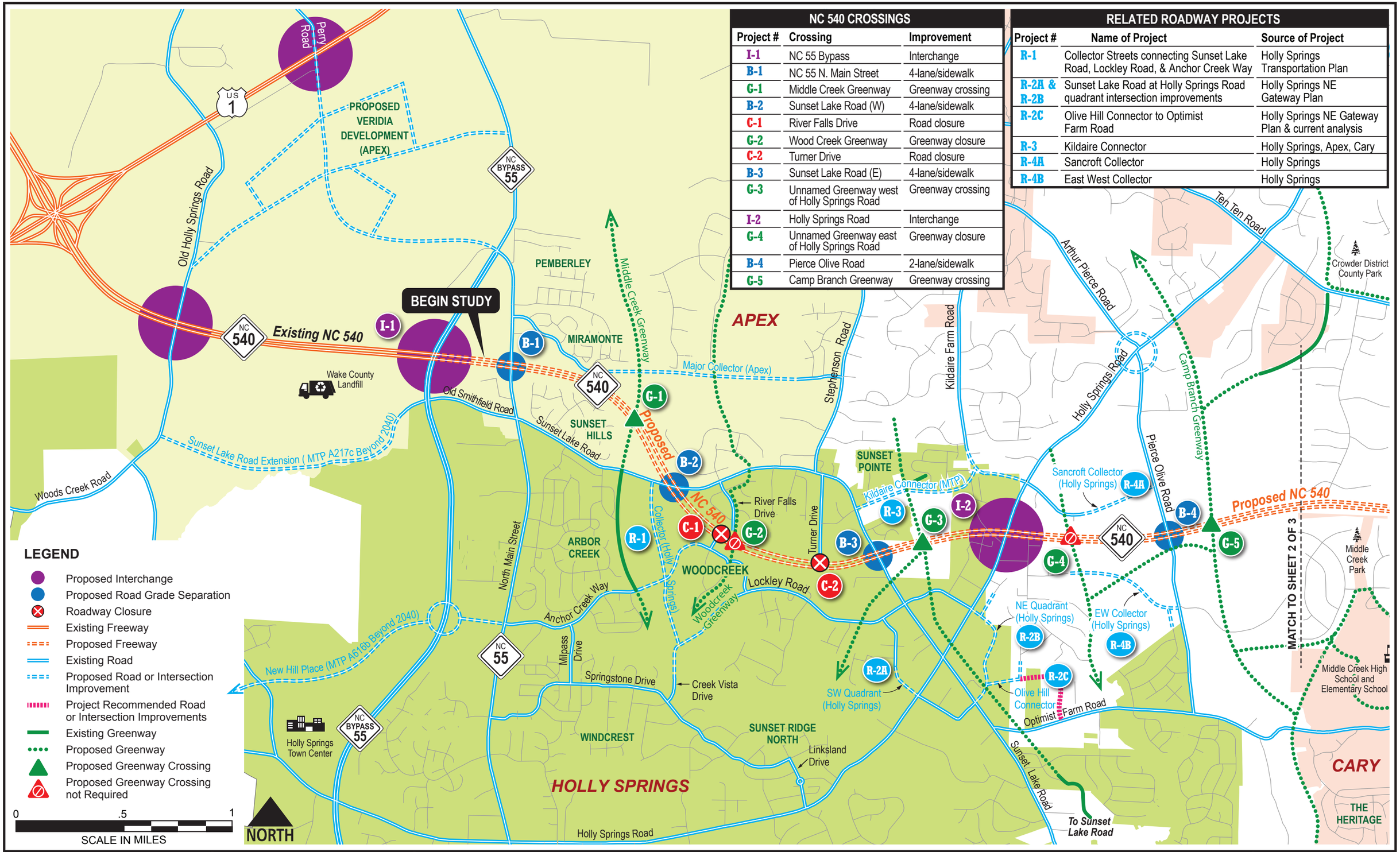
- This study examined the proposed locations of interchanges on NC 540. The analysis confirmed that NCDOT is assessing interchanges at the appropriate cross roads. The six interchange locations (from west to east) include:
    - NC 55 Bypass (I-1)
    - Holly Springs Road (I-2)
    - Bells Lake Road (I-3)
    - US 401 Fayetteville Road (I-4)
    - Old Stage Road (I-5)
    - NC 50 Benson Road (I-6)
- Grade crossings are recommended at 11 road crossings of NC 540. For these 11 crossings, Table 1 identifies the anticipated cross section needed including number of lanes and the provision of bicycle and pedestrian elements. The eleven grade crossings (from west to east) are:
    - NC 55 Business Main Street (B-1)
    - Sunset Lake Drive (west) (B-2)
    - Sunset Lake Drive (east) (B-3)
    - Pierce Olive Road (B-4)
    - West Lake Road (B-5)
    - Johnson Pond Road (B-6)
    - Lake Wheeler Road (B-7)
    - Old McCullers Road (B-8)
    - Fanny Brown Road (B-9)
    - Sauls Road (B-10)
    - Jordan Road (B-11)

NC 540 CROSSINGS

Project #	Crossing	Improvement
I-1	NC 55 Bypass	Interchange
B-1	NC 55 N. Main Street	4-lane/sidewalk
G-1	Middle Creek Greenway	Greenway crossing
B-2	Sunset Lake Road (W)	4-lane/sidewalk
C-1	River Falls Drive	Road closure
G-2	Wood Creek Greenway	Greenway closure
C-2	Turner Drive	Road closure
B-3	Sunset Lake Road (E)	4-lane/sidewalk
G-3	Unnamed Greenway west of Holly Springs Road	Greenway crossing
I-2	Holly Springs Road	Interchange
G-4	Unnamed Greenway east of Holly Springs Road	Greenway closure
B-4	Pierce Olive Road	2-lane/sidewalk
G-5	Camp Branch Greenway	Greenway crossing

RELATED ROADWAY PROJECTS

Project #	Name of Project	Source of Project
R-1	Collector Streets connecting Sunset Lake Road, Lockley Road, & Anchor Creek Way	Holly Springs Transportation Plan
R-2A & R-2B	Sunset Lake Road at Holly Springs Road quadrant intersection improvements	Holly Springs NE Gateway Plan
R-2C	Olive Hill Connector to Optimist Farm Road	Holly Springs NE Gateway Plan & current analysis
R-3	Kildaire Connector	Holly Springs, Apex, Cary
R-4A	Sancroft Collector	Holly Springs
R-4B	East West Collector	Holly Springs



LEGEND

- Proposed Interchange
- Proposed Road Grade Separation
- Roadway Closure
- Existing Freeway
- Proposed Freeway
- Existing Road
- Proposed Road or Intersection Improvement
- Project Recommended Road or Intersection Improvements
- Existing Greenway
- Proposed Greenway
- Proposed Greenway Crossing
- Proposed Greenway Crossing not Required

0 .5 1
SCALE IN MILES

FUTURE NC 540 INTERCHANGE TECHNICAL ASSESSMENT

North Carolina Capital Area Metropolitan Planning Organization

NC 540 CORRIDOR GRADE CROSSINGS AND ROADWAY IMPROVEMENTS

ES-2

SHEET 1 OF 3

NC 540 CROSSING

Project #	Crossing	Improvement
B-5	West Lake Road	4-lane/sidewalk
G-6	Unnamed Greenway west of Bells Lake Road	Greenway closure
I-3	Bells Lake Road	Interchange
C-3	Rhodes Road	Road closure
C-4	Deer Meadow Drive	Road closure
B-6	Johnson Pond Road	2-lane/bike lane/sidewalk
C-5	Proposed Connector	Road closure
B-7	Lake Wheeler Road	4-lane/bike lane/sidewalk
I-4	US 401/Fayetteville Road	Interchange
B-8	Old McCullers Road	2-lane
RR-1	Norfolk Southern RR	2 existing tracks with future transit
B-9	Fanny Brown Road	2-lane/wide outside lane
I-5	Old Stage Road	Interchange - wide outside lane and multi-use path

RELATED ROADWAY PROJECTS

Project #	Name of Project	Source of Project
R-5	Oxford Green Drive	Cary
R-6	West Lake Road Extension	Cary
R-7	Banks Road Collector	Fuquay Varina
R-8	Johnson Pond Road at Blarney Franks Road Intersection Realignment	
R-9	Connector Street between Johnson Pond Road to Lake Wheeler Road (not recommended for construction)	Fuquay Varina
R-10	Realign Donny Brook Road Intersection at Lake Wheeler Road	Fuquay Varina
R-11	Realign Donny Brook Road	Fuquay Varina
R-12	Wake Tech Loop	
R-13	Old McCullers Road Extension to Fayetteville Road	
R-14	Realignment of Rock Service Station Road at Old Stage Road intersection	

MATCH TO SHEET 1 OF 3

MATCH TO SHEET 3 OF 3

Proposed NC 540

NC 540

BELLE POINT

Middle Creek Park

Oxford Green Drive (Cary)

LANGSTON

Middle Creek High School and Elementary School

WEST LAKE

Optimist Farm Road

CARY

THE HERITAGE

THE PARK AT WEST LAKE

GLEN ARBOR

WOODS OF ASHBURY

Donny Brook Road Realignment

Wake Technical Community College

Tech Road

LANEVIEW GLEN

Vance Elelmentary School

Old Stage Road Greenway

Connector Street (Fuquay Varina)

FUQUAY VARINA

Banks Road Extension Collector Street (Fuquay Varina)

Banks Road Elelmentary School

GARNER

Graham Newton Road

Ten Ten Road

Blaney Franks Road

West Lake Road

Bells Lake Road

Rhodes Road

Deer Meadow Drive

Johnson Pond Road

Lake Wheeler Road

Fayetteville Road

US 401

Old McCullers Road Extension

Norfolk Southern RR

Donny Brook Road

Old McCullers Road

Ransdell Road

Fanny Brown Road

Old Stage Road

Rock Service Station Road

Banks Road

West Lake Road Extension (MTP A77a)

Johnson Pond Road

LEGEND

- Proposed Interchange
- Proposed Road Grade Separation
- Roadway Closure
- Existing Freeway
- Proposed Freeway
- Existing Road
- Proposed Road or Intersection Improvement
- Project Recommended Road or Intersection Improvements
- Existing Greenway
- Proposed Greenway
- Proposed Greenway Crossing
- Proposed Greenway Crossing not Required

0 .5 1

SCALE IN MILES

NORTH

FUTURE NC 540 INTERCHANGE TECHNICAL ASSESSMENT

North Carolina Capital Area Metropolitan Planning Organization

NC 540 CORRIDOR GRADE CROSSINGS AND ROADWAY IMPROVEMENTS

ES-3

NC 540 CROSSING		
Project #	Crossing	Improvement
G-7	Old Stage Road Greenway	Greenway closure
C-6	Holland Church Road	Road closure
B-10	Sauls Road	2-lane/wide outside lane
B-11	Jordan Road	2-lane/wide outside lane
G-8	Unnamed Greenway west of Benson Road	Greenway closure
I-6	NC 50/Benson Road	4-lane/wide outside lane
G-9	Swift Creek Greenway	Greenway crossing

RELATED ROADWAY PROJECTS		
Project #	Name of Project	Source of Project
R-14	Realignment of Rock Service Station Road at Old Stage Road intersection	
R-15	Cleveland School Road Extension	Wake County
R-16	Ten Ten Road Extension	Wake County

Vance Elelmentary School
Old Stage Road Greenway
Old Stage Road
Proposed NC 540
I-5
G-7
C-6
NC 540
R-14
Rock Service Station Road
Old Stage Road Greenway
MATCH TO SHEET 2 OF 3
KINGS RIDGE
Holland Church Road
TAVERNIER
CAROLINA MEADOWS
Crowder Road
Ten Ten Road
GARNER
NC 50
Benson Road
B-10
TURNER FARMS
South Garner Neighborhood Greenway
Harvey Johnson Road
Sauls Road
B-11
KEENLAND TRAILS
UPCHURCH PLACE
Jordan Road
GRISSOM FARMS
I-6
G-8
STEVENS OAKS
R-16
Ten Ten Road Extension (Wake County)
SOUTHERN PLACE
TURNER FARMS
New Bethel Church Road
Proposed NC 540
END STUDY
Proposed NC 540
G-9
NC 540
Swift Creek Greenway
BYPASS US 70
WAKE COUNTY
JOHNSTON COUNTY
To NC 42
Pagan Road
R-15
Cleveland School Road Extension (Wake County)
Sauls Road
Brack Penny Road
NC 50
Benson Road
Cleveland School Road
NC 42
INTERSTATE 40

LEGEND

- Proposed Interchange
- Proposed Road Grade Separation
- Roadway Closure
- Existing Freeway
- Proposed Freeway
- Existing Road
- Proposed Road or Intersection Improvement
- Project Recommended Road or Intersection Improvements
- Existing Greenway
- Proposed Greenway
- Proposed Greenway Crossing
- Proposed Greenway Crossing not Required

0 .5 1
SCALE IN MILES

NORTH

FUTURE NC 540 INTERCHANGE TECHNICAL ASSESSMENT

Capital Area Metropolitan Planning Organization — North Carolina

NC 540 CORRIDOR GRADE CROSSINGS AND ROADWAY IMPROVEMENTS

ES-4

SHEET 3 OF 3

Table 1. NC 540 Grade Separation & Cross Section Recommendations

LEGEND
Interchanges
Bridge Crossing / Grade Separation
Closure (No overpass required at NC 540)
Greenway
Railroad

REFERENCE INFORMATION			EXISTING & FUTURE CONDITIONS						RECOMMENDATIONS							
						2040 Lanes on Plans										
Reference Number	Roadway (listed west to east)	Planning Jurisdiction	Roadway Functional Class (NC Capital Area MPO)	2010 Existing Daily Traffic (vpd)	2040 Daily Traffic from V5 TRM (vpd)	2040 MTP	Other Local Plans	Crossing Recommendation	2040 Recommended Lanes	Bicycle & Pedestrian Treatment requested by Local Jurisdiction	Bicycle & Pedestrian Hierarchy/ Priority in 2040 MTP	Recommended Cross Section [1]	NC Capital Area MPO MTP Project Number	Year of MTP Project	Year Widening Required for Capacity	COMMENTS AND CAVEATS
I-1	NC 55 Bypass	Apex	Principal Arterial - Expressway	26,000	37,100	6	6 - Holly Springs 4 - Apex	Expand existing interchange	6 plus auxiliary	Match existing	Regional Off Road Facility	#15 (subject to interchange analysis)	A98	2030	2040	The NC 55 Bypass overpass was constructed as part of the NC 540 Western Wake Expressway construction. If there is inadequate width to widen to six lane divided section in the future, adequate horizontal clearance for a future 6-lane cross section at NC 55 Business (B-1) should be provided.
B-1	NC 55 Business (N. Main Street)	Apex	Minor Arterial	15,000	43,800	4	4 Apex & Holly Springs	Grade separation	4 (with potential provision of 6 lanes - see comments)	Sidewalk (Holly Springs & Apex)	Regional On Road Bicycle Facility	#7 (or #15 if six lanes)	A426	2040	2015	A four lane section is recommended to be consistent with the 2040 MTP and local government plans. It is anticipated that a six lane section and future revised access on NC 55 Bypass (I-1) will be provided to distribute traffic volumes from NC 55 Business. If, however, the current overpass at NC 55 Bypass is inadequate to provide for a future NC 55 Bypass widening, then adequate horizontal clearance for an ultimate six lane section should be provided at the NC 55 Business (N. Main Street) grade separation.
G-1	Middle Creek Greenway	Apex & Holly Springs					Apex & Holly Springs - Crossing	Greenway crossing		Greenway	Regional Off Road Facility	Greenway				High priority greenway.
B-2	Sunset Lake Road (West)	Apex & Holly Springs	Major Collector	5,900	16,800	4	4 Apex & Holly Springs	Grade separation	4	Sidewalk (Holly Springs & Wake County)	Regional On Road Bicycle Facility	#8	A217A	2030	2025	None
C-1	River Falls Drive	Holly Springs	Local	Not available (< 1000)	< 1000	2	2	Closure or other measure	2 (if grade separation provided)	Sidewalk & bike shoulders to provide cross over for Greenway G-2 (if grade separation provided)	Not identified in MTP	Match existing (if grade separation provided)	NA	NA	NA	This road could be considered for closing as part of the NC 540 design. If, however, a bridge crossing is preferred by NCDOT for cost or other reasons, then a grade separation would be an acceptable solution.
G-2	Greenway (unnamed) through Woodcreek subdivision	Holly Springs & Apex					Holly Springs - Crossing Apex - No crossing or greenway	No crossing		Greenway	Local Off Road Facility	No crossing of NC 540.				Low priority greenway. Mapping in plans seem to overlap River Falls Drive (C-1)
C-2	Turner Drive	Holly Springs	Local	<100 vpd	< 1000	2	2	Closure or other measure	2 (if grade separation provided)	Sidewalk (if grade separation provided)	Not identified in MTP	#2 (if grade separation provided)	NA	NA	NA	Depending upon NC-540 alignment, Turner Drive may not be crossed or impacted by NC 540. If it is impacteed, this road could be considered for closing as part of the NC 540 design. If, however, a bridge crossing is preferred by NCDOT for cost or other reasons, then a grade separation would be an acceptable solution.
B-3	Sunset Lake Road (East)	Holly Springs & Wake County	Major Collector	7,900	28,600	4	4 Holly Springs	Grade separation	4	Sidewalk (Holly Springs)	Regional On Road Bicycle Facility	#8	A217A	2030	2025	If split diamond interchange selected for Holly Springs Road interchange, this bridge would be part of the interchange design and operations.
G-3	Greenway (unnamed) west of Holly Springs Road	Holly Springs & Apex					Holly Springs - Crossing Apex - No crossing or greenway	Greenway crossing		Greenway	Local Off Road Facility	Greenway				Greenway crossing is recommended due to existing greenway section located both north of the future NC 540 and south of Optimist Farm Road. Alternatively, future greenway plans could be rerouted onto the Holly Springs Road or Sunset Lake Road grade separations allowing for linkage north and south of NC540.
I-2	Holly Springs Road	Holly Springs	Minor Arterial	15,000	52,300	4	4 Cary 6 Holly Springs 4 Wake County	Interchange	6 plus auxiliary	Sidewalk on Holly Springs & Wake County plan	Statewide On Road Bicycle Facility (through interchange area)	#15 (subject to interchange analysis)	A163a, A71, & A41	2030	2018	Widening to six lanes dependent upon Holly Springs interchange configuration and Holly Springs Road at Sunset Lake Road intersection. Preliminary analysis indicates six lane section definitely required from Sunset Lake Road north to interchange and possibly as far north as the future Kildaire Farm intersection. Note that if Pierce Olive Road (B-4) could be extended south of Optimist Farm Road to Sunset Lake Road, it may be possible to reduce laneage on Holly Springs Road due to a diversion of up to 8,000 vpd from Sunset Lake Rd and Holly Springs Road to Pierce Olive Road.
G-4	Greenway (unnamed) east of Holly Springs Road	Holly Springs & Cary					Holly Springs - Crossing Cary - No crossing or greenway	No crossing		Greenway	Local Off Road Facility	No crossing of NC 540.				No greenway crossing of NC 540 is recommended. If needed in the future, alternate routes could be routed onto the Holly Springs Road (I-2) or Pierce Olive Road (B-4) allowing for linkage north and south of NC540.
B-4	Pierce Olive Road	Wake County & Cary & Holly Springs	Local	3,300	8,400 (16,000 if extended south to Sunset Lake Rd)	2 exist	2 Cary 2 Wake County	Grade separation	2 (initial construction) 4 (possible future need if extended)	Sidewalk on Wake County plan Bike lanes on Holly Springs plan	Local On Road Bicycle Facility	#2 (#12 if four lanes)	NA	NA	2030 (if extended)	Note that if Pierce Olive Road (B-4) could be extended south of Optimist Farm Road to Sunset Lake Road, the new link could divert up to 8,000 vpd from Sunset Lake Road and Holly Springs Road improving traffic operations. If extended, the ADT on Pierce Lake Road would increase to 16,000 vpd warranting a future four-lane section. Therefore, a bridge design that would not preclude future widening of Pierce Olive Road to four lanes is preferred.
G-5	Camp Branch Greenway	Cary					Cary - Crossing Holly Springs - Crossing	Greenway crossing		Greenway	Statewide Off Road Facility	Greenway				High priority greenway crossing.

Footnotes:

1. NC Capital Area MPO recommended cross sections shown in Appendix D.
2. NC Capital Area MPO has adopted universal access and complete street policies. Therefore, appropriate bicycle and pedestrian improvements should be provided on all roadways unless demonstrated to be impracticable.

LEGEND
Interchanges
Bridge Crossing / Grade Separation
Closure (No overpass required at NC 540)
Greenway
Railroad

Table 1. NC 540 Grade Separation & Cross Section Recommendations
(continued p. 2 of 2)

REFERENCE INFORMATION			EXISTING & FUTURE CONDITIONS						RECOMMENDATIONS							
						2040 Lanes on Plans										
Reference Number	Roadway (listed west to east)	Planning Jurisdiction	Roadway Functional Class (NC Capital Area MPO)	2010 Existing Daily Traffic (vpd)	2040 Daily Traffic from V5 TRM (vpd)	2040 MTP	Other Local Plans	Crossing Recommendation	2040 Recommended Lanes	Bicycle & Pedestrian Treatment requested by Local Jurisdiction	Bicycle & Pedestrian Hierarchy/ Priority in 2040 MTP	Recommended Cross Section [1]	NC Capital Area MPO MTP Project Number	Year of MTP Project	Year Widening Required for Capacity	COMMENTS AND CAVEATS
B-5	West Lake Road	Cary	Local		9,500	4	Cary 4 lanes	Grade separation	4	Sidewalk	Not identified in MTP	#11	A77	2030	2040	Shared use path could be routed along West Lake Road to the proposed streetside trail on Ten Ten Road as part of a rerouted greenway identified west of Bells Lake Road (G-6).
G-6	Greenway (unnamed) west of Bell's Lake Road	Cary					Cary - Crossing	No crossing		Greenway	Local Off Road Facility	No crossing of NC 540.				Since a crossing is not required, an alternative shared use path could be routed along West Lake Road (B-5) north to the proposed streetside trail on Ten Ten Road. This could serve pedestrian and bicycle connectivity from Middle Creek schools to the north.
I-3	Bells Lake Road	Wake County	Major Collector	4,500	20,200	4	4 Cary 4 Wake County	Interchange	4 plus auxiliary	Sidewalk on Wake County plan, Cary has Greenway G5 just to the west of Bells Lake, sidewalk - Fuquay Varina	Local On Road Bicycle Facility	#11 (subject to interchange analysis)	A192	beyond 2040	2035	Bridge crossing will require four through lanes plus auxiliary lanes as determined by final interchange design.
C-3	Rhodes Road	Wake County	Local	1000	4200	cut off	cut off	Closure or other measure	2 (if grade separation provided)	NA	Not identified in MTP	#5 (if grade separation provided)	NA	NA	NA	This road could be considered for closing as part of the NC 540 design. If, however, a bridge crossing is preferred by NCDOT for cost or other reasons, then a grade separation would be an acceptable solution.
C-4	Deer Meadow Drive	Wake County	Local	1,100	1,100	cut off	cut off	Closure or other measure	2 (if grade separation provided)	NA	Not identified in MTP	#5 (if grade separation provided)	NA	NA	NA	This road could be considered for closing as part of the NC 540 design. If, however, a bridge crossing is preferred by NCDOT for cost or other reasons, then a grade separation would be an acceptable solution. A review of the existing street network does require some additional links to access property south of NC 540. Possible solution would be to connect Deerhorn Dr to Buckhorn Dr.
B-6	Johnson Pond Road	Wake County	Local	2,500	11,000	2	Wake County 2 Fuquay Varina 2	Grade separation	2	Wide outside lane & multi-use path - Wake County, proposed bike lane & sidewalk - Fuquay Varina	Local On Road Bicycle Facility	#3 with shared use path on one side	NA	NA	NA	None
C-5	Future Connector between Johnson Pond Road and Lake Wheeler Road	Fuquay Varina	Local			cut off	cut off	Closure	NA	NA	Not identified in MTP	NA	NA	NA	NA	Collector is identified as part of Fuquay Varina's collector street plan. City should evaluate if alternative routing or removal from the plan is possible.
B-7	Lake Wheeler Road	Wake County	Major Collector	7,000	13,100	4	Wake County 5 Garner 2	Grade separation	4	Bike lane & sidewalk - Fuquay Varina, wide outside lane - Wake County	Regional On Road Bicycle Facility	#8	A136c	2040	2030	Recommended as grade separation. Evaluation of interchange (as called for in Wake County plan) was conducted. For multiple reasons, an interchange is not recommended at this location as documented in the report.
I-4	US 401 Fayetteville Road	Wake County & Garner & Fuquay Varina	Principal Arterial - Other	29,000	53,000	6	Garner 6 Fuquay Varina 6 (i.e. 150 ft ROW)	Interchange	6 plus auxiliary	Sidewalk	Regional On Road Bicycle Facility	#16 (subject to interchange analysis)	A480a & A480b	2030 & 2040	2025 (to 6 lanes)	Bridge crossing will require six through lanes plus auxiliary lanes as determined by final interchange design.
B-8	Old McCullers Road	Wake County	Local	1,100	3,000	2 on overpass	2 cutoff	Grade separation	2	Sidewalk since may serve as Wake Tech alternate entrance	Not identified in MTP	#2	NA	NA	NA	Grade separation should be aligned to allow for a southern roadway extension to link directly into Tech Road, a circulatory roadway serving Wake Tech Community College. Coordination with Wake Tech will be required.
RR-1	Norfolk Southern RR	Norfolk Southern						RR grade separation								Identified in 2040 MTP as future commuter rail corridor.
B-9	Fanny Brown Road	Wake County	Local	4,700	16,100	2	Wake County 2 Fuquay Varina 2	Grade separation	4	Wide outside lane - Wake County	Local On Road Bicycle Facility	#5 with 2 lanes #11 with 4 lanes	NA	NA	2030	Future ADT volumes will require four-lane section.
I-5	Old Stage Road	Wake County & Garner & Fuquay Varina	Minor Arterial	9,400	39,500	4	Wake County 4 Garner 3	Interchange	4	Wide outside lane & multi-use path - Wake County, Old Stage Greenway in Garner approaches crossing but stays north	Regional On Road Bicycle Facility	#11 (subject to interchange analysis)	A137b	2030	2020	Bridge crossing will require four through lanes plus auxiliary lanes as determined by final interchange design.
G-7	Unnamed Greenway east of Old Stage Road	Wake County						No crossing		Greenway	Local Off Road Facility	No crossing of NC 540.				
C-6	Holland Church Road	Wake County	Local	3,300	3,300	2	Wake County 2	Closure or other measure	2 (if grade separation provided)	Bike signage (Wake Count)	Not identified in MTP	#2	NA	NA	NA	This road could be considered for closing as part of the NC 540 design. If, however, a bridge crossing is preferred by NCDOT for cost or other reasons, then a grade separation would be an acceptable solution.
B-10	Sauls Road	Wake County	Local	3,400	8,800	2	Wake County 2/3 (Community Road)	Grade separation	3	Wide outside lane - Wake County	Not identified in MTP	#5	NA	NA	NA	Three-lane section recommended for conformity with Wake County plans.
B-11	Jordan Road	Wake County	Local	2,000	4,200	2	Wake County 2/3 (Community Road)	Grade separation	3	Wide outside lane - Wake County	Not identified in MTP	#5	NA	NA	NA	Three-lane section recommended for conformity with Wake County plans.
G-8	Unnamed Greenway west of NC 50 Benson Road	Wake County						No crossing		Greenway	Local Off Road Facility	No crossing of NC 540.				
I-6	NC 50 Benson Road	Wake County & Garner	Minor Arterial	12,500	34,800	4	Wake County 4 Garner 4	Interchange	4	Wide outside lane - Wake County	Regional On Road Bicycle Facility	#12 (subject to interchange analysis)	A228a	2040	2015	Bridge crossing will require four through lanes plus auxiliary lanes as determined by final interchange design.
G-9	Unnamed Regional Greenway west of I-40	Wake County						Greenway Crossing		Greenway	Regional Off Road Facility					

Footnotes:

1. NC Capital Area MPO recommended cross sections shown in Appendix D.
2. NC Capital Area MPO has adopted universal access and complete street policies. Therefore, appropriate bicycle and pedestrian improvements should be provided on all roadways unless demonstrated to be impracticable.

- In addition, multiple crossings were identified for which a grade separation is not required. If NCDOT determines that it is more economical to provide a grade separation, however, a grade separation would be acceptable. The roadway crossings for which a closure may occur are:
    - River Falls Drive (C-1)
    - Turner Drive (C-2)
    - Rhodes Road (C-3)
    - Deer Meadow Drive (C-4)
    - Future Connector Road from Johnson Pond Road to Lake Wheeler Road (C-5)
    - Holland Church Road (C-6)
- Potential greenway crossings were also examined. Of the nine greenways identified on local plans crossing NC 540, four greenways were recommended for a grade separated crossing as part of original construction. For the other five crossing locations, the design should not preclude the future provision of a grade crossing at the crossing location or should allow future connections to other grade separation structures with pedestrian and bicycle provisions. The required greenway crossing locations are:
    - Middle Creek Greenway (G-1)
    - Unnamed Greenway west of Holly Springs Road (G-3)
    - Camp Branch Greenway (G-5)
    - Swift Creek Greenway (G-9)
- Through the study area, local plans were identified that could support the development of a local roadway network that could improve local connectivity. Overall 18 local roadway projects were identified.

Interchange Types at Holly Springs Road

This study provides a review of the proposed interchange types examined by NCDOT and identifies interchange types for further consideration as the formal NEPA review of the project moves forward. Overall, five interchange concepts were identified for more detailed consideration including the Diverging Diamond interchange recommended by NCDOT and the Holly Spring's Northeast Gateway Plan. The alternative concepts recommended are:

- Diverging Diamond Interchange
- Half Clover Interchange
- Half Clover Interchange with 2 ramps
- Split Diamond at Kildaire Farm Road and Holly Springs Road

In addition, the following two phase interchange scheme is recommended for examination if there is support for a modified vision of the interchange area.

- Simple Diamond Interchange – Phase 1
- Split Diamond at Sunset Lake Road and Holly Springs Road – Phase 2

Interchange Types at Other NC 540 Interchanges

At several interchanges along the corridor, a less detailed analysis was conducted using Federal Highway Administration's (FHWA) CAP-X software and a review of the NCDOT interchange comparison developed before the NC 540 EIS project was put on hold. Based on this review, the interchange concepts identified in Table 2 are recommended for further study. Interchange layouts are illustrated in Section 4.0 and Appendices A and B.

Table 2. Summary of Interchange Layouts

Interchange	NCDOT Recommendation	Other Layouts Warranting Additional Consideration
NC 55 Bypass	Existing Interchange Plan	Same as NCDOT (See Section 4.2)
Holly Springs Road	Diverging Diamond Interchange	Multiple Options (See Section 4.3)
Bells Lake Road	Partial Clover with Loops in NE (A) and SW (C) quadrants	Same as NCDOT (See Section ◎)
US 401 Fayetteville Road	Partial Clover with Loops in NE (A) and SW (C) quadrants & 4 ramps	Partial Clover with Loops in NW (B) and SE (D) quadrants & 4 ramps (See Section 4.5)
Old Stage Road	Partial Clover with Loops in NW (B) and SW (C) quadrants	Partial Clover with Loops in NE (A) and SW (C) quadrants (See Section 4.6)
NC 50 Benson Road	Half Tight Demand with a Loop in the NW (B) Quadrant	Same as NCDOT (See Section 4.7)

1.0 Introduction

The North Carolina Department of Transportation (NCDOT) is currently developing an Environmental Impact Statement (EIS) for the proposed NC 540 Southern Wake Expressway (aka the Triangle Expressway – Southern Extension project). The proposed freeway will be an extension of the recently opened Western Wake Expressway.

The purpose of the North Carolina Capital Area Metropolitan Planning Organization's (NC Capital Area MPO) current study is to examine the long-term traffic operations and identify the needs for a local roadway network near the proposed interchange at NC 540 Southern Wake Expressway and Holly Springs Road. In addition, the study will develop alternatives for roadway crossings of NC 540 Southern Wake Expressway, new interchange connection options, and long-term capacity and lane requirements on the local roadway network.

1.1 Project Goals

The goals of the feasibility analysis are as follows:

- Analyze existing conditions and trends;
- Identify and evaluate transportation improvements with traffic analysis;
- Identify and evaluate transportation improvements with roadway design and impact analysis; and
- Present preliminary recommendations of the preferred alternative to NC Capital Area MPO and local stakeholders.

1.2 Study Area

The study area focuses on the proposed NC 540-Holly Spring Road interchange area. The study considered the NC 540 Southeast Extension Orange alignment (as depicted in the NCDOT's Updated Corridor Overview Map, TIP Nos. R-2721, R-2828 & R-2829, November 2010) as the basis for traffic analysis. The roadway needs and adequacy analysis assumed that the interchanges at NC 55 Bypass to the west and Bells Lake Road to the east are not subjected to any modifications.

The local roadway network was examined within roughly a one-mile radius of the Holly Springs Road interchange, including Ten Ten Road to the north, Stephenson Road to the west, Optimist Farm Road to the south, and Bells Lake Road to the east. Roads potentially crossing the proposed NC 540 Southeast Extension in the study area included Sunset Lake Road, Holly Springs Road, Kildaire Farm Road, Pierce Olive Road, West Lake Road, and Bells Lake Road.

1.3 Project Assumptions

The project assumptions are as follows:

- The focus of the traffic analysis is on the local street network. Evaluation of the NC 540 freeway operations is not anticipated beyond consideration of interchange spacing items.
- The level of traffic and impact analysis was at a level suitable for a feasibility study, and focused on identifying viable alternatives – not a National Environmental Protection Act (NEPA) environmental assessment.
- In some cases projects identified may or may not be part of the 2040 Metropolitan Transportation Plan for the region. It is recommended that these projects be considered in the future with respect to their either mitigating access and connectivity issues or complementing the NC 540 construction.

2.0 Local Transportation Plans

Several local transportation plans were examined as part of the analysis process. This included an examination of available thoroughfare, bicycle/pedestrian, and other transportation plans for each municipality along the study corridor. This effort included examination of plans from Apex, Cary, Fuquay-Varina, Garner, Holly Springs, and Wake County. In addition, the recently approved 2040 Metropolitan Transportation Plan was reviewed. A brief summary of each study/plan within the NC 540 corridor are presented in sections below.

2.1 NCDOT and NCTA

NCDOT and the North Carolina Turnpike Authority (NCTA) were developing an Environmental Impact Statement (EIS) for the proposed NC 540 Southern Wake Freeway (R-2828). The project has been on hold for approximately two years awaiting resolution on the specific alignments to be examined for the EIS. For this NC Capital Area MPO project, the proposed Orange line which has been part of the corridor protection plan since the 1990s was assumed. Note, however, that this study in no way is intended to replace the NEPA EIS process which requires the evaluation of multiple alternate alignments.

Prior to the project being put on hold, NCDOT had begun studies of multiple corridors including the Orange line. Key elements that were utilized in this analysis include the traffic forecasts as well as a comparison study of alternate interchange layouts.

2.1.1 NC 540 Traffic Forecasts

Two sources were used for the traffic forecast review. Specifically, the February 2009 and updated June 2012 Final Traffic Forecast Memoranda for the NC 540 project (R-2721, R-2828, and R-2829) were examined. In addition, the latest version of the official Transportation Regional Model (TRM) Version 5 was utilized. A review of these sources identified the following land use and transportation parameters:

- Between the 2009 and 2012 forecasts, the official TRM was updated to include toll forecasting related to NC 540. Therefore, a secondary toll model was not required for the 2012 traffic forecast effort;
- The forecast developed in 2012 used the official 2035 TRM Version 4. Since 2012, the TRM model has been updated to Version 5 and includes roadway network revisions and updated land use projections to year 2040;
- A comparison of Version 4 (2035) and Version 5 (2040) TRM socio-economic data was done for the study area identified in the project forecast. For the study area in southern Wake County, the projected population for 2040 was approximately 9 percent lower than the 2035 model assumptions. Note, however, that employment in the southern Wake County study was increased by 27 percent when comparing the 2040 and 2035

model data. Note that the 2040 update for the entire region included downward adjustments in both population (21 percent) and employment (9 percent);

- A comparison of the 2035 forecast was made with the 2040 TRM volumes. In general, the updated 2040 model shows a reduction in traffic on NC 540 in southern Wake County. Both the reduction in anticipated 2040 development (as compared with the previous 2035 model) as well as the assumed inclusion of additional lanes on I-40 south of the Beltline have resulted in fewer vehicles on NC 540;
- Due to changes in the NC 540 volumes, some changes were noted at Y-line crossings as compared with the project forecast. In general, however, these changes were less than noted on NC 540; and
- It should be noted that the use of the 2040 V5 TRM is not a valid comparison with a formal forecast. A formal forecast as required for the NEPA process takes into account multiple data sources and extensive evaluation in determining the official project forecast.

For this study, the 2040 traffic volumes are based on the 2040 TRM V5 model. In addition, this project focuses exclusively on the local roadway network connecting into or crossing NC 540, not the NC 540 alignment itself.

2.1.2 NC 540 Interchange Layouts

One of the final steps taken before the NEPA study process was put on hold was the development of a Project Memo dated April 15, 2011. This memo examined multiple interchange configurations for six interchange locations on the protected NC 540 corridor (i.e. the Orange line). The six locations are Holly Springs Road, Bells Lake Road, US 401 Fayetteville Road, Old Stage Road, NC 50, and I-40. Specific elements noted include:

- Between two to eight alternate layouts were examined at each location. The evaluation examined multiple elements including intersection level of service, number of bridge structures, and stream and wetland impacts. Although a formal scoring mechanism was not implemented, a recommended layout was identified at each location.
- Formal review with local agencies does not seem to have occurred. It is likely that the suspension of the study process was a possible cause for this stop in the standard process. As part of the standard NEPA process, these details would be carried to both local agencies and the public for comment. (As an exception, there was coordination between NCDOT and the Town of Holly Springs as part of the Northeast Gateway Plan development); and
- At each interchange, a comparison of the traffic forecast used by NCDOT for the interchange analysis is compared with the 2040 TRM Version 5 model results in Appendix C.

Note that the specific layout alternatives are discussed in more detail in Section 4.0.

2.2 NC Capital Area MPO

2.2.1 2040 Metropolitan Transportation Plan

The 2040 Metropolitan Transportation Plan (MTP) was released in May 2013 as this project was beginning. It was used as the starting point for evaluating the NC 540 corridor and determining interchange locations, grade crossings, required lanes, and other elements. It was developed by the NC Capital Area MPO including input and participation of all local municipalities and governments included in the MPO boundaries. Within the study area this includes the towns of Apex, Cary, Fuquay-Varina, Garner, Holly Springs, and Wake County. Specific findings from the 2040 MTP include:

- Five NC 540 interchange locations were identified between the NC 55 Bypass and I-40 south of Raleigh including Holly Springs Road, Bells Lake Road, US 401 Fayetteville Road, Old Stage Road, and NC 50;
- Eleven grade separations between local roads and NC 540 were identified including NC 55 Business/North Main Street, Sunset Lake Road (two crossings), Pierce Olive Road, West Lake Road, Johnson Pond Road, Lake Wheeler Road, McCullers Road, Fanny Brown Road, Sauls Road, and Jordan Road;
- Grade separations were not identified at Rhodes Road, Deer Meadow Drive, or Holland Church Road; and
- Multiple roadways parallel to and crossing NC 540 have been identified for additional improvements.

2.2.2 Southwest Area Study

In 2011, the NC Capital Area MPO completed the Southwest Area Study which included recommendations for the roadway network in the western section of the NC 540 study area. Specific recommendations included:

- Multiple new roadway connections in the Holly Springs area were recommended to improve connectivity. Examples include:
    - Connection of Lockley Road to developments located on the east side of NC 55 Business/North Main Street as well as north of Holly Springs Road. These connections require a bridge over Middle Creek and linkage of existing streets.
    - Extension of Sunset Lake Road west of NC 55 Bypass.
    - Collector streets in the northeast and southwest quadrants of the Holly Springs Road at Sunset Lake Drive intersection. These roadways could potentially be used for a quadrant roadway intersection improvement.
    - Widening to four lanes on multiple cross roads as well as Optimist Farm Road.
- Recommended five greenway corridors with grade separations between NC 55 Business/North Main Street and Bells Lake Road. Two additional greenways were identified crossing NC 540 with no indication that a grade separation was recommended. Of these seven greenways, the Middle Creek Greenway was the only facility identified as a "key" recommended greenway.

2.3 Wake County Plans

The Wake County Transportation Plan, adopted in 2002 (published in April 2003), builds on the 2025 NC Capital Area MPO Plan and addresses mobility needs in unincorporated areas. Sections of the Wake County Transportation Plan reviewed for this project included the Recommended Thoroughfare Plan and the Pedestrian and Bicycle Element. Specific findings included in the project area:

- Most proposed interchanges and grade separation are consistent with the 2040 MTP. Proposed interchange at Lake Wheeler Road and proposed NC 540 (NC Capital Area MPO identified a grade separation in the 2040 MTP).
- No grade separation at McCullers Road or Fanny Brown Road (NC Capital Area MPO identified grade separations in the 2040 MTP), and grade separation at Holland Church Road and proposed NC 540 (NC Capital Area MPO did not identify a grade separation in the 2040 MTP).
- The Ten Ten Road Extension from NC 50 to New Bethel Church Road, and proposed connectivity of Pagan Road and Cleveland School Road, from Sauls Road to NC 50 (both are not included in the 2040 MTP).
- Widening of the following roadways crossing proposed NC 540: Holly Springs Road, West Lake Road, Bells Lake Road, Lake Wheeler Road (from Optimist Farm Road to Penny Road), Old Stage Road (from Rock Service Station Road to Ten Ten Road), Ten Ten Road (from Penny Road to Old Stage Road), and NC 50.

2.4 Town of Apex Plans

The Apex Transportation Plan was updated by the Town Council in July 2011, and recently amended in September 2012. The plan identifies transportation system improvement recommendations and strategies to help accommodate growth in travel demand. Sections of the Apex Transportation Plan reviewed for this project include the Bicycle, Pedestrian, and Equestrian Plan; Thoroughfare and Collector Street Plan; Transit Plan; and Parks, Recreation, Greenways, and Open Space Master Plan; and Sustainable Development Plan. Specific findings included within the project limits:

- Proposed interchanges and grade separation are consistent with the 2040 MTP;
- Proposed Veridia development north of NC 540 including proposed collector streets;
- Widening of the following roadways crossing proposed NC 540: NC 55 Business/North Main Street, Sunset Lake Road (and connectivity to Woods Creek Road west of NC 55 Bypass), and Stephenson Road; and
- Proposed Middle Creek Greenway extension east of NC 55 Business/North Main Street crossing proposed NC 540, and connects to the existing greenway south of Sunset Lake Road in Holly Springs.

2.5 Town of Holly Springs Plans

Vision Holly Springs, which is the Town of Holly Springs' Comprehensive Plan, and the Northeast Gateway Plan were reviewed. The intent of the Comprehensive Plan is to provide staff and council members with a framework to respond to the rapidly changing needs of Holly Springs. The Comprehensive Plan was updated in 2009. Land use and transportation figures and maps, which were updated in June 2013, were also reviewed. Sections of Vision Holly Springs reviewed for this project include Future Land Use; Transportation; and Parks, Recreation, and Open Space.

The Northeast Gateway Plan is a supplement to the Comprehensive Plan's Future Land Use Plan and Thoroughfare Plans. The latest plan dated June 13, 2013 was provided by Holly Springs for inclusion in this study. Specific findings included within the project limits:

- Proposed interchanges and grade separation are consistent with the 2040 MTP;
- Widening of the following roadways near the proposed NC 540: NC 55 Bypass, NC 55 Business/North Main Street, Sunset Lake Drive (and realignment/new location at NC 55 Bypass), Lockley Road, Kildaire Farm Road (and realignment/new location at the intersection with Holly Springs Road), Holly Springs Road, Optimist Farm Road, and Pierce Olive Road;
- New residential developments and residential streets in the Woodcreek subdivision south of Sunset Lake Road;
- Proposed collector streets east of NC 55 Business/North Main Street connecting Sunset Lake Road to Creek Vista Drive (along the Middle Creek Greenway), and connecting Anchor Creek Way to Lockley Road in the Woodcreek subdivision; and
- Proposed greenway crossings of NC 540 include the Middle Creek Greenway east of NC 55 Business, and unnamed greenways east of River Falls Drive in the Woodcreek subdivision, west of Holly Springs Road near the Sunset Pointe subdivision, and east of Holly Springs Road and Pierce Olive Road (connects to the proposed Camp Branch Greenway in Cary).

2.6 Town of Cary Plans

The Town of Cary Comprehensive Transportation Plan Update, amended May 9, 2013, serves as a guide for future transportation in Cary. Specific findings within the project limits include:

- Most proposed interchanges and grade separation are consistent with the 2040 MTP, except the proposed grade separation at Bells Lake Road (NC Capital Area MPO identified an interchange in the 2040 MTP);
- Existing Camp Branch Greenway along West Lake Road (south of proposed NC 540) and proposed Camp Branch Greenway along neighborhoods west and east of West Lake Road (crossing proposed NC 540).

2.7 Town of Fuquay-Varina Plans

The Town of Fuquay-Varina Community Transportation Plan, published in 2006, is intended to serve as a tool and guide for the future success in the implementation of Fuquay-Varina's transportation system. Document and maps reviewed include the Community Transportation Plan (Thoroughfare, Future Collector Street, Pedestrian-Bicycle elements, and Greenway Plan) and the Community Thoroughfare Plan (May 9, 2011). Specific findings included within the project limits:

- Proposed interchanges are consistent with the 2040 MTP; however, proposed grade separation at Johnson Pond Road, Lake Wheeler Road, McCullers Road, and Fanny Brown Road are not shown in plans (NC Capital Area MPO identified grade separations in the 2040 MTP);
- The Future Collector Streets Plan proposes a new location collector street connecting Johnson Pond Road and Lake Wheeler Road across the proposed NC 540 alignment. The street is also shown as serving both pedestrian and bicycle facilities. A grade separation is not recommended for this location. Therefore, an alternative route should be identified linking Johnson Pond Road and Lake Wheeler Drive.

2.8 Town of Garner Plans

The Town of Garner Transportation Plan, adopted in October 2010, provides its citizens and businesses with efficient and safe travel options for auto, bicycle, pedestrian, and public transit users that serve transportation needs. Documents and maps reviewed include Roadway Conditions, Bicycle and Pedestrian Conditions, Roadway and Intersection Recommendations, Greenway & Sidewalk Master Plan, Proposed Bicycle Facilities, Proposed Sidewalk Projects, and the Action Plan. Specific findings included within the project limits:

- Proposed interchanges are consistent with the 2040 MTP; however, proposed grade separation at McCullers Road, Fanny Brown Road, Sauls Road, and Jordan Road are not shown in plans (NC Capital Area MPO identified grade separations in the 2040 MTP).
- Widening of the following roadways in the vicinity or crossing proposed NC 540: US 401/Fayetteville Road, Ten Ten Road, and Old Stage Road.
- Proposed Old Stage Road Greenway along Old Stage Road north of the proposed NC 540 interchange, and connects to proposed South Garner Neighborhood Greenway between the proposed NC 540 alignment and Ten Ten Road.

3.0 Identification of Interchange Locations & Grade Separations

A review of the 2040 MTP and local government transportation plans was conducted to identify and verify the planned interchange locations, grade separations, and potential closures. As part of this analysis multiple items including existing and future traffic volumes, connectivity, and road hierarchy were examined. In addition, greenway crossings were identified along NC 540.

The review of grade crossings is summarized in Figure 1 and Table 1. The table examines each potential crossing location starting from the west end of the project at the existing NC 55 Bypass interchange and extending east to the proposed NC 50 interchange location. The crossings are divided into five categories:

- Interchanges (light blue)
- Roadway grade separations (white)
- Roadways not requiring a grade separation (tan)
- Greenway crossings (light green)
- Railroad crossings (grey)

3.1 Interchange Locations

The 2040 MTP identifies six interchange locations on the corridor. After review of traffic volumes, the road hierarchy, and local plans, it was concluded that the six interchanges in the 2040 MTP are the preferred locations. Therefore, no changes from the 2040 MTP recommended interchange locations were identified for this study. The six interchange locations in the project study area include:

- NC 55 Bypass (I-1)
- Holly Springs Road (I-2)
- Bells Lake Road (I-3)
- US 401 Fayetteville Road (I-4)
- Old Stage Road (I-5)
- NC 50 Benson Road (I-6)

3.1.1 Lake Wheeler Road Interchange Review

The need for an interchange on Lake Wheeler Road was investigated as part of this study. A Lake Wheeler Road interchange was identified as a planned interchange in the Wake County plan, but not included on the 2040 MTP. A review of the interchange location was conducted using the 2040 TRM V5 and other measures. After review, it was determined that Lake Wheeler Road was not an ideal location, and therefore it is proposed that it remain a grade separation with no interchange access.

This conclusion to not recommend an interchange was based on:

- Interchange spacing between Lake Wheeler Road and US 401 (road to road) is 0.8 miles which is less than the preferred 1 mile spacing in an urban area;
- US 401 is a high priority highway anticipated to carry over 50,000 vpd in 2040. In comparison, Lake Wheeler Road is forecast to carry less than 20,000 vpd. Therefore, US 401 would have priority for an interchange over Lake Wheeler Road;
- With both interchanges in place, volumes on US 401 remain almost unchanged (potentially a 2 percent drop in traffic). As a result, the future six-lane section on US 401 would be unchanged;
- If an interchange were to be added to Lake Wheeler Road, it would need to be widened to four lanes south of NC 540 to Optimist Farm Road;
- The new interchange has negligible traffic volume shifts on NC 540. East of US 401 total volumes remain unchanged. Similarly west of Bells Lake Road the volumes have a slight increase (less than 1,000 vpd). The only change on NC 540 is between Bells Lake Road and Lake Wheeler Road which carries 4,000 vpd higher volumes in 2040. This increase only applies to this section since the volumes on NC 540 are only slightly higher west of Bells Lake Road. Essentially, the Lake Wheeler Road interchange picks up some NC540 traffic that would use Bells Lake Road to access NC 540 if there were no interchange at Lake Wheeler Road; and
- Traffic on Optimist Farm Road is reduced slightly (2,000 vpd) with a Lake Wheeler Road interchange, but there is no change in road requirements.

3.2 Grade Separations along NC 540

The primary purpose of this analysis is to identify the grade separations required over or under NC 540 to maintain the local roadway network and provide adequate future capacity. The initial step in this analysis was reviewing the current transportation plan of the NC Capital Area MPO as well as the local municipalities along the corridor. This overview of existing plans was then enhanced with a review of future traffic volumes to identify needed cross sections. This evaluation is summarized in Table 1 with locations of crossings mapped in Figure 1.

3.2.1 Roadway Crossings Requiring Grade Separation

Based on this review, 11 grade separations are proposed for (from west to east):

- NC 55 Business Main Street (B-1)
- Sunset Lake Drive (west) (B-2)
- Sunset Lake Drive (east) (B-3)
- Pierce Olive Road (B-4)
- West Lake Road (B-5)
- Johnson Pond Road (B-6)

- Lake Wheeler Road (B-7)
- Old McCullers Road (B-8)
- Fanny Brown Road (B-9)
- Sauls Road (B-10)
- Jordan Road (B-11)

3.2.2 Roadway Crossings Not Requiring Grade Separation

Multiple crossings were identified for which a grade separation is not required. For each of these locations, closure of the crossing roadway would be acceptable assuming public road access could be maintained to any properties. Nevertheless, if NCDOT determines that it is more economical to provide a grade separation, a grade separation would be acceptable. The roadway crossings for which a closure would be acceptable are:

- River Falls Drive (C-1)
- Turner Drive (C-2)
- Rhodes Road (C-3)
- Deer Meadow Drive (C-4)
- Future Connector Road from Johnson Pond Road to Lake Wheeler Road (C-5)
- Holland Church Road (C-6)

3.2.3 Greenway Crossings

A similar review was conducted for potential greenway crossings. Local plans were reviewed for existing, high priority, and longer term greenway corridors which identified nine future greenway crossings of the NC 540 alignment. In reviewing the plans and conferring with local planners, four greenway crossings were identified as higher priority requiring the provision of a grade separation with the planned NC 540 corridor. Five additional greenway crossing locations were identified at which a future greenway grade separation may occur. In these locations, the NC 540 design team would ideally verify the feasibility of constructing a future grade separation at these locations or the provision of alternate routing to provide pedestrian and bicycle access across NC 540. The nine greenway crossing locations and the recommended crossing treatments are summarized in Table 3.

Table 3. Summary of Greenway Crossings

Greenway Crossing	Facility Name	2040 MTP Off-Road Hierarchy / Priority Designation	Recommended Crossing Treatment with NC 540
G-1	Middle Creek Greenway	Statewide	Grade separation
G-2	River Falls Drive Greenway	Local	No crossing
G-3	Unnamed greenway west of Holly Springs Road	Local	Grade separation
G-4	Unnamed greenway east of Holly Springs Road	Local	No crossing
G-5	Camp Branch Greenway	Regional	Grade separation
G-6	Unnamed greenway west of Bells Lake Road	Local	No crossing
G-7	Unnamed greenway east of Old Stage Road	Local	No crossing
G-8	Unnamed greenway west of NC 50 Benson Road	Local	No crossing
G-9	Unnamed greenway west of I-40	Regional	Grade separation

3.3 Cross Sections at Grade Separations

For each grade separation identified in Section 3.2.1, a review of the recommended cross section was completed. The key data and recommended cross sections are summarized in Table 1 for each of the crossing locations identified in Figure 1. Appendix D provides an illustration of the typical sections. All typical sections are based upon NC Capital Area MPO templates.

This included an examination of the 2040 MTP at each crossing locations, review of local plans, and coordination with NC Capital Area MPO and local staff. In addition, the 2040 Version 5 of the TRM was used to estimate 2040 traffic volumes. This information was utilized to identify the required number of lanes at each crossing.

In addition, the local plans were reviewed to determine planned pedestrian and bicycle accommodations for the local roadways at each roadway crossing. In addition to this information, it must be noted that the Capital Area MPO has adopted universal access and complete street policies. Therefore, it is anticipated that all crossings will be examined independently as part of the design project by applying Complete Streets practices to evaluate and provide appropriate bicycle and pedestrian improvements unless demonstrated to be impracticable.

Taking the recommended number of lanes, the types of bicycle and pedestrian features identified by local plans, and the context of each roadway, a cross section was identified and recommended for each crossing roadway. The cross sections were identified using a series of 16

cross sections utilized by NC Capital Area MPO for the MTP planning process. They range from two to six lanes with various sidewalk, bike offsets or lanes, and different median types. The 16 typical sections are identified in Appendix D.

At this planning stage, it is recommended that 12 foot lanes be assumed for the cross sections at all locations. In addition, as part of the project design, if it is identified that an intersection or access is located near a bridge crossing, analysis should determine if a turn lane is needed on the structure.

3.4 Other Local Roadway Network Connections

In addition to the roads crossing NC 540, this study examined the local transportation plans to identify local road projects that could be constructed to improve connectivity and safety, focusing specifically on routes roughly paralleling NC 540 to improve access to the proposed interchanges. These projects are identified for consideration as separate local road projects, and not typically as part of the NC 540 construction. The local road projects are identified in Figure 1 and summarized in Table 4. Note the following key items:

- North of NC 540 and east of Holly Springs Road to NC 50 Benson Road, Ten Ten Road provides a continuous east-west roadway roughly paralleling the NC 540 alignment. The one project anticipated in this section to improve connectivity is a planned Wake County extension of Ten Ten Road to the east (R-16).
- South of NC 540, the local road network is split by US 401. West of US 401, Optimist Farm Road and Donny Brook Road are proposed as a continuous east-west route. Completion of this objective will require an intersection improvement where Optimist Farm Road and Donny Brook Road connect along Lake Wheeler Road (R-10) and realignment of Donny Brook Road at the connection with US 401 (R-11).
- East of US 401, a semi-direct route is identified including Banks Road, Rock Service Station Road, Pagan Road, and Cleveland School Road. Connection of this route will require an extension of Cleveland School Road (R-15) that is included in the Wake County plans as well as an intersection improvement connecting Banks Road into Rock Service Station Road at Old Stage Road (R-14).
- Multiple local roadway connections have been identified for the Holly Springs Road interchange to improve traffic flows and provide local access. These local road projects are identified in Section 4.3.5.
- Multiple local roadway connections have been identified for the US 401 interchange. These local road projects are identified in Section 4.5.3.

As with grade separation crossings of NC 540, appropriate bicycle and pedestrian improvements should be provided on local roadways unless demonstrated to be impracticable.

Table 4. Other Proposed Local Roadway Connections

Project No.	Project Description	Source of Project	2040 ADT	In 2040 MTP?	Purpose
R-1	Collector Streets connecting Sunset Lake Road, Lockley Road, & Anchor Creek Way	Holly Springs Transportation Plan	5,000 vpd	No	• Provide alternate exit from Woodcreek to Sunset Lake Road • Improve connectivity
R-2A & R-2B	Sunset Lake Road at Holly Springs Road quadrant intersection improvements	Holly Springs NE Gateway Plan	Intersection improvement	No	• Capacity relief at high volume intersection • Economic development • Access control on Holly Springs Road due to I-540 interchange. • Requires detailed analysis to determine traffic control treatment including turn restrictions
R-2C	Olive Hill Connector to Optimist Farm Road	Holly Springs NE Gateway Plan & current analysis	Local traffic only	No	• Provide alternate route from Optimist Farm Road to NE quadrant to reduce volumes and turns on Holly Springs Road & Sunset Lake Road • Improved connectivity and access for development currently accessing Holly Springs Road
R-3	Kildaire Connector	Holly Springs, Apex, Cary	4,000 vpd	Yes (A414)	• Reduce volumes at Holly Springs Road interchange • Improve Connectivity
R-4A	Sancroft Collector	Holly Springs	Local traffic only	No	• Improve Connectivity for Local Traffic
R-4B	East West Collector	Holly Springs	Local traffic only	No	• Provide Access for developments affected by interchange • Improve Connectivity
R-5	Oxford Green Drive	Cary	Local traffic only	No	• Improve connectivity between West Lake Road and Bells Lake Road
R-6	West Lake Road Extension and Extension to Johnson Pond Road	Cary	3,000 vpd	Yes (F77a)	• Access to future development • Improve Connectivity • Provide 4-leg intersection realignment at Johnson Pond Rd and Bells Lake Road.
R-7	Banks Road Extension Collector	Fuquay Varina	6,000 vpd	No	• Provide a continuous road south of NC-540 from Lake Wheeler Road to Old Stage Road • Extension west of Lake Wheeler Road to Johnson Pond Road was considered for improving network connectivity, but likely not feasible due to wetlands

Table 4. Other Proposed Local Roadway Connections (continued)

Project No.	Project Description	Source of Project	2040 ADT	In 2040 MTP?	Purpose
R-8	Johnson Pond Road at Blarney Franks Road intersection realignment	Wake County	Intersection improvement	No	• Provide continuous north-south route • Intersection safety
R-9	Connector Street between Johnson Pond Road to Lake Wheeler Road	Fuquay Varina	Not recommended	No	• Recommend removing from collector street plan since grade separation not proposed at NC 540
R-10	Realign Donny Brook Road intersection at Lake Wheeler Road	Fuquay Varina	Intersection improvement	No	• Improve intersection safety • Provide continuous EW road
R-11	Realign Donny Brook Road	Fuquay Varina	11,200 vpd	No	• Required due to NC 540 interchange construction at US 401 closing Donny Brook Road intersection • Provides improved access to Wake Tech from west
R-12	Wake Tech Loop	Wake County	Varies depending upon final alignment and connections	No	• Provides direct connection to Old McCullers Road bridge at NC 540 • Provides alternate road network for Wake Tech (needs to be coordinated with Wake Tech long term plans) • Alignment could also connect Old McCullers Road directly into Tech Road.
R-13	Old McCullers Road Extension to Fayetteville Road	Wake County	TBD by US 401 Hot Spot study	No	• Identified as part of US 401 HOT Spot study
R-14	Realignment of Rock Service Road at Old Stage Road intersection	Wake County	Intersection improvement	No	• Provides a continuous road from Pagan Road to Banks Road south of NC 540 • Intersection safety
R-15	Cleveland School Road Extension	Wake County	10,500 vpd	No	• Provides continuous east west road south of NC 540 between NC 42 and Rock Service Station Road
R-16	Ten Ten Road Extension	Wake County	6,000 vpd	No	• Provides continuous road north of NC-540 east of NC 50

4.0 Interchange Needs with NC 540

The purpose of this section is to identify key issues and requirements for interchanges on NC 540. In particular, this analysis examines the possibility that changes or upgrades to the local network could improve operations or result in a different configuration. Examples would include the creation of alternate alignments, number of lanes approaching the interchange, or intersection spacing.

This analysis is not intended to specify a single option for future provision. Instead, it is intended to identify possible interchange concepts that should be examined in the future environmental studies required for each interchange. These alternatives would be in addition to the interchange options recommended by NCDOT previously.

As identified in Section 3.1, interchanges layouts were examined for six locations as shown in Table 5. Of these locations, Holly Springs Road was examined in greater detail utilizing Synchro analysis. The NC 55 Bypass already exists so the extension to the east will utilize the current NCDOT plans. The remaining four interchanges were tested using planning level interchange analysis software from FHWA.

Table 5. Summary of Interchange Layouts

Interchange	NCDOT Recommendation	Other Layouts Warranting Additional Consideration
NC 55 Bypass	Existing Interchange Plan	Same as NCDOT
Holly Springs Road	Diverging Diamond Interchange	Multiple Options (See Section 4.3)
Bells Lake Road	Partial Clover with Loops in NE (A) and SW (C) quadrants	Same as NCDOT
US 401 Fayetteville Road	Partial Clover with Loops in NE (A) and SW (C) quadrants & 4 ramps	Partial Clover with Loops in NW (B) and SE (D) quadrants & 4 ramps
Old Stage Road	Partial Clover with Loops in NW (B) and SW (C) quadrants	Partial Clover with Loops in NE (A) and SW (C) quadrants
NC 50 Benson Road	Half Tight Demand with a Loop in the NW (B) Quadrant	Same as NCDOT

As with grade separation crossings of NC 540, appropriate bicycle and pedestrian improvements should be investigated and provided at all interchanges to provide access to either side of NC 540 unless such accommodations are demonstrated to be impracticable.

4.1 Methodology

4.1.1 FHWA CAP-X Software

The FHWA software CAP-X was utilized to provide a planning level capacity analysis of interchange types for four generic interchange types (i.e. excluding NC 55 Bypass which is already half constructed and designed). This software allows for the user to identify expected peak hour turn movements and various laneage scenarios to identify how different types of interchanges would function. Note, however, that the CAP-X analysis (particularly for partial clover interchanges) assumes a single interchange configuration.

Due to this limitation, the CAP-X software is a useful planning level tool, but more detailed Synchro analysis and potentially simulation analysis will be needed before interchange designs can be finalized as part of the NCDOT analysis of NC 540. In many cases, alternative quadrants for loops can not be evaluated directly with CAP-X. Nevertheless, the software can provide valuable insights for screening potential interchange types.

The software uses critical lane methodology to look at conflicting turn movements at all intersections that are part of the interchange concept. Assuming a critical lane capacity of 1,600 conflicting movements per hour per lane, each intersection is identified as either under, near or over capacity as shown in Table 6.

Table 6. Critical Lane Methodology Thresholds

Overall Conditions	Under Capacity	Near Capacity for Some Movements	Very Near Capacity	Over Capacity
Critical Lane Sum	<1200	1201-1399	1400—1599	> 1600
V/C ratio	< 0.75	0.76 – 0.86	0.87 – 0.99	> 1.00
Congestion levels	Low congestion	Moderate Congestion	High Congestion	Very High Congestion

4.1.2 Synchro Software

In addition to the CAP-X software, more detailed Synchro analysis was conducted for the Holly Springs Road interchange. The Synchro software is more detailed and examines volumes, geometrics, and traffic signal phasing as part of the analysis to identify whether specific intersections are operating acceptably. The Synchro software provides detailed delay information as well as a level of service ranking at each intersection. An overview of 11 scenarios identifying the assumed laneage and average vehicular delay at each traffic signal is provided in Appendix C.

Due to alternate methods of routing and access to nearby routes including Holly Springs Road, Kildaire Farm Road, and Sunset Lake Road, Synchro was used to examine the operations of multiple interchange concepts for the Holly Springs interchange. Using Synchro, the analysis

allowed consideration of the shifting of traffic volumes to alternate routes and examining network delays in addition to specific intersections. Synchro also allowed for the consideration of multiple signals, particularly along Holly Springs Road.

4.1.3 Traffic Volumes

As noted in Section 2.1.1, the analysis for this project was conducted using the results directly from the 2040 Version 5 TRM regional model. Since these volumes were different than the 2035 forecast utilized by NCDOT in their interchange assessment, a comparison of the assumed traffic volumes between the NCDOT forecast and this study are presented in balanced average daily traffic projections for each interchange. The future volumes from both sources are shown in Appendix C.

4.2 NC 55 Bypass Interchange

The NC 55 Bypass was designed, constructed, and is now under operation by the NCDOT west of NC 55 Bypass. For the extension of NC 540 to the east, some additional construction will be needed to provide full access with additional ramps. The design and layout for the future ramps was identified as part of the interchange selection process for the existing interchange. Therefore, no additional review of interchange layout is needed for this location.

4.3 Holly Springs Road Interchange

The Holly Springs interchange has multiple traffic and network connectivity issues that need to be reviewed as part of the interchange selection process. In addition to operation of the interchange itself, the tie-in of Kildaire Farm Road to the north as well as operations for the Holly Springs Road at Sunset Lake Drive intersection were examined as part of this review. As part of this review, a Synchro analysis was conducted in addition to the CAP-X analysis noted above. The following sections breakdown the key issues examined.

4.3.1 Traffic Operations Review

The interchange volumes were examined based on the 2040 TRM Version 5 and compared with the 2035 NCDOT forecast. The primary volume difference between the two forecasts is that the Holly Springs Road daily traffic from the Version 5 TRM is up to 15,000 vpd higher than the NCDOT forecast. Examining specific turn movements, however, similar volumes were observed for quadrant turns.

For the Holly Springs interchange, two different methods were used to examine traffic capacity. The FHWA CAP-X software was performed primarily to provide a comparison with the other interchanges (which focued exclusively on the CAP-X analysis). In addition, a more detailed Synchro analysis was examined at Holly Springs Road due to the complexities of the local road network which includes Kildaire Farm Road and Sunset Lake Road in addition to Holly Springs Road.

In general, the Synchro analysis is more robust and customized for each specific option examined than CAP-X. Note, however, that the purpose of this Synchro review was at a planning level so more detailed Synchro analysis and possibly simulation analysis would be conducted in future planning and design studies of NC 540.

CAP-X Analysis

Using the 2040 model results from the 2040 TRM V5 model, the FHWA CAP-X program was applied to provide a planning level capacity analysis of generic interchange types as shown in Table 7. The primary conclusion from this CAP-X analysis was that either a diverging diamond or a partial cloverleaf interchange were the most viable solutions. Detailed capacity analysis will be required to verify the final design requirements including the impacts of alternative loop configurations.

Table 7. CAP-X Interchange Review at Holly Spring Road

Interchange Type	With 4 through lanes		With 6 through lanes		Comments
	V/C Ratio	Ranking	V/C Ratio	Ranking	
Simple Diamond	1.34	Exceeds capacity	1.12	Exceeds capacity	Exceeds capacity with 4 or 6 lanes. Not feasible.
Partial Cloverleaf (NW & SE) quadrants)	0.87	3	0.64	1	Very near capacity with 4 lanes. Under capacity with 6 lanes
Diverging Diamond (aka DDI)	1.28	Exceeds capacity	0.85	2	Under capacity with 6 lanes.
Single Point	1.63	Exceeds capacity	1.31	Exceeds capacity	Exceeds capacity with 4 or 6 lanes

Notes:

1. CAP-X software from FHWA utilized to identify basic capacity operations at interchanges. It is intended for longer term planning projects. Additional detailed analysis will be required in future studies.
2. V/C ratio calculated by testing the 2040 AM and PM peak interchange traffic volumes using the critical lane methodology.
3. Through lanes are shown above without turn lanes or auxiliary lanes. For most options, there will be a need for 1-2 additional lanes.
4. The CAP-X software evaluates a single generic partial cloverleaf option. Other variations of loop layouts are possible. More detailed capacity analysis is required to examine scenarios with loop or ramps in different quadrants than assumed in the CAP-X software. Regardless, the resulting V/C does provide a valid comparison of the potential capacity reductions with a dual loop partial clover interchange for planning purposes.

Synchro Analysis

In addition to the CAP-X review, the Holly Springs interchange and network area was evaluated using Synchro software. Synchro is a more detailed analysis which examines peak period operations (including delays and queueing) with more detailed information on signal phasing and timing.

In all, 11 separate roadway options were tested using Synchro as summarized graphically in Appendix C. Each of the Appendix C figures show the assumed laneage with the average signal delay per vehicles shown at each traffic signal. Level of Service was estimated for each

intersection using the Highway Capacity Manual (HCM) criteria as shown in Table 8. The levels of service determined in the Synchro analysis are identified and compared in Section 4.3.2 for nine of the interchange concepts.

Table 8. HCM Average Delay Thresholds for Traffic Signal Level of Service

LOS	Average Delay per Vehicle (sec/veh)
A	0 - 10
B	> 10 - 20
C	> 20 - 35
D	> 35 - 55
E	> 55 - 80
F	> 80

Source: Exhibit 18-4 LOS Criteria for Automobile Modes, HCM 2010, p 18-4.

4.3.2 Criteria for Interchange Comparison at Holly Springs Road

For the nine alternatives developed for Holly Springs Road, a comparison matrix was developed focusing on five key criteria. The criteria were:

- Total Bridge Lanes over NC 540 – More bridges was viewed as more costly and less desirable.
- Traffic Operations on Holly Springs Road and Sunset Lake Road including the interchange – This review focused on intersection LOS. In general LOS C or better is good, LOS D is acceptable in an urban area, and LOS E and F are considered poor. The Synchro analysis discussed in Section 4.3.1 and illustrated in Appendix C was used to determine level of service.
- System Delay, Operations, and Speed – Synchro allows for the calculation of overall delay for an entire roadway system, not just an intersection. For this comparison each alternative concept was investigated using a Synchro model that included Holly Springs Road, Kildaire Farm Road, Sunset Lake Drive, and the proposed Kildaire connector.
- Social Impacts – Social impacts were scored examining the extent that the alternative stayed within the NCDOT protected corridor for the Orange line, conformity with Holly Spring's Northeast Gateway Plan, and potential impacts to structures. Note that in final design it may be possible to tighten up designs to reduce impacts.
- Environmental Impact – Using the available information from NCDOT's interchange analysis, wetland and stream impacts were estimated for each alternative. In some cases there was a matching NCDOT concept, and in others engineering judgment was applied in estimating variations from the NCDOT alternatives. In the next steps of environmental review, detailed analysis of all impacts will be calculated.

Using these criteria, each alternative was ranked using a score from 1 through 4 with one being Good and 4 being Poor. For comparison purposes, a color code was applied where light green

represented 1 point, yellow 2 points, orange 3 points, and red 4 points. In this way, each alternative was ranked with the lower numbers representing a preferred solution. Note that the weighting of criteria is a very subjective process, so this should be used as a screening mechanism and not as a final criteria for selecting a preferred option.

4.3.3 Interchange Review and Comparison at Holly Springs Road

Using the previously developed NCDOT interchange review, the Version 5 TRM model results and the results from the CAP-X software, multiple interchange alternates were identified for testing. Using the criteria noted in Section 4.3.2, 11 interchange concepts were tested.

Of these, nine were identified for further analysis. A comparison matrix was prepared of the nine alternative concepts and is summarized in Table 9. In addition, illustration of multiple concepts are included in Appendix A. Note that the Holly Springs Northeast Gateway Plan is used as the background for the concepts to illustrate future development plans. Critical findings for each concept include:

- Concept 4 (the Diverging Diamond Interchange (DDI)) scored very well with 9 points. It required 11 bridge lanes, operated acceptably at intersections, and had reduced impacts. From a network view, however, volumes were concentrated along Holly Springs Road at the interchange as well as Kildaire Farm Road and Sunset Lake Road. This variation required six through lanes. (See Figure 2.)
- Concept 2 (the Simple Diamond interchange) scored 11 points as a result of 13 bridge lanes (primarily due to dual left turns at the interchange ramps), was less efficient with 6 through lanes at both the intersections and from an overall network standpoints. Impacts could potentially be minimized with a tight design. This alternative is recommended for further study only as a potential Phase 1 of a dual phased project to construct a split diamond interchange in the future. (No figure provided but footprint is similar to Concept 4.)
- Based on CAP-X software and review of the turning movements, Concept 5 (a Half Clover variation with loops in the NE (A) and SE (D) quadrants) was tested and scored very well with 9 points. The use of the half clover to drop lanes allowed for a bridge with 4 through lanes and 1 auxiliary lane to be constructed at Holly Springs Road indicating the need for the fewest overall bridge lanes. In addition, the alternative had improved traffic flow as compared with the DDI. The primary difference from the DDI was an increase in impacts to residential development in the NE (A) and SW (B) quadrants with loops including impacts to two neighborhood wells. This alternative is recommended for more study. (See Figure 3.)
- Building off the Concept 5 Half Clover interchange, Concept 6 was tested with two additional ramps added to the partial clover in the two western quadrants. This option scored well with 10 overall points. These ramps reduced the conflicting movements at intersections by eliminating left turns at two of the loops. The option was slightly better than the half clover interchange from a traffic perspective, but does require construction and impacts of two additional ramps. (See Figure 4)

Table 9. Comparison of Interchange Concepts at Holly Springs Interchange Location

Criteria Used In Evaluation	Concept 2: Diamond 6 Ln	Concept 4: DDI 6 lane	Concept 5: Half clover	Concept 6: Half clover plus 2 ramps	Concept 7: Half clover with Kildaire Farm Rd aligned south	Concept 8: Half clover with Kildaire Farm tie in at north ramp	Concept 9: Half clover with 1 way pair Kildaire Farm Rd tie in	Concept 10: Split Diamond Holly Springs Rd & Kildaire Farm Rd	Concept 11: Split Diamond Holly Springs Rd & Sunset Lake Rd
Report Figure #	**Not shown**	**2**	**3**	**4**	**Not shown**	**Not shown**	**Not shown**	**5**	**6**
Total Bridge Lanes over NC 540	**13**	**11**	**9**	**9**	**13**	**10**	**12**	**16**	**12**
Lanes at NC 540 Holly Springs Rd bridge	9 6 thru + 3 aux	7 6 thru + 1 aux	5 4 thru + 1 aux	5 4 thru + 1 aux	5 4 thru + 1 aux	6 4 thru + 2 aux	6 4 thru + 2 aux	6 4 thru + 2 aux	6 4 thru + 2 aux
Lanes at Sunset Lake Rd Bridge	4	4	4	4	4	4	4	4	6 4 thru + 2 aux
Lanes at NC 540 Kildaire Farm bridge	NA	NA	NA	NA	4	NA	2	6 4 thru + 2 aux	NA
Holly Springs & Kildaire Farm signals (worst LOS)	**D**	**C**	**C**	**C**	**D**	**D**	**C**	**B**	**C**
Ramp Intersection LOS	C & C	C & C	B & C	B & B	B & C	D & B	C & C	B, B, B & B	B,C,C & C
Kildaire Farm Rd Tie in Intersection LOS	D	B	C	C	D	D	C	B	C
Sunset Lake Rd at Lockley Rd	B	B	B	B	B	B	B	B	B
Sunset Lake Rd at Holly Springs Rd (conventional)	E (66s)	E (78s)	E (78s)	E (78s)	E (74s)	E (80s)	E (80s)	E (70s)	E (77s)
System Delay & Operations & Speed	**Fair**	**Fair**	**Average**	**Average**	**Average**	**Fair**	**Average**	**Good**	**Fair**
Total Delay (sec/veh)	32	23	31	31	30	33	29	19	32
Total Delay (hrs)	253	311	268	260	268	272	249	201	317
Total Stops	17302	19360	15766	14043	15890	15851	15361	16091	21604
Average Speed	16	14	16	16	16	15	16	17	15
Performance Index	301.3	365	312.1	299.2	312.1	315.5	291.5	245.7	377.2
Social Impacts	**Lower**	**Lower**	**Moderate**	**Moderate**	**Moderately High**	**Moderately High**	**Moderately High**	**Moderate**	**High**
Stays within Protected Corridor (quadrants)	4	4	2	2	0	1	0	0	<0
Maintains Northeast Gateway Plans	Mostly	Yes	Reduces Developable Area	Reduces Developable Area	Splits Parcels	Splits Parcels	Splits Parcels	Reduces Developable Area	Reduces Developable Area
Existing residential lots impacted (approx)	16	16	28	28	16	16	16	16	45
Environmental Impacts	**Lower**	**Lower**	**Moderate**	**Moderately High**	**Moderate**	**Moderate**	**Moderate**	**Moderately High**	**High**
Stream (lf)- approx.	2600	2600	4110	4610	4110	4510	4510	4910	5510
Wetlands (ac) approx.	3.57	3.57	3.27	4.27	3.27	3.77	3.47	6.23	8.23
Overall Score (lower is better)	**11**	**9**	**9**	**10**	**13**	**13**	**12**	**11**	**16**
Recommended for Further Study?	**Yes (Phase 1 of a split diamond)**	**Yes (recommended by NCDOT)**	**Yes**	**Yes**	**No**	**No**	**No**	**Yes**	**Yes (future Phase 2)**

Scoring Based on Ranking of 1 to 4 for each Primary Criteria	1	2	3	4

Figure 2. Concept 4: Diverging Diamond Interchange at Holly Springs Road

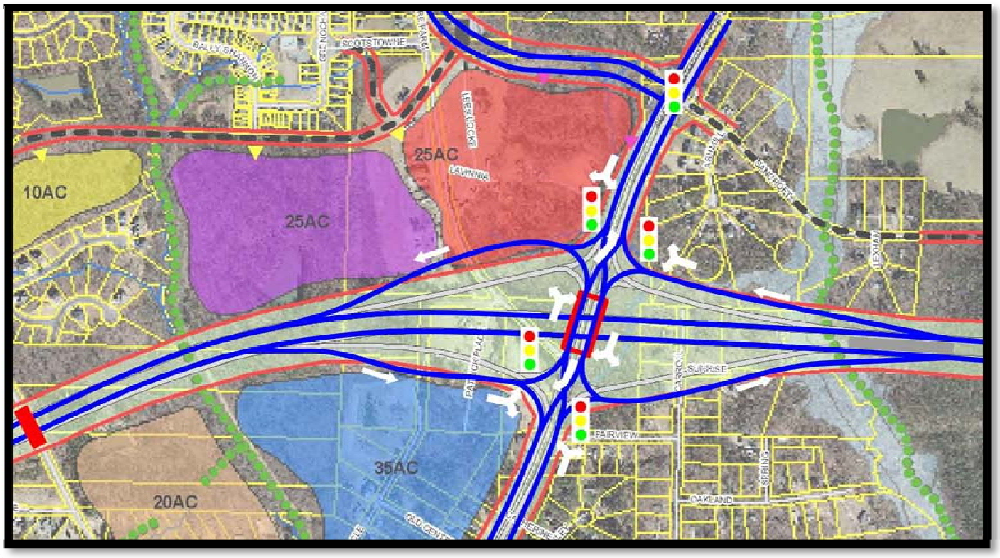


Figure 3. Concept 5: Half Clover Interchange at Holly Springs Road

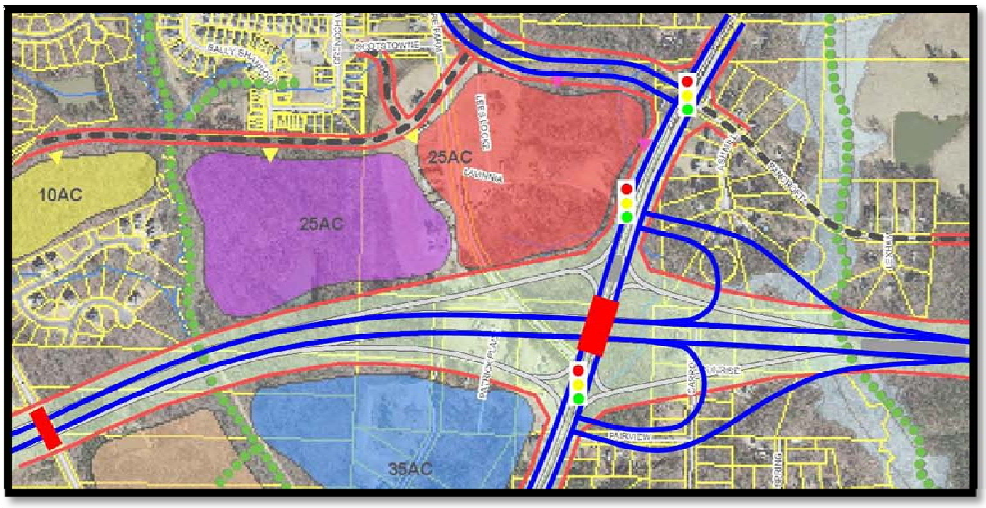
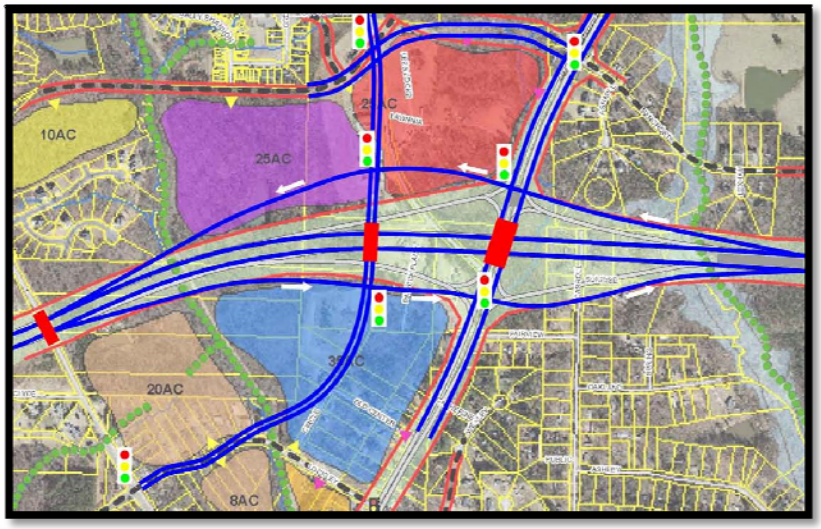


Figure 4. Concept 6: Half Clover Interchange with 2 Ramps at Holly Springs Road

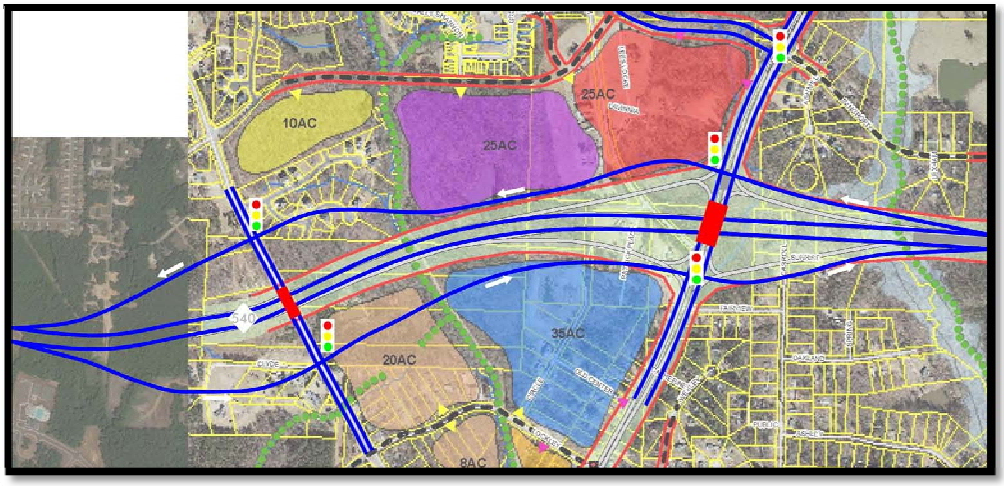
- Three Partial Clover options (Concepts 7, 8, and 9) were tested with Kildaire Farm Road connecting either directly into the ramps connection from the west (creating 4 leg instead of 3 leg intersections) or connecting with Holly Springs Road south of the interchange. For multiple reasons, these options are not recommended for further study since the options scored 12 or 13 points. (No figure provided.)
- For Concept 10, a Split Diamond interchange was examined to allow for both Kildaire Farm Road and Holly Springs Road to have direct access to NC 540 as illustrated in Figure 5. As indicated in Table 9, this alternative concept scored 11 points and is recommended for further review. The primary advantage of this interchange layout is that it processes both intersection level and network level traffic the most efficiently of all alternates examined. The primary drawback of this concept is that as a result of the proposed Kildaire Farm Road bridge, the concept has more bridge structure and related costs. In addition, the larger footprint has higher impacts than some other concepts. (See Figure 5.)

Figure 5. Concept 10: Split Diamond at Kildaire Farm Road and Holly Springs Road



- For Concept 11, a Split Diamond interchange was also examined a method of splitting the Sunset Lake Road traffic from Holly Springs Road traffic. This approach was taken to allow Sunset Lake traffic to access NC 540 directly minimizing turns at the Holly Springs Road at Sunset Lake Road interchange. Overall this option did not score well with 16 total points. The primary reason, however, was that the conceptual level design was done using the currently identified centerline of NC 540. With a slight shift south and tightening of the ramps, it may be possible to reduce impacts at the Tuscany subdivision north of Sunset Lake Drive and substantially improve the overall score. In addition, this option was the only option studied which indicated a possible increase in vehicles using NC 540. There may be potential to phase the Sunset Lake Road portion of the interchange in a future phase, but it must be noted that a DDI cannot be phased as part of a split diamond because exiting traffic from NC 540 would not be able to travel through the ramp termini intersection to the connecting ramps. (See Figure 6.)

Figure 6. Concept 11: Split Diamond at Sunset Lake Road and Holly Springs Road



4.3.4 Interchange Recommendations at Holly Springs Road

It is recommended that the following concepts be considered for additional study:

- Concept 4: Diverging Diamond Interchange (Overall Score 9)
- Concept 5: Half Clover Interchange (Overall Score 9)
- Concept 6: Half Clover Interchange with 2 ramps (Overall Score 10)
- Concept 10: Split Diamond at Kildaire Farm Road and Holly Springs Road (Overall Score 11)

In addition, the following two phase interchange scheme is recommended for examination if there is support for a modified vision of the interchange area.

- Concept 2: Simple Diamond Interchange (Overall Score 11) - Only review as a possible Phase 1 if a Split Diamond concept is pursued.
- Concept 11: Split Diamond at Sunset Lake Road and Holly Springs Road (Overall Score 16)

4.3.5 Local Network Connections Required at Holly Springs Road

The roadway network near the Holly Springs Road interchange is forecast to carry very high volumes of traffic due to the combination of traffic from two minor arterials (Kildaire Farm Road and Holly Springs Road) and a major collector (Sunset Lake Road). Local network connections that should be considered are:

- Multiple collectors (R-1) connecting local subdivisions to Sunset Lake Road as well as providing alternate access to Main Street, Holly Springs Road, and Sunset Lake Road are proposed in the Holly Springs transportation plan. The roadways includes collector streets connecting Sunset Lake Road, Lockley Road, Anchor Creek Way, and Springstone Drive. These connections provide an alternate route for local development to access Sunset Lake Road west of the Lockley Road intersection. The diversion of up to 6,000 vpd are anticipated which will improve operations on Sunset Lake Road and improve efficiency of the quadrant intersection.

- A quadrant intersection for Sunset Lake Road at Holly Springs Road (R-2) is recommended to handle the high volumes. Due to very high left turns, it is recommended that a detailed traffic alternative analysis be conducted to identify the optimum traffic management strategy including consideration of left turn restrictions.
- The Kildaire Connector (R-3) has been identified in the 2040 MTP to disperse the Kildaire Farm Road traffic to minimize volumes on Holly Springs Road. Nevertheless the key movement is Kildaire Farm Road so it is recommended that Kildaire Farm Road tie directly to Holly Springs Road, and the western segment of the Kildaire Connector come in at a tee intersection.
- Holly Springs has identified two east west collectors (R-4 and R-5) providing local access to Pierce Olive Road. These routes will relieve traffic trying to access Holly Springs Road in the vicinity of the NC 540 interchange; and
- As part of this study, it was identified that a project extending Pierce Olive Road south of Optimist Farm Road to Sunset Lake Road could provide relief to multiple intersections on Holly Springs Road including the quadrant intersection at Sunset Lake Road and Holly Springs Road, the proposed interchange (regardless of the selected configuration), and the Lidaire Farm Road intersection. Based on the 2040 TRM, this coinnector could divert 7,000 vpd travelling through on Sunset Lake Road to Holly Springs Road. An extension of Pierce Olive Road was not recommended for inclusion in this study, however, due to the need for more detailed evaluation of potential alignments to minimize impacts to existing developments as well as wetlands. By 2040 it may also be necessary to widen Pierce Olive Road to four lanes if this extension is provided. Nevertheless, this connection could improve the local roadway network efficiency and provide a north-south alternate to Holly Springs Road over NC 540.

4.4 Bells Lake Road Interchange

4.4.1 Traffic Operations Review

The interchange volumes were examined based on the 2040 TRM Version 5 and compared with the 2035 NCDOT forecast. The primary difference was a significant reduction in volume on Bells Lake Road south of the interchange (8,800 vpd with updated model compared with 37,000 vpd in NCDOT forecast). Examining specific turn movements, however, similar volumes were observed for quadrant turns.

Using the 2040 model results from the 2040 TRM V5 model, the FHWA CAP-X program was applied to provide a planning level capacity analysis of generic interchange types. The primary conclusion from this CAP-X analysis was that any of multiple interchange types could be viable at Bells Lake Road. Specifically, Table 10 indicates that a partial clover had the lowest delays related to intersection operations. Detailed capacity analysis will be required to verify the final design requirements including the impacts of alternative loop configurations.

Table 10. CAP-X Interchange Review at Bells Lake Road

Interchange Type	With 4 through lanes		With 6 through lanes		Comments
	V/C Ratio	Ranking	V/C Ratio	Ranking	
Simple Diamond	0.82	8	0.76	6	Lowest ranked
Partial Cloverleaf (NW & SE quadrants)	0.55	2	0.53	1	Operates well with 4 lanes
Diverging Diamond (aka DDI)	0.68	4	0.62	3	Operates well with 4 lanes
Single Point	0.79	7	0.75	5	Near capacity for some movements

Notes:

1. CAP-X software from FHWA utilized to identify basic capacity operations at interchanges. It is intended for longer term planning projects. Additional detailed analysis will be required in future studies.
2. V/C ratio calculated by testing the 2040 AM and PM peak interchange traffic volumes using the critical lane methodology.
3. Through lanes are shown above without turn lanes or auxiliary lanes. For most options, there will be a need for 1-2 additional lanes.
4. The CAP-X software evaluates a single generic partial cloverleaf option. Other variations of loop layouts are possible. More detailed capacity analysis is required to examine scenarios with loop or ramps in different quadrants than assumed in the CAP-X software. Regardless, the resulting V/C does provide a valid comparison of the potential capacity reductions with a dual loop partial clover interchange for planning purposes.

4.4.2 Interchange Type at Bells Lake Road

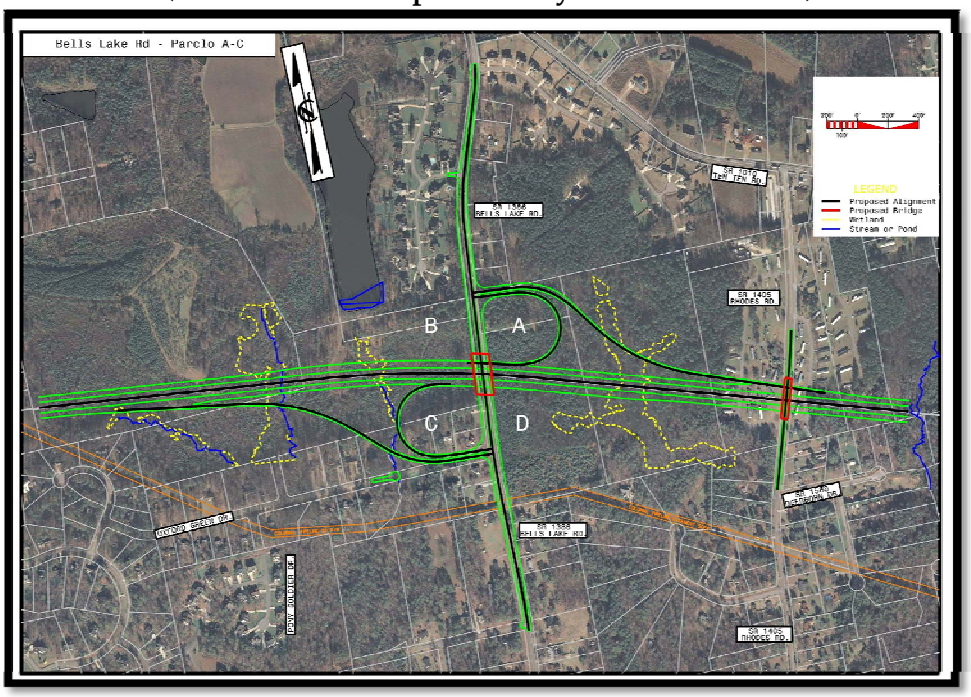
The July 2011 NCDOT review examined three interchange types at Bells Lake Road – a diverging diamond interchange (DDI), partial clover with loops in NE (A) and NW (B) quadrant, and a partial clover with loops in the NE (A) and SW (C) quadrants.

The NCDOT analysis recommended the partial clover with loops in the NE (A) and SW (C) quadrants. Based on a review of the NCDOT analysis and a re-examination of traffic operations and volumes, this study agrees with the preliminary NCDOT recommendation.

The interchange layout concept is shown in Figure 7. Overall, the Partial Clover with Loops in NE (A) and SW (C) quadrants is recommended due to several reasons:

- Human and environmental impacts minimized
  - Avoids impacts to NW (B) quadrant with earthen dam and subdivision.
  - Avoids impacts to SE (D) quadrant with highest amount of wetlands.
- Improved traffic operations
  - The DDI required a six lane section to avoid LOS E.
  - Highest volume movement (NC 540 on the east to/from Bells Lake Road on the north) served by loop in SW (C) quadrant and right turn for NE (A) quadrant ramp.
  - No weaves on NC 540 or Bells Lake Road.

Figure 7. Bells Lake Road Interchange Concept Recommended for Further Review (matches NCDOT preliminary recommendation)



4.4.3 Local Network Connections Required at Bells Lake Road

Two local roadway connections need to be considered as part of the NC 540 interchange on Bells Lake Road. These two local roads are:

- Oxford Green Drive: The Town of Cary has identified Oxford Green Drive as a local collector linking West Lake Road to Bells Lake Road. Due to the high level of development and required access to the Middle Creek schools on West Lake Road, it is recommended that this connection be maintained with NC 540. Since the proposed interchange (all configuration options) will have minimal (or no) spacing to the Oxford Green Drive intersection, an alternate routing will be required. Although a detailed analysis will be required, the most likely route would extend Forester Drive north to Oxford Green Drive providing a connection to Truelove Drive. (R-5)
- Rhodes Road (SR 1405): The NCDOT interchange analysis assumed that a grade crossing would be provided at Rhodes Road over NC 540. As documented in Section 3.2, however, neither the 2040 MTP nor any local transportation plan has identified this roadway for a future grade separation. Based on this observation, the recommended treatment is that a grade separation is not required at Rhodes Road. (C-3)

4.5 US 401 Fayetteville Road Interchange

US 401 is the highest volume interchange on the NC 540 corridor under study. In addition to the higher volumes, the interchange must be designed to maintain access to Wake Tech Community College. Multiple local roadway modifications are needed to reroute local traffic as well as the interchange.

4.5.1 Traffic Operations Review

As part of the review, the interchange volumes were examined based on the 2040 TRM Version 5 and compared with the 2035 NCDOT forecast. The primary difference was a reduction in volume on US 401 (65,100 vpd with updated TRM V5 model compared with 77,000 vpd in the NCDOT forecast). Examining specific turn movements, however, similar volumes were observed for quadrant turns.

Using the 2040 model results from the 2040 TRM V5 model, the FHWA CAP-X program was applied to provide a planning level capacity analysis of generic interchange types. Due to the high US 401 volumes, the CAP-X analysis indicated that a partial clover interchange was the only concept that would meet capacity requirements with a six lane section as shown in Table 11. Detailed capacity analysis will be required to verify the final design requirements including the impacts of alternative loop configurations.

Table 11. CAP-X Interchange Review at US 401 Fayetteville Road

Interchange Type	With 6 through lanes		With 8 through lanes		Comments
	V/C Ratio	Ranking	V/C Ratio	Ranking	
Simple Diamond	1.40	Exceeds capacity	1.24	Exceeds capacity	Exceeds capacity with 6 or 8 lanes
Partial Cloverleaf (NW & SE quadrants)	0.84	2	0.68	1	Operates well with 8 lanes. Near capacity for some movements with 6 lanes.
Diverging Diamond (aka DDI)	1.11	Exceeds capacity	0.94	3	Very near capacity with 8 lanes. Signal spacing issues with Wake Tech possible.
Single Point	1.66	Exceeds capacity	1.44	Exceeds capacity	Exceeds capacity with 6 or 8 lanes

Notes:

1. CAP-X software from FHWA utilized to identify basic capacity operations at interchanges. It is intended for longer term planning projects. Additional detailed analysis will be required in future studies.
2. V/C ratio calculated by testing the 2040 AM and PM peak interchange traffic volumes using the critical lane methodology.
3. Through lanes are shown above without turn lanes or auxiliary lanes. For most options, there will be a need for 1-2 additional lanes.
4. The CAP-X software evaluates a single generic partial cloverleaf option. Other variations of loop layouts are possible. More detailed capacity analysis is required to examine scenarios with loop or ramps in different quadrants than assumed in the CAP-X software. Regardless, the resulting V/C does provide a valid comparison of the potential capacity reductions with a dual loop partial clover interchange for planning purposes.

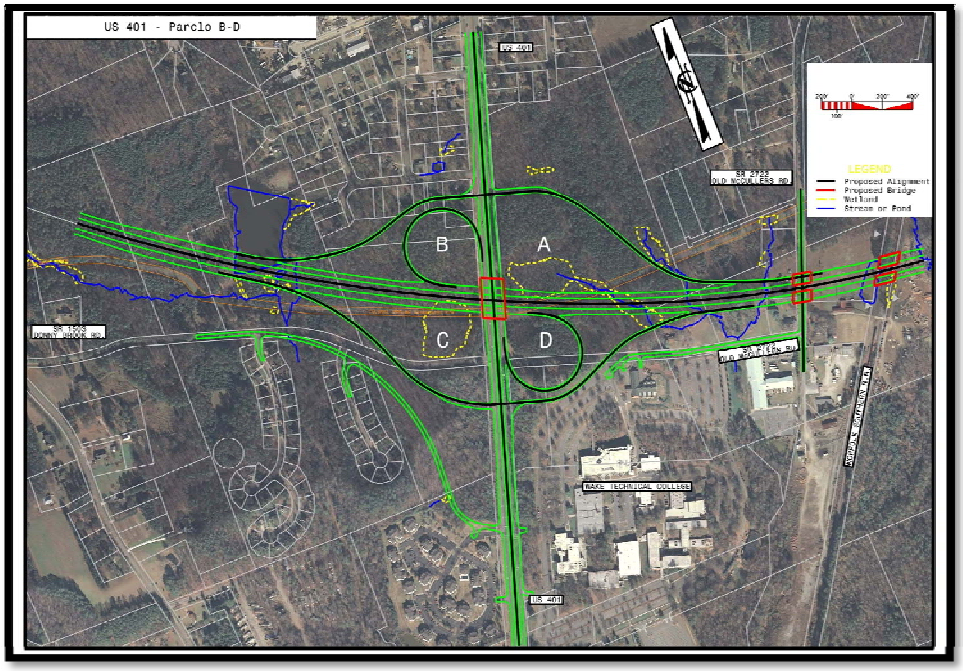
4.5.2 Interchange Type at US 401 Fayetteville Road

The July 2011 NCDOT review examined four interchange layouts at US 401 – a diverging diamond interchange (DDI), partial clover with loops in the NE (A) and SE (D) quadrants, a partial clover with loops in the SW (C) and SE (D) quadrants, and a full diamond with provisions for future loops.

The NCDOT analysis recommended a partial clover with loops in the NE (A) and SW (C) quadrants. Based on a review of the NCDOT analysis and a re-examination of traffic operations and volumes, this study agrees with the conclusion that a partial cloverleaf interchange is the preferred solution. A full clover was also examined, but the introduction of weaves on NC 540 is not preferred.

It is recommended, however, that some consideration be given to one additional partial clover scenario as shown in Figure 8. Specifically, a partial clover with loops in the NW (B) and SE (D) quadrants would serve higher volumes on each loop, would also not have weaves on either NC 540 or US 401, and would have lower left turn volumes at the ramp terminals. The minor skew on the interchange may result in a bigger footprint with the shifted loops, but wetland impacts would be reduced. This option should be considered in additional detailed review. Note that the NCDOT forecast has different turn movements that used in this study which may also account for differences in loop evaluation.

Figure 8. US 401 Fayetteville Road Interchange Concept Recommended for Further Review



4.5.3 Local Network Connections Required at US 401 Fayetteville Road

The US 401 interchange will require multiple modifications to the local roadway network. In the vicinity of the US 401 interchange, the Donny Brook Road/ Old McCullers Road signalized intersection will be removed, effectively eliminating one of three primary access points to Wake Tech. To mitigate the potential impacts, the following projects should be considered:

Southwest Quadrant

- Donny Brook Road (SR 1503) currently connects with Old McCullers Road with a four leg signalized intersection at US 401. This intersection location will be removed as part of the interchange reconstruction.
- The NCDOT proposed design shows a viable route extending Donny Brook Road south to the existing signal at Chandler Ridge Circle where the main entrance to Wake Tech is located currently. This will provide adequate spacing on US 401 and continue to provide access to Wake Tech from the west. (R-11)
- Randsdell Road is an existing connection between Donny Brook Road and US 401. Although it does not provide access to Wake Tech, it should be considered as a second route for diverting traffic around this section of US 401.
- The intersection of Optimist Farm Road at Donny Brook Road should be connected at a single four leg intersection. This would likely be a local road project not affiliated with NC 540. (R-10)

Southeast Quadrant

- Old McCullers Road (SR 2722) crosses NC 540 just east of the proposed US 401 interchange. A grade separation is recommended here to maintain existing access, and as a potential alternate access to Wake Tech. It is proposed the alignment match the current location unless Wake Tech would prefer for the bridge to tie directly into Tech Road which is an eastern loop of the campus. (R-12)

North of US 401

- Oakvale Street is a local subdivision street that connects with US 401 less than 600 feet north of the proposed interchange. In order to provide increased spaing to the interchange, it is recommended that Oakvale Street access to US 401 should be eliminated. Local traffic from lots directly access Oakvale Street (approximately 10 residences) could use existing subdivision streets including LobeliaStreet and Marigold Street to reach West Allen Street which connects to US 401. Depending upon the amount of trip diversion, analysis should be conducted to determine if East Allen Street or West Allen Street should be slightly realigned to provide a four leg intersection with US 401.
- An extension of Old McCullers Road north between Ten Ten Road and US 401 has been proposed as part of NC Capital Area MPO's US 401 Hot Spot study. (R-13)

4.6 Old Stage Road Interchange

4.6.1 Traffic Operations Review

As part of the review, the interchange volumes were examined based on the 2040 TRM Version 5 and compared with the 2035 NCDOT forecast. The primary difference at Old Stage Road was an increase in traffic volumes on Old Stage Road, particularly south of NC 540. As a result, the peak turning movements toward the south increased as compared with the NCDOT forecast.

Using the 2040 model results from the 2040 TRM V5 model, the FHWA CAP-X program was applied to provide a planning level capacity analysis of generic interchange types. The CAP-X analysis indicates that a partial cloverleaf interchange was the only configuration that would allow for a four-lane basic section on Old Stage Road as shown in Table 12. Detailed capacity analysis will be required to verify the final design requirements including the impacts of alternative loop configurations.

Table 12. CAP-X Interchange Review at Old Stage Road

Interchange Type	With 4 through lanes		With 6 through lanes		Comments
	V/C Ratio	Ranking	V/C Ratio	Ranking	
Simple Diamond	1.14	Exceeds capacity	0.96	4	Lowest ranked
Partial Cloverleaf (NW & SE quadrants)	0.88	3	0.76	1	Near capacity for some movements with 6 lanes. Very near capacity with 4 lanes.
Diverging Diamond (aka DDI)	1.08	Exceeds capacity	0.87	2	Very near capacity with 6 lanes. Over capacity with 4 lanes.
Single Point	1.46	Exceeds capacity	1.19	Exceeds capacity	Exceeds capacity with 4 or 6 lanes

Notes:

1. CAP-X software from FHWA utilized to identify basic capacity operations at interchanges. It is intended for longer term planning projects. Additional detailed analysis will be required in future studies.
2. V/C ratio calculated by testing the 2040 AM and PM peak interchange traffic volumes using the critical lane methodology.
3. Through lanes are shown above without turn lanes or auxiliary lanes. For most options, there will be a need for 1-2 additional lanes.
4. The CAP-X software evaluates a single generic partial cloverleaf option. Other variations of loop layouts are possible. More detailed capacity analysis is required to examine scenarios with loop or ramps in different quadrants than assumed in the CAP-X software. Regardless, the resulting V/C does provide a valid comparison of the potential capacity reductions with a dual loop partial clover interchange for planning purposes.

4.6.2 Interchange Type at Old Stage Road

The July 2011 NCDOT review examined four interchange layouts at Old Stage Road – a diverging diamond interchange (DDI), partial clover with loops in the NE (A) and SE (D) quadrants, a partial clover with loops in the NW (B) and SW (C) quadrants, and a full diamond with provisions for future loops.

The NCDOT analysis recommended the partial clover with loops in the NW (B) and SW (C) quadrants. Based on a review of the NCDOT analysis and a re-examination of traffic operations and volumes, this study agrees with the conclusion that a partial cloverleaf interchange is the preferred solution. It is recommended, however, that some consideration be given to locating loops in different quadrants:

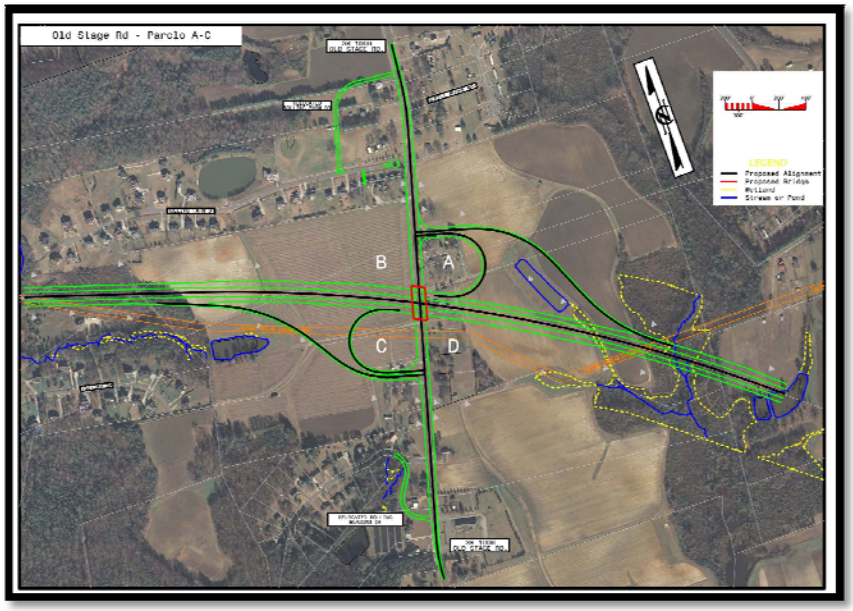
- The NE (A) quadrant is the preferred location for a loop from a traffic perspective since it serves the highest volume movement. However, construction in this quadrant does have impacts to wetland and stream resources.
- A loop in the NW (B) quadrant would require a weave on NC 540 and is not recommended if a loop is provided in the NE (A) quadrant. In addition, if a loop is not provided in the NE (A) quadrant, the northbound left turn to a NC 540 ramp would likely require a dual left turn.
- The SW (C) quadrant loop would not require dual left turns for traffic turning onto or from Old Stage Road. In addition, the quadrant does not have wetland or stream resources and would generally stay within the protected corridor.
- A loop in the SE (D) quadrant is not recommended because of the fact that the reverse of the highest volume movement would be forced to take a left turn onto Old Stage Road, potentially requiring a dual lleft turn from the loop. In addition, construction would result in stream and wetland impacts.

Based on this review, it is recommended that a Partial Clover with Loops in the NE (A) and SW (C) quadrants be considered as illustrated in Figure 9. This arrangement would provide improved traffic operations, eliminate weaves on Old Stage Road, and provide a higher speed exit from NC 540 in both directions. It is likely that there are some wetland and stream impacts in the NE (A) quadrant, however.

4.6.3 Local Network Connections Required at Old Stage Road

Two local roadway connections will need to be modified to provide increased spacing between the interchange ramps and local roadway connections. The two subdivision access roads requiring realignment are Rolling Farm Drive north of NC 540 and Rolling Meadows Drive south of NC 540. Rerouting of the roads is shown in the NCDOT interchange layouts.

Figure 9. Old Stage Road Interchange Concept Recommended for Further Review



4.7 NC 50 Benson Road Interchange

4.7.1 Traffic Operations Review

As part of the review, the interchange volumes were examined based on the 2040 TRM Version 5 and compared with the 2035 NCDOT forecast. The primary difference in forecasts is that NC 50 has higher volumes with the 2040 TRM model (37,200 vpd) versus the NCDOT forecast (23,500 vpd). In addition, the peak turning movements are between south NC 50 and east NC 540 (instead of west NC 540 as in the NCDOT forecast).

Using the 2040 model results from the 2040 TRM V5 model, the FHWA CAP-X program was applied to provide a planning level capacity analysis of generic interchange types. The CAP-X analysis indicates that a partial cloverleaf interchange is the only configuration that would allow for a four-lane basic section on NC 50 as shown in Table 13. Detailed capacity analysis will be required to verify the final design requirements including the impacts of alternative loop configurations.

Table 13. CAP-X Interchange Review at NC 50 Benson Road

Interchange Type	With 4 through lanes		With 6 through lanes		Comments
	V/C Ratio	Ranking	V/C Ratio	Ranking	
Simple Diamond	1.24	Exceeds capacity	1.08	Exceeds capacity	Exceeds capacity with 4 or 6 lanes
Partial Cloverleaf (NW & SE quadrants)	0.65	2	0.54	1	Under capacity with 4 or 6 lanes.
Diverging Diamond (aka DDI)	0.97	4	0.78	3	Near capacity with 6 lanes. Very near capacity with 4 lanes.
Single Point	1.38	Exceeds capacity	1.18	Exceeds capacity	Exceeds capacity with 4 or 6 lanes

Notes:

1. CAP-X software from FHWA utilized to identify basic capacity operations at interchanges. It is intended for longer term planning projects. Additional detailed analysis will be required in future studies.
2. V/C ratio calculated by testing the 2040 AM and PM peak interchange traffic volumes using the critical lane methodology.
3. Through lanes are shown above without turn lanes or auxiliary lanes. For most options, there will be a need for 1-2 additional lanes.
4. The CAP-X software evaluates a single generic partial cloverleaf option. Other variations of loop layouts are possible. More detailed capacity analysis is required to examine scenarios with loop or ramps in different quadrants than assumed in the CAP-X software. Regardless, the resulting V/C does provide a valid comparison of the potential capacity reductions with a dual loop partial clover interchange for planning purposes.

4.7.2 Interchange Type at NC 50 Benson Road

The July 2011 NCDOT review examined six interchange layouts at NC 50 – a single point urban interchange (SPUI), a diverging diamond interchange (DDI), a diamond with one loop in the NE (A) quadrant, a partial clover with loops in the NW (B) and SW (C) quadrants, a partial clover with loops in the NW (B) and SE (D) quadrants, and a half tight diamond with a loop in the NW (B) quadrant. The NCDOT analysis was developed using lower traffic volumes with two lanes envisioned on NC 50.

The NCDOT analysis recommended the half tight diamond with a loop in the NW (B) quadrant. This recommendation took into account multiple factors including:

- The NE (A) quadrant has a stream that was avoided. The NW (B) and SW (C) quadrants border against established subdivisions;
- The protected corridor in the interchange area is fairly extensive which can generally fit a loop in any of the four quadrants; and
- The NCDOT capacity analysis was conducted using lower traffic volumes with a focus on maintaining a two-lane section.
- The NW (B) quadrant is the preferred location for a loop from a traffic perspective since the it serves the highest volume movement. Note that construction in this quadrant does have impacts to wetland and stream resources.

Utilizing these factors, some additional traffic review was conducted. Key findings were:

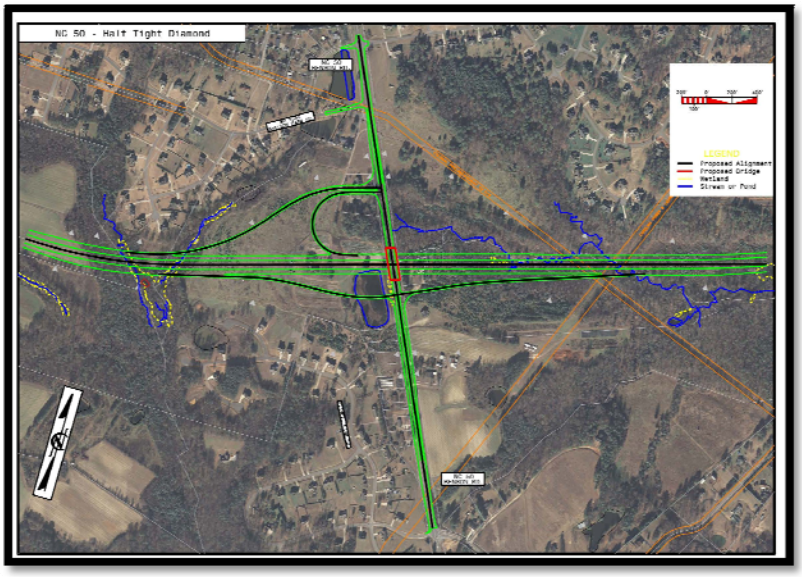
- The NW (B) quadrant would serve the highest volume and eliminate the need for a double left turn;
- The NE (A) quadrant would serve the second highest volume, but would require stream impacts. In addition, a loop in the quadrant would create a weave on NC 540 if a corresponding loop were in the NW (B) quadrant; and
- Loops in either the SW (C) or SE (D) quadrants create layouts likely requiring dual left turns either to/from the loop.

Based on the review of the NCDOT interchange review and the revised traffic volumes, the NCDOT recommended half tight diamond with a loop in the NW (B) quadrant is a viable concept (see Figure 10). More detailed traffic analysis should be conducted as part of future studies, however. If additional alternatives are reviewed, focusing on partial clover interchanges with 3 or 4 ramps is suggested to minimize left turns.

4.7.3 Local Network Connections Required at NC 50 Benson Road

The proposed Orange line alignment for NC 540 intersects NC 50 in a location without intersections offset close to a future interchange. The closest intersection will be Grissom Farm Road (SR 5530) located approximately 800 feet north of the interchange ramps. Realignment of this road to Turner Pond Road would increase the spacing to 1200 feet, but would require the relocation of at least one home. Future review should determine if this is required.

Figure 10. NC 50 Benson Road Interchange Concept Recommended for Further Review (matches NCDOT preliminary recommendation)



FUTURE NC 540 GRADE SEPARATION & INTERCHANGE TECHNICAL ASSESSMENT

APPENDIX A
HOLLY SPRINGS INTERCHANGE LAYOUTS

Table of Contents

Concepts:

4. DIVERGING DIAMOND (DDI)…….....A-1

5. HALF CLOVER…….....A-1

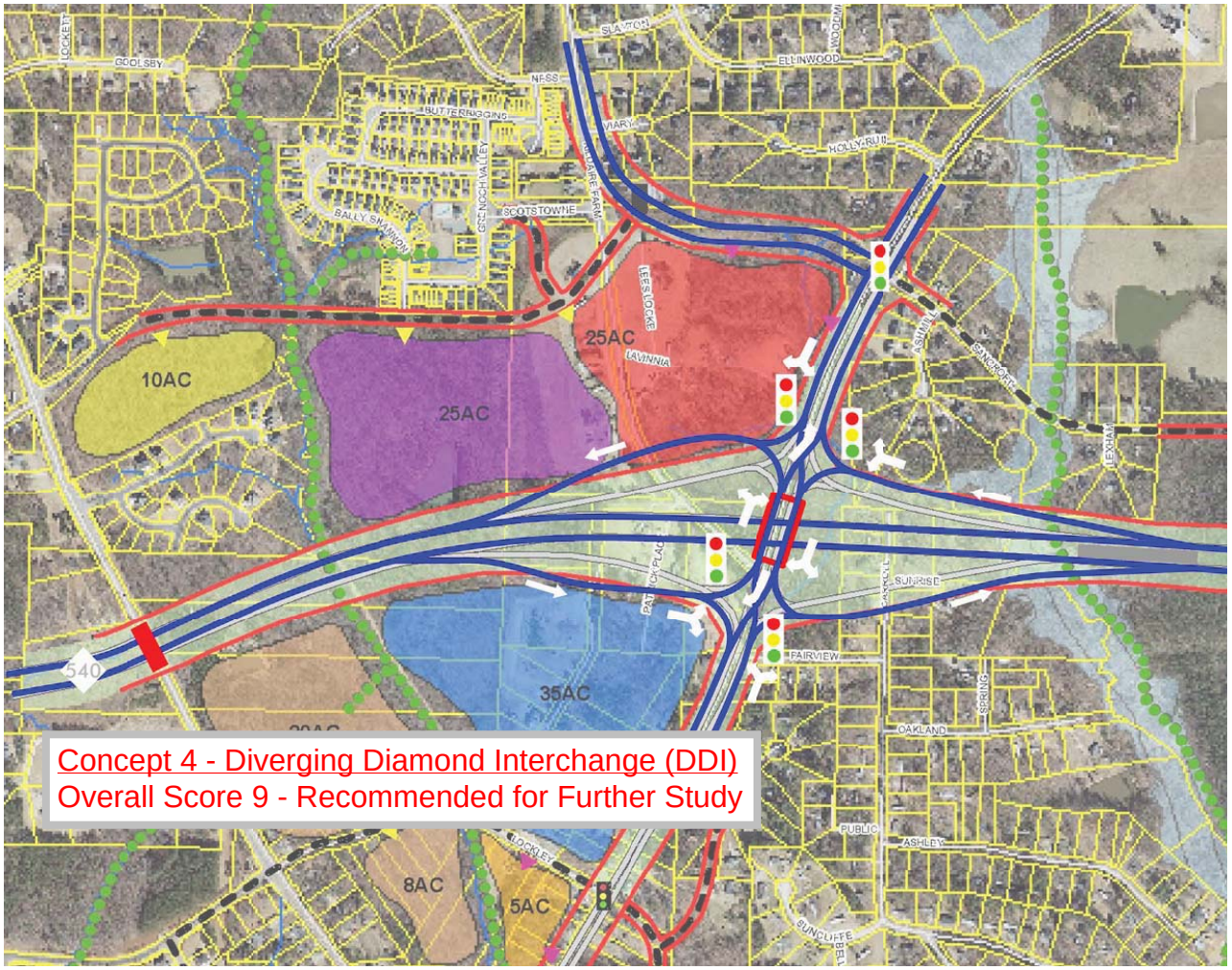
6. HALF CLOVER WITH 2 RAMPS …….....A-2

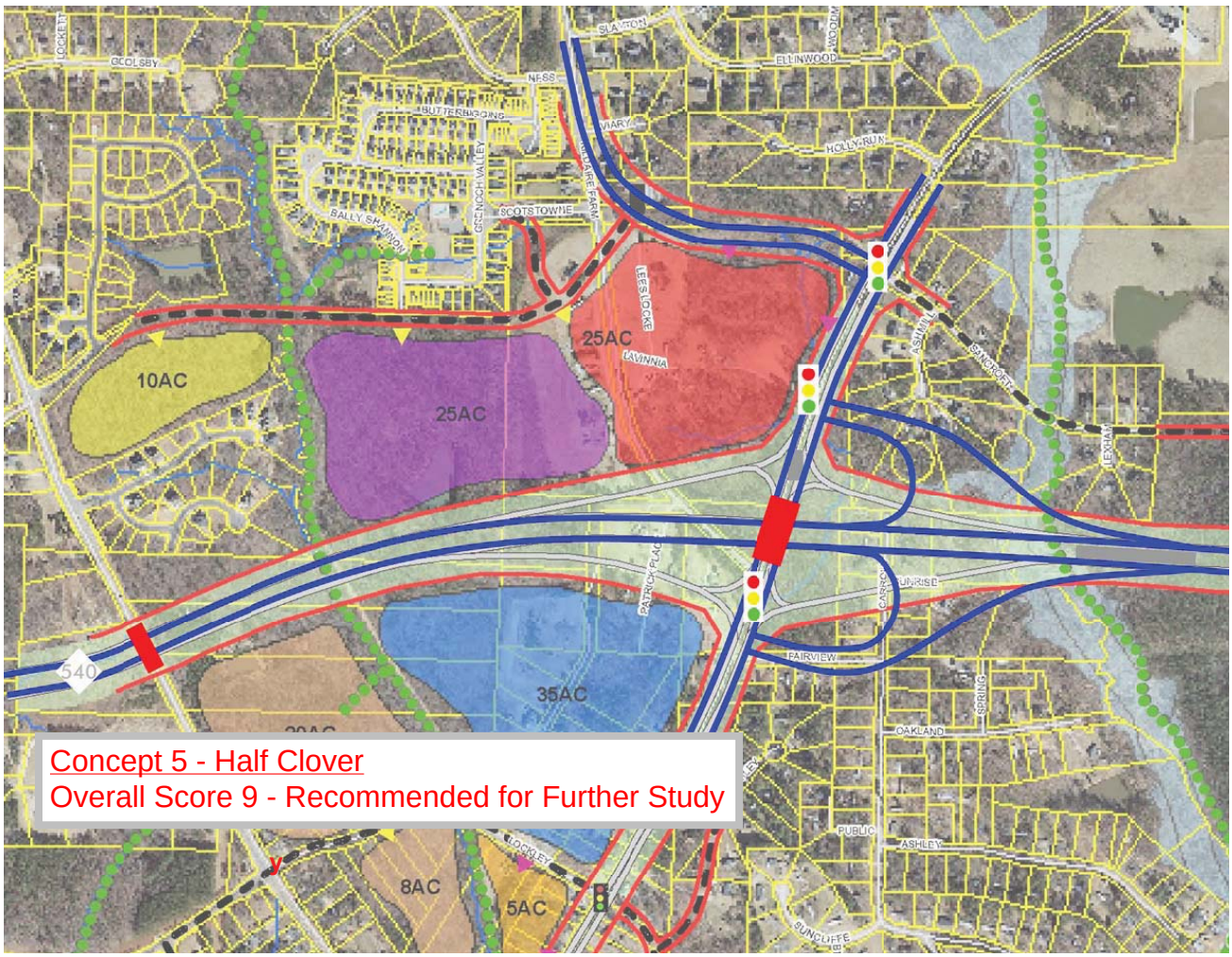
9. HALF CLOVER WITH 1 WAY RAMP TO KILDAIRE FARM ROAD.....A-2

10. SPLIT DIAMOND WITH KILDAIRE FARM RD & HOLLY SPRINGS RD.....A-3

11. SPLIT DIAMOND WITH SUNSET LAKES RD & HOLLY SPRINGS RD.....A-3

Note: Concept numbers were assigned for traffic analysis. Interchange layouts included herein were only developed for the concepts which scored better (i.e. a lower number rating as described in Table 9 of the report.


10AC
25AC
25AC
35AC
8AC
5AC
540
LEES MOCKE
LAVINNIA
SCOTSTOWNE
BALLY SHANNON
GREENCH VALLEY
BUTTERRIGGING
MARY
ELLINWOOD
HOLLY RUN
FAIRVIEW
SUNRISE
OAKLAND
ASHLEY
PUBLIC
LOCKLEY
GOOLSBY
SLATTON
Concept 4 - Diverging Diamond Interchange (DDI)
Overall Score 9 - Recommended for Further Study


10AC
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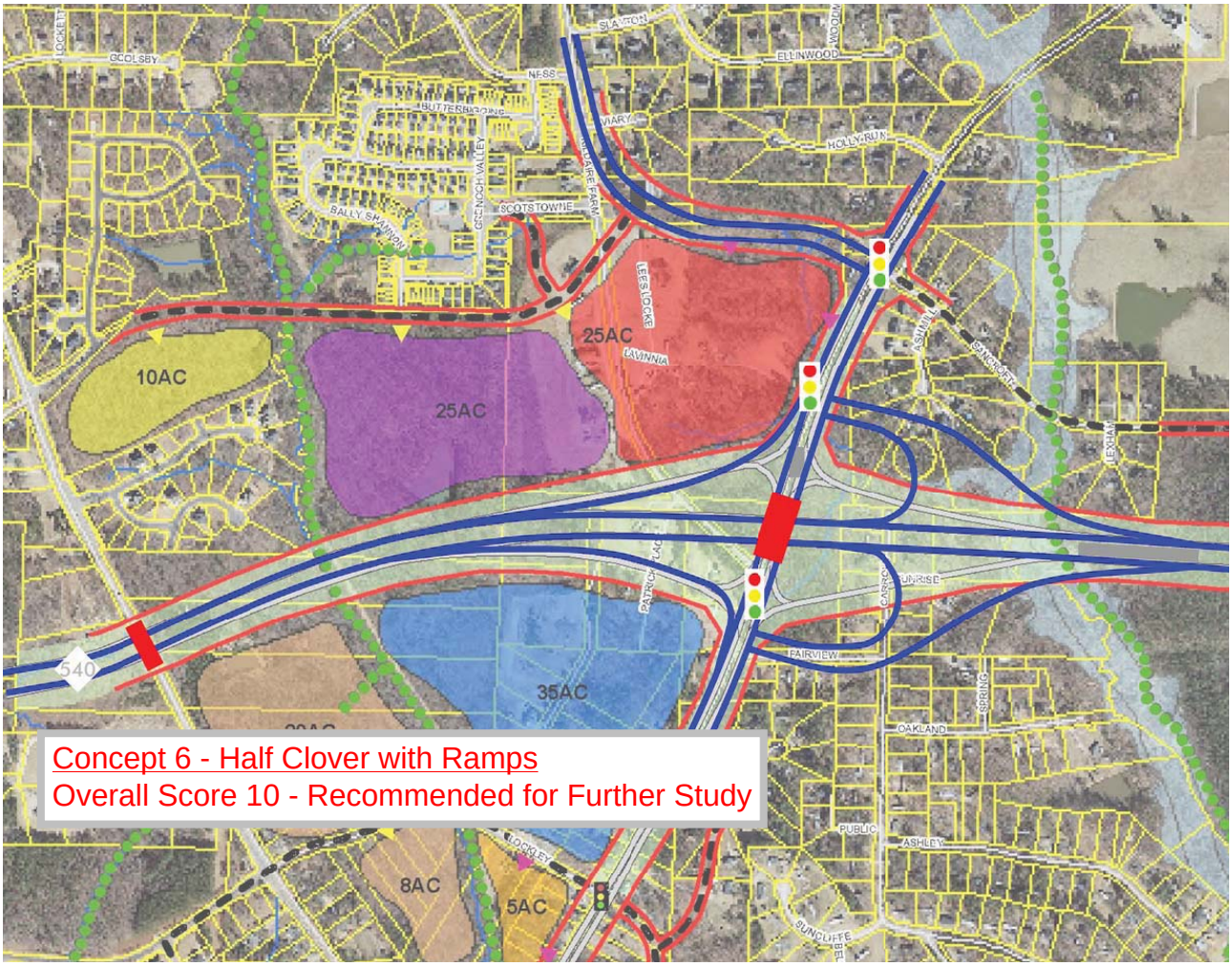
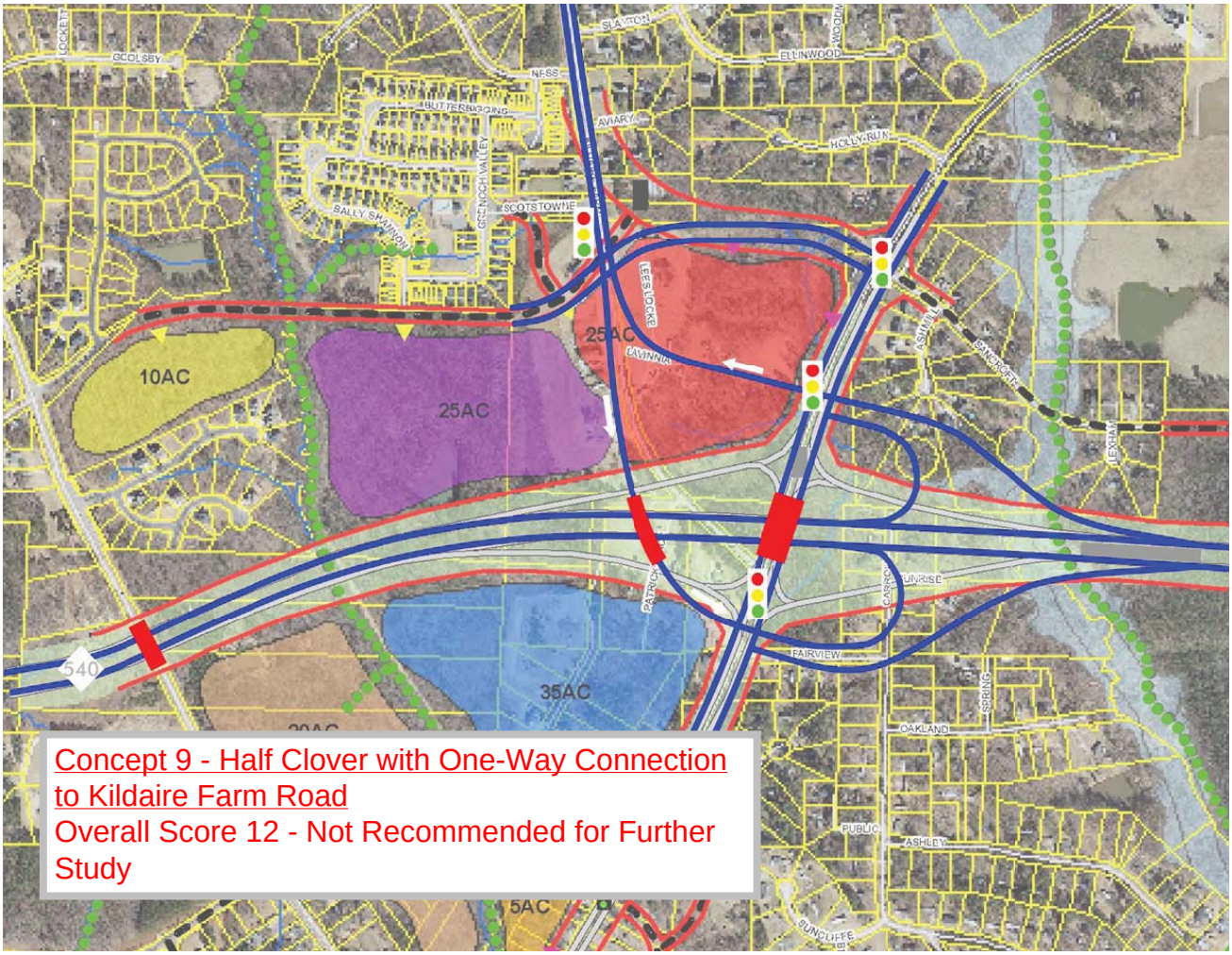
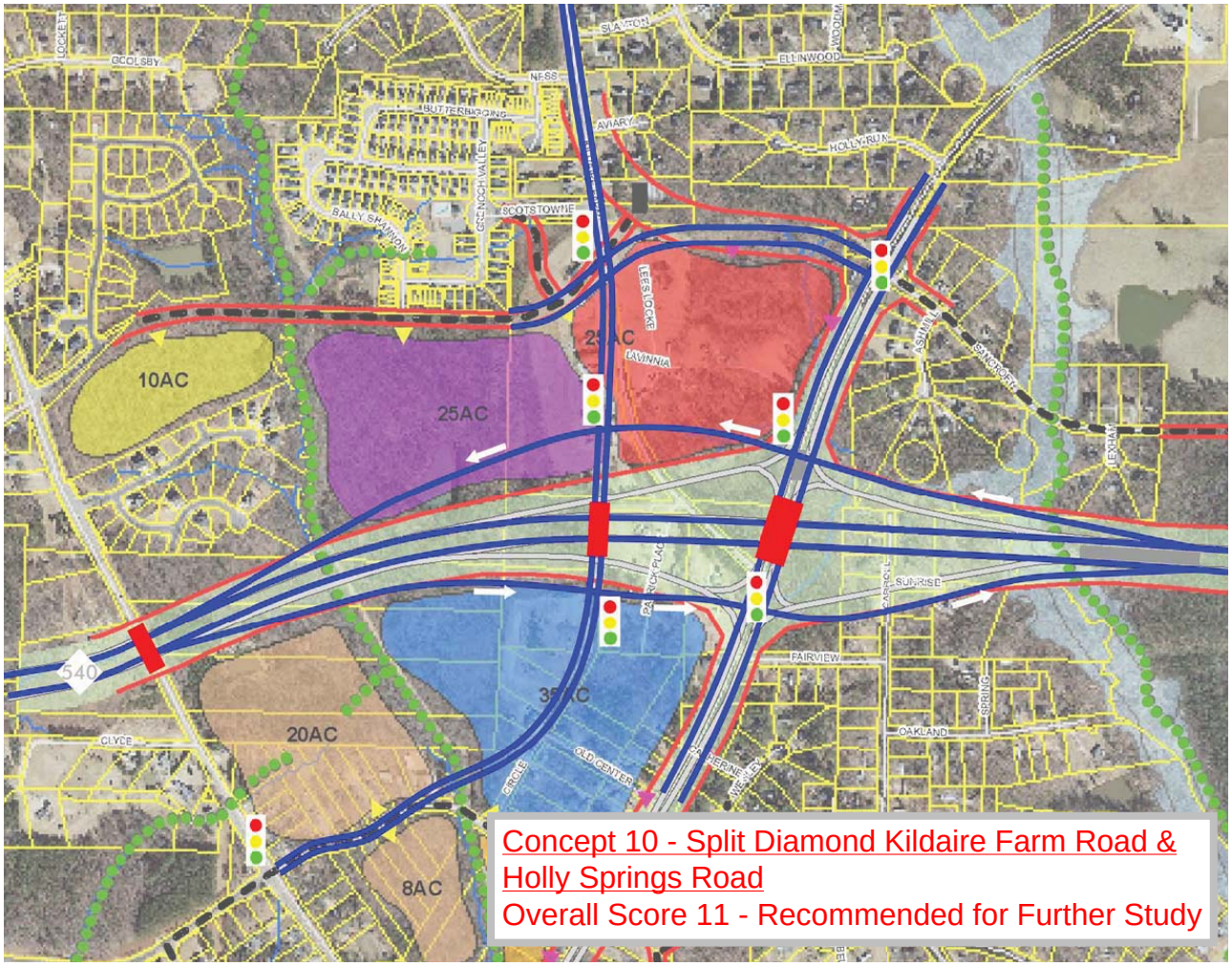
25AC
35AC
8AC
5AC
540
LEES MOCKE
LAVINNIA
SCOTSTOWNE
BALLY SHANNON
GREENCH VALLEY
BUTTERRIGGING
MARY
ELLINWOOD
HOLLY RUN
FAIRVIEW
SUNRISE
OAKLAND
ASHLEY
PUBLIC
LOCKLEY
GOOLSBY
SLATTON
Concept 5 - Half Clover
Overall Score 9 - Recommended for Further Study



Concept 6 - Half Clover with Ramps
Overall Score 10 - Recommended for Further Study

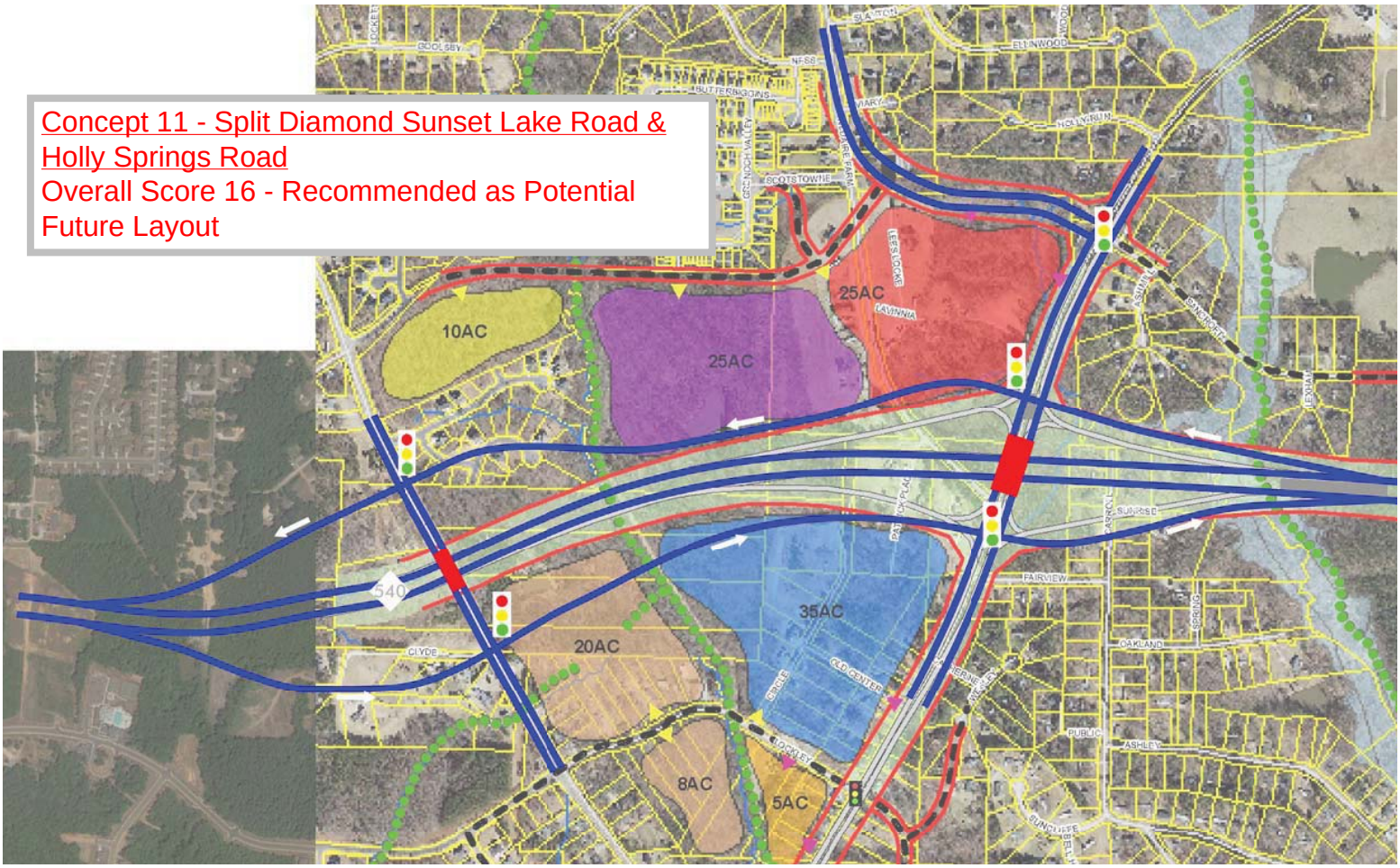


Concept 9 - Half Clover with One-Way Connection to Kildaire Farm Road
Overall Score 12 - Not Recommended for Further Study



Concept 10 - Split Diamond Kildaire Farm Road & Holly Springs Road
Overall Score 11 - Recommended for Further Study

Concept 11 - Split Diamond Sunset Lake Road & Holly Springs Road
Overall Score 16 - Recommended as Potential Future Layout



FUTURE NC 540 GRADE SEPARATION & INTERCHANGE TECHNICAL ASSESSMENT

APPENDIX B
OTHER INTERCHANGE LAYOUTS

Table of Contents

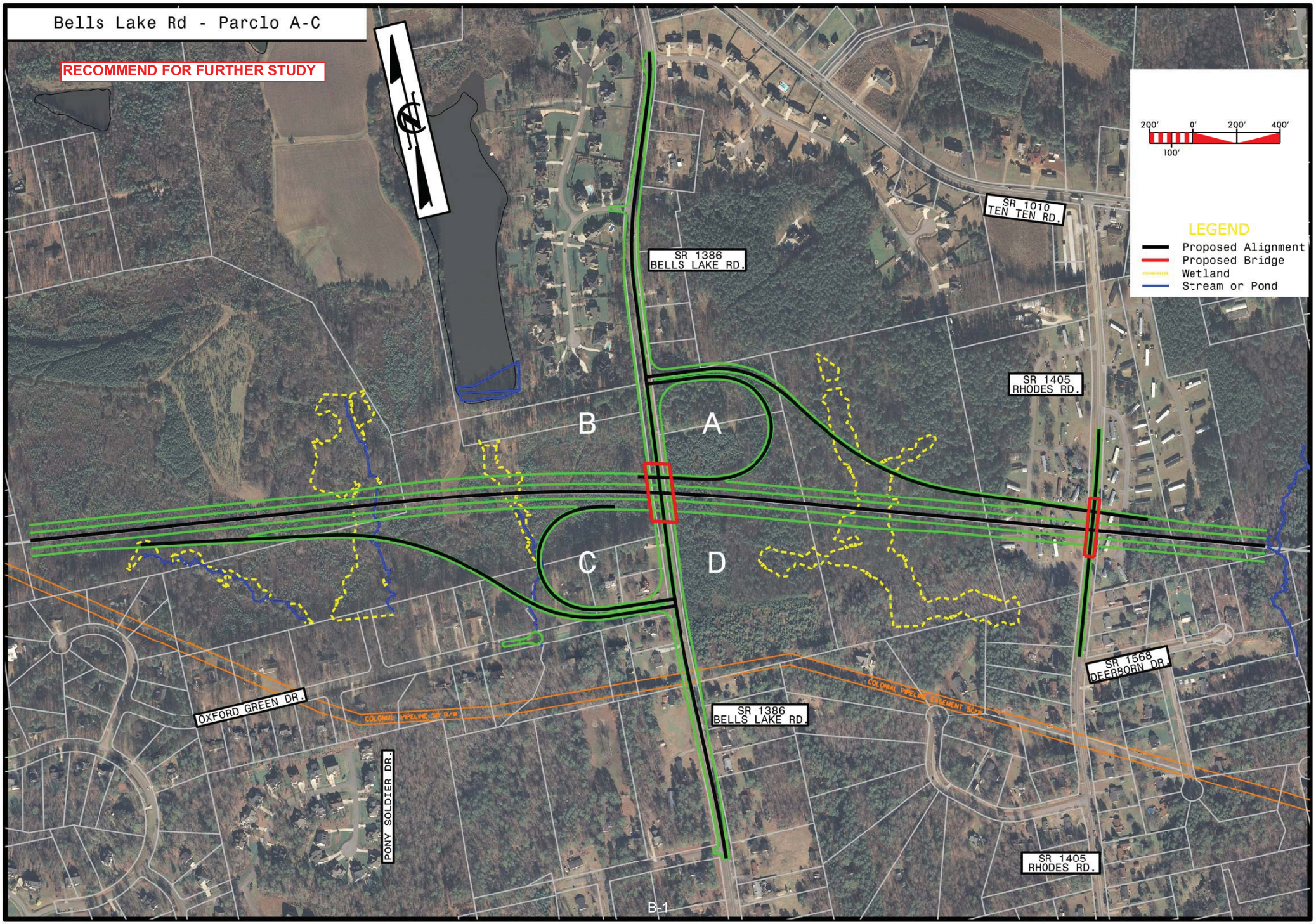
BELLS LAKE ROAD ……..…….....B-1

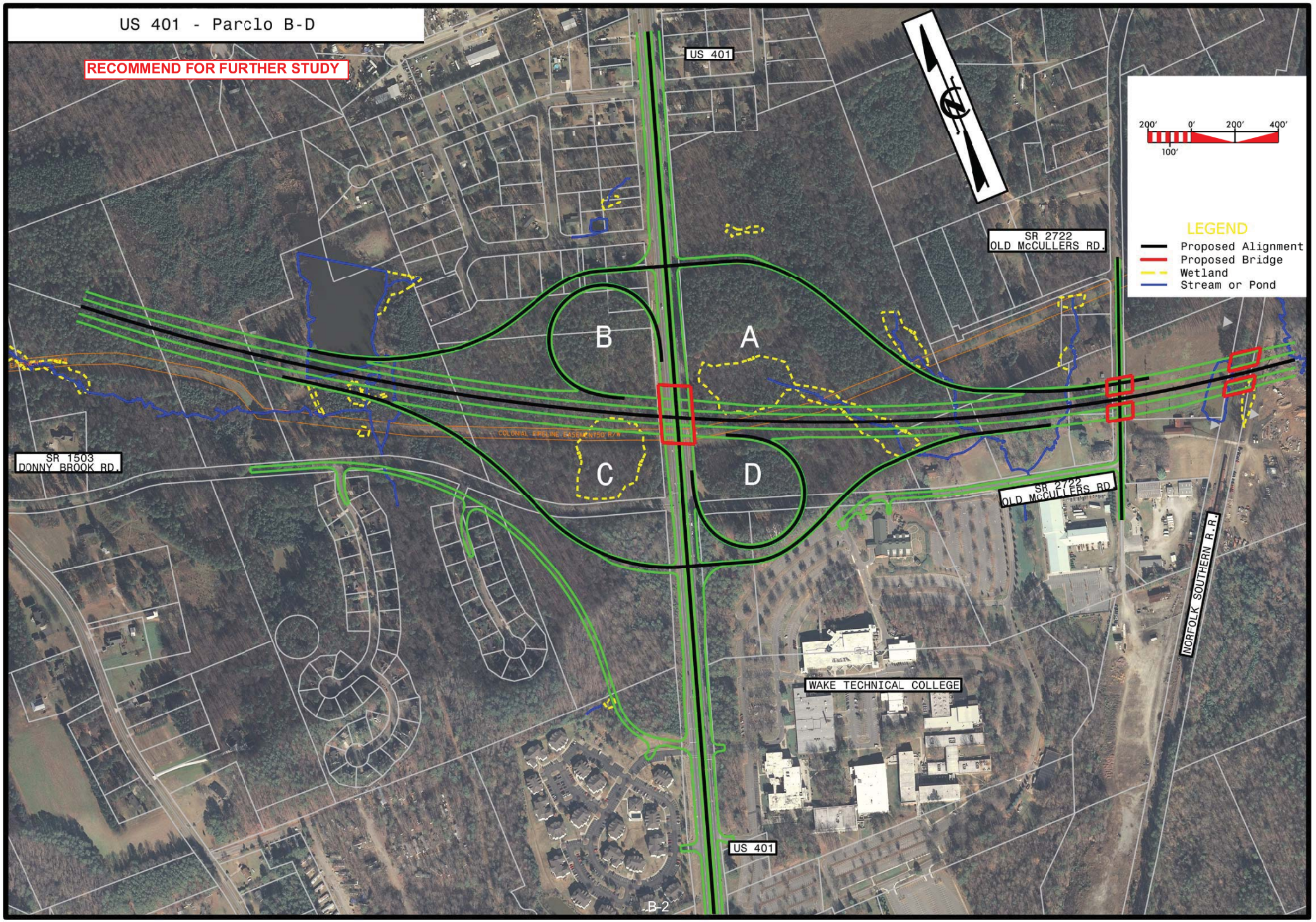
US 401 FAYETTEVILLE ROAD…….....B-2

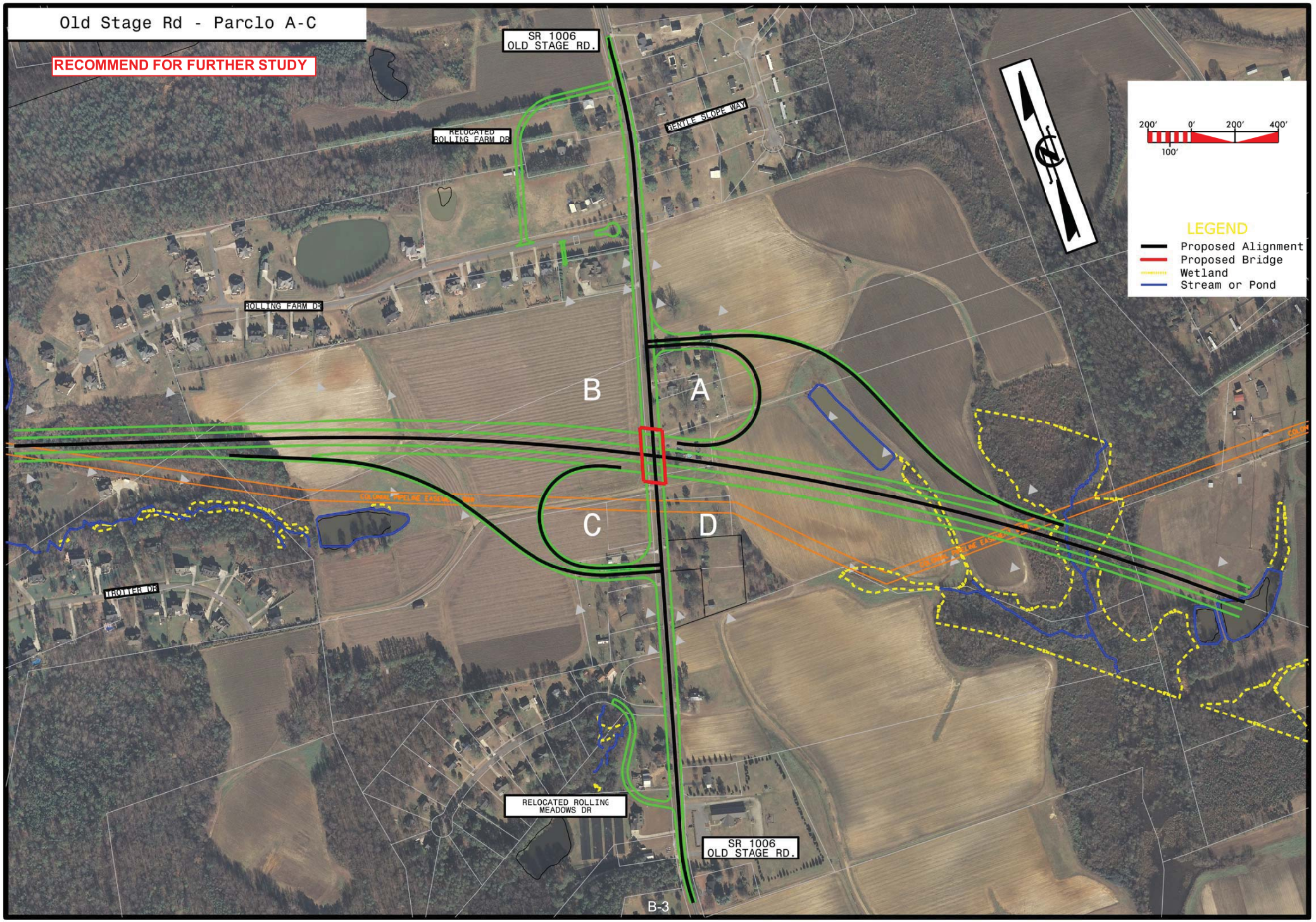
OLD STAGE ROAD ……..…….....B-3

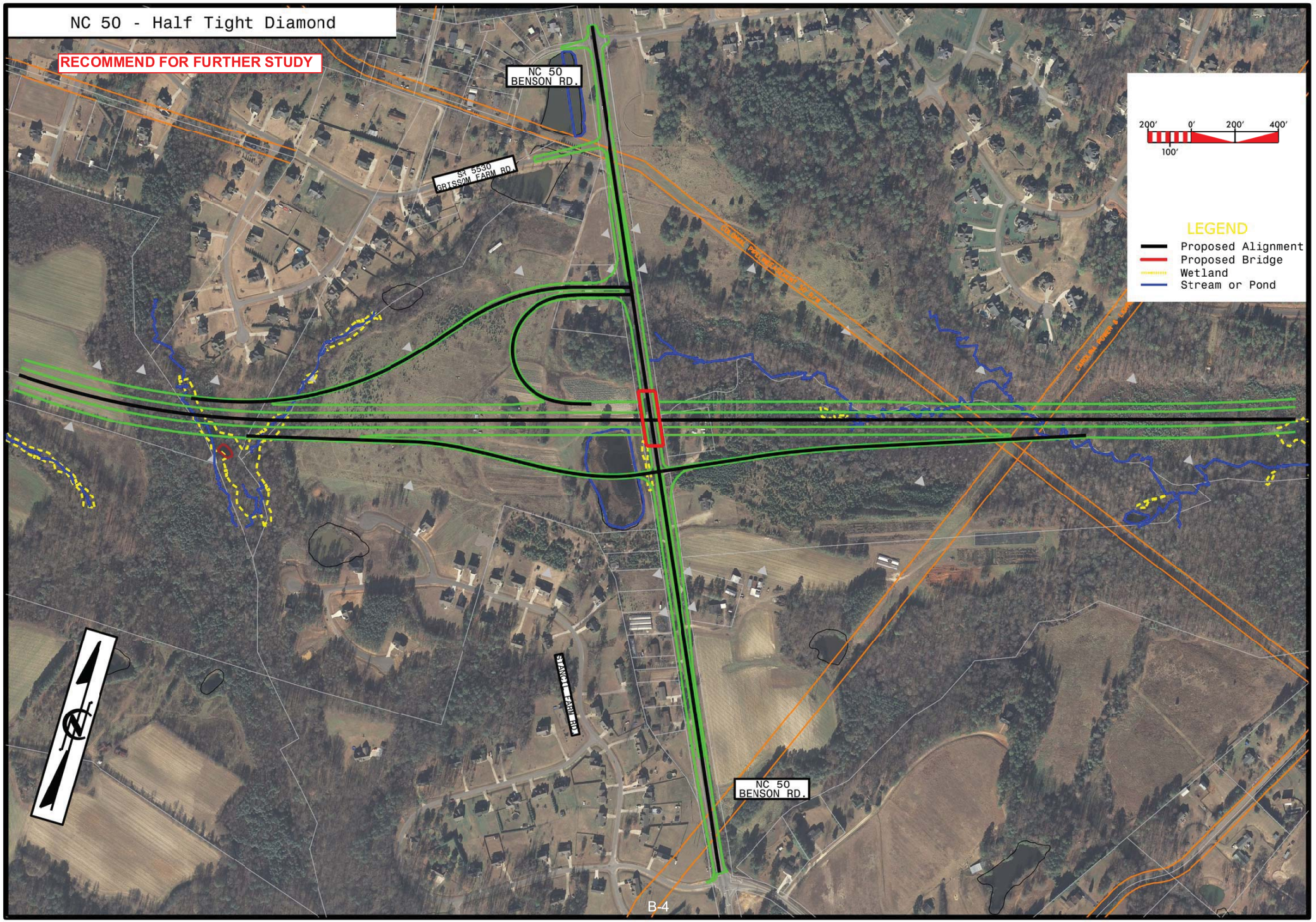
NC 50 BENSON ROAD …….....B-4

Note: The graphics shown are taken from preliminary interchange layout produced by Lochner for NCDOT and NCTA as part of the NC 540 Environmental Impact review.


Bells Lake Rd - Parclo A-C
RECOMMEND FOR FURTHER STUDY
200' 0' 200' 400'
100'
LEGEND
Proposed Alignment
Proposed Bridge
Wetland
Stream or Pond
SR 1010
TEN TEN RD.
SR 1386
BELLS LAKE RD.
SR 1405
RHODES RD.
B
A
C
D
SR 1568
DEERBORN DR.
OXFORD GREEN DR.
COLONIAL PIPELINE 50' R/W
COLONIAL PIPELINE EASEMENT 50'
SR 1386
BELLS LAKE RD.
PONY SOLDIER DR.
SR 1405
RHODES RD.
B-1


US 401 - Parclo B-D
RECOMMEND FOR FURTHER STUDY
US 401
SR 2722
OLD McCULLERS RD.
200' 0' 200' 400'
100'
LEGEND
Proposed Alignment
Proposed Bridge
Wetland
Stream or Pond
B
A
C
D
SR 1503
DONNY BROOK RD.
SR 2722
OLD McCULLERS RD.
NORFOLK SOUTHERN R.R.
WAKE TECHNICAL COLLEGE
US 401
B-2


Old Stage Rd - Parclo A-C
RECOMMEND FOR FURTHER STUDY
SR 1006
OLD STAGE RD.
RELOCATED
ROLLING FARM DR
GENTLE SLOPE WAY
ROLLING FARM DR
B
A
C
D
TROTTER DR
RELOCATED ROLLING
MEADOWS DR
SR 1006
OLD STAGE RD.
B-3
200′ 0′ 200′ 400′
100′
LEGEND
Proposed Alignment
Proposed Bridge
Wetland
Stream or Pond


NC 50 - Half Tight Diamond
RECOMMEND FOR FURTHER STUDY
NC 50
BENSON RD.
SR 5530
GRISSOM FARM RD.
200' 0' 200' 400'
100'
LEGEND
Proposed Alignment
Proposed Bridge
Wetland
Stream or Pond
NC 50
BENSON RD.
B-4

FUTURE NC 540 GRADE SEPARATION & INTERCHANGE TECHNICAL ASSESSMENT

APPENDIX C
TRAFFIC ANALYSIS

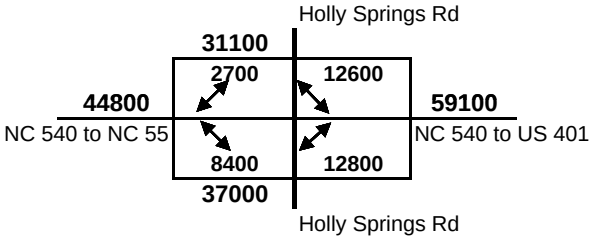
Table of Contents

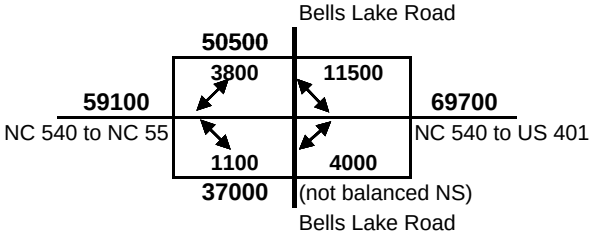
TRAFFIC VOLUME COMPARISON – NCDOT VS. TRM VERSION 5…….....C-1

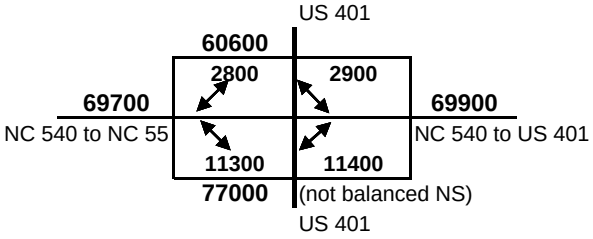
SYNCHRO DELAY AND LANEAGE: HOLLY SPRINGS INTERCHANGE CONCEPTS

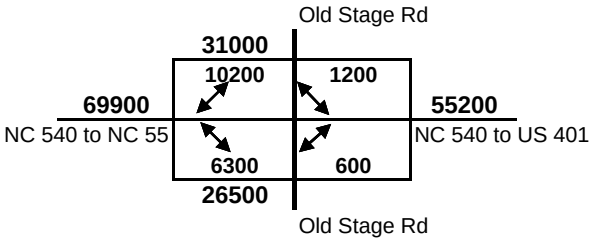
1. 4 LANE DIAMOND …….....C-2
2. 6 LANE DIAMOND …….....C-3
3. 4 LANE DIVERGING DIAMOND (DDI)…….....C-4
4. 6 LANE DIVERGING DIAMOND (DDI)…….....C-5
5. HALF CLOVER…….....C-6
6. HALF CLOVER WITH 2 RAMPS …….....C-7
7. HALF CLOVER WITH KILDAIRE FARM ROAD TO SOUTH.....C-8
8. HALF CLOVER WITH KILDAIRE FARM ROAD TIE IN AT NORTH RAMP.....C-9
9. HALF CLOVER WITH 1 WAY RAMPS TO KILDAIRE FARM ROAD.....C-10
10. SPLIT DIAMOND WITH KILDAIRE FARM RD & HOLLY SPRINGS RD.....C-11
11. SPLIT DIAMOND WITH SUNSET LAKES RD & HOLLY SPRINGS RD.....C-12

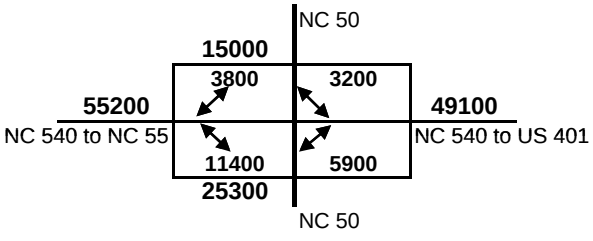
NCTA 2035 Forecast



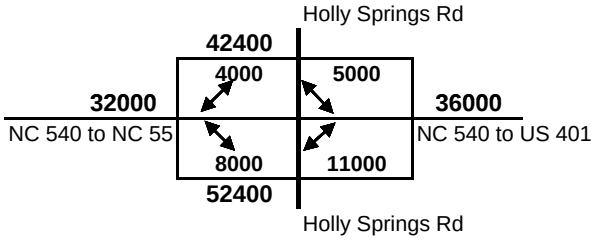


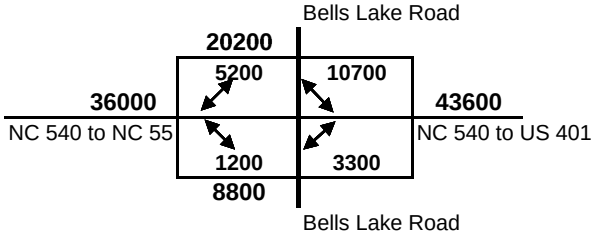


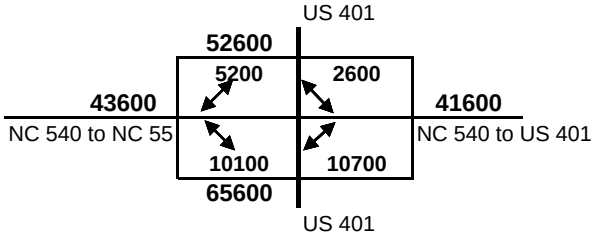


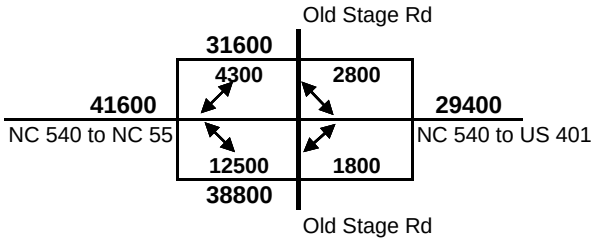


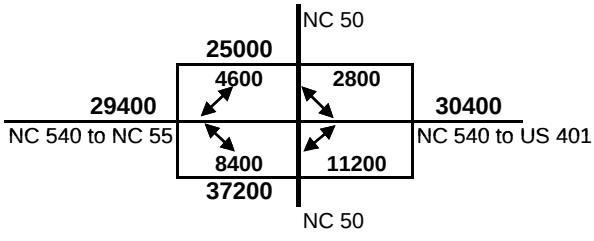
2040 TRM Version 5

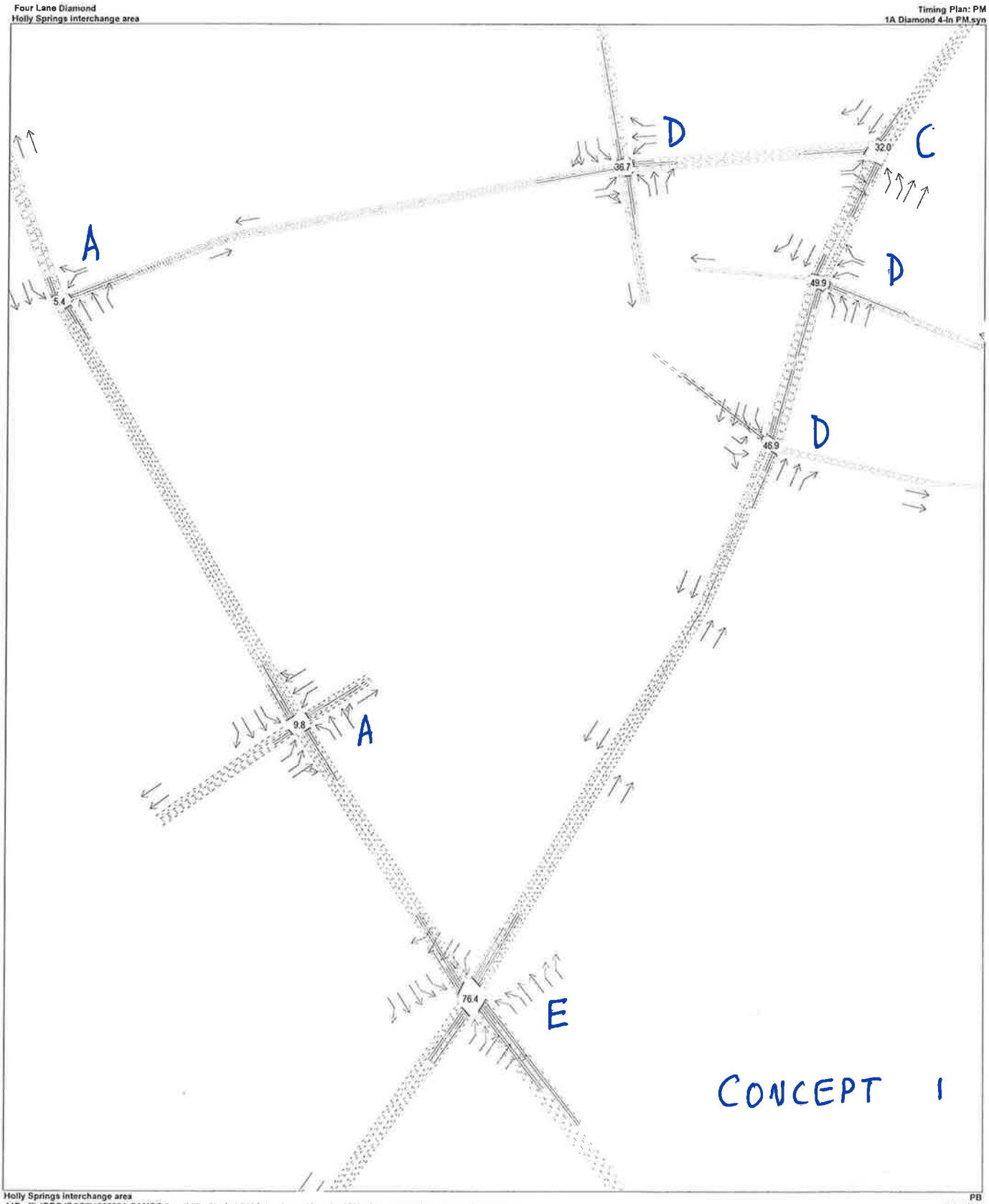


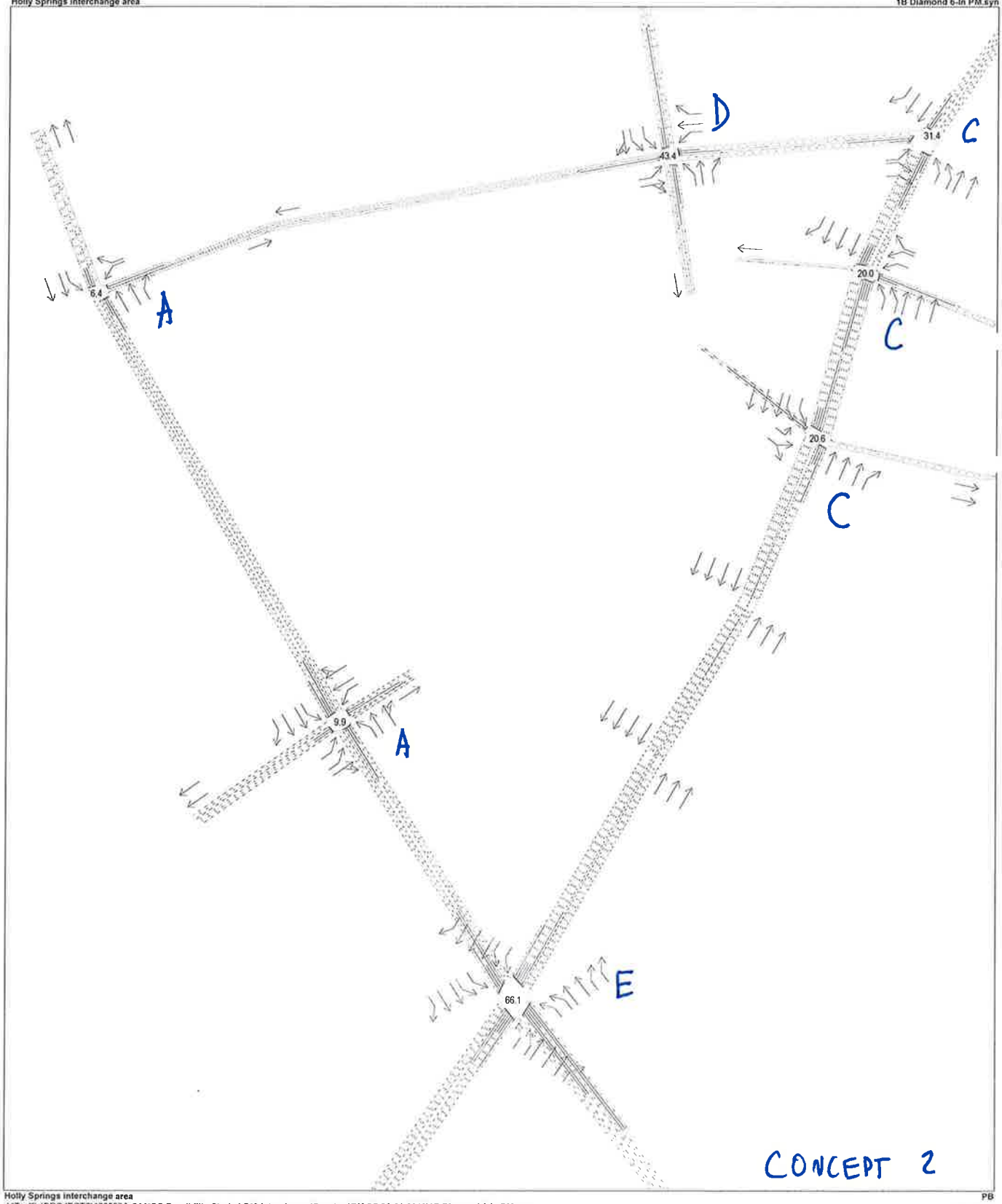


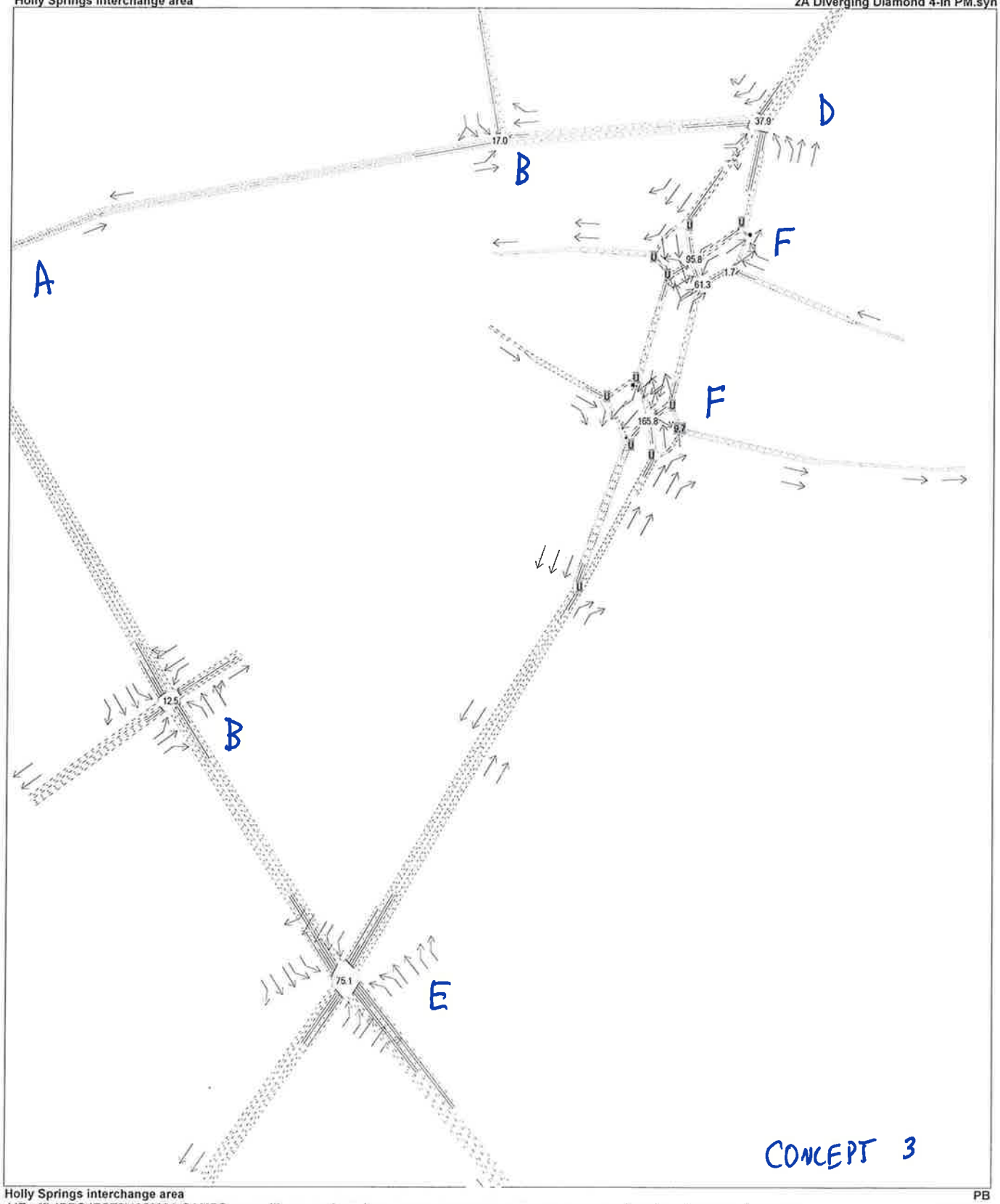


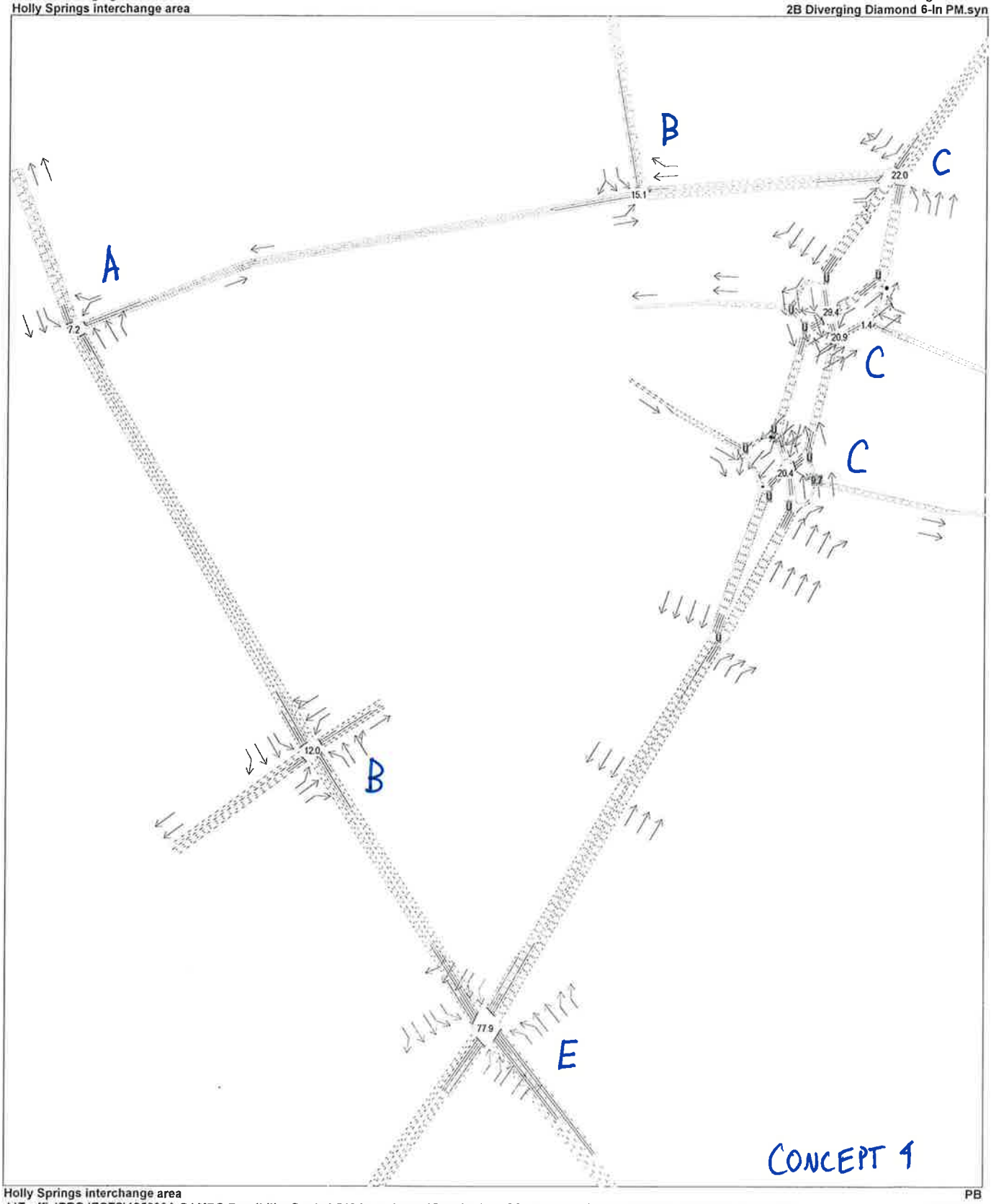


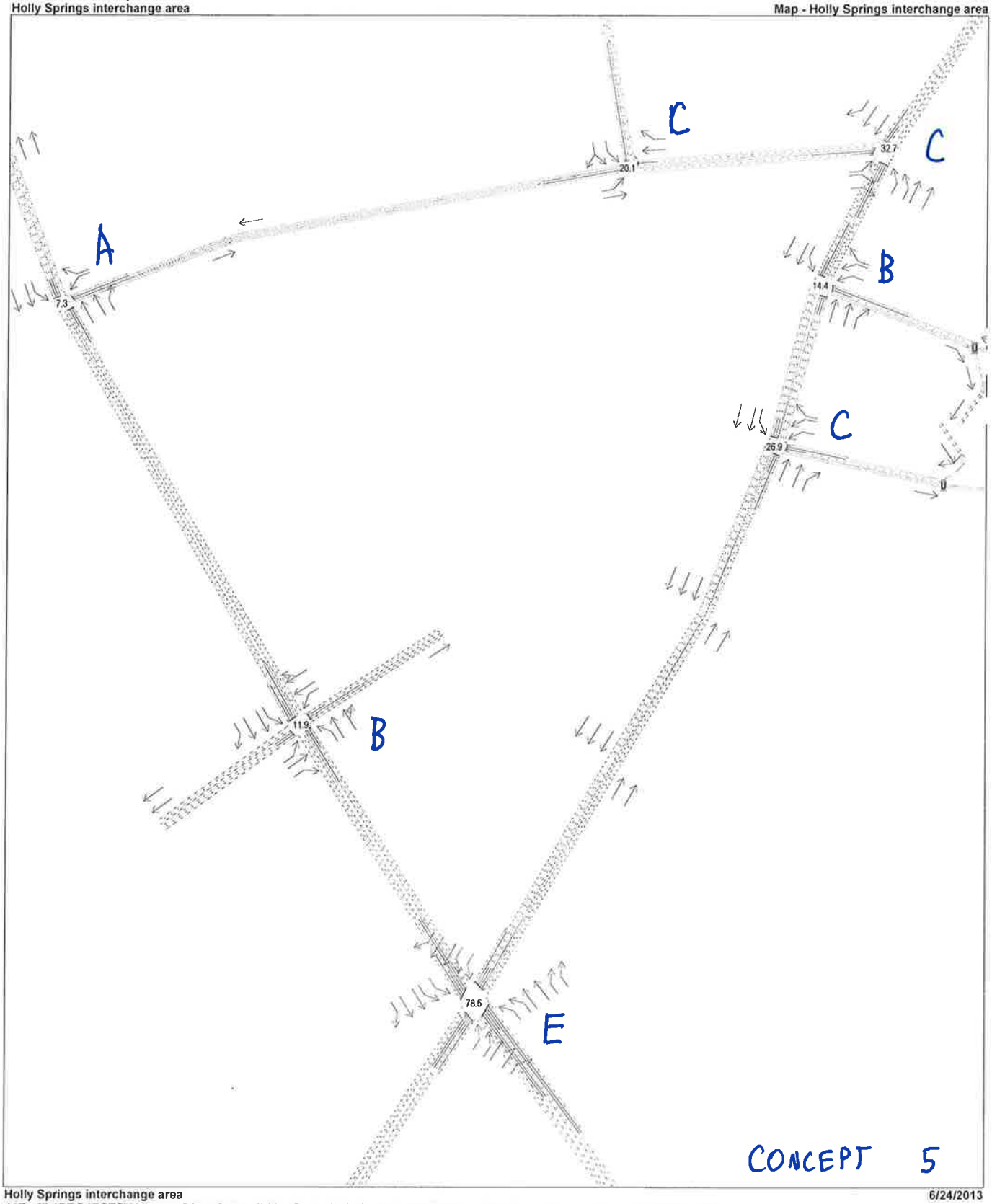


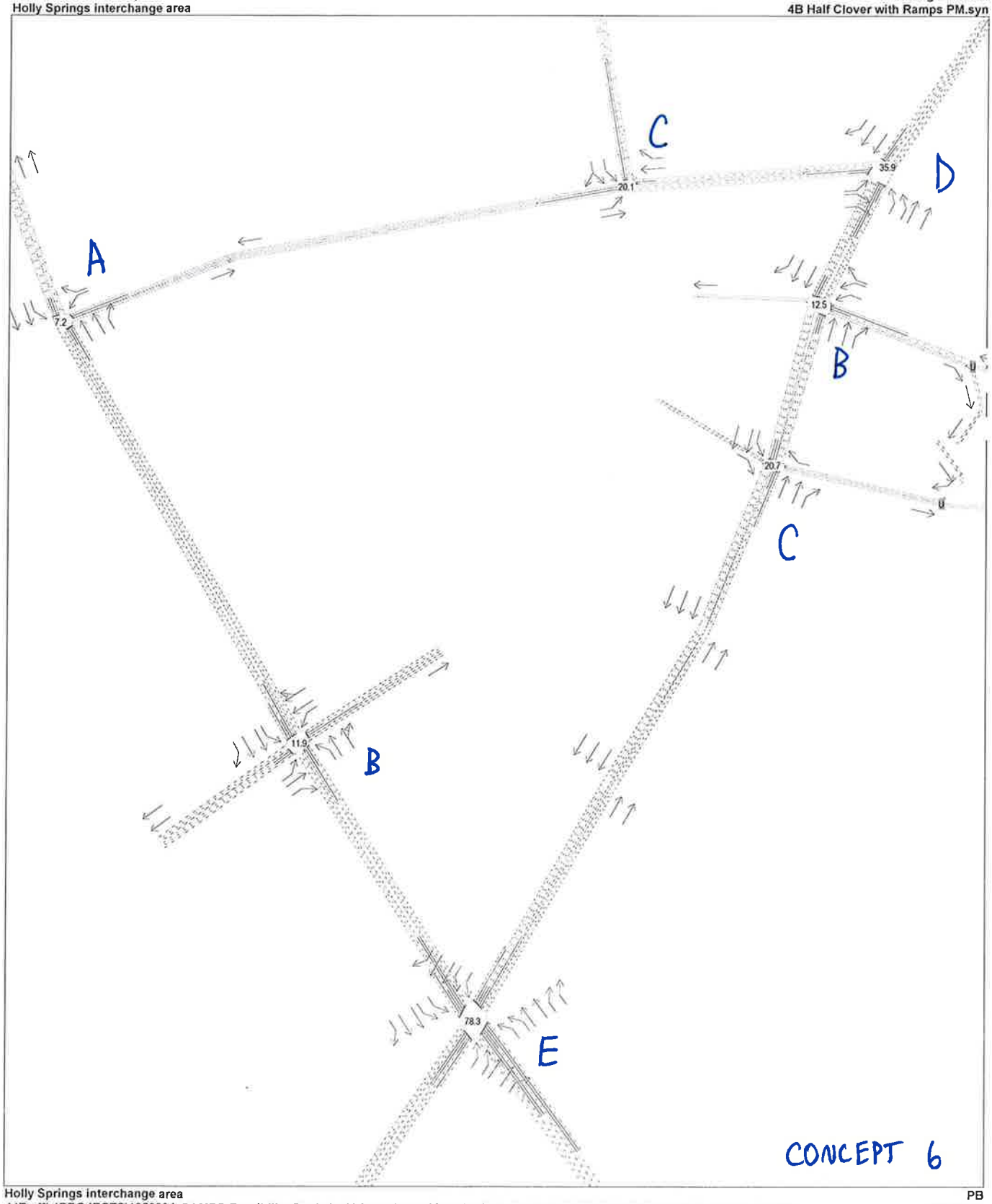

Four Lane Diamond
Holly Springs interchange area
Timing Plan: PM
1A Diamond 4-In PM.syn
A
5.4
D
36.7
C
32.0
D
49.9
D
46.9
A
9.8
E
76.4
CONCEPT 1
Holly Springs interchange area
J:\Traffic\PROJECTS\185290A CAMPO Feasibility Study I-540 Interchange\Synchro\PM SS 06-21-2013\1A Diamond 4-In PM.syn
PB
6/24/2013

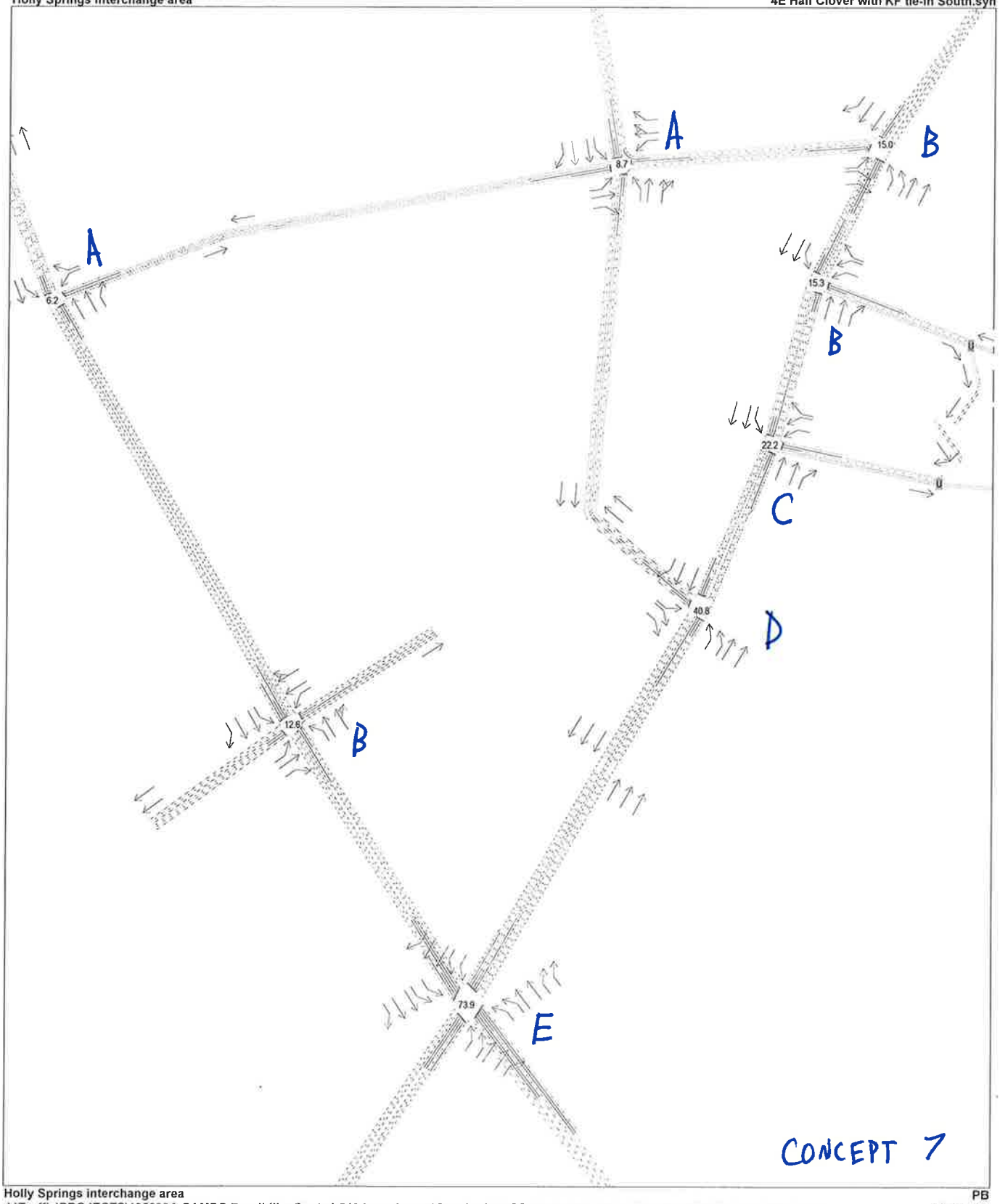

D
C
A
C
C
A
E
6.4
43.4
31.4
20.0
20.6
9.9
66.1
CONCEPT 2

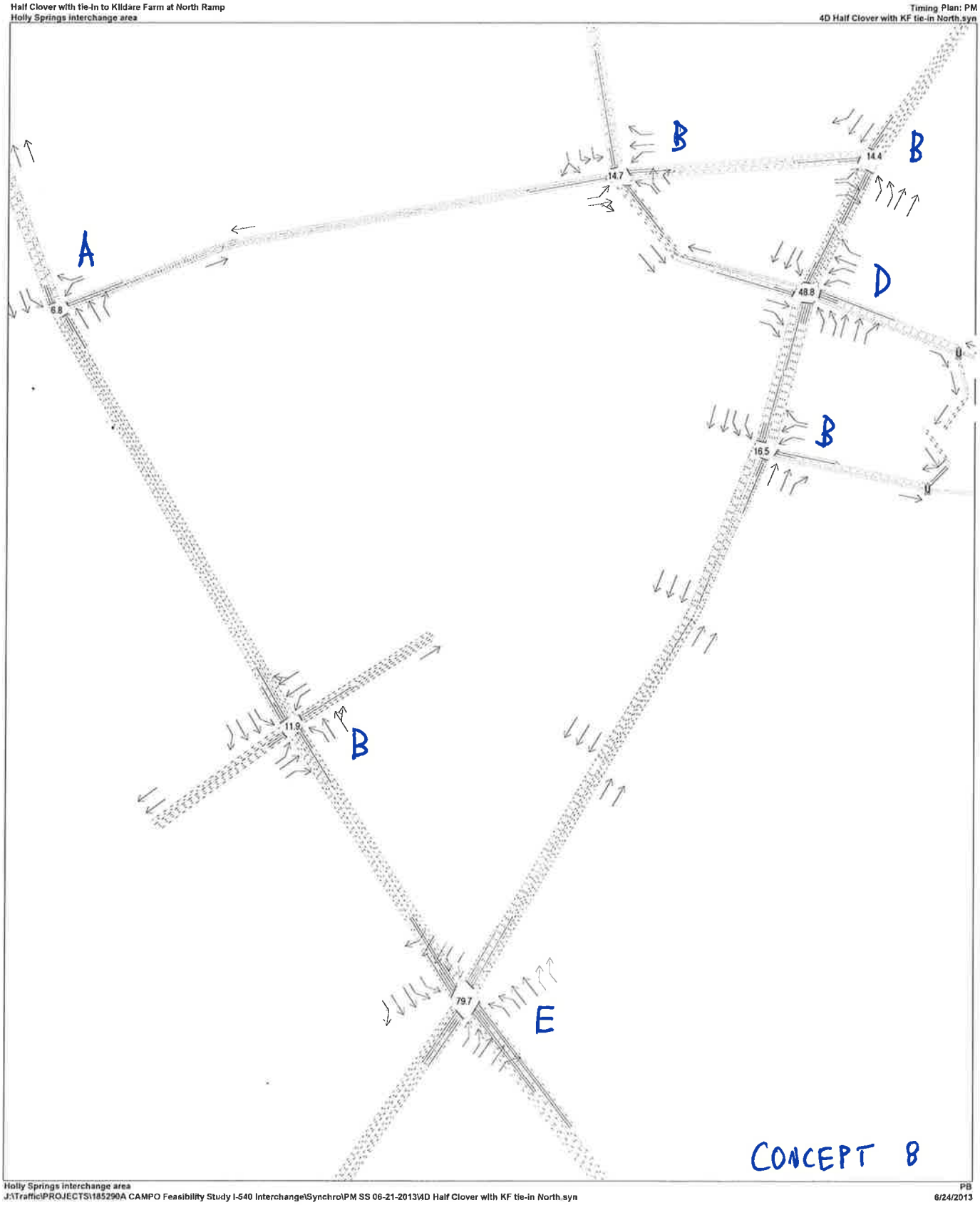

A
B
17.0
D
37.9
F
95.8
61.3
1.7
F
165.8
9.7
B
12.5
E
75.1
CONCEPT 3


A
B
C
C
C
B
E
7.2
15.1
22.0
29.4
20.9
1.4
20.4
9.7
12.0
77.9
CONCEPT 1


A
7.3
C
20.1
C
32.7
B
14.4
C
26.9
B
11.9
E
78.5
CONCEPT 5


A
C
D
B
C
B
E
7.2
20.1
35.9
12.5
20.7
11.9
78.3
CONCEPT 6


A
A
8.7
B
15.0
A
6.2
B
15.3
C
22.2
D
40.8
B
12.6
E
73.9
CONCEPT 7


Half Clover with tie-in to Kildare Farm at North Ramp
Holly Springs interchange area
Timing Plan: PM
4D Half Clover with KF tie-in North.syn
A
B
B
D
B
B
E
6.8
14.7
14.4
48.8
16.5
11.9
79.7
CONCEPT 8
Holly Springs interchange area
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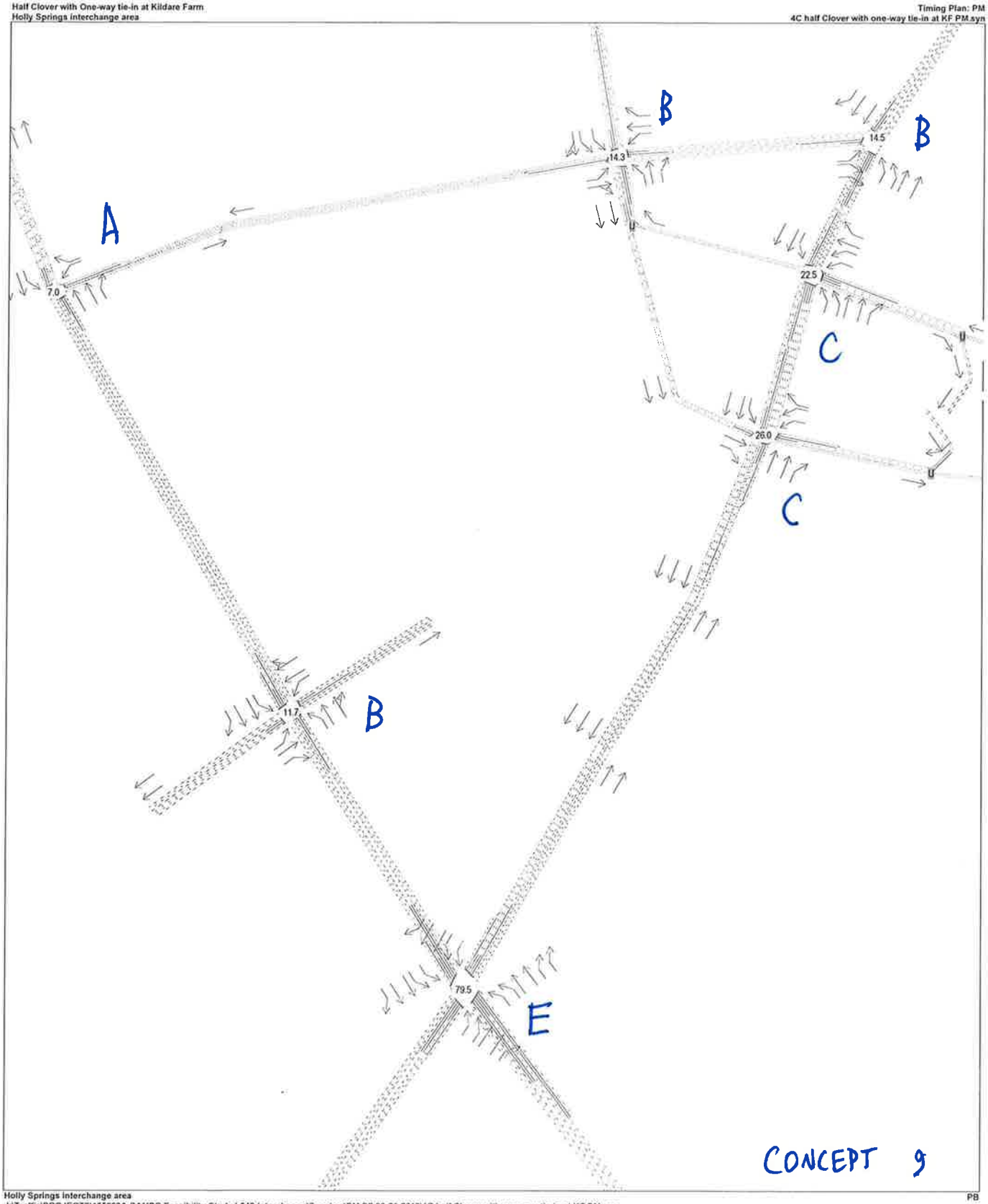
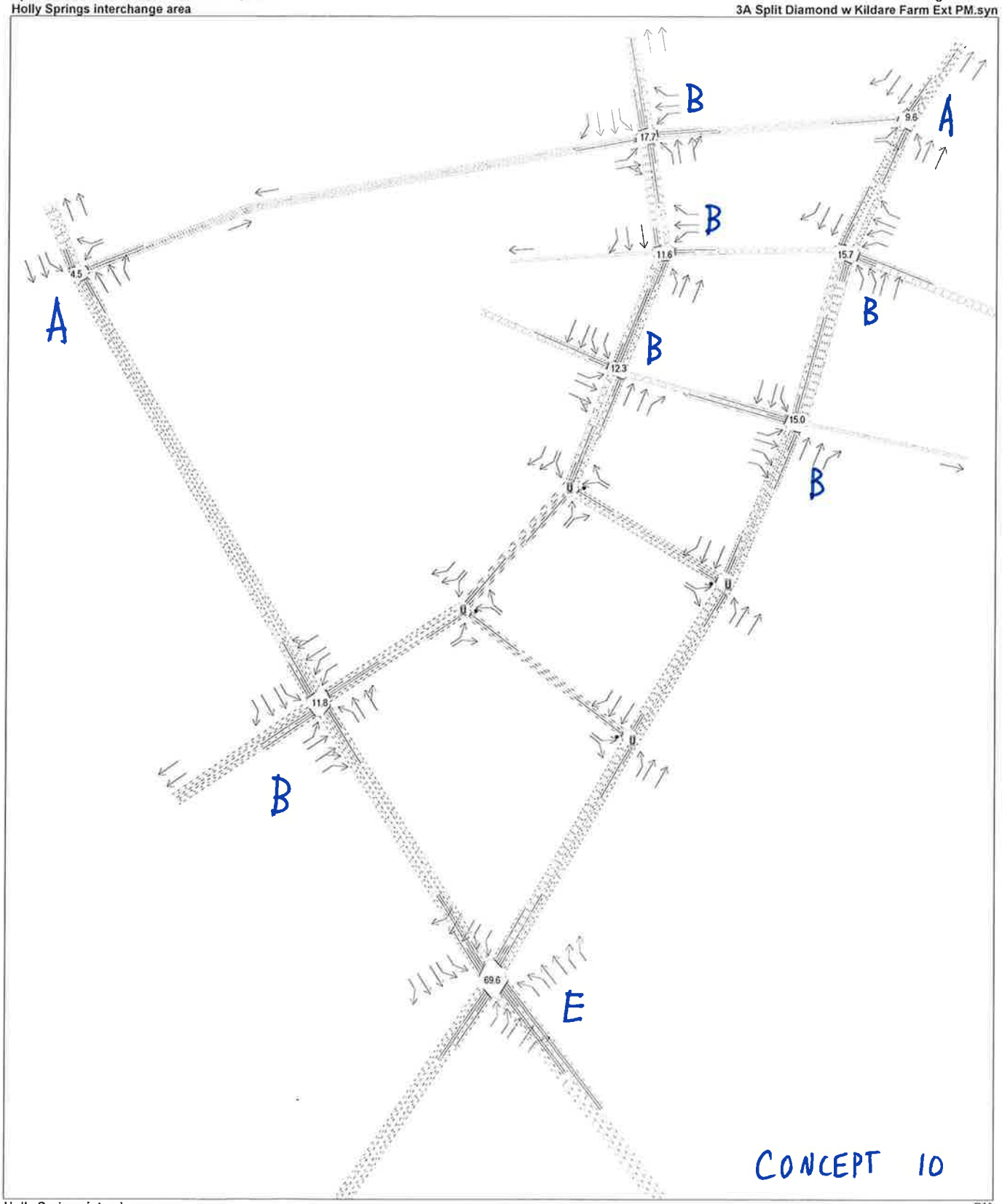
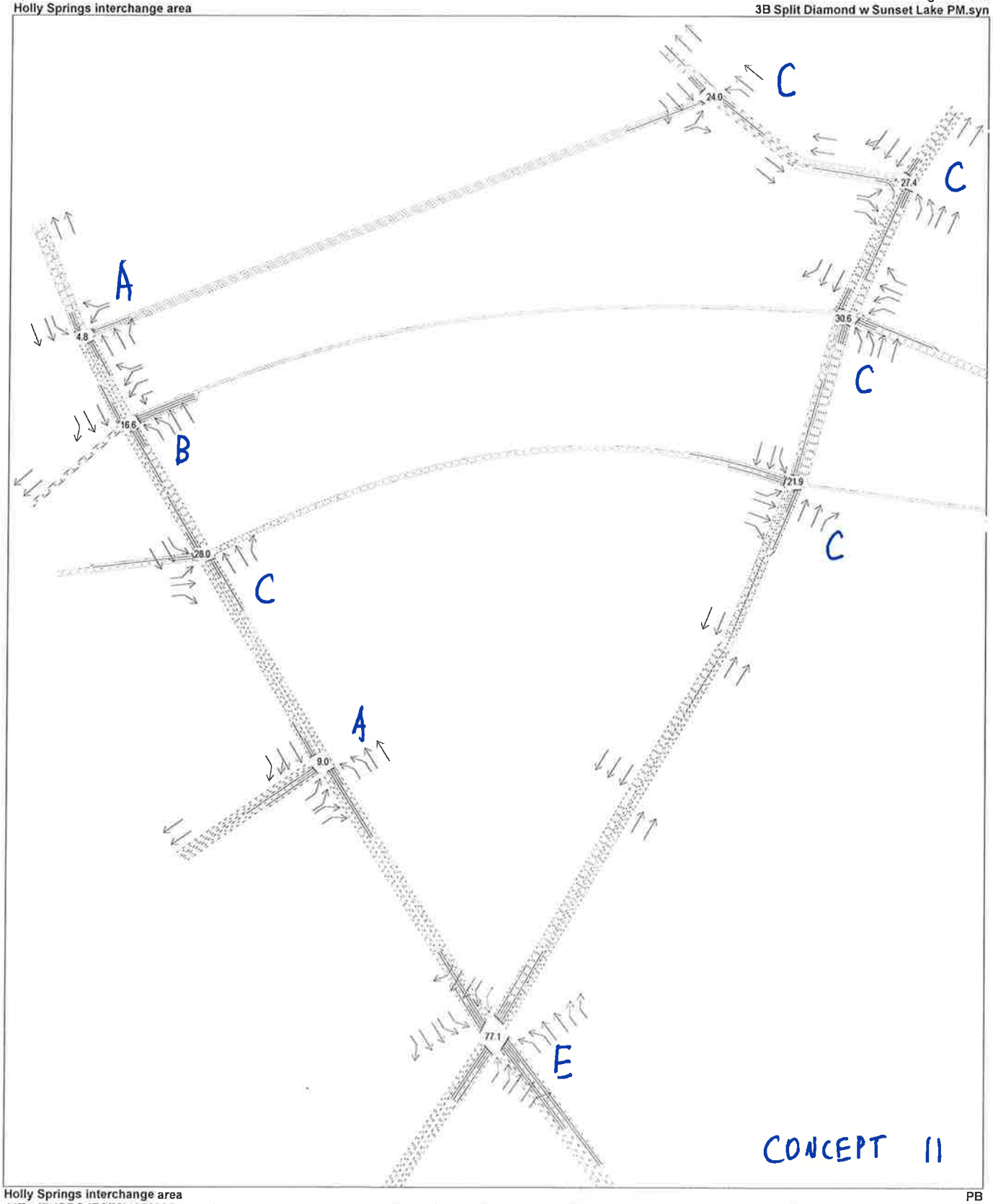
PB
6/24/2013


Half Clover with One-way tie-in at Kildare Farm
Holly Springs interchange area
Timing Plan: PM
4C half Clover with one-way tie-in at KF PM.syn
A
B
B
C
C
B
E
7.0
14.3
14.5
22.5
26.0
11.7
79.5
CONCEPT 9
Holly Springs interchange area
J:\Traffic\PROJECTS\185290A CAMPO Feasibility Study I-540 Interchange\Synchro\PM SS 06-21-2013\4C half Clover with one-way tie-in at KF PM.syn
PB
6/24/2013


B
A
9.6
17.7
B
11.6
15.7
A
4.5
B
B
12.3
15.0
B
11.8
B
69.6
E
CONCEPT 10


A
B
C
A
C
C
C
C
E
4.8
16.6
28.0
9.0
24.0
27.4
30.6
21.9
77.1
CONCEPT 11

FUTURE NC 540 GRADE SEPARATION & INTERCHANGE TECHNICAL ASSESSMENT

APPENDIX D
CAMPO TYPICAL SECTIONS

Table of Contents

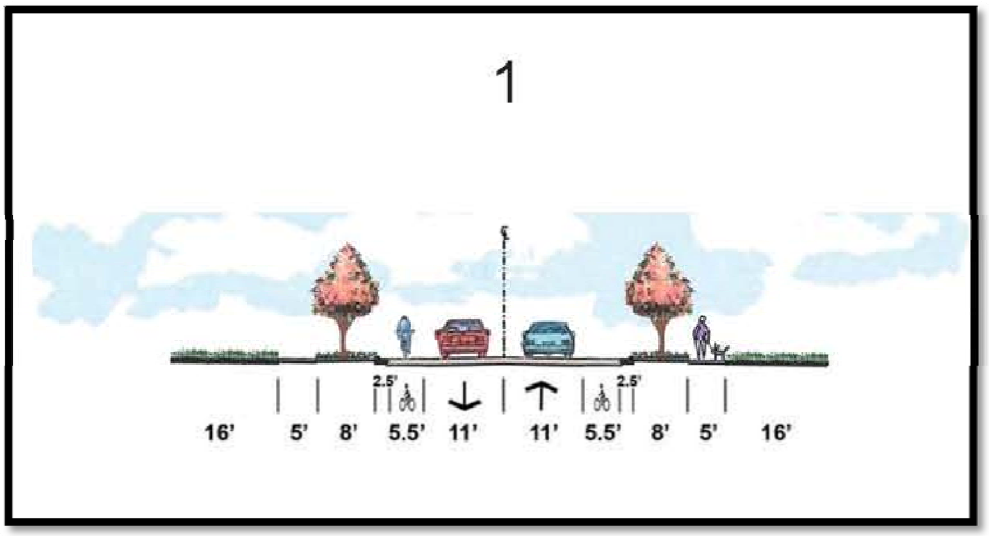
TWO & THREE LANE TYPICAL SECTIONS.....D-1
FOUR LANE TYPICAL SECTIONS.....D-3
SIX LANE TYPICAL SECTIONS D-6

Note:

1. For recommended cross sections on this project, it is assumed that a standard lane width of 12 feet is applied for all sections.

2. The Capital Area MPO has adopted universal access and complete street policies. Therefore, it is anticipated that all crossings will be examined independently as part of the design project by applying Complete Streets practices to evaluate and provide appropriate bicycle and pedestrian improvements unless demonstrated to be impracticable.

1



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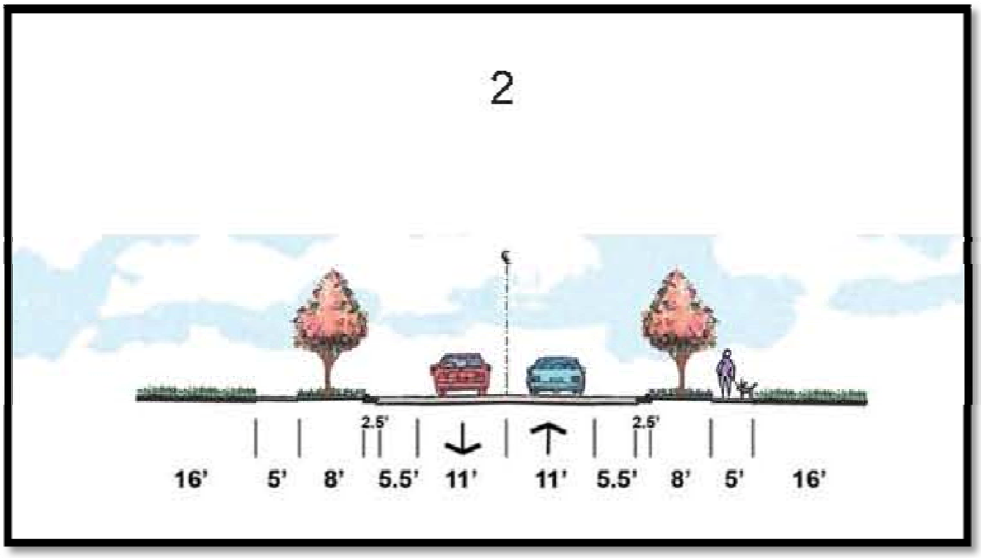

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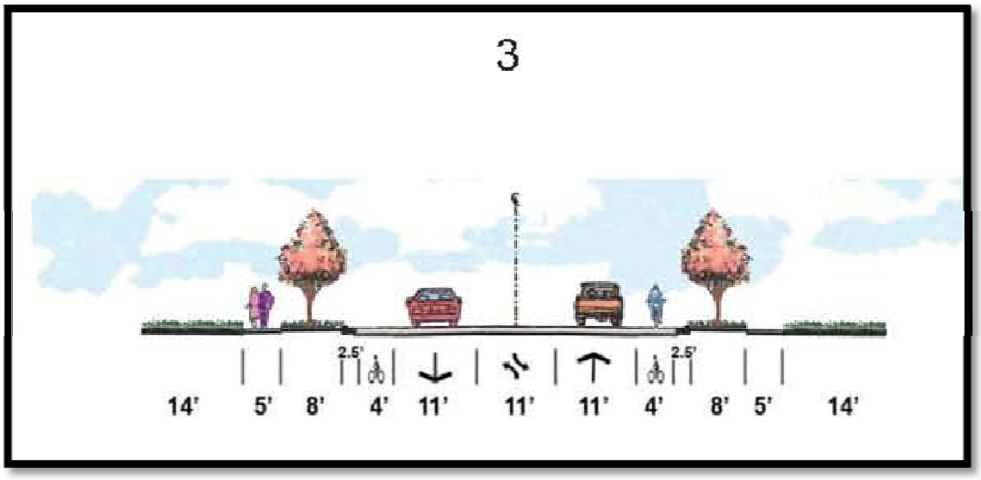
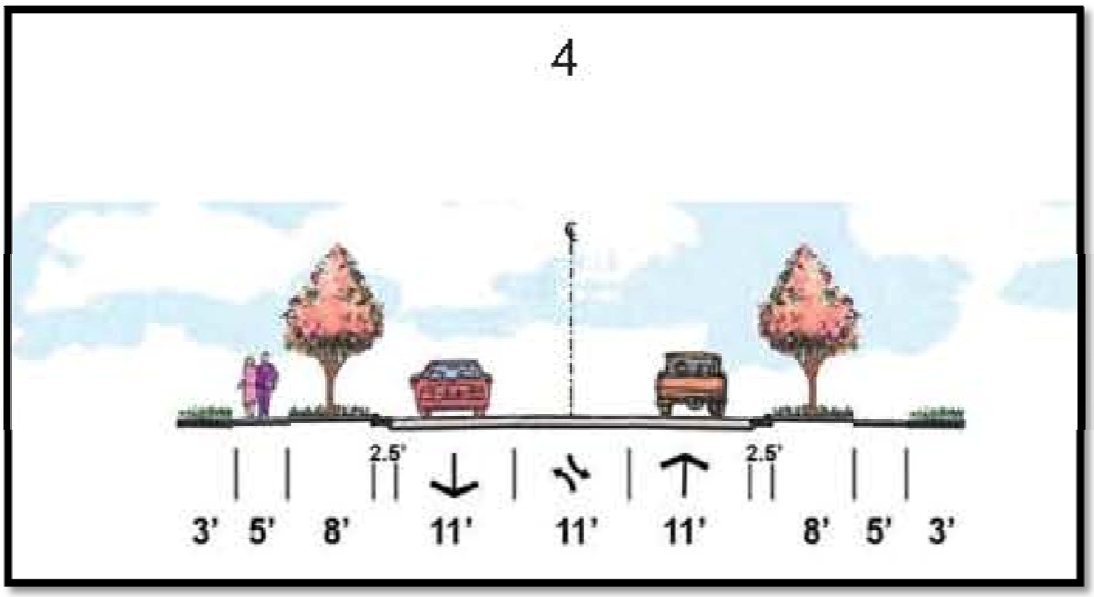
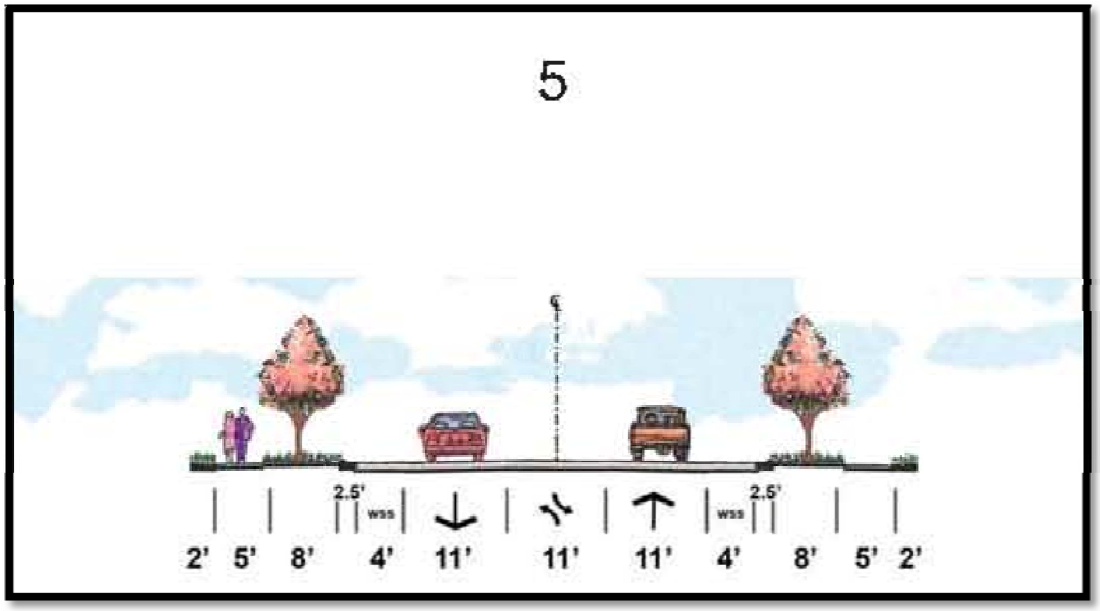


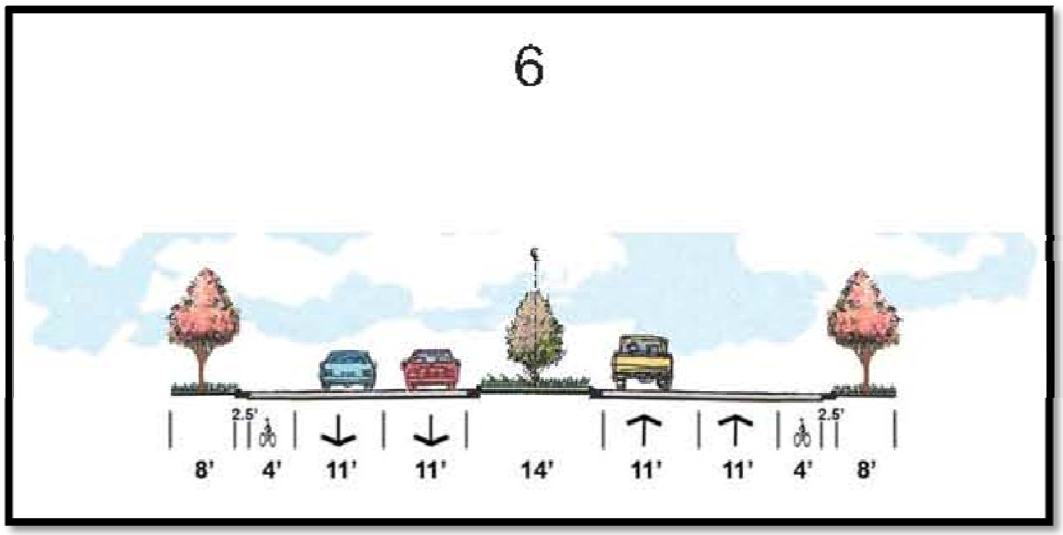
Note: For recommended cross sections for this project, it is assumed that a standard lane width of 12 feet is applied for all typical sections.





Note: For recommended cross sections for this project, it is assumed that a standard lane width of 12 feet is applied for all typical sections.

6



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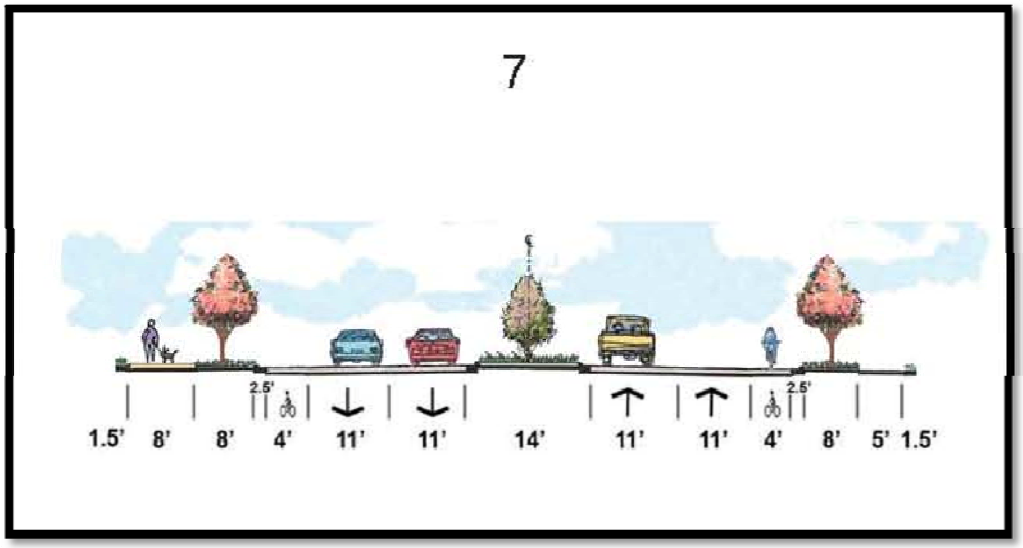

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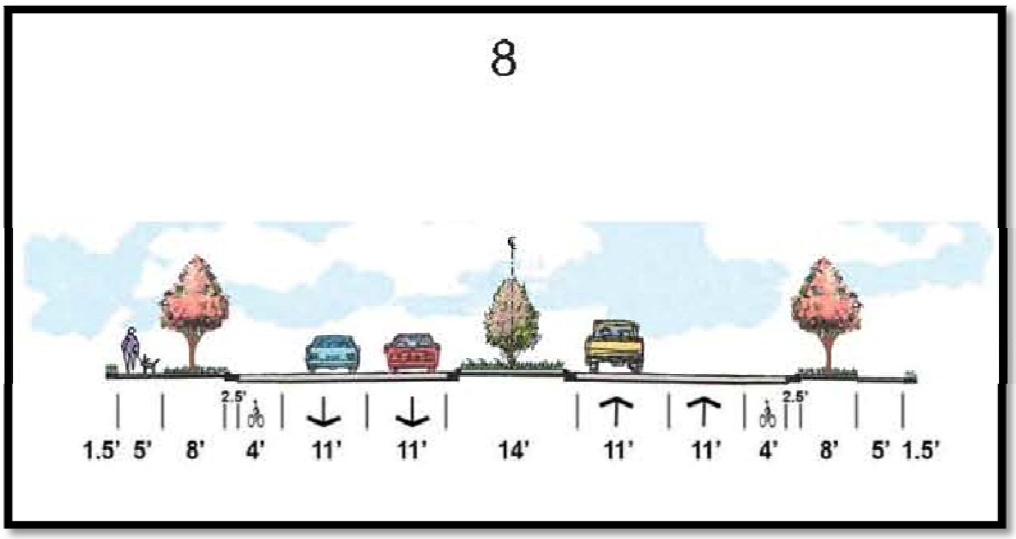
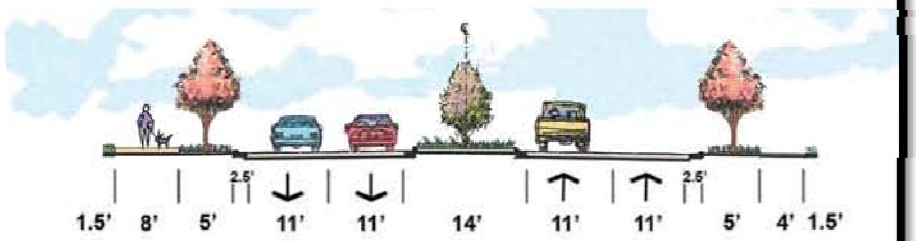


Note: For recommended cross sections for this project, it is assumed that a standard lane width of 12 feet is applied for all typical sections.

9



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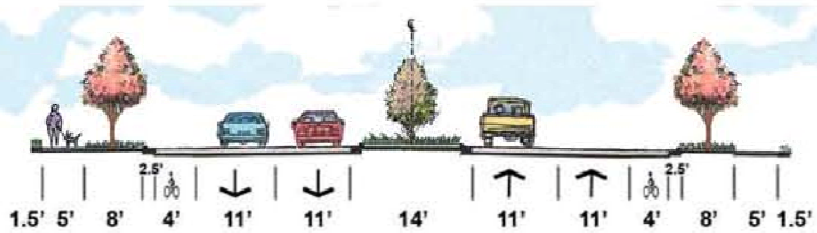

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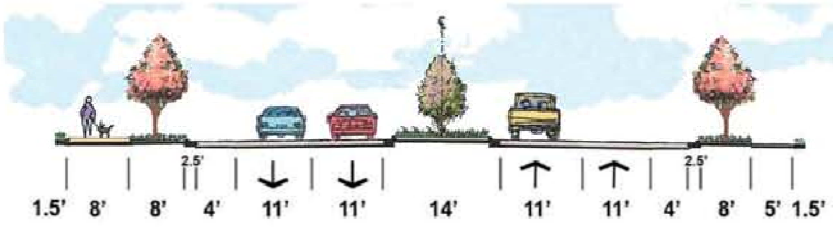
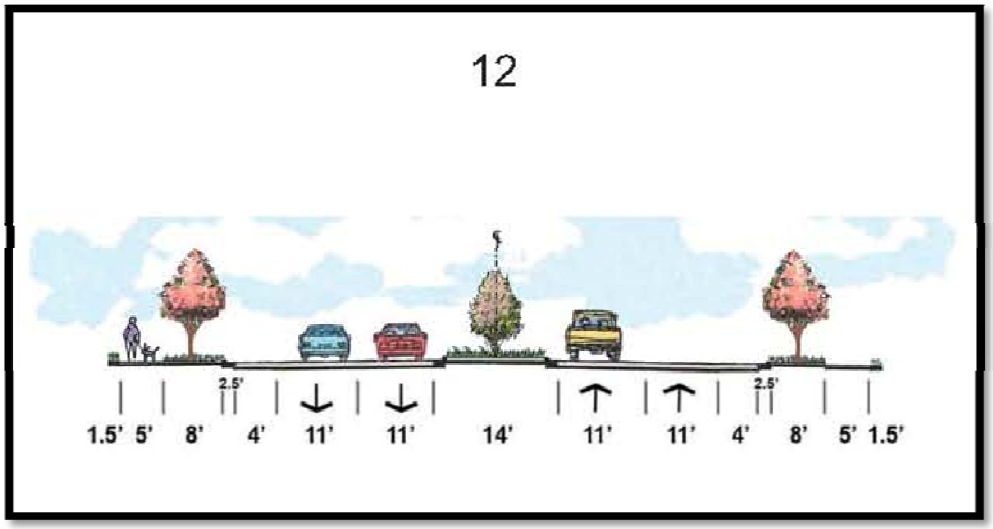
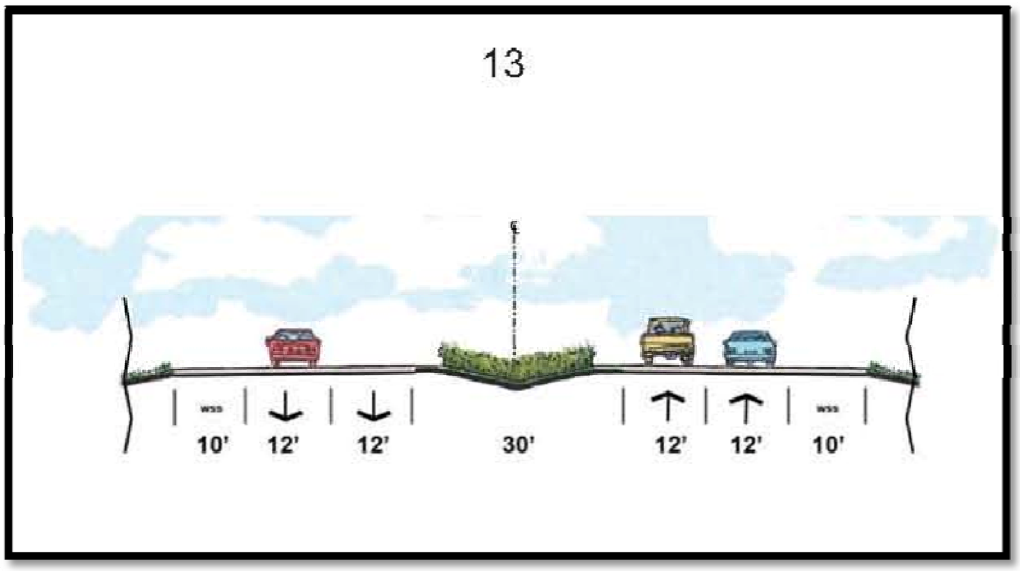
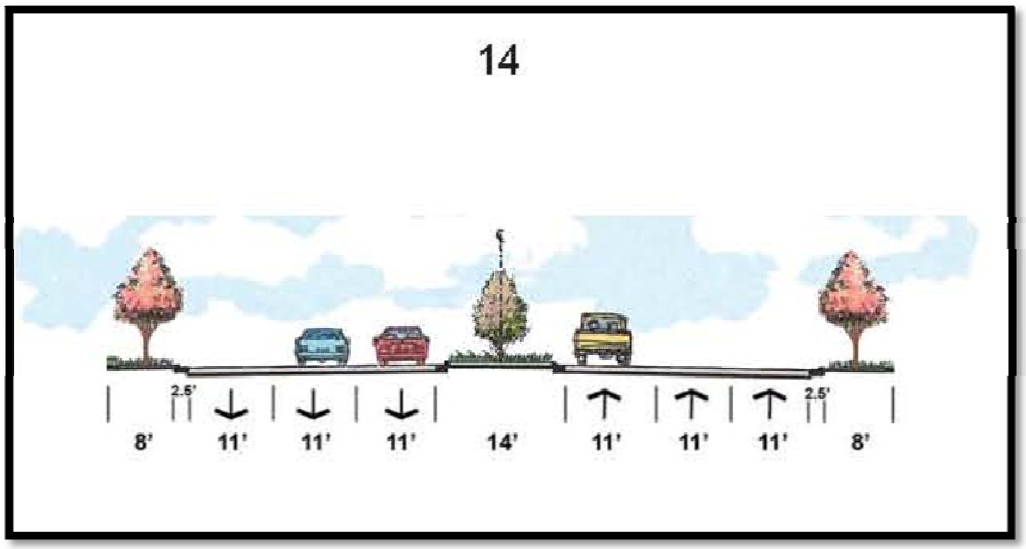


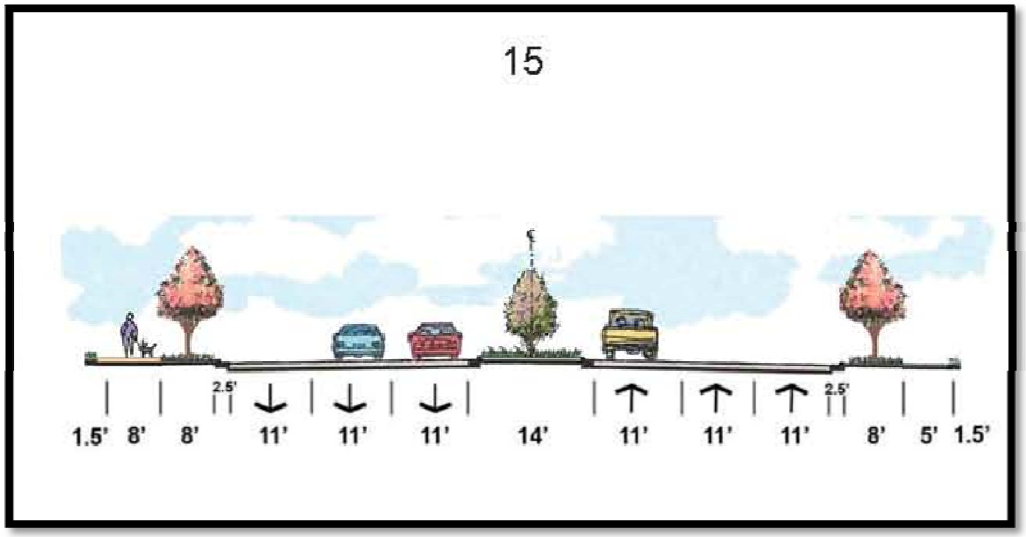
Note: For recommended cross sections for this project, it is assumed that a standard lane width of 12 feet is applied for all typical sections.

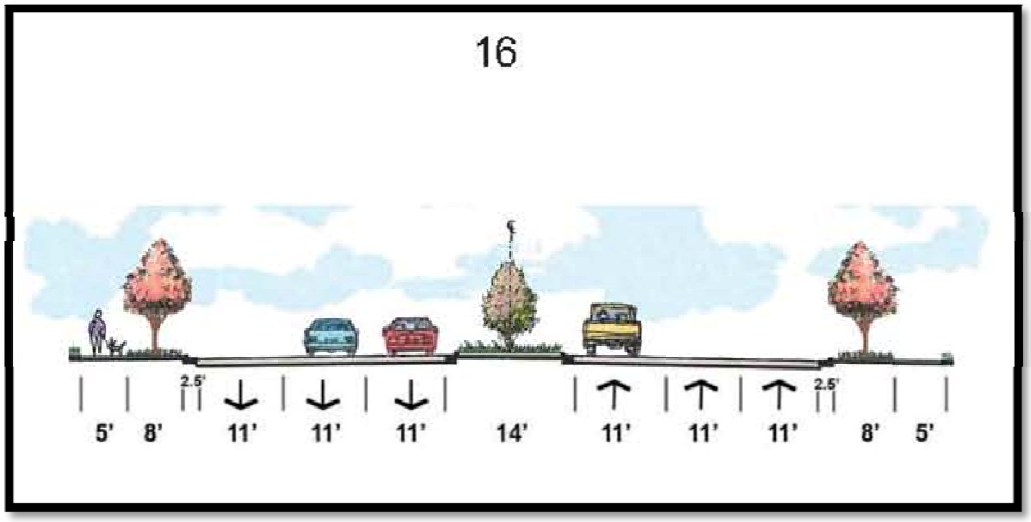




Note: For recommended cross sections for this project, it is assumed that a standard lane width of 12 feet is applied for all typical sections.







Note: For recommended cross sections for this project, it is assumed that a standard lane width of 12 feet is applied for all typical sections.