Hydraulic Aspects Report

Independence Boulevard Extension

Randall Parkway to US 74 (Martin Luther King Jr. Parkway)
City of Wilmington, New Hanover County, North Carolina
State Transportation Improvement Program Project No. U-4434

JUNE 2014

Prepared For:
North Carolina Department of Transportation
Project Development and Environmental Analysis
Prepared By:
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Project Description

The North Carolina Department of Transportation (NCDOT) is proposing to construct a multi-lane facility on new location in New Hanover County, North Carolina. The proposed project is designated in the Draft 2012-2018 NCDOT State Transportation Improvement Program (STIP) as STIP Number U-4434 and described as "Independence Boulevard Extension, Randall Parkway to Martin Luther King Jr., Parkway; multi-lanes on new location.

The proposed 1.7-mile long project would be an extension of existing Independence Blvd (SR 1209) from the intersection with Randall Parkway and Mercer Avenue northward to Martin Luther King Jr. Parkway (US 74). The extension will carry over Burnt Mill Creek as well as over two tributaries to Smith Creek. The proposed project would include an interchange linking the new extension with US 74, just south of Wilmington International Airport. The existing Independence Bouldevard is classified as a Minor Arterial. Final design of Independence Blvd extension would provide a roadway classification of Urban Arterial-Freeway/Blvd.

The hydraulic analysis in this report is based on the proposed -L-, –Y20-, and –Y25- alignment of Build Alternate 2.

Description of Major Hydraulic Crossings

For the preliminary hydraulic assessment, five hydraulic crossings, four requiring a 72-inch diameter pipe or larger, were identified for this report during a preliminary field investigation performed January 19, 2012. There are no USGS Stream Gage sites nearby, however a detailed flood study has been completed for Smith Creek and Burnt Mill Creek. Applicable pages of the Flood Insurance Study (FIS) are included in the appendix of this report.

Crossing #1

Crossing 1 consists of a proposed new location over an unnamed, jurisdictional tributary to Smith Creek. An elevated sanitary sewer line and several access manholes are the only visible infrastructure existing. The site is surrounded by an up to 275-foot wide area of delineated wetland with multiple tributaries in the surrounding area. An approximate water depth of four feet was measured, at the time of the field visit. Due to inaccessibility, the width of the existing channel was not measured. Existing vegetation consisted of a combination of thick brush and trees. The drainage area for this proposed crossing is approximately 234 acres or 0.37 square miles. A plan view of the crossing is included in Appendix B.

A portion of Crossing 1 lies within the backwater of the Smith Creek FEMA detailed study base flood boundary limits. There is no existing FEMA flood study at the crossing location; therefore no FEMA involvement would be required. Due to the amount of fill associated with the proposed design and the narrowing of the existing flow path, changes to the existing landscape may result in changes to the existing flood boundaries. A submittal to NCFMP/FEMA would not be required for changes to existing flood boundaries.

Approximately 0.6 miles downstream, at the confluence of the tributary and Smith Creek, Smith Creek is jurisdictional surface water classified as a C (Aquatic Life, Secondary Recreation, Fresh) and Sw (Swamp Water) surface water.

No major upstream structure was identified. Approximately 0.4 miles downstream is Crossing 3, four (4) 72-inch circular reinforced concrete pipes (RCPs) and one 9-foot (span) by 6-foot

(height) reinforced concrete box culvert (RCBC) with wing walls carrying the unnamed tributary flow beneath US74.

Crossing #2

The existing culvert beneath Independence Boulevard at the intersection with Randall Parkway and Mercer Avenue utilizes a double 12-foot (span) by 10-foot (height) RCBC to carry the flow of Burnt Mill Creek. Wingwalls extend past the opening on the upstream and downstream sides. The existing structure appeared to be in good condition. Further details can be seen in the field schematic in the Appendix. The existing downstream channel measured with an approximate 20' base width, 33' top width, 9' channel depth, and 3' flow depth. Water appeared to flow primarily through the northern barrel and was measured to be approximately one foot deep from the culvert invert. A high water mark was noted approximately five feet up from the culvert invert. The stream banks appeared vegetated and stable with little scour or erosion. A small channel flowing to Burnt Mill Creek was noted near the south wingwall, upstream of the existing culvert. Approximately 110 feet downstream of the existing culvert is a small drainage ditch carrying runoff from the north. An exposed sanitary sewer pipe crosses the stream at a location approximately 130 feet upstream of the box culvert as well as at another location approximately 150 feet downstream. No wetlands have been delineated at this crossing. The drainage area to the existing culverts at Crossing 2 is approximately 2060 acres or 3.2 square miles. A plan view of the crossing is included in the Appendix.

Burnt Mill Creek is jurisdictional surface water classified as a C (Aquatic Life, Secondary Recreation, Fresh) and Sw (Swamp Water) surface water, and is also listed as a Category 5, 303d impaired water for poor bioclassification.

Approximately one mile upstream is NCDOT Bridge Management structure number 640138, a 10-foot (span) by 4-foot (height) RCBC at Winston Boulevard crossing Downey Branch. Approximately one mile downstream is NCDOT Bridge Management structure 640038, a 14-foot (span) by 4.75-foot (height) steel arch culvert at Metts Avenue crossing Burnt Mill Creek.

This crossing is located within the flood limits of FEMA Revised or Newly Studied by detailed methods for Burnt Mill Creek. Any modifications to the existing culvert may result in changes to the existing flood boundaries.

Crossing #3

Located approximately 0.4 miles downstream of Crossing 1, Crossing 3 consists of a pipe -box culvert combination carrying an unnamed tributary flowing to Smith Creek beneath US74 (Martin Luther King Jr. Parkway). The proposed new alignment would likely require an extension of each culvert at this location. Presently, the crossing consists of four (4) 72-inch circular RCPs and a RCBC with wing walls with an opening measuring approximately 9-foot (span) by 6-foot (height). The RCBC contained approximately 1-foot of sediment within the box. The box/pipe combination spans an estimated 94 feet in total width on the upstream side and 81 feet in total width on the downstream side. The culverts have an overall length of approximately 205 feet perpendicular to US74. The existing culverts appeared to be in good condition. See drawing in the appendix for placement details.

Wetlands with a width of 160 feet are present upstream and downstream of the culverts, and will be impacted by the proposed construction. Upstream, minor erosion is seen on the channel banks but the banks are generally stable with thick vegetation within the floodplain. Downstream, there

is evidence of minor erosion in the channel banks but the banks appear stable with trees growing within the channel limits with a heavily wooded floodplain. Low flow appears to move primarily through the box culvert. The existing downstream channel was measured with approximately an 18' bottom width, 200' overall top width, and 15' channel depth. At the time of the field visit, the water depth at the deepest point in the upstream channel was approximately 2 feet. Visible high water marks appeared to be approximately 3-4 feet deep in the circular conduits. Scour was not visible. Debris potential is moderate to high in this area as evidenced by the numerous branches present at the pipe culverts. The box culvert does not experience the same degree of debris potential due to its size.

Upstream of Crossing 3 is a wide floodplain consisting of existing wetlands. The proposed interchange alignment will impact these wetlands. Significant impacts are likely. Photos can be seen in the appendix. The drainage area for this crossing is approximately 394 acres, or 0.63 square miles.

Crossing 3 lies within the backwater of the Smith Creek FEMA detailed study base flood boundary limits. There is no existing FEMA flood study at the crossing location; therefore no FEMA involvement should be required. Due to the amount of fill associated with the proposed design and the narrowing of the existing flow path, these changes may result in changes to the existing flood boundaries. A submittal to NCFMP/FEMA would not be required for changes to existing flood boundaries.

No major upstream structure was identified. Approximately 0.1 miles downstream is the confluence of the tributary and Smith Creek.

Crossing #4

One half mile east of Crossing 3 is Crossing 4. The crossing carries a tributary that flows toward Smith Creek. Presently, there is an existing cross pipe beneath Martin Luther King Jr. Parkway consisting of a single 42-inch RCP. It is estimated to be 225 feet long. This pipe will likely need to be extended to the north to accommodate the proposed interchange. Wetlands have been identified upstream and downstream of the culvert. The upstream end was inaccessible, but the downstream end of the culvert was open with few signs of erosion downstream. The banks downstream were vegetated and stable. The distance between top of banks is approximately 6 feet. The water depth was measured to be 1.5 feet at the time of the site visit. Layout details can be found in the appendix. Although no significant debris was seen at the time of the field visit, debris potential is considered moderate to high due to the relative size of the hydraulic opening and highly vegetated banks. The drainage area for this crossing is approximately 42 acres, or 0.07 square miles.

No major upstream structure was identified. Approximately 0.3 miles downstream is the confluence of the tributary and Smith Creek.

Crossing #5

Located approximately 0.5 miles southwest of Crossing 3 is Crossing 5, a proposed new location crossing. The crossing carries a tributary that flows toward Smith Creek. The channel is bordered by a steep slope with an estimated height of about 25 feet. Due to inaccessibility, existing channel dimensions were unable to be obtained. Existing vegetation consisted of a combination of thick brush and trees. The drainage area for this proposed crossing is approximately 422 acres or 0.66 square miles. A plan view of the crossing is included in the Appendix.

Wetland limits and stream channels were delineated in 2012. These delineations show a different stream channel alignment along the west side of 26th Street than is shown on the current USGS Quad map and New Hanover County Environmental Sensitivity Map. The 2012 stream delineation lines can be seen on the Location and Drainage Area Maps.

Approximately 700 feet downstream of the proposed crossing is a 4-foot (span) by 6-foot (height) RCBC with wing walls under Martin Luther King Junior Parkway. No major upstream structure was identified. There is a confluence with another small channel from the west approximately 65 feet south of the proposed -Y25- alignment.

Crossing 5 lies within the backwater of the Smith Creek FEMA detailed study base flood boundary limits. There is no existing FEMA flood study at the crossing location; therefore no FEMA involvement should be required. Due to the amount of fill associated with the proposed design and the narrowing of the existing flow path, these changes may result in changes to the existing flood boundaries. A submittal to NCFMP/FEMA would not be required for changes to existing flood boundaries.

Hydraulic Recommendations for Proposed Major Crossings

Based on a preliminary hydraulic analysis in conjunction with a field reconnaissance of the site, the following proposed structures are recommended:

- *Crossing 1* – Spanning a tributary to Smith Creek at Independence Boulevard new location, a single 9-foot (span) by 8-foot (height) RCBC buried 1-foot with wingwalls approximately 260 feet in length is recommended. The slope of the proposed culvert should be set to match the existing stream channel. Hydraulic sizing of the culvert for the 25-year design storm was made by setting the culvert headwater depth to culvert opening height to 1.2 and adding 1 foot to the required hydraulic depth for bury. The recommended skew is 60 degrees with the Alternate 2, -L- alignment and 65 degrees with the proposed interchange ramp alignment. A plan view was prepared for this crossing and is included in Appendix C.

- *Crossing 2* – Spanning Burnt Mill Creek at the intersection of Independence Boulevard and Randall Parkway, an extension of the existing double barrel 12-foot (span) by 10-foot (height) RCBC with 1-foot buried 35 feet on the upstream end and 60 feet on the downstream end is recommended as a modification to the existing culvert. The existing culvert can accommodate the calculated peak flow of the 50-year storm with a headwater to depth ratio of 1.15. A plan view for this crossing and a field sketch of the existing culvert are included in the Appendix.

  The proposed -Y1- alignment on the west side of the -L- alignment was not considered in the design assessment of Crossing 2. Should the -Y1- alignment be included in the proposed design, an additional 250 feet of culvert extension or a bridge structure will be needed.

- *Crossing 3* – Spanning a tributary to Smith Creek, the existing culverts provide sufficient flow capacity to pass the peak flow of the 50-year storm. The proposed slope stake lines of the alignment –MLK_FLY_DB- encroach upon the stream limits on the upstream end of the crossing. Therefore, utilizing a junction box and extension of the southernmost 72”

RCP and extension of the RCBC and three 72" RCP culverts is recommended for this crossing beneath Martin Luther King Jr. Parkway. A 58-foot extension of the southernmost 72" RCP, a 35-foot extension of the RCBC, and a 20-foot extension of the triple 72" RCP culverts on the upstream end is recommended to allow for the proposed increase in roadway width. The slope and skew of the RCBC and triple 72" RCP extensions should match the existing structures. The proposed design would likely incorporate a beveled edge on the RCBC and headwalls on the 72" RCPs. The extension of the culverts can accommodate the 50-year storm with approximately a 0.2 foot increase in the headwater depth. Approximately 105 feet of channel realignment will be needed to continue the low flow path to the box culvert. A plan view for this crossing and a field sketch of the existing culvert are included in the Appendix.

- *Crossing 4* – Spanning a tributary to Smith Creek, a culvert extension is recommended for this crossing. However, due to the small proposed drainage area, the future culvert is likely not needed to be larger than 72 inches and its sizing is therefore out of scope at this time.

- *Crossing 5* – Spanning a tributary to Smith Creek at new location, a single 9-foot (span) by 8-foot (height) RCBC buried 1-foot with wingwalls approximately 135 feet in length is recommended. The slope of the proposed culvert should be set to match the existing stream channel. Hydraulic sizing of the culvert for the 50-year design storm was made by setting the culvert headwater depth to culvert opening height to 1.2 and adding 1 foot to the required hydraulic depth for bury. The recommended skew is 105 degrees with the -Y25- alignment. Hydraulic design will also require approximately 150 feet of channel realignment to continue uninterrupted flow. A plan view for this crossing is included in the Appendix.

The proposed design for existing major hydraulic crossings incorporates improvements to existing roadway facilities as well as new location. The length and/or size of the proposed structures are based on preliminary assessments and may be adjusted to accommodate design floods as determined in the final hydrologic study and hydraulic design. Mitigation for wetlands at Crossings 1 and 3 is anticipated. Changes to existing FEMA flood boundaries are anticipated at Crossings 1, 2, 3, and 5.

Table 1. Crossing Summary

Crossing	Location	FEMA Flood Study	Existing Structure	Recommended Structure
1	Sta. 98+18 -ALT2_L-	Backwater	None	1 @ 9' x 8' RCBC w/1' Buried
2	Sta. 14+74 -ALT2_L-	Detailed Study	None	2 @ 12' x 10' RCBC Extension w/ 1' Buried
3	Sta. 35+71 -Y20-	Backwater	1 @ 72" RCP; 1@ 9' x 6' RCBC; 3 @ 72" RCP	1 @ 72" RCP Extension; 1@ 9' x 6' RCBC Extension; 3 @ 72" RCP Extension
4	Sta. 56+54 -Y20-	None	1 @ 42" RCP	NA
5	Sta. 12+26 -Y25-	Backwater	None	1 @ 9' x 8; RCBC w/1' Buried

Additional Considerations

The proposed main roadway alignment has been planned to cross a significant amount of delineated wetland area. Construction will impact wetlands directly adjacent to Crossings 1, 3, and 4. Anticipated environmental impacts should be considered and discussed with the appropriate environmental agencies while preparing the proposed structure and drainage design. Drainage from proposed bridges should be collected and handled such that there is no direct discharge to surface waters.

New Hanover County is a participant in the National Flood Insurance Program, administered by the Federal Emergency Management Agency (FEMA). Based on the most current information available from the NC Floodplain Mapping Program (NCFMP), Crossings 1, 3, and 5 are within the mapped flood boundaries of Smith Creek. Crossing 2 is within mapped floodway limits for Burnt Mill Creek. Copies of the Flood Insurance Rate Maps (FIRMs) for the project site are included in the Appendix. The FIRM illustrates the approximate limits of the 100-year floodplain in the vicinity of the project. The Hydraulics Unit will coordinate with the North Carolina Floodplain Management Program (FMP), the delegated state agency for administering FEMA's National Flood Insurance Program, to determine the status of the project with regard to the applicability of NCDOT's Memorandum of Agreement with FMP, or approval of a Conditional Letter of Map Revision (CLOMR) and subsequent final Letter of Map Revision (LOMR). The division shall submit sealed as-built construction plans to the Hydraulics Unit upon completion of project construction, certifying that the drainage structures and roadway embankment that are located within the 100-year floodplain were built as shown in the construction plans, both horizontally and vertically.

New Hanover County is located in a Coastal Area Management Act (CAMA) county and involves construction activities on or adjacent to a FEMA-regulated stream and jurisdictional wetlands. Therefore, the site is considered to be an Area of Concern (AEC), and is subject to the rules and policies of the Coastal Resources Commission, which administers CAMA.

Siltation of adjacent areas and streams due to project construction should be kept to a minimum with the use and maintenance of the standard erosion control measures and devices. Areas directly adjacent to delineated wetlands and areas directly draining to Burnt Mill Creek may require more stringent erosion control. Existing drainage patterns will be maintained to the extent practicable and groundwater resources will not be affected.

Assessment of Permit Requirements

It is anticipated that this project will require a final Jurisdictional Delineation (JD), 404, Permit and Nationwide Permit 14 from the US Army Corps of Engineers (USACE), a 401 Certificate from NCDWQ, a CAMA Major Permit from the Division of Coastal Management, and a State Stormwater Permit. As a condition of approval of a State Stormwater Permit, stormwater treatment measures (e.g. water quality islands, etc.) may be required and additional right-of-way may need to be acquired as a result.

APPENDIX

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APPENDIX A

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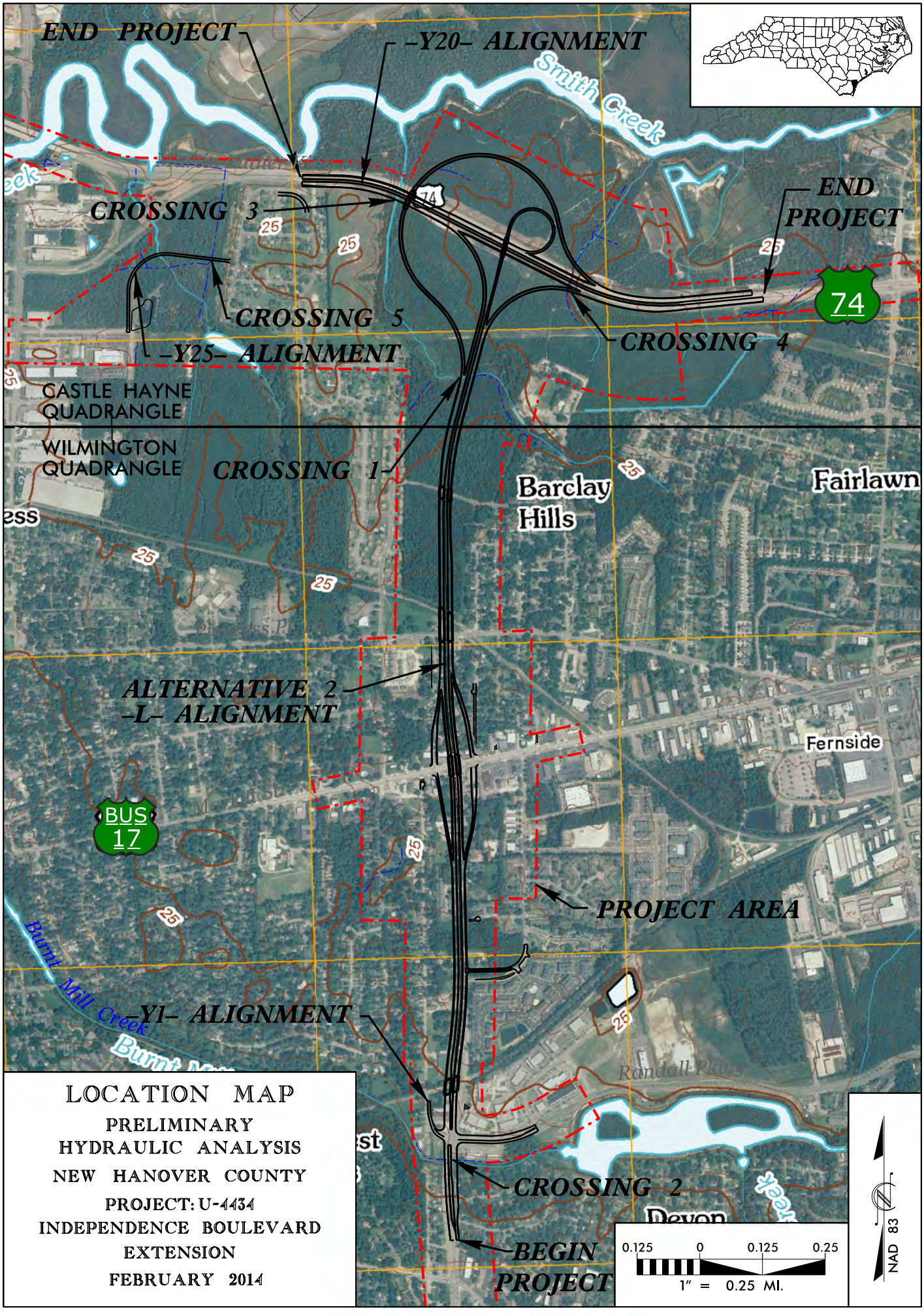

LOCATION MAP

PRELIMINARY
HYDRAULIC ANALYSIS
NEW HANOVER COUNTY
PROJECT: U-4434
INDEPENDENCE BOULEVARD
EXTENSION
FEBRUARY 2014

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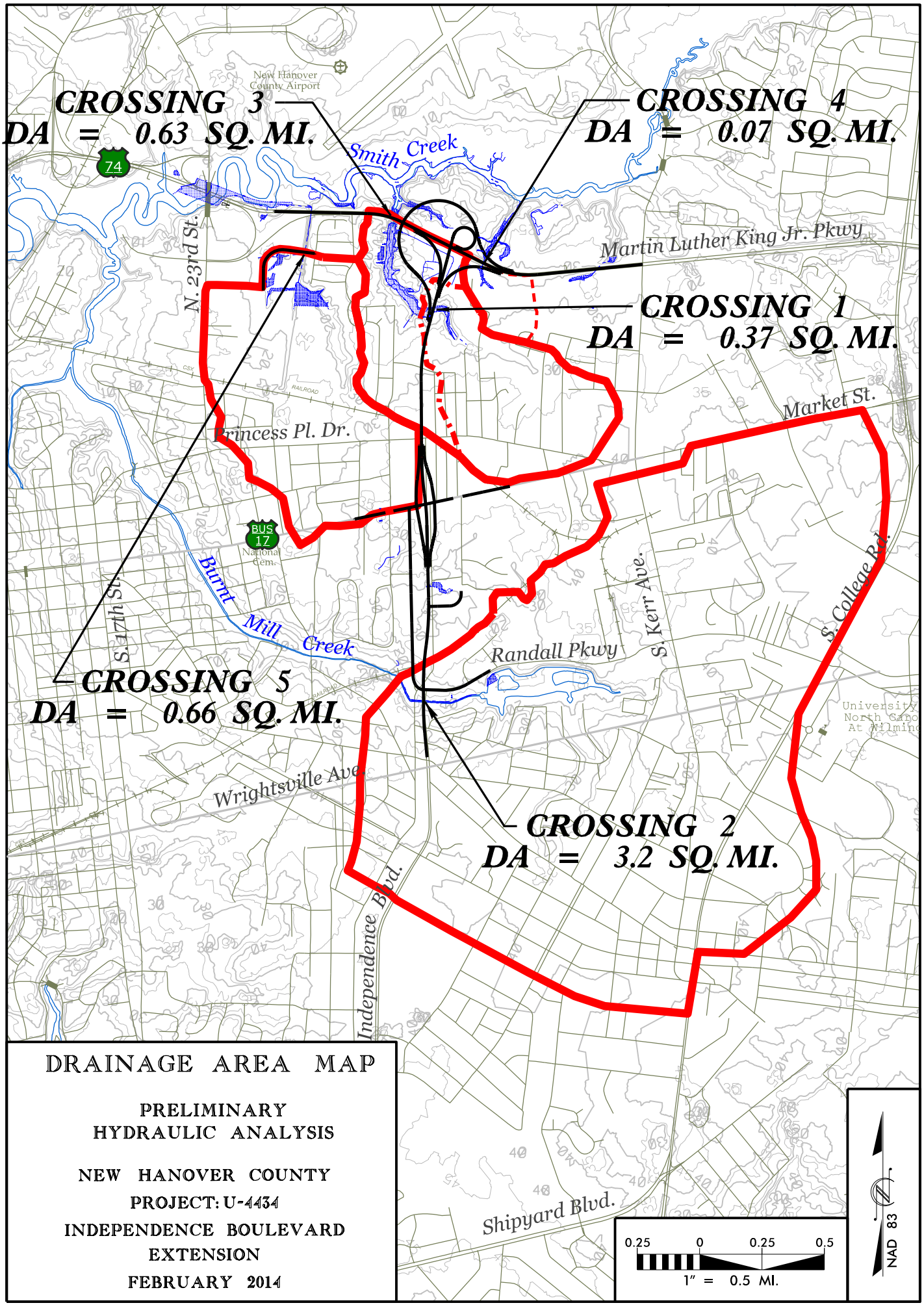

DRAINAGE AREA MAP

PRELIMINARY
HYDRAULIC ANALYSIS

NEW HANOVER COUNTY
PROJECT: U-4434
INDEPENDENCE BOULEVARD
EXTENSION
FEBRUARY 2014

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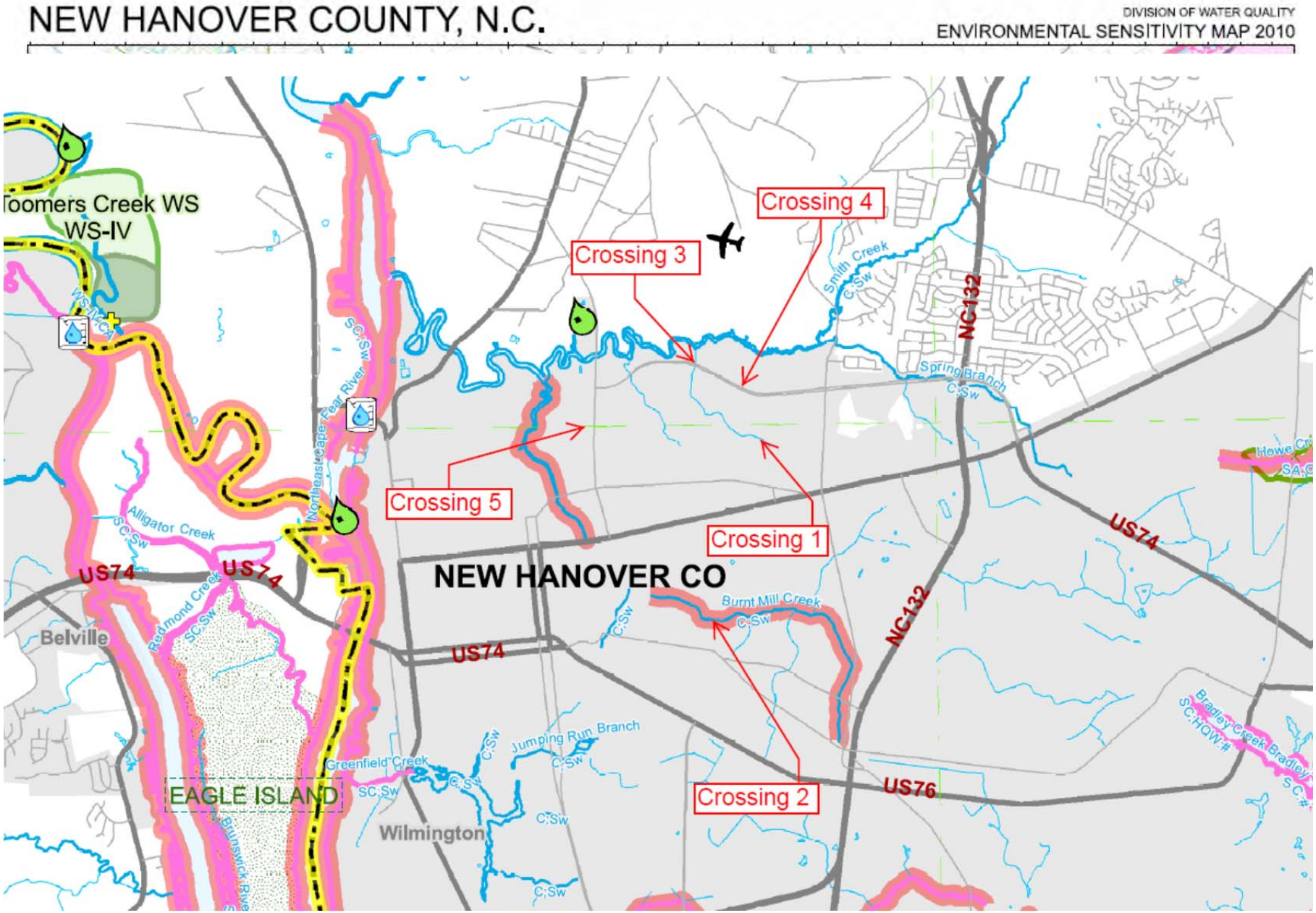
NEW HANOVER COUNTY, N.C.
DIVISION OF WATER QUALITY
ENVIRONMENTAL SENSITIVITY MAP 2010
Toomers Creek WS
WS-IV
Crossing 1
Crossing 2
Crossing 3
Crossing 4
Crossing 5
NEW HANOVER CO
Belville
Wilmington
EAGLE ISLAND
US74
US76
NC132
Alligator Creek
Redmond Creek
Greenfield Creek
Jumping Run Branch
Burnt Mill Creek
Smith Creek
Spring Branch
Northeast Cape Fear River
Brunswick River
Bradley Creek
SC;Sw
C;Sw
SC;HQW

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Name of Stream	Subbasin	Stream Index Number	Map Number	Class
Run Branch	CPF21	18-74-6-2	G27NW5	C;Sw
Russells Creek	CPF17	18-81-5	K26NW9	C;Sw
Ryan Creek	CPF02	16-11-14-2-3	C19SE8	WS-V;NSW
Salt Marsh Ditch	CPF20	18-68-22-1-2-1-1	J25NE6	C;Sw
Salters Lake	CPF16	18-44-4	I24NW6	C
Sand Hill Creek	CPF23	18-74-42-1	I27SE8	C;Sw
Sand Hill Creek	CPF17	18-83	K27SW1	C;Sw
Sandy Branch	CPF12	17-43-16-1	E21NW9	C
Sandy Creek	CPF05	16-41-1-11	C23SW8	WS-V;NSW
Sandy Creek	CPF09	17-16-(1)	D20NW9	WS-III
Sandy Creek	CPF09	17-16-(3.5)	E20NW2	WS-III;CA
Sandy Creek	CPF09	17-16-(4)	E20NW2	C
Sandy Creek	CPF18	18-68-12-6	H24NW3	C;Sw
Sandy Run	CPF09	17-18-1	E20NW6	C
Sandy Run	CPF21	18-74-6.5	G27NW9	C;Sw
Sandy Run	CPF21	18-74-14	G27SE1	C;Sw
Sandy Run Swamp	CPF23	18-74-33-2	I28NE7	C;Sw
Sawyer Branch	CPF21	18-74-13-1	G27SE3	C;Sw
Sawyer Creek	CPF22	18-74-29-5	I27NW4	C;Sw
Schoolhouse Branch	CPF13	18-20-13-8	F22SE3	C
Scotchman Creek	CPF10	17-28.3	F20NE6	C;HQW
Scott Branch	CPF17	18-64-4	J26SW7	C;Sw
Scrub Creek	CPF02	16-18-4.5-(1)	C21NE8	WS-II;HQW,NSW
Scrub Creek	CPF02	16-18-4.5-(2)	C21NE8	WS-II;HQW,NSW,CA
Second Silver Run	CPF13	18-20-33-1	F23SE3	WS-IV
Service Creek (Servis Creek)	CPF02	16-15	C21SW2	WS-V;NSW
Sevenmile Swamp	CPF19	18-68-1-3	G25NW5	C;Sw
Shaddox Creek	CPF07	16-43	E22NE9	WS-IV
Shade Branch	CPF19	18-68-2-11-1	H26SW4	C;Sw
Shaken Creek	CPF23	18-74-33-4	I28SW5	C;Sw
Shelbed Creek	CPF17	18-88-4	L27NW7	SA;HQW
Shelter Swamp Creek	CPF23	18-74-33-2-2	I28SE2	C;Sw
Shinn Creek	CPF24	18-87-25	K27NE5	SA;HQW
Sikes Mill Run	CPF19	18-68-2-10-4	H26NW9	C;Sw
Sills Creek	CPF22	18-74-29-4	I26NE5	C;Sw
Silver Lake	CPF17	18-82-1	K27NW9	C;Sw
Silver Run	CPF14	18-23-13-2	G21NE8	WS-III
Silver Stream Branch	CPF17	18-76-1-1	K27NW5	C;Sw
Simlin Creek	CPF10	17-26-7	F20NE7	C
Simmons Branch	CPF08	17-10-(1)	D19SE2	WS-IV:*
Simmons Branch	CPF08	17-10-(2)	D19SE2	WS-IV;CA:*
Simon Branch	CPF17	18-64-8	J25SE6	C;Sw
Singletary Lake	CPF20	18-68-17-5-1	I25SW1	B;Sw
Sings Creek	CPF10	17-26-5-5-1	F20SW2	WS-III
Six Runs Creek	CPF19	18-68-2-(0.3)	G25NE9	C;Sw
Six Runs Creek	CPF19	18-68-2-(11.5)	H26SW1	C;Sw,ORW:+
Skipper Hill Branch	CPF17	18-66-6-2	J26SW6	C;Sw
Skunk Creek	CPF11	17-40-1	F22NW2	C
Slash Branch	CPF14	18-23-16-6-1	F22SW7	WS-III
Smith Branch	CPF02	16-11-11	C20NW5	WS-V;NSW
Smith Branch	CPF13	18-20-31	F23SE5	WS-IV
Smith Creek	CPF23	18-74-63	J27SE7	C;Sw
Smith Swamp (Jones Lake Drain)	CPF16	18-46-7	I24NE4	C

Crossings 1, 3, 5
Tributary to Smith Creek

Name of Stream	Subbasin	Stream Index Number	Map Number	Class
Bull Run	CPF09	17-11-4-(2)	D19SE3	WS-III,B;CA
Bullard Branch	CPF22	18-74-19-14	G27SW5	C;Sw
Bullard Pond	CPF18	18-68-12-8-1	H24NE1	C;Sw
Bulldog Cut	CPF17	18-68-23	J26SE2	C;Sw
Bulldog Cut	CPF20	18-68-23	J26SE2	C;Sw
Bullhead Branch	CPF20	18-68-18-1	I26NW9	C;Sw
Bulltail Creek	CPF20	18-68-18-2	I26NW9	C;Sw
Bulltail Creek	CPF22	18-74-29-3-1	H26SW7	C;Sw
Burdens Creek	CPF05	16-41-1-17-1-(0.3)	D23NW9	WS-V;NSW
Burdens Creek	CPF05	16-41-1-17-1-(0.7)	D23NW9	WS-IV;NSW
Burgaw Creek	CPF23	18-74-39	I27SW6	C;Sw
Burn Coat Creek (Maxwell Millpond)	CPF22	18-74-17	G27SE5	C;Sw
Burnt Mill Creek	CPF23	18-74-63-2	K27NW2	C;Sw
Burris Creek	CPF17	18-88-8-2-3	L27NW7	SA;HQW
Bush Creek	CPF05	16-41-4-(0.3)	D22SE5	WS-IV;NSW
Bush Creek	CPF05	16-41-4-(0.7)	D22SE5	WS-IV;NSW,CA
Bush Creek	CPF09	17-15	D20SW7	C
Bush Creek	CPF07	18-6	E22SE9	C
Butler Branch	CPF14	18-23-16-8-3	F22SW4	WS-III
Butler Creek	CPF24	18-87-18	J28SW4	SA;ORW
Buttermilk Creek	CPF02	16-14-5	C20NE3	WS-II;HQW,NSW
Buxton Branch	CPF20	18-68-18-9	I26SE4	C;Sw
Buzzard Bay	CPF17	18-88-8-2	L27NW7	SA;HQW
Buzzard Branch	CPF15	18-28-3	G23SE7	C
Cabin Branch	CPF15	18-31-8	G21SE5	C
Cabin Branch	CPF21	18-74-8-3	G27NW6	C;Sw
Cabin Branch	CPF22	18-74-24-1-1-1	H26SE3	C;Sw
Cabin Creek	CPF10	17-26-5-(1)	F20SW1	WS-III
Cabin Creek	CPF10	17-26-5-(7)	F20NE4	WS-III;CA
Cabin Creek	CPF22	18-74-23-2	H27NE2	B;Sw
Caesar Swamp	CPF19	18-68-1-17-4-(2)	G24NE8	C;Sw
Caesar Swamp (Williams Lake)	CPF19	18-68-1-17-4-(1)	G24NE9	B;Sw
Calf Branch	CPF15	18-31-5	G21SE2	C
Calf Gulley Creek	CPF17	18-88-9-3-3-1	L26NE5	SC;Sw,HQW
Came Branch	CPF23	18-74-33-6	I27SE2	C;Sw
Camels Creek	CPF07	18-12-(1)	F23NW5	C
Camels Creek	CPF07	18-12-(2)	F23NW3	WS-IV
Cameron Branch	CPF16	18-50-5-1	I25SW4	C
Camp Branch	CPF21	18-74-15	G27SE4	C;Sw
Candy Creek	CPF01	16-5	C20NW3	WS-V;NSW
Cane Creek	CPF04	16-27-(1)	C22SW8	WS-II;HQW,NSW
Cane Creek	CPF04	16-27-(7)	D22NW4	WS-V;NSW
Cane Creek	CPF20	18-68-20	J26NE7	C;Sw
Cane Creek (Cane Creek Reservoir)	CPF04	16-27-(2.5)	D22NW2	WS-II;HQW,NSW,CA
Cane Creek (South side of Haw River)	CPF04	16-28	D21NW7	WS-V;NSW
Canty Mill Creek	CPF19	18-68-7	I26NW1	C;Sw
Cape Creek	CPF17	18-88-8-3	L27SW2	SA;HQW
CAPE FEAR RIVER	CPF07	18-(1)	E22SE2	WS-IV
CAPE FEAR RIVER	CPF11	18-(1)	E22SE2	WS-IV
CAPE FEAR RIVER	CPF07	18-(4.5)	E22SE6	WS-IV;CA
CAPE FEAR RIVER	CPF07	18-(5.5)	E22SE6	WS-V
CAPE FEAR RIVER	CPF07	18-(10.5)	E23SW8	WS-IV
CAPE FEAR RIVER	CPF07	18-(16.3)	F23NE8	WS-IV;CA

Crossing 2

NC 2010 Integrated Report Categories 4 and 5 Impaired Waters

All 13,123 Waters in NC are in Category 5-303(d) List for Mercury due to statewide fish consumption advice for several fish species

AU_Number	AU_Name	AU_Description	LengthArea	AU_Units	Classification
Category	Parameter	Reason for Rating	Use Category	Collection Year	303(d)year

Cape Fear River Basin — **Goshen Swamp Watershed** **0303000701**

Cape Fear River Basin — Northeast Cape Fear River Subbasin — 03030007

Cape Fear River Basin — **Goshen Swamp Watershed** **0303000701**

18-74-19a	**Goshen Swamp**	From source to Bear Swamp	**16.6**	**FW Miles**	C;Sw
5	**Ecological/biological Integrity Benthos**	Severe Bioclassification	Aquatic Life	2003	2006

Cape Fear River Basin — **Headwaters Northeast Cape Fear River Watershed** **0303000702**

18-74-2	**Barlow Branch**	From source to Northeast Cape Fear River	**1.0**	**FW Miles**	C;Sw
5	**Chloride**	Standard Violation	Aquatic Life	2008	1998
18-74-(1)a	**Northeast Cape Fear River**	From source to SR 1558	**3.4**	**FW Miles**	C;Sw
4b	**Chloride**	Standard Violation	Aquatic Life	2008	1998

Cape Fear River Basin — **Limestone Creek-Northeast Cape Fear River Watershed** **0303000703**

18-74-25	**Muddy Creek**	From source to Mortheast Cape Fear River	**14.0**	**FW Miles**	C;Sw
5	**Ecological/biological Integrity Benthos**	Fair Bioclassification	Aquatic Life	2003	2000

Cape Fear River Basin — **Long Creek Watershed** **0303000707**

18-74-55a	**Long Creek**	From source to Cypress Creek	**7.7**	**FW Miles**	C;Sw
5	**Ecological/biological Integrity Benthos**	Severe Bioclassification	Aquatic Life	2003	2006

Cape Fear River Basin — **Harrisons Creek-Northeast Cape Fear River Watershed** **0303000708**

18-74-39a	**Burgaw Creek**	From source to Osgood Branch	**2.1**	**FW Miles**	C;Sw
5	**Chlorophyll a**	Standard Violation	Aquatic Life	2008	2008
18-74-39b	**Burgaw Creek**	From Osgood Branch to Northeast Cape Fear River	**9.5**	**FW Miles**	C;Sw
5	**Copper**	Standard Violation	Aquatic Life	2008	2008
4s	**Ecological/biological Integrity Benthos**	Poor Bioclassification	Aquatic Life	1998	2008
18-74-63-2	**Burnt Mill Creek**	From source to Smith Creek Crossing 2	**4.6**	**FW Miles**	C;Sw
5	**Ecological/biological Integrity Benthos**	Poor Bioclassification	Aquatic Life	1998	1998
18-74-42	**Lillington Creek**	From source to Northeast Cape Fear River	**5.0**	**FW Miles**	C;Sw
5	**Low pH**	Standard Violation	Aquatic Life	2008	2010
18-74-(61)	**Northeast Cape Fear River**	From mouth of Ness Creek to Cape Fear River	**1.0**	**S Acres**	SC;Sw
5	**Copper**	Standard Violation	Aquatic Life	2008	2008

Name of Stream	Subbasin	Stream Index Number	Map Number	Class
Run Branch	CPF21	18-74-6-2	G27NW5	C;Sw
Russells Creek	CPF17	18-81-5	K26NW9	C;Sw
Ryan Creek	CPF02	16-11-14-2-3	C19SE8	WS-V;NSW
Salt Marsh Ditch	CPF20	18-68-22-1-2-1-1	J25NE6	C;Sw
Salters Lake	CPF16	18-44-4	I24NW6	C
Sand Hill Creek	CPF23	18-74-42-1	I27SE8	C;Sw
Sand Hill Creek	CPF17	18-83	K27SW1	C;Sw
Sandy Branch	CPF12	17-43-16-1	E21NW9	C
Sandy Creek	CPF05	16-41-1-11	C23SW8	WS-V;NSW
Sandy Creek	CPF09	17-16-(1)	D20NW9	WS-III
Sandy Creek	CPF09	17-16-(3.5)	E20NW2	WS-III;CA
Sandy Creek	CPF09	17-16-(4)	E20NW2	C
Sandy Creek	CPF18	18-68-12-6	H24NW3	C;Sw
Sandy Run	CPF09	17-18-1	E20NW6	C
Sandy Run	CPF21	18-74-6.5	G27NW9	C;Sw
Sandy Run	CPF21	18-74-14	G27SE1	C;Sw
Sandy Run Swamp	CPF23	18-74-33-2	I28NE7	C;Sw
Sawyer Branch	CPF21	18-74-13-1	G27SE3	C;Sw
Sawyer Creek	CPF22	18-74-29-5	I27NW4	C;Sw
Schoolhouse Branch	CPF13	18-20-13-8	F22SE3	C
Scotchman Creek	CPF10	17-28.3	F20NE6	C;HQW
Scott Branch	CPF17	18-64-4	J26SW7	C;Sw
Scrub Creek	CPF02	16-18-4.5-(1)	C21NE8	WS-II;HQW,NSW
Scrub Creek	CPF02	16-18-4.5-(2)	C21NE8	WS-II;HQW,NSW,CA
Second Silver Run	CPF13	18-20-33-1	F23SE3	WS-IV
Service Creek (Servis Creek)	CPF02	16-15	C21SW2	WS-V;NSW
Sevenmile Swamp	CPF19	18-68-1-3	G25NW5	C;Sw
Shaddox Creek	CPF07	16-43	E22NE9	WS-IV
Shade Branch	CPF19	18-68-2-11-1	H26SW4	C;Sw
Shaken Creek	CPF23	18-74-33-4	I28SW5	C;Sw
Shelbed Creek	CPF17	18-88-4	L27NW7	SA;HQW
Shelter Swamp Creek	CPF23	18-74-33-2-2	I28SE2	C;Sw
Shinn Creek	CPF24	18-87-25	K27NE5	SA;HQW
Sikes Mill Run	CPF19	18-68-2-10-4	H26NW9	C;Sw
Sills Creek	CPF22	18-74-29-4	I26NE5	C;Sw
Silver Lake	CPF17	18-82-1	K27NW9	C;Sw
Silver Run	CPF14	18-23-13-2	G21NE8	WS-III
Silver Stream Branch	CPF17	18-76-1-1	K27NW5	C;Sw
Simlin Creek	CPF10	17-26-7	F20NE7	C
Simmons Branch	CPF08	17-10-(1)	D19SE2	WS-IV:*
Simmons Branch	CPF08	17-10-(2)	D19SE2	WS-IV;CA:*
Simon Branch	CPF17	18-64-8	J25SE6	C;Sw
Singletary Lake	CPF20	18-68-17-5-1	I25SW1	B;Sw
Sings Creek	CPF10	17-26-5-5-1	F20SW2	WS-III
Six Runs Creek	CPF19	18-68-2-(0.3)	G25NE9	C;Sw
Six Runs Creek	CPF19	18-68-2-(11.5)	H26SW1	C;Sw,ORW:+
Skipper Hill Branch	CPF17	18-66-6-2	J26SW6	C;Sw
Skunk Creek	CPF11	17-40-1	F22NW2	C
Slash Branch	CPF14	18-23-16-6-1	F22SW7	WS-III
Smith Branch	CPF02	16-11-11	C20NW5	WS-V;NSW
Smith Branch	CPF13	18-20-31	F23SE5	WS-IV
Smith Creek	CPF23	18-74-63	J27SE7	C;Sw
Smith Swamp (Jones Lake Drain)	CPF16	18-46-7	I24NE4	C

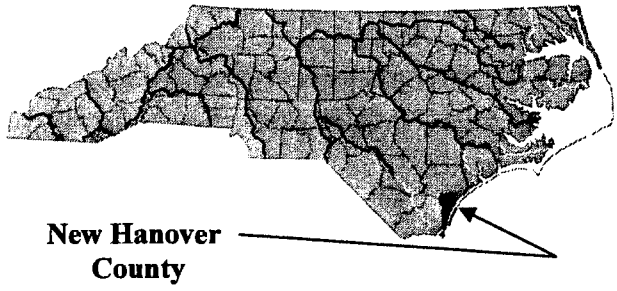
Crossings 1, 3, 5
Tributary to Smith Creek

FLOOD INSURANCE STUDY

A Report of Flood Hazards in

NEW HANOVER COUNTY, NORTH CAROLINA

AND INCORPORATED AREAS



Community Name	Community Number	River Basin
Carolina Beach, Town of	375347	Cape Fear
Kure Beach, Town of	370170	Cape Fear
New Hanover County (Unincorporated Areas)	370168	Cape Fear
Wilmington, City of	370171	Cape Fear
Wrightsville Beach, Town of	375361	Cape Fear

Cooperating Technical State
FEMA'S COOPERATING TECHNICAL PARTNER

April 3, 2006

Federal Emergency Management Agency
State of North Carolina

Flood Insurance Study Number
37129CV000A

www.fema.gov and www.ncfloodmaps.com

Floyd passed relatively close to the entire U.S. east coast, justifying hurricane warnings from Florida to Massachusetts and requiring an estimated two million people to evacuate. The last hurricane to require warnings for as large a stretch of coastline was Hurricane Donna in 1960.

Table 3, "Historic Flood Elevations," lists selected flooding sources in New Hanover County with records of past stages. The table shows the historic peak, a location description, approximate stream station, the date of the historic peak, and approximate recurrence interval of the flood elevation. The approximate recurrence interval for a flood is often estimated based on an analysis of rainfall amounts from a storm and /or stream gage data.

Table 3—Historic Flood Elevations

Flooding Source/ Tropical Storm	Location Description	Approximate Stream Station	Historic Peak (Feet NAVD 88)	Date	Approximate Recurrence Interval
Burnt Mill Creek	2002 Princess Place Drive	6,200	3.05	Sept. 1999 (Floyd)	100-year to 500-year
Smith Creek	625 Candlewood Drive	36,740	21.51	Sept. 1999 (Floyd)	100-year to 500-year
Smith Creek	1220 Dove Field Drive	44,330	37.05	Sept. 1999 (Floyd)	100-year to 500-year
Spring Branch	4221 Lynnbrook Drive	2,500	11.54	Sept. 1999 (Floyd)	100-year to 500-year
Hurricane Floyd	2 Clamshell Lane	N/A	7.3	Sept. 1999	100-year to 500-year
Hurricane Floyd	Great Mistakes Clothing Store – Harper Street	N/A	8.1	Sept. 1999	100-year to 500-year
Hurricane Floyd	217 Kilnary Road	N/A	8.1	Sept. 1999	100-year to 500-year
Hurricane Floyd	1314 St. Joseph Street	N/A	8.1	Sept. 1999	100-year to 500-year
Hurricane Floyd	202 South Channel Drive	N/A	8.1	Sept. 1999	100-year to 500-year
Hurricane Floyd	4 Seagull Street	N/A	8.1	Sept. 1999	100-year to 500-year
Hurricane Floyd	Bridge Tender Marina	N/A	8.1	Sept. 1999	100-year to 500-year
Hurricane Floyd	Johnson's Marina	N/A	8.1	Sept. 1999	100-year to 500-year
Hurricane Floyd	202 Harper Street	N/A	8.2	Sept. 1999	100-year to 500-year
Hurricane Floyd	1318 North Carolina Beach Avenue	N/A	8.2	Sept. 1999	100-year to 500-year
Hurricane Floyd	5 Shearwater Street	N/A	8.2	Sept. 1999	100-year to 500-year
Hurricane Floyd	Carolina Yacht Marina	N/A	8.2	Sept. 1999	100-year to 500-year

Table 3—Historic Flood Elevations

Flooding Source/ Tropical Storm	Location Description	Approximate Stream Station	Historic Peak (Feet NAVD 88)	Date	Approximate Recurrence Interval
Hurricane Floyd	13 West Henderson Street	N/A	8.2	Sept. 1999	100-year to 500-year
Hurricane Floyd	209 Water Street	N/A	8.3	Sept. 1999	100-year to 500-year
Hurricane Floyd	602 Canal Drive	N/A	8.3	Sept. 1999	100-year to 500-year
Hurricane Floyd	316 Waynick Boulevard	N/A	8.6	Sept. 1999	100-year to 500-year
Hurricane Floyd	Island North Apartments – Canal Drive	N/A	8.8	Sept. 1999	100-year to 500-year
Hurricane Floyd	Bradley Creek Marina	N/A	8.8	Sept. 1999	100-year to 500-year
Hurricane Floyd	Fort Fisher Recreational Building	N/A	9.1	Sept. 1999	100-year to 500-year
Hurricane Floyd	Breakers Apartment	N/A	9.3	Sept. 1999	100-year to 500-year
Hurricane Floyd	Masonboro Boat Yard	N/A	9.4	Sept. 1999	100-year to 500-year
Hurricane Floyd	1314 St Joseph Street	N/A	13.1	Sept. 1999	100-year to 500-year
Hurricane Floyd	1901 Fort Fisher Boulevard	N/A	13.5	Sept. 1999	100-year to 500-year
Hurricane Floyd	Riggings Condominiums	N/A	14.1	Sept. 1999	100-year to 500-year

4.4 Flood Protection Measures

Flood protection measures may be structural (such as levees, dams, and reservoirs) or non-structural (such as land-use management ordinances, policies, or practices).

To provide safe flood protection and be mapped as such, FEMA specifies that all levees must: have a minimum of three feet of freeboard against the 1% annual chance flood event; be equipped with closure devices at every opening; be constructed with embankments and foundations that are certified not to fail due to erosion, seepage, or instability; and be certified against future loss of freeboard due to settling. For additional requirements, please refer to 44 CFR 65.10.

Table 4, "Flood Protection Measures," lists the flood protection measures undertaken to mitigate flood damage in New Hanover County.

Table 8--Summary of Discharges

Flooding Source	Location	Drainage Area (*square miles*)	Discharges (*cfs*) 10% Annual Chance	2% Annual Chance	1% Annual Chance	1% Future Annual Chance	0.2% Annual Chance
Bradley Creek Tributary 1	At Mouth	1.4	490	980	1,200	*	2,000
	At U.S. Route 74	1.0	420	880	1,100	*	1,830
	Approximately 110 feet downstream of Eastwood Road	1.0	*	*	1,130	*	*
Burnt Mill Creek	At confluence with Smith Creek	7.2	2,090	3,170	3,530	3,730	4,550
	Approximately 0.4 mile downstream of Princess Place Drive	5.5	1,780	2,750	3,080	3,240	3,980
	Approximately 140 feet downstream of Market Street	5.1	1,710	2,650	2,970	3,110	3,840
	Approximately 0.2 mile upstream of Metts Avenue	4.2	1,510	2,370	2,660	2,790	3,460
	Approximately 0.4 mile upstream of Colonial Drive	3.5	1,360	2,160	2,420	2,540	3,170
	Approximately 0.9 mile upstream of Colonial Drive	2.5	1,100	1,780	2,010	2,120	2,650
	Approximately 0.3 mile downstream of Mill Creek Ct.	1.9	942	1,550	1,760	1,850	2,330
	Approximately 0.1 mile downstream of Mill Creek Ct.	1.4	771	1,300	1,470	1,520	1,960
	Approximately 220 feet downstream of Varsity Drive	1.1	669	1,140	1,300	1,360	1,740
	Approximately 1.2 miles downstream of New Hanover/Pender County boundary	7,055	*	*	131,000	*	*

effective Flood Insurance Study water-surface elevations. Manning's "n" values were field investigated and delineated on USGS Digital Orthophoto Quarter Quads (DOQQ) for both channel and overbank areas.

For the detailed study streams, future conditions 1% annual chance simulations were also performed, the basis of which were solely the expected future conditions runoff.

The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail. The computer models were calibrated using historic high water data collected during field investigations.

The cross section geometries were obtained from a combination of digital elevation data obtained by Light Detection and Ranging (LIDAR) and field surveys. All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry. Natural floodplain cross sections were surveyed approximately every 4,000' along the detail study reaches to obtain the channel geometry between bridges and culverts. Overbank cross-section data for the backwater analyses were obtained from recently flown LIDAR data.

Channel roughness factors (Manning's "n") used in the hydraulic computations were made in the field by an engineer where stream access was possible, with orthophotos used to supplement areas that could not be accessed. The channel and overbank "n" values for all of the streams studied by detailed methods are shown in Table 9, "Roughness Coefficients."

Table 9—Roughness Coefficients

Stream	Channel "n"	Overbank "n"
Bradley Creek Tributary 1	0.030 – 0.070	0.100 – 0.500
Burnt Mill Creek	0.040-0.160	0.060-0.200
Cape Fear River	0.038	0.25
Doctors Branch	0.040	0.040-0.160
Island Creek	0.030 – 0.070	0.150 – 0.500
Mott Creek	0.030 – 0.070	0.060-0.500
Mott Creek Tributary 1	0.040	0.100-0.150
Murrayville Tributary	0.030 – 0.070	0.100 – 0.500
Prince George Creek Tributary 3	0.050	0.150
Smith Creek	0.030 – 0.070	0.100-0.500
Spring Branch	0.040	0.060-0.150

For flooding sources studied by limited detailed methods in the county, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this report and the FIRM panels. This method entails developing a HEC-RAS hydraulic model, resulting in the calculation of BFEs and the delineation of the 1% annual chance floodplain (designated as Zone AE). Cross sections for the flooding sources studied by limited detailed methods were obtained using digital elevation data obtained with LIDAR technology developed as part of the North Carolina Statewide Floodplain Mapping Program. The hydraulic model is prepared using this digital elevation data, without surveying bathymetric or structural data. Where bridge or culvert

Crossing 2

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Burnt Mill Creek								
001	122	179	1,199	2.9	8.4	2.8[2]	2.9	0.1
016	1,639	179	1,250	2.8	8.4	3.5[2]	3.6	0.1
029	2,921	224	1,519	2.3	8.4	6.4[2]	6.9	0.5
044	4,407	182	2,000	1.5	8.9	8.9	9.7	0.8
064	6,350	446	3,326	0.9	9.1	9.1	10.1	1.0
079	7,905	170	1,674	1.8	9.4	9.4	10.4	1.0
089	8,905	295	2,768	1.1	11.0	11.0	12.0	1.0
097	9,650	255	2,588	1.2	11.3	11.3	12.3	1.0
114	11,405	220	1,919	1.6	11.8	11.8	12.8	1.0
129	12,905	110	951	2.8	12.4	12.4	13.4	1.0
142	14,208	77	696	3.5	14.0	14.0	14.7	0.7
159	15,905	78	505	4.8	16.3	16.3	17.3	1.0
178	17,754	545	4,007	0.5	18.2	18.2	18.4	0.2
193	19,349	47	189	7.8	18.8	18.8	18.9	0.1
214	21,390	225	803	1.6	29.0	30.1	30.9	0.8
224	22,426	46	198	6.6	31.9	31.9	32.1	0.2
231	23,078	31	135	9.6	36.8	36.8	37.0	0.2

[1]Feet above mouth

[2]Elevation computed without consideration of backwater effects from Smith Creek

TABLE 15

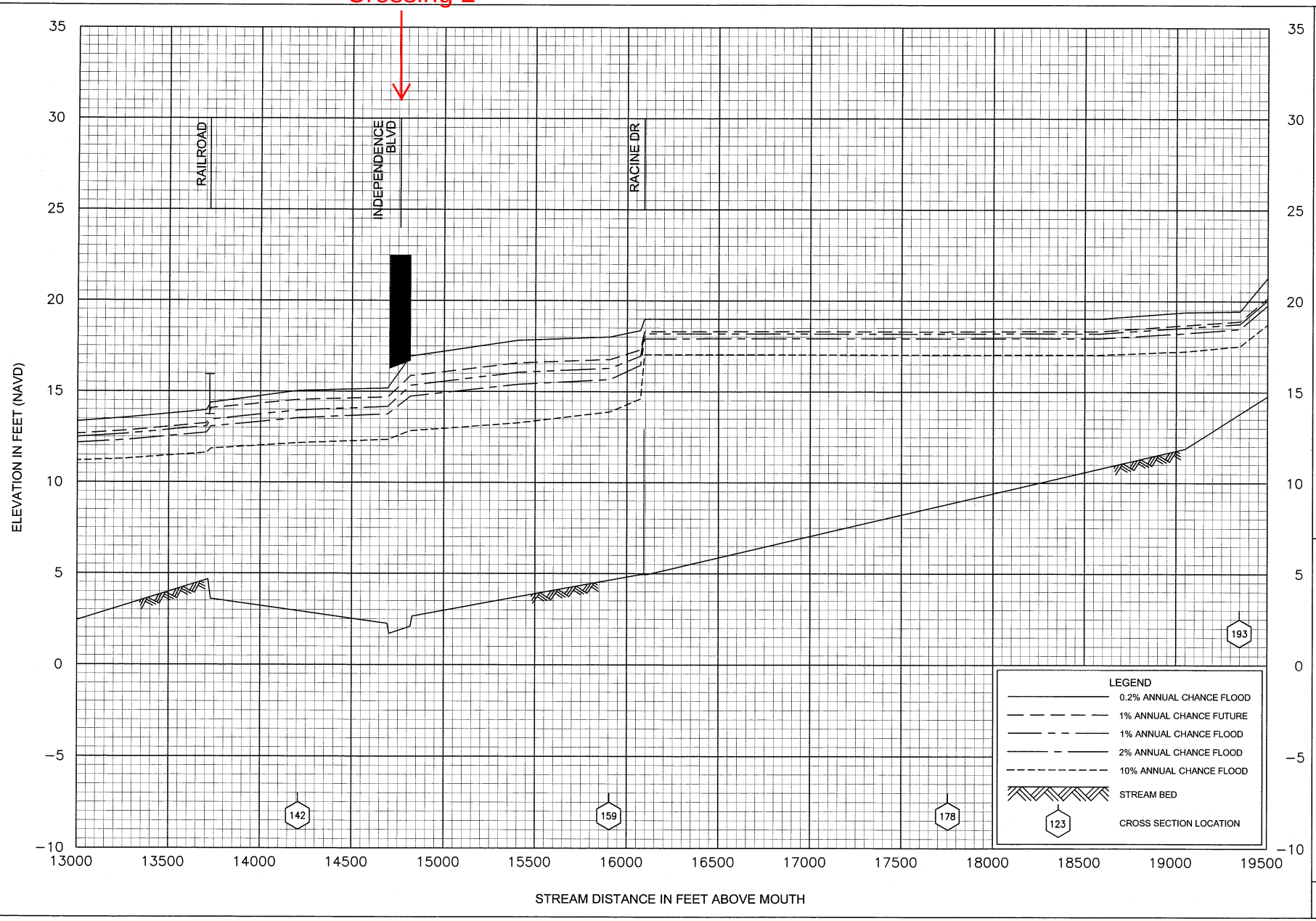
FEDERAL EMERGENCY MANAGEMENT AGENCY

NEW HANOVER COUNTY, NC AND INCORPORATED AREAS

FLOODWAY DATA

BURNT MILL CREEK

Crossing 2



FLOOD PROFILES

BURNT MILL CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

NEW HANOVER COUNTY, NC
AND INCORPORATED AREAS

06P

Crossing 1 & 3 (Backwater)

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Smith Creek								
087	8,700	168[2]	2,790	1.9	8.4	1.5[3]	2.4	0.9
145	14,520	155[2]	1,911	2.7	8.4	2.0[3]	2.8	0.8
198	19,779	236[2]	2,403	1.5	8.4	2.5[3]	3.3	0.8
307	30,700	130	1,044	4.3	8.4	2.7[2]	3.5	0.8
312	31,200	370	1,891	2.4	8.4	3.2[2]	4.0	0.8
317	31,700	268	1,636	2.7	8.4	3.4[2]	4.3	0.9
334	33,369	257	1,669	2.7	8.4	4.1[2]	5.1	1.0
349	34,851	499	2,702	1.6	8.4	5.5[2]	6.2	0.7
358	35,757	847	4,438	0.9	8.4	6.0[2]	7.0	1.0
369	36,851	691	4,221	1.0	8.4	6.6[2]	7.6	1.0
379	37,851	652	3,644	1.1	8.4	7.1[2]	8.0	0.9
384	38,351	474	2,817	1.4	8.4	7.4[2]	8.3	0.9
389	38,851	485	2,832	1.4	8.4	7.8[2]	8.8	1.0
394	39,351	489	2,737	1.5	8.4	8.2[2]	9.1	0.9
399	39,851	429	2,261	1.8	8.6	8.6	9.6	1.0
404	40,351	500	2,785	1.4	9.2	9.2	10.2	1.0
409	40,851	446	2,761	1.5	9.6	9.6	10.6	1.0
419	41,851	534	3,071	0.9	10.3	10.3	11.2	0.9
424	42,351	576	2,836	1.0	10.4	10.4	11.4	1.0
438	43,840	67	566	5.0	14.3	14.3	15.1	0.8
446	44,644	103	1,009	2.8	16.5	16.5	17.1	0.6
459	45,851	256	2,302	1.2	18.8	18.8	19.4	0.6
463	46,319	245	2,170	1.3	18.9	18.9	19.5	0.6

[1]Feet above mouth

[2]Floodway contained in channel

[3]Elevation computed without consideration of backwater effects from Northeast Cape Fear River

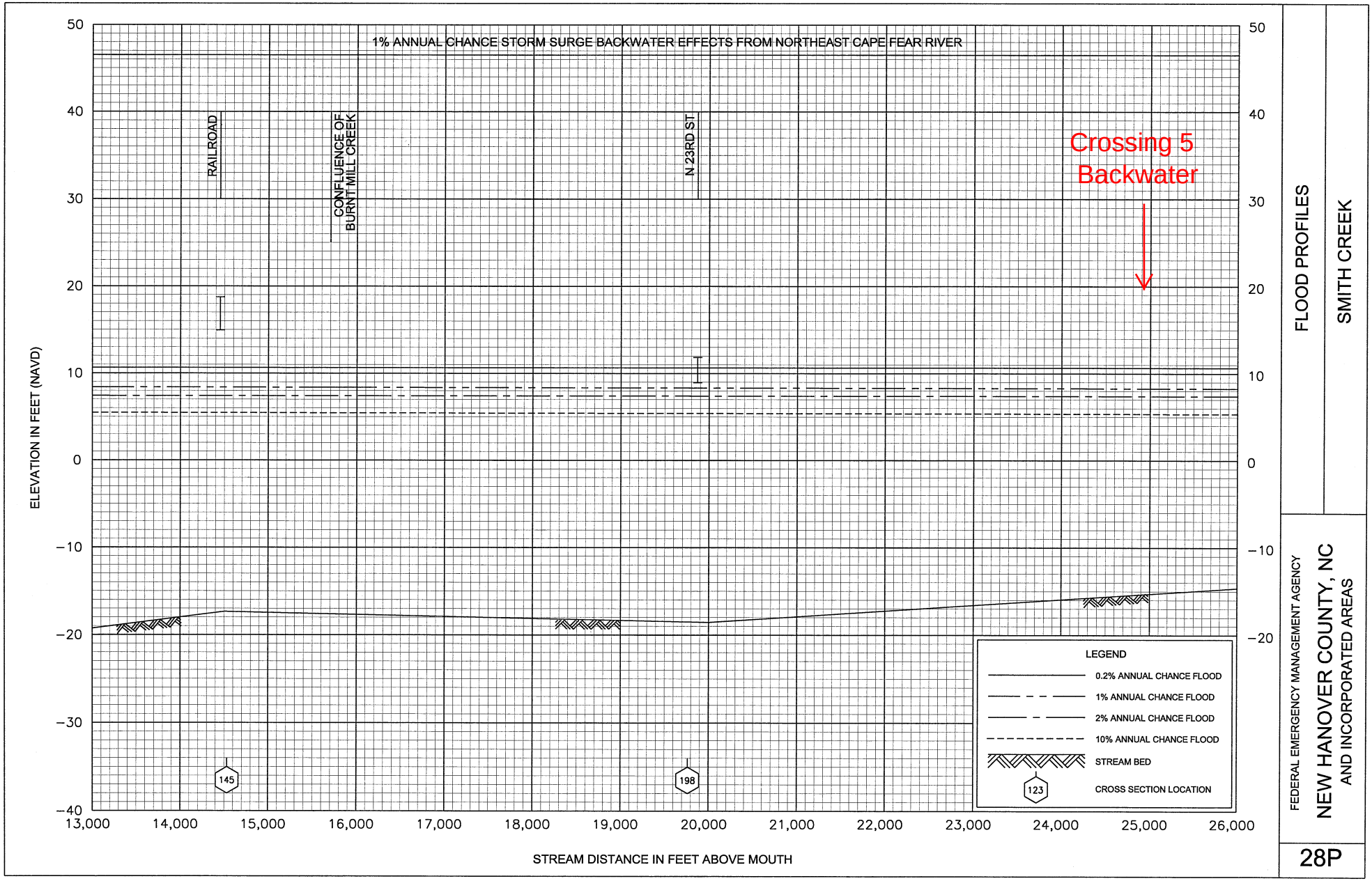
TABLE 15

FEDERAL EMERGENCY MANAGEMENT AGENCY

NEW HANOVER COUNTY, NC AND INCORPORATED AREAS

FLOODWAY DATA

SMITH CREEK



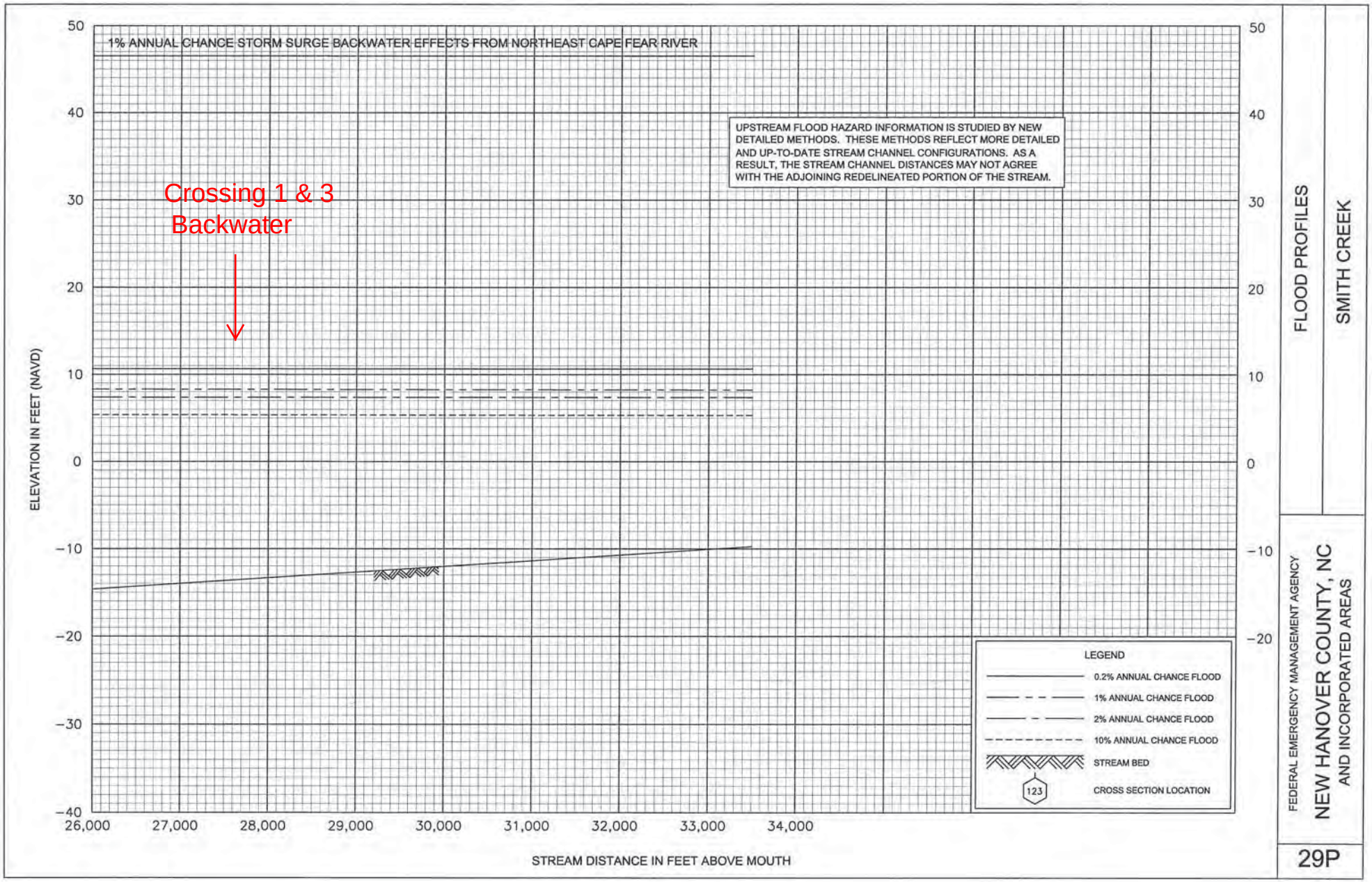
FLOOD PROFILES

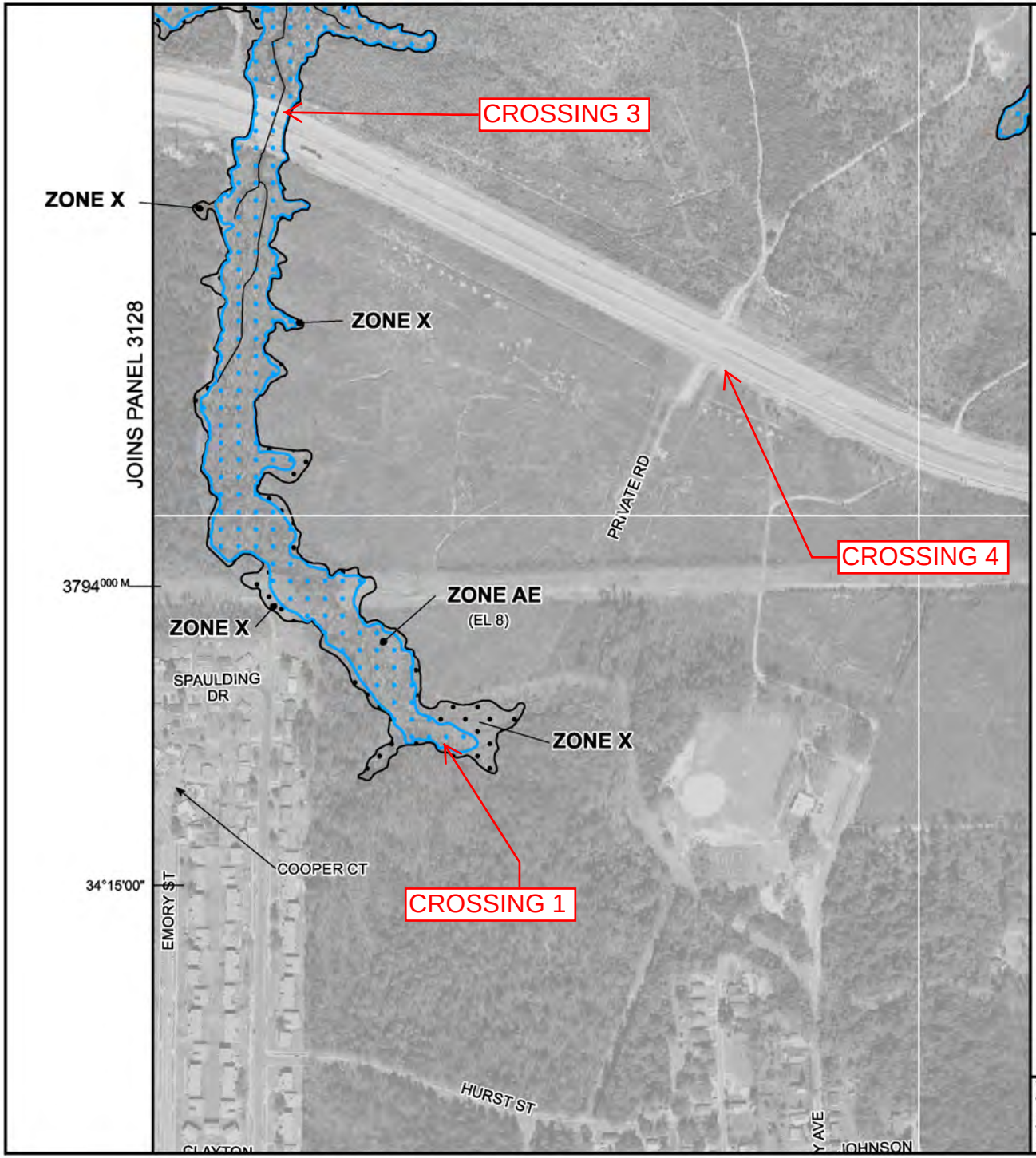
SMITH CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

NEW HANOVER COUNTY, NC
AND INCORPORATED AREAS

28P


1% ANNUAL CHANCE STORM SURGE BACKWATER EFFECTS FROM NORTHEAST CAPE FEAR RIVER
UPSTREAM FLOOD HAZARD INFORMATION IS STUDIED BY NEW DETAILED METHODS. THESE METHODS REFLECT MORE DETAILED AND UP-TO-DATE STREAM CHANNEL CONFIGURATIONS. AS A RESULT, THE STREAM CHANNEL DISTANCES MAY NOT AGREE WITH THE ADJOINING REDELINEATED PORTION OF THE STREAM.
Crossing 1 & 3
Backwater
ELEVATION IN FEET (NAVD)
50
40
30
20
10
0
−10
−20
−30
−40
26,000
27,000
28,000
29,000
30,000
31,000
32,000
33,000
34,000
STREAM DISTANCE IN FEET ABOVE MOUTH
LEGEND
0.2% ANNUAL CHANCE FLOOD
1% ANNUAL CHANCE FLOOD
2% ANNUAL CHANCE FLOOD
10% ANNUAL CHANCE FLOOD
STREAM BED
123
CROSS SECTION LOCATION
FLOOD PROFILES
SMITH CREEK
FEDERAL EMERGENCY MANAGEMENT AGENCY
NEW HANOVER COUNTY, NC
AND INCORPORATED AREAS
29P



GRID NORTH

MAP SCALE 1" = 500' (1 : 6,000)

PANEL 3138J

FIRM

FLOOD INSURANCE RATE MAP

NORTH CAROLINA

PANEL 3138

(SEE LOCATOR DIAGRAM OR MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	CID No.	PANEL	SUFFIX
NEW HANOVER COUNTY	370168	3138	J
WILMINGTON, CITY OF	370171	3138	J

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

EFFECTIVE DATE
APRIL 3, 2006

MAP NUMBER
3720313800J

State of North Carolina
Federal Emergency Management Agency

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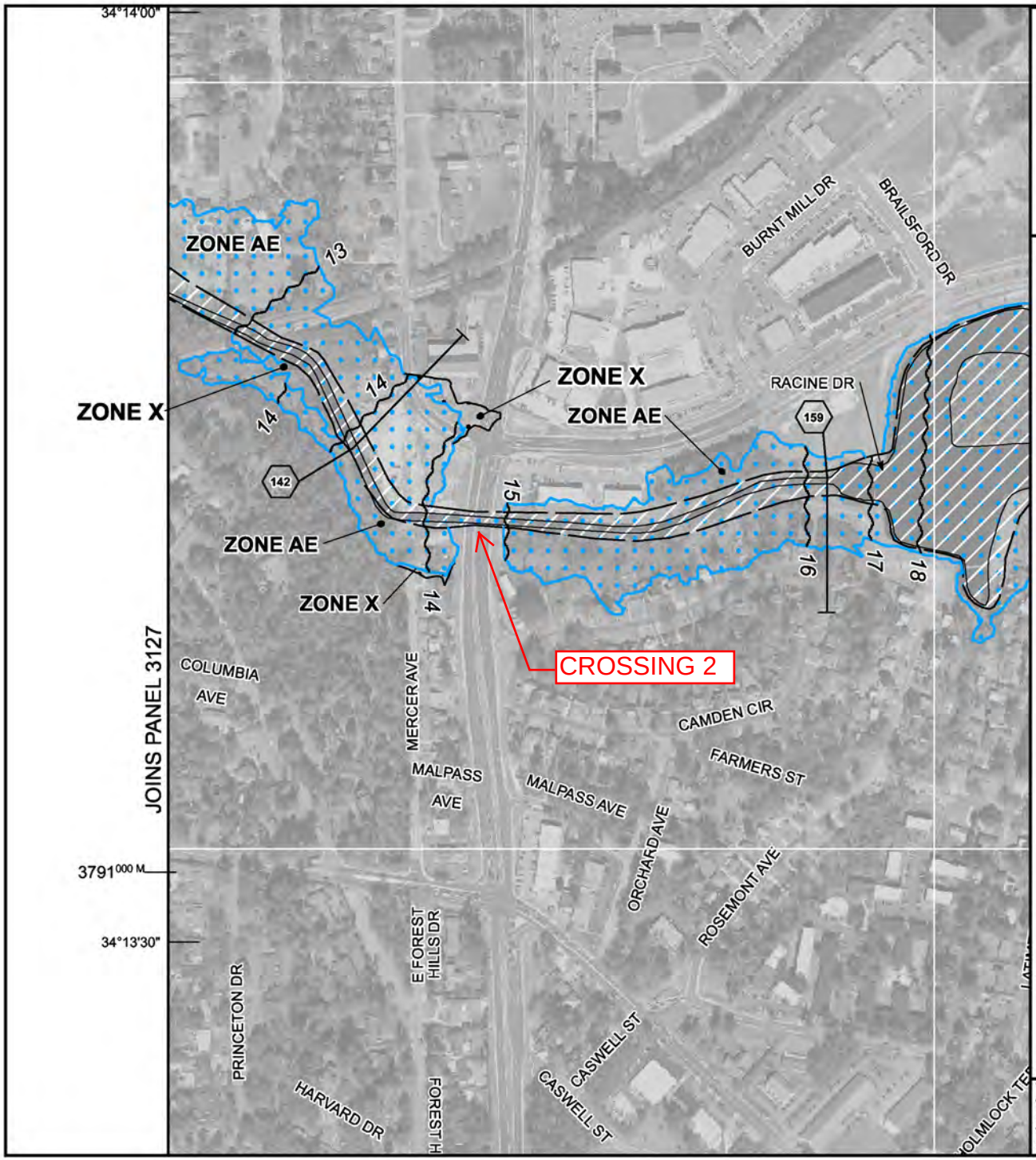

GRID NORTH

MAP SCALE 1" = 500' (1 : 6,000)

PANEL 3137J

FIRM

FLOOD INSURANCE RATE MAP

NORTH CAROLINA

PANEL 3137

(SEE LOCATOR DIAGRAM OR MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	CID No.	PANEL	SUFFIX
WILMINGTON, CITY OF	370171	3137	J

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

EFFECTIVE DATE
APRIL 3, 2006

MAP NUMBER
3720313700J

State of North Carolina
Federal Emergency Management Agency

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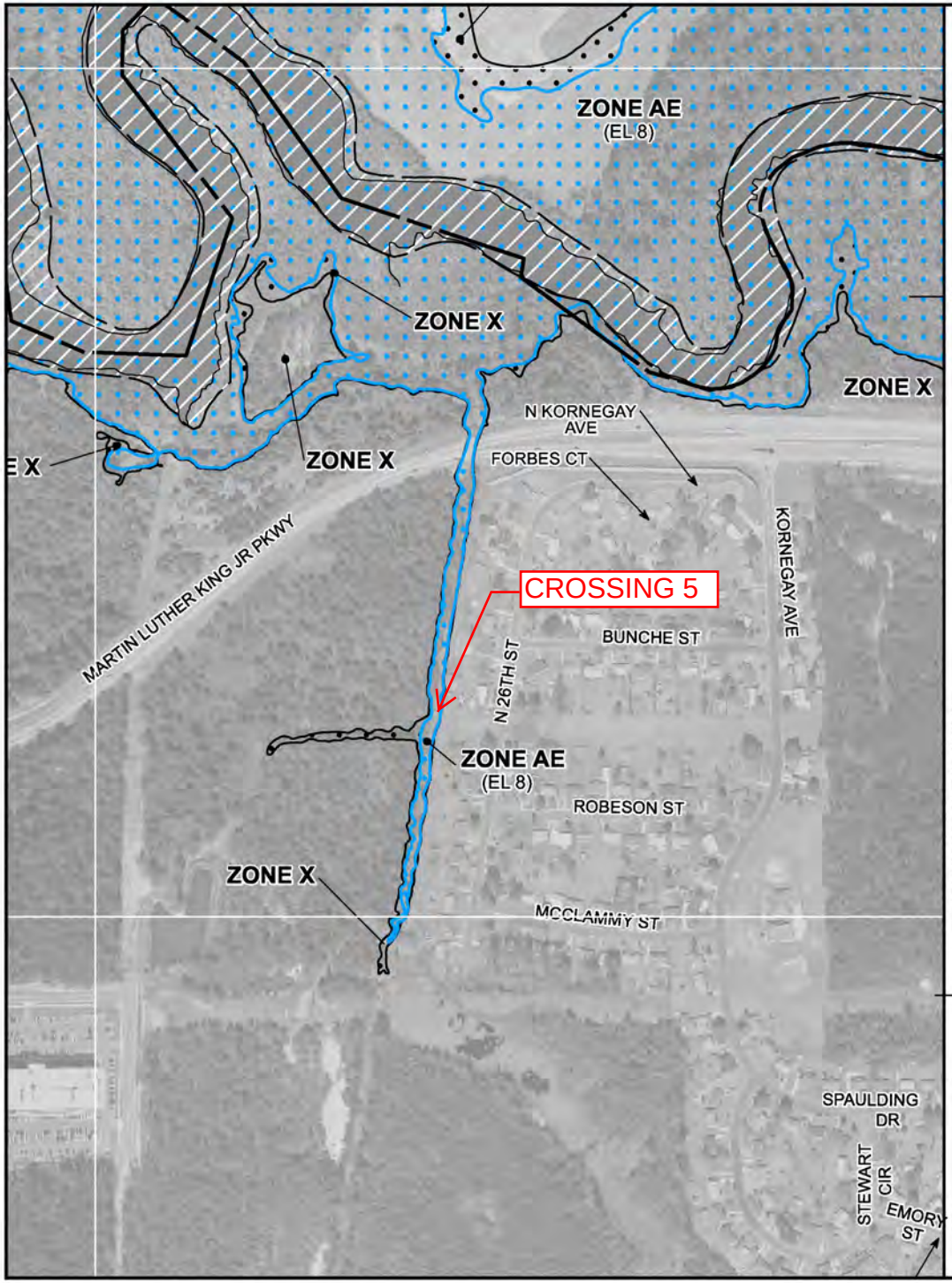

187 500 FEET

34°15'30"

JOINS PANEL 3138

3794000 M

GRID NORTH

MAP SCALE 1" = 500' (1 : 6,000)

PANEL 3128J

FIRM

FLOOD INSURANCE RATE MAP

NORTH CAROLINA

PANEL 3128

(SEE LOCATOR DIAGRAM OR MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	CID No.	PANEL	SUFFIX
NEW HANOVER COUNTY	370168	3128	J
WILMINGTON, CITY OF	370171	3128	J

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

EFFECTIVE DATE
APRIL 3, 2006

MAP NUMBER
3720312800J

State of North Carolina
Federal Emergency Management Agency

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CHECKLIST FOR PRELIMINARY HYDRAULIC INVESTIGATION

TIP No.: U-4434 **County:** New Hanover **Prepared By:** URS Corporation
Date: 1/19/2012

ITEM NO.		COLLECTED DATA:
1	x	**PROJECT INITIATION** - existing files
2	x	**PRELIMINARY DESIGN FORM** - Appendix D of design guidelines
3	x	**LOCATION MAP** - Identify project limits and nearby drainage structures
4	x	**FLOOD MAP** - Label: panel no. & date, community name, stream, scale, legend -FIS data (discharge, profiles, etc.) -Requested model for Burnt Mill Creek
5	x	**PRELIMINARY HYDROLOGIC DESIGN** **-**Determine drainage area from gauge records, old structure reports, FEMA studies, or planimeter - Compute and compare discharges with other studies
6	x	**USGS QUAD MAP** -Label: quad map name, begin/end project, streams, major drainage structures
7	x	**PRELIMINARY HYDRAULIC DESIGN** - Check with bridge scour group for previous scour studies -Determine replacement and detour structures
8	x	**PERMIT** -Attach a copy of the environmental sensitivity map -Determine if above (<5cfs average daily flow) or (>5cfs adf) headwaters -Water Classification
9	x	**FIELD DATA:** **PLAN AND PROFILE VIEWS OF THE SITE** -Plan; Label: north arrow, utilities, road name/#, stream name and direction, structures in flood plain -Profile; Label: road direction, high water marks, road and flood plain profiles normal and ordinary high water marks -Investigate alignments of replacement and detour structures
10	X	**PHOTOS** - Upstream structure face, up and downstream waterways, and other significant features
11	X	**BMU DATABASE DATA** - highly important information (old project #, structures, etc)
12	N/A	**OLD BRIDGE/CULVERT SURVEY REPORTS**

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APPENDIX B

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Crossing 1

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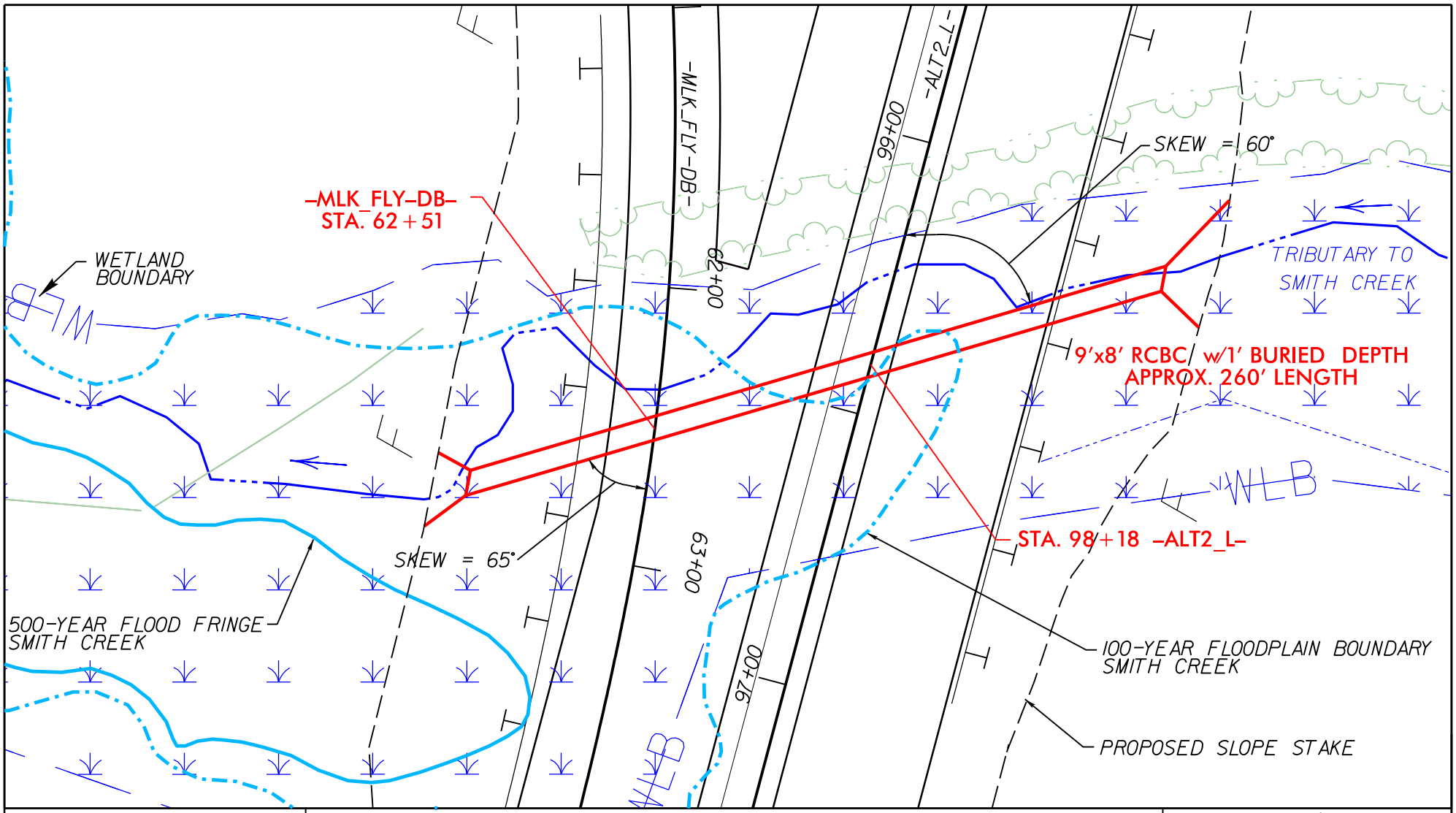

25' 0 25' 50'

1" = 50 FT.

RECOMMENDED CULVERT FOR CROSSING 1

PRELIMINARY HYDRAULIC ANALYSIS

NEW HANOVER COUNTY

PROJECT: U-4434

INDEPENDENCE BOULEVARD EXTENSION

FEBRUARY 2014

NAD 83

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PRELIMINARY DESIGN AND ASSESSMENT OF STREAM CROSSINGS AND ENCROACHMENTS

COUNTY New Hanover PROJECT NUMBER U-4434

STREAM trib to Smith Creek ROUTE Proposed Independence Blvd ext. CROSSING 1

ASSESSMENT PREPARED BY CGW/MAD DATE 1/19/2012

HYDROLOGIC EVALUATION

NEAREST GAGING STATION ON THIS STREAM _____ (NONE X) _____

ARE FLOOD STUDIES AVAILABLE ON THIS STREAM: No - overflow from Smith Creek

FLOOD DATA:

Q_{10} 320 CFS EST. BKWTR. 5.3 FT. Q_{25} 500 CFS EST. BKWTR. ___ FT.

Q_{50} 590 CFS EST. BKWTR. 7.3 FT. Q_{100} 680 CFS EST. BKWTR. 8.4 FT.

Q_{500} 820 CFS OR OVERTOPPING CFS EST. BKWTR. 10.7 FT.

DRAINAGE AREA 0.37 sq mi METHOD USED TO COMPUTE Q USGS Urban Regression

PROPERTY RELATED EVALUATIONS

DAMAGE POTENTIAL: LOW X MODERATE _____ HIGH _____

COULD THIS BE SIGNIFICANTLY INCREASED BY PROPOSED

ENCROACHMENT: YES X NO _____

EXPLANATION: proposed design fill could impede the existing drainage flow

LIST BUILDINGS IN FLOOD PLAIN None LOCATION N/A

FLOOR ELEVATION N/A

UPSTREAM LAND USE High density residential, woods

ANTICIPATE ANY CHANGE? No

ANY FLOOD ZONING? (FIA STUDIES, ETC.) YES X NO _____

TYPE OF STUDY Detailed study of Smith Creek (downstream)

BASE FLOOD ELEVATION 8.4' (100 YEAR)

REGULATORY FLOODWAY WIDTH N/A (AS NOTED IN FIA STUDIES)

COMMENTS: Backwater from Smith Creek detailed study. Backwater from Cape Fear River.

TRAFFIC RELATED EVALUATIONS

PRESENT YEAR N/A TRAFFIC COUNT N/A VPD % TRUCKS N/A

DESIGN YEAR 2040 TRAFFIC COUNT 52,300 VPD % TRUCKS 6%

EMERGENCY ROUTE _____ SCHOOL BUS ROUTE _____ MAIL ROUTE _____

DETOUR AVAILABLE? No LENGTH OF DETOUR _____ MILES

DOES THE LEVEL OF TRAFFIC SERVICE OF AN EXISTING CROSSING VARY GREATLY FROM STANDARD DESIGN LEVELS? N/A

IS THE TRAFFIC VOLUME, TYPE, USAGE SUCH TO WARRANT CONSIDERATION FOR VARIANCE FROM STANDARDS OR EXISTING LEVEL OF INTERRUPTION? N/A

COMMENTS: New location

HIGHWAY AND BRIDGE (CULVERT) RELATED EVALUATIONS

NOTE ANY OUTSIDE FEATURES WHICH MIGHT AFFECT STAGE, DISCHARGE OR FREQUENCY.

LEVEES _____ AGGRADATION/DEGRADATION _____ RESERVOIRS _____

DIVERSIONS _____ DRAINAGE DISTRICT _____ NAVIGATION _____

BACKWATER FROM ANOTHER SOURCE Smith Creek

EXPLANATION: _____

ROADWAY OVERFLOW SECTION (NONE X) LENGTH _____ ELEVATION _____

EMBANKMENT: SOIL TYPE Baymeade Fine Sand & Johnston Soils TYPE SLOPE COVER N/A

COMMENTS: _____

ENVIRONMENTAL CONSIDERATIONS

LIST SPECIAL CONDITIONS OR CONSIDERATIONS WHICH AFFECT HYDRAULIC DESIGN (NONE _____)
Wetlands; Mapped FEMA AE, X Flood Zones

MISCELLANEOUS COMMENTS

IS THERE UNUSUAL SCOUR POTENTIAL? YES __ NO X PROTECTION NEEDED No
ARE BANKS STABLE? Yes PROTECTION NEEDED No
DOES STREAM CARRY APPRECIABLE AMOUNT OF LARGE DEBRIS? No
COMMENTS:
Wetlands present upstream and downstream of proposed crossing.

ALTERNATIVES

RECOMMENDED DESIGN 9' x 8' RCBC w/1' buried depth and wingwalls
DETOUR STRUCTURE None
LOW ROADWAY GRADE 0.8% DETOUR GRADE _____
BRIDGE WATERWAY OPENING _____ CULVERT OPENING 63 sf (eff.)
WERE OTHER HYDRAULIC ALTERNATES CONSIDERED? YES _____ NO X
DISCUSSION: _____

THIS SITE ASSESSMENT INDICATES THE DESIGN SHOULD FOLLOW:

(1) _____ NORMAL PROCESS

(2) X NORMAL PROCESS WITH SPECIAL SPECIFIC CONSIDERATION FOR Wetlands, FEMA AE Flood Zone

(3) _____ SPECIFIC DESIGN PROCESS WITH APPROPRIATE RISK/ECONOMIC EVALUATION ADDRESSING: _____

U-4434 1/19/12

- possible culverts

• 34° 15' 12"
– 77° 54' 02"
- no flowing water
- ~18' ToB to ToB
- some standing water, ~8" deep

• 34° 15' 08" - 77° 54' 21"
channel W/E ~12'
~3' depth of water
surrounding wetlands
tib on west side

CROSSING 1

Field Notes

STIP NO:	U-4434
COUNTY:	New Hanover
DATE:	1/19/2012

CROSSING 1, POWER EASEMENT LOOKING NORTHWEST

CROSSING 1, POWER EASEMENT LOOKING EAST

STIP NO:	U-4434
COUNTY:	New Hanover
DATE:	1/19/2012

CROSSING 1, LOOKING UPSTREAM (SOUTHEAST)

CROSSING 1, LOOKING SOUTHWEST

STIP NO:	U-4434
COUNTY:	New Hanover
DATE:	1/19/2012

CROSSING 1, EXPOSED SANITARY SEWER LOOKING EAST

CROSSING 1 DOWNSTREAM CHANNEL, BY POWER EASEMENT, LOOKING UPSTREAM (SOUTHEAST)

Crossing 1

Peak Discharge

Project Name:	U-4434 - Independence Blvd. Preliminary Hydraulic Analysis		
Project No.:	31823722		
Design Engineer:	C. Williams	**Date:**	1/24/2012

Crossing 1 -Proposed New Location Crossing for Independence Blvd. Extension

North Carolina Rural Flood-Frequency Equations [1]

Drainage Area = 0.37 sq. mi.

Rural Flood-Recurrence Interval (years)	Coastal Plain	RQ (cfs)
2	$64.7 * DA^{0.673}$	33
5	$129 * DA^{0.635}$	69
10	$188 * DA^{0.615}$	102
25	$281 * DA^{0.593}$	156
50	$367 * DA^{0.579}$	207
100	$468 * DA^{0.566}$	267
500	$773 * DA^{0.539}$	453

North Carolina Urban Flood-Frequency Equations [1]

Drainage Area = 0.37 sq. mi.
Impervious Area = 26.1 %

Recurrence Interval (years)	Urban Flood-Frequency Equation	Q (cfs)
2	$26.9 * DA^{0.722} * IA^{0.686}$	130
5	$68.2 * DA^{0.655} * IA^{0.572}$	240
10	$109 * DA^{0.625} * IA^{0.515}$	320
25	$209 * DA^{0.570} * IA^{0.436}$	500
50	$280 * DA^{0.558} * IA^{0.396}$	590
100	$363 * DA^{0.547} * IA^{0.358}$	680

1. The National Flood-Frequency Program - Methods for Estimating Flood Magnitude and Frequency in Rural and Urban Areas in North Carolina, 2001. 2002. U.S. Geological Survey Fact Sheet 007-00.

No equation for Q500 so use ratio between Q50 and Q100 to find Q500 based on Q100

$$\frac{Q100}{Q50} = \frac{680.0}{590.0} = 1.2$$

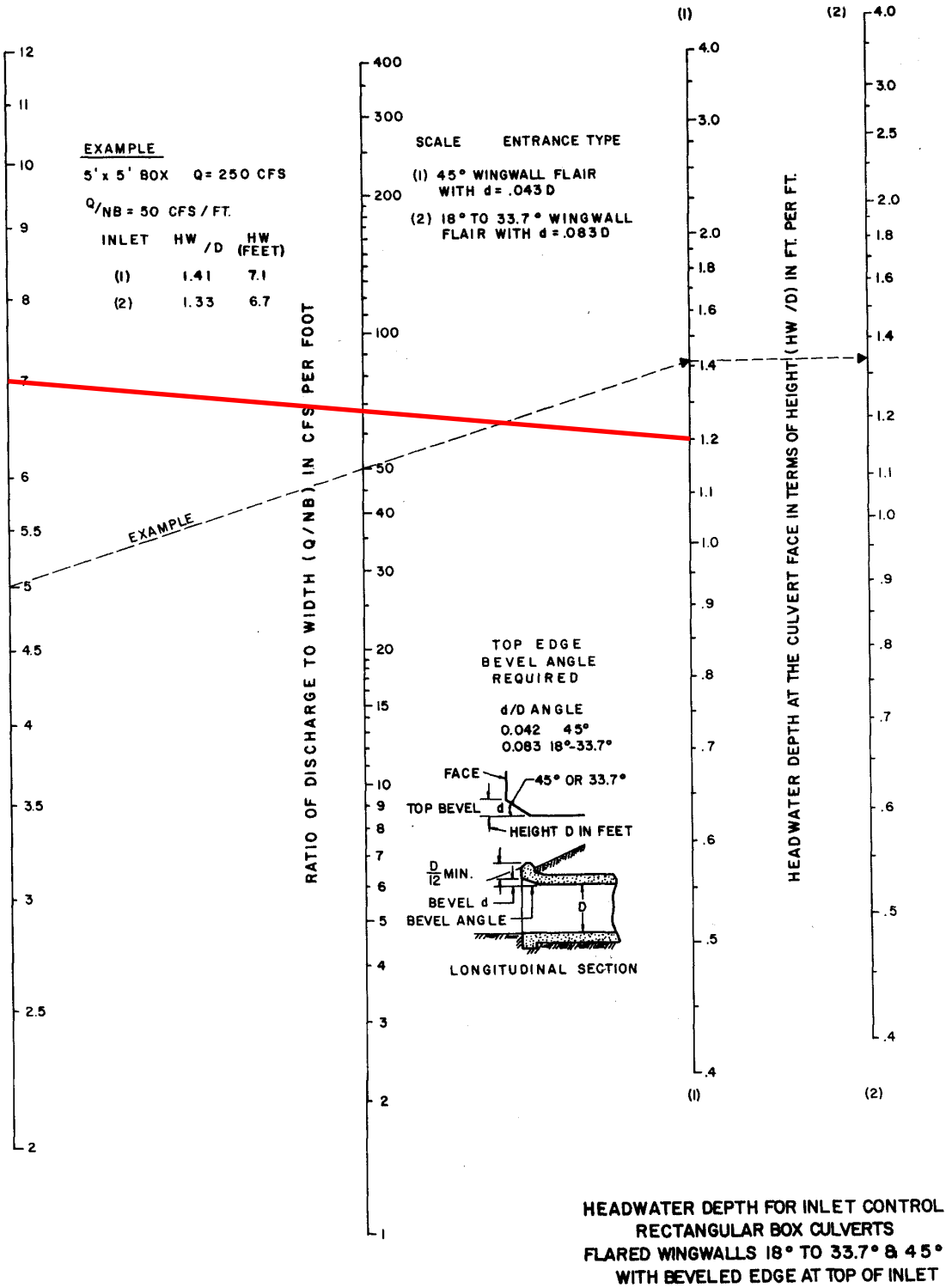
$$Q500 = 1.15 * Q100 = 784 \text{ cfs}$$

U-4434
Crossing 1
DA = 0.38 sq. mi.
USGS Urban Coastal Plain
Imperv. = 26.1%
Q50 = 590 cfs

Design
HW/D = 1.2
Q/B=68 cfs/ft
9' x 8' RCBC
w/ 1' buried
Length=260'

Crossing 1

CHART 9B

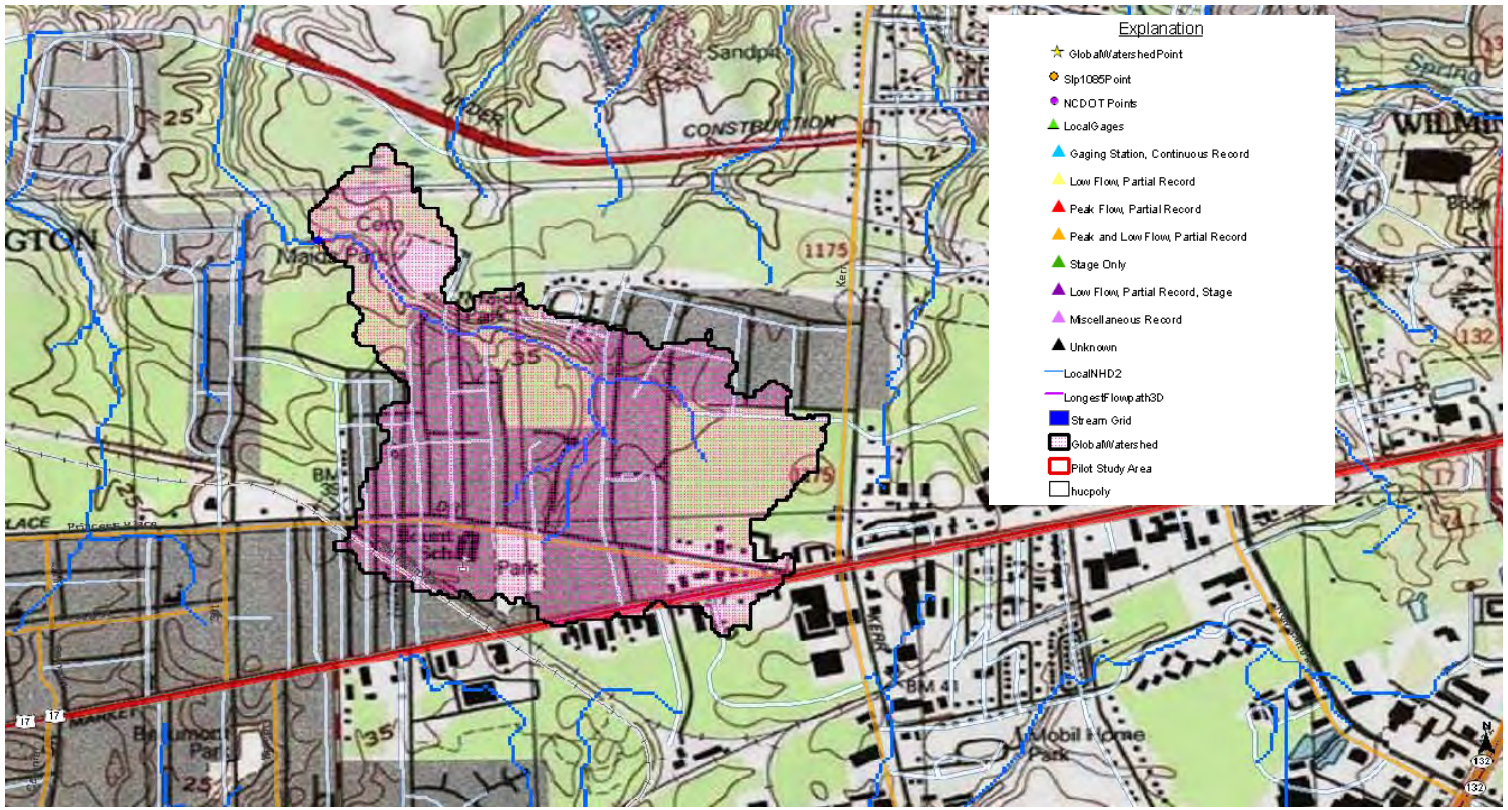


HEADWATER DEPTH FOR INLET CONTROL
RECTANGULAR BOX CULVERTS
FLARED WINGWALLS 18° TO 33.7° & 45°
WITH BEVELED EDGE AT TOP OF INLET

USGS North Carolina StreamStats

U-4434

Crossing 1



1/22/2014 4:42:20 PM

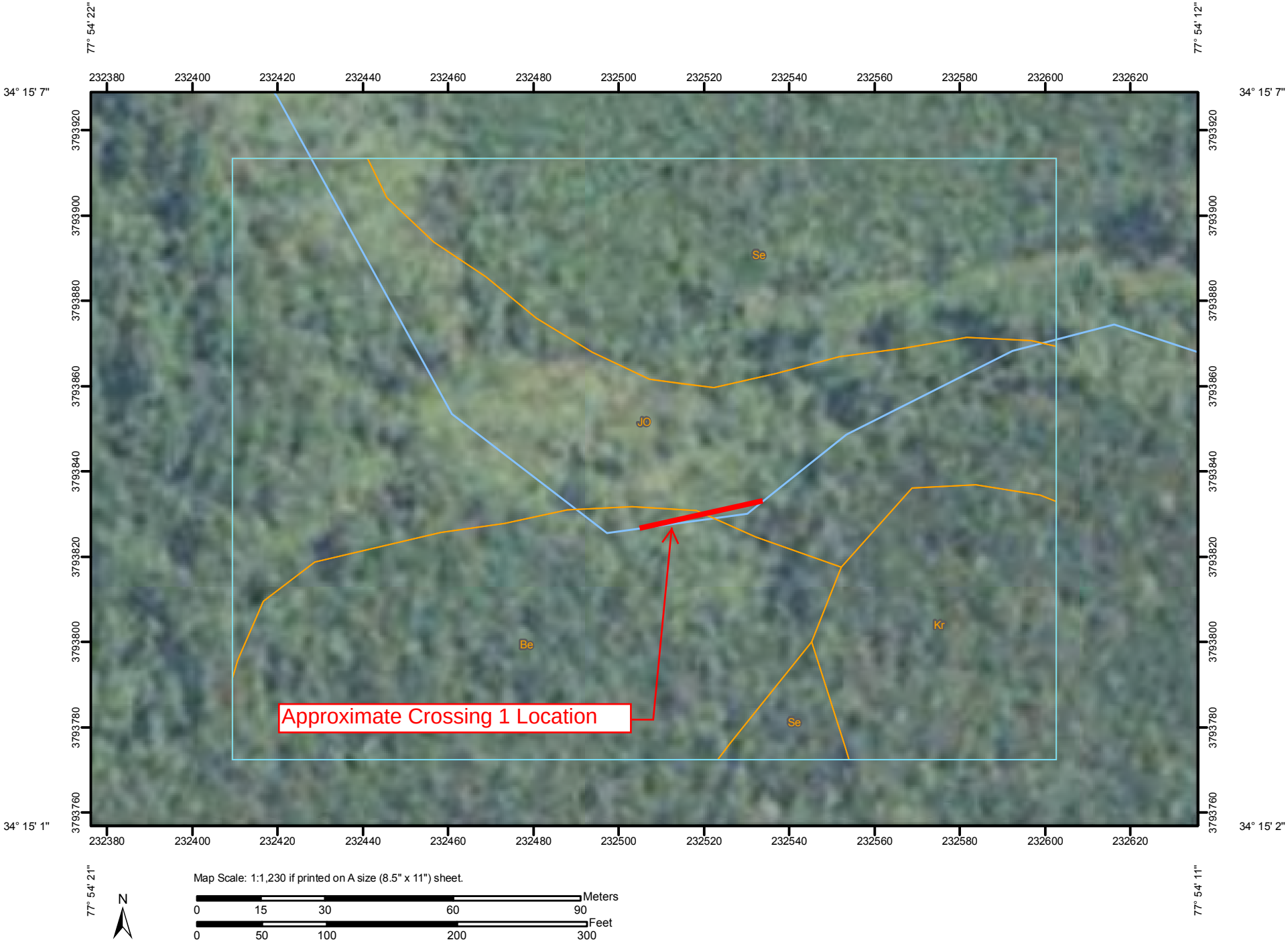
Crossing 1

Basin Characteristics Report

Date: Wed Jan 22 2014 16:33:45 Mountain Standard Time
NAD27 Latitude: 34.2513 (34 15 05)
NAD27 Longitude: -77.9047 (-77 54 17)
NAD83 Latitude: 34.2515 (34 15 05)
NAD83 Longitude: -77.9044 (-77 54 16)

Parameter	Value
Area in square miles	0.38
Percent of area covered by hydrologic region 1	0.000
Percent of area covered by hydrologic region 2	0.000
Percent of area covered by hydrologic region 3	0.000
Percent of area covered by hydrologic region 4	100.000
Percent of area covered by hydrologic region 5	0.000
Perimeter in miles	4.53
Mean basin slope, based on slope percent grid	1.61
Percent of area covered by barren rock using 2006 NLCD	0.000
Percent of area in cultivation using 2006 NLCD	0.000
Percent of area covered by all densities of developed land using 2006 NLCD	78.673
Percent of area covered by forest using 2006 NLCD	12.366
Percent of area covered by grassland/herbaceous using 2006 NLCD	0.824
Percent of area covered by impervious surface 2006 NLCD	26.07
Percent of area covered by shrubland using 2006 NLCD	5.206
Percent of area in hydric soil 'A' defined by SSURGO	14.5
Percent of area in hydric soil 'B' defined by SSURGO	80.8
Percent of area in hydric soil 'C' defined by SSURGO	0.95
Percent of area in hydric soil 'D' defined by SSURGO	3.26
Percent of area covered by water using 2006 NLCD	0.000
Percent of area covered by wetland using 2006 NLCD	2.930

Soil Map—New Hanover County, North Carolina
(U-4434 Crossing 1)



Crossing 2

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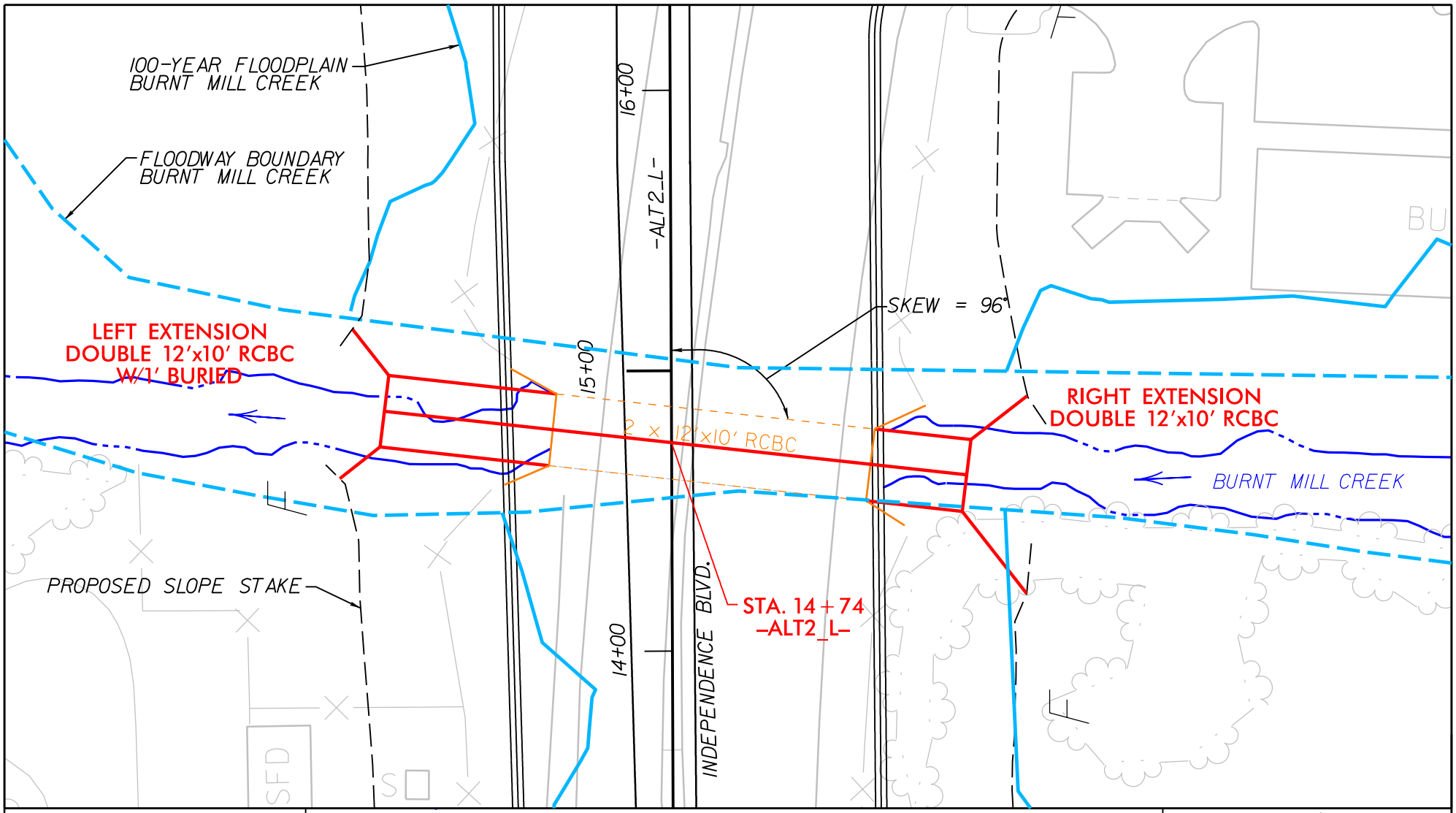

RECOMMENDED CULVERT FOR CROSSING 2

PRELIMINARY HYDRAULIC ANALYSIS

NEW HANOVER COUNTY

PROJECT: U-4434

INDEPENDENCE BOULEVARD EXTENSION

FEBRUARY 2014

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PRELIMINARY DESIGN AND ASSESSMENT OF STREAM CROSSINGS AND ENCROACHMENTS

COUNTY New Hanover PROJECT NUMBER U-4434

STREAM Burnt Mill Creek ROUTE Independence Blvd at Covil Ave Crossing 2

ASSESSMENT PREPARED BY CGW/MAD DATE 1/19/2012

HYDROLOGIC EVALUATION

NEAREST GAGING STATION ON THIS STREAM _____ (NONE X) _____

ARE FLOOD STUDIES AVAILABLE ON THIS STREAM: Yes - detailed study

FLOOD DATA:

Q_{10} 1430 CFS EST. BKWTR. ___ FT. Q_{25} 1940 CFS EST. BKWTR. ___ FT.

Q_{50} 2220 CFS EST. BKWTR. ___ FT. Q_{100} 2480 CFS EST. BKWTR. ___ FT.

Q_{500} 3270 CFS OR OVERTOPPING CFS EST. BKWTR. ___ FT.

DRAINAGE AREA 3.2 sq. mi. METHOD USED TO COMPUTE Q USGS Urban Regression

PROPERTY RELATED EVALUATIONS

DAMAGE POTENTIAL: LOW _____ MODERATE X HIGH _____

COULD THIS BE SIGNIFICANTLY INCREASED BY PROPOSED ENCROACHMENT: YES _____ NO X

EXPLANATION: _____

LIST BUILDINGS IN FLOOD PLAIN Business & Residential LOCATION See Note Below

FLOOR ELEVATION ~14.0'

UPSTREAM LAND USE Residential, Commercial

ANTICIPATE ANY CHANGE? No

ANY FLOOD ZONING? (FIA STUDIES, ETC.) YES X NO _____

TYPE OF STUDY Detailed Flood Study - Burnt Mill Creek

BASE FLOOD ELEVATION 14.0' DS; 15.0' US of Independence Blvd. (100 YEAR)

Note: Up to a point 1000' upstream, 10 residential buildings and 2 businesses within floodplain. Up to a point 600' downstream, 2 residential buildings and 2 businesses within floodplain.

REGULATORY FLOODWAY WIDTH 77' (AS NOTED IN FIA STUDIES)

COMMENTS: Floodway width at Cross Section 142

TRAFFIC RELATED EVALUATIONS

PRESENT YEAR 2012 TRAFFIC COUNT 25,900 VPD % TRUCKS 6%

DESIGN YEAR 2040 TRAFFIC COUNT 49,000 VPD % TRUCKS 6%

EMERGENCY ROUTE X SCHOOL BUS ROUTE _____ MAIL ROUTE _____

DETOUR AVAILABLE? No LENGTH OF DETOUR _____ MILES

DOES THE LEVEL OF TRAFFIC SERVICE OF AN EXISTING CROSSING VARY GREATLY FROM STANDARD DESIGN LEVELS? Yes - five of 12 intersections currently operate at LOS E or worse.

IS THE TRAFFIC VOLUME, TYPE, USAGE SUCH TO WARRANT CONSIDERATION FOR VARIANCE FROM STANDARDS OR EXISTING LEVEL OF INTERRUPTION? No

COMMENTS: See the U-4434 Traffic Capacity Technical Memorandum for additional detail.

HIGHWAY AND BRIDGE (CULVERT) RELATED EVALUATIONS

NOTE ANY OUTSIDE FEATURES WHICH MIGHT AFFECT STAGE, DISCHARGE OR FREQUENCY.

LEVEES -- AGGRADATION/DEGRADATION -- RESERVOIRS --

DIVERSIONS -- DRAINAGE DISTRICT -- NAVIGATION --

BACKWATER FROM ANOTHER SOURCE _____

EXPLANATION: _____

ROADWAY OVERFLOW SECTION (NONE X) LENGTH _____ ELEVATION _____

EMBANKMENT: SOIL TYPE Johnston TYPE SLOPE COVER Vegetation

COMMENTS: _____

ENVIRONMENTAL CONSIDERATIONS

LIST SPECIAL CONDITIONS OR CONSIDERATIONS WHICH AFFECT HYDRAULIC DESIGN (NONE _____)

Floodway, AE, and X Flood Zones

MISCELLANEOUS COMMENTS

IS THERE UNUSUAL SCOUR POTENTIAL? YES __ NO X PROTECTION NEEDED No

ARE BANKS STABLE? Yes PROTECTION NEEDED No

DOES STREAM CARRY APPRECIABLE AMOUNT OF LARGE DEBRIS? No

COMMENTS:

ALTERNATIVES

RECOMMENDED DESIGN Extension of existing culvert - 35' u/s, 60' d/s

DETOUR STRUCTURE None

LOW ROADWAY GRADE 1.9% DETOUR GRADE _____

BRIDGE WATERWAY OPENING _____ CULVERT OPENING +/- 240 sf

WERE OTHER HYDRAULIC ALTERNATES CONSIDERED? YES _____ NO X

DISCUSSION: Extension of existing culvert allows for the flow of the 50-year storm peak flow.

THIS SITE ASSESSMENT INDICATES THE DESIGN SHOULD FOLLOW:

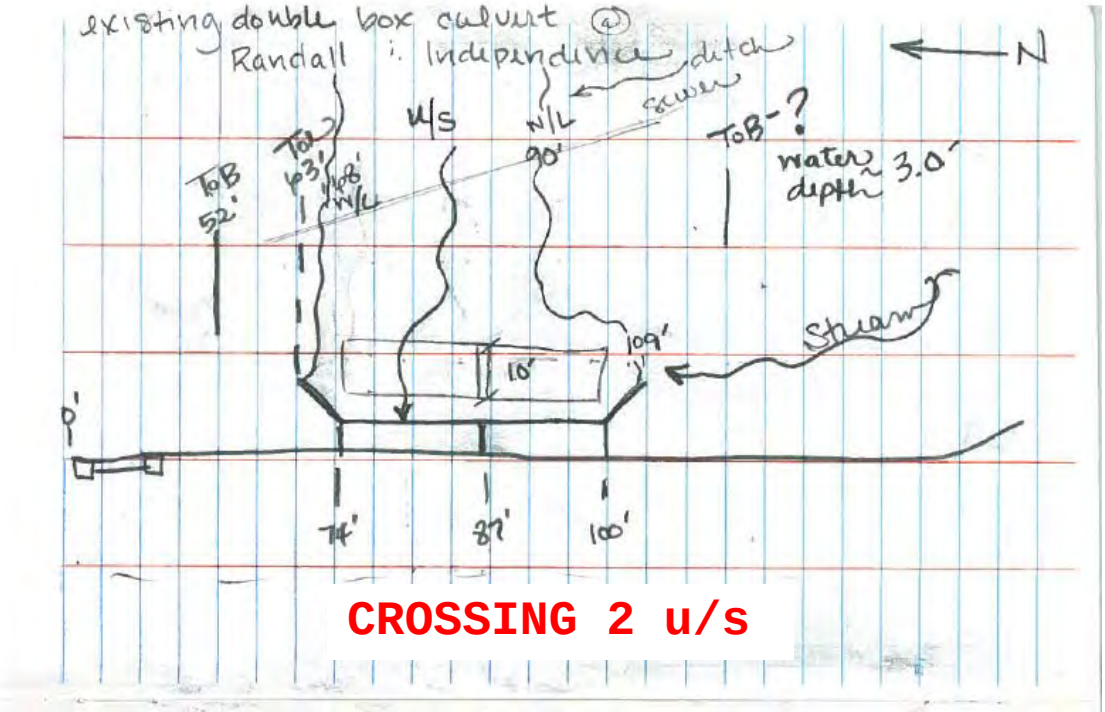
(1) _____ NORMAL PROCESS

(2) X NORMAL PROCESS WITH SPECIAL SPECIFIC CONSIDERATION FOR Floodway, AE, and X Flood Zones

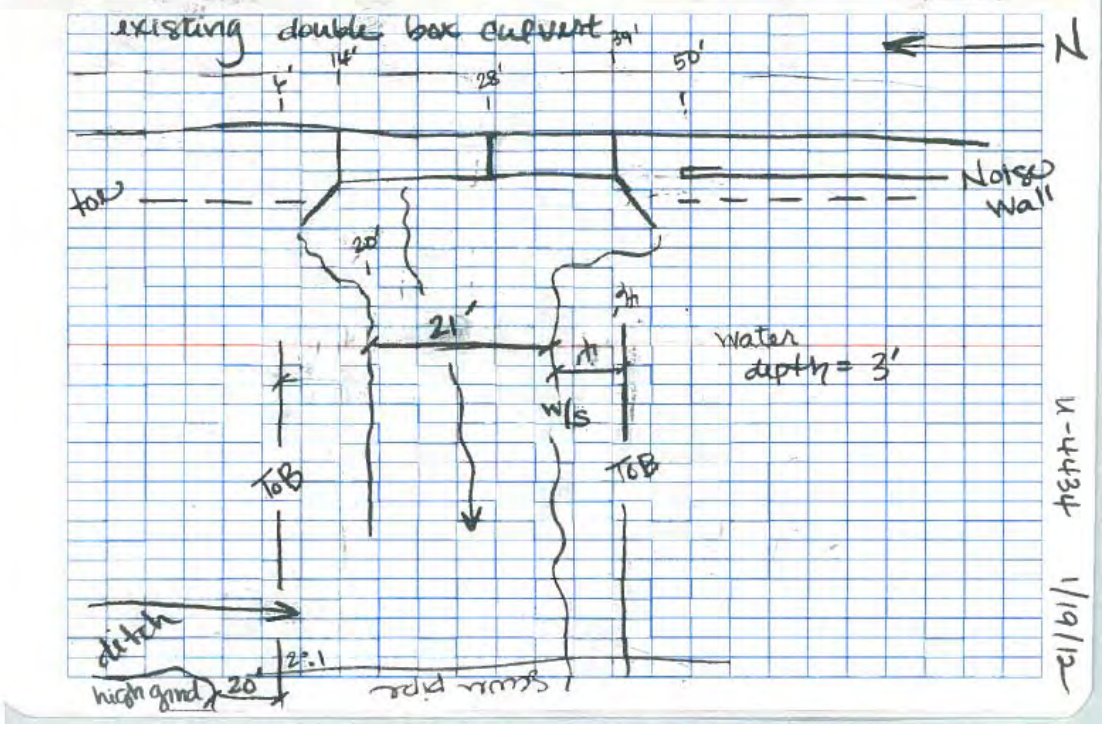
(3) _____ SPECIFIC DESIGN PROCESS WITH APPROPRIATE RISK/ECONOMIC EVALUATION ADDRESSING: _____

CROSSING 2

Field Notes



CROSSING 2 u/s



CROSSING 2 d/s

STIP NO:	U-4434
COUNTY:	New Hanover
DATE:	1/19/2012

CROSSING 2, LOOKING UPSTREAM (EAST)

CROSSING 2, LOOKING DOWNSTREAM (WEST)

STIP NO:	U-4434
COUNTY:	New Hanover
DATE:	1/19/2012

CROSSING 2, UPSTREAM (EAST) FACE

CROSSING 2, DOWNSTREAM (WEST) FACE

Crossing 2
Peak Discharge

Project Name:	U-4434 - Independence Blvd. Preliminary Hydraulic Analysis		
Project No.:	31823722		
Design Engineer:	C. Williams	**Date:**	1/24/2012

Crossing 2 - Existing Double RCBC at Burnt Mill Creek (Future Conditions)

North Carolina Rural Flood-Frequency Equations [1]

Drainage Area = 3.2 sq. mi.

Rural Flood-Recurrence Interval (years)	Coastal Plain	RQ (cfs)
2	$64.7 * DA^{0.673}$	142
5	$129 * DA^{0.635}$	271
10	$188 * DA^{0.615}$	386
25	$281 * DA^{0.593}$	562
50	$367 * DA^{0.579}$	722
100	$468 * DA^{0.566}$	907
500	$773 * DA^{0.539}$	1452

North Carolina Urban Flood-Frequency Equations [1]

Drainage Area = 3.2 sq. mi.
Impervious Area = 35.8 %

Recurrence Interval (years)	Urban Flood-Frequency Equation	Q (cfs)
2	$26.9 * DA^{0.722} * IA^{0.686}$	730
5	$68.2 * DA^{0.655} * IA^{0.572}$	1140
10	$109 * DA^{0.625} * IA^{0.515}$	1430
25	$209 * DA^{0.570} * IA^{0.436}$	1940
50	$280 * DA^{0.558} * IA^{0.396}$	2220
100	$363 * DA^{0.547} * IA^{0.358}$	2480

1. The National Flood-Frequency Program - Methods for Estimating Flood Magnitude and Frequency in Rural and Urban Areas in North Carolina, 2001. 2002. U.S. Geological Survey Fact Sheet 007-00.

No equation for Q500 so use ratio between FIS Q100 and Q500

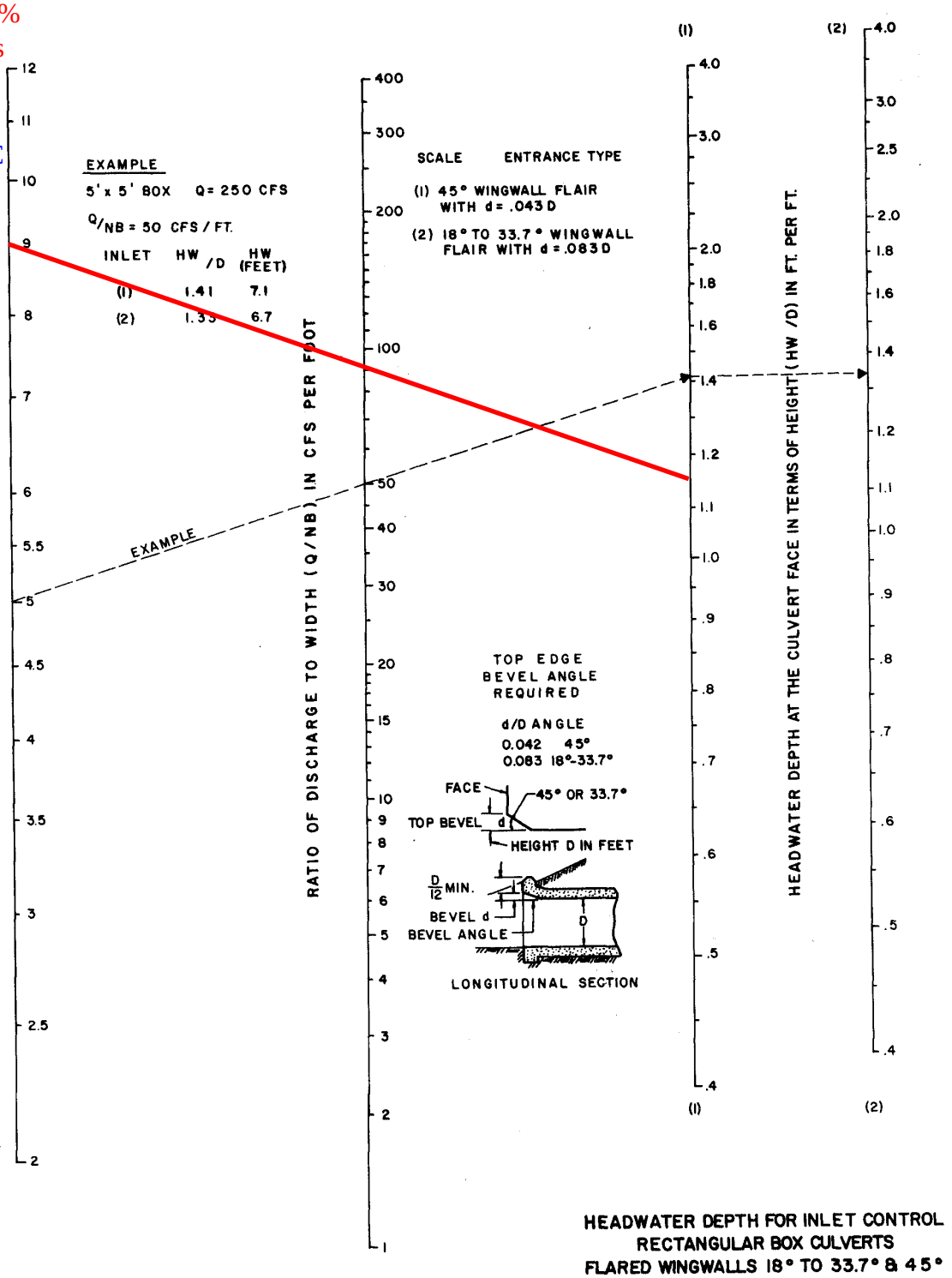
$$\frac{Q500}{Q100} = \frac{2650}{2010} = 1.3$$

Q500 = 1.32 * Q100 = 3270 cfs

U-4434
Crossing 2
DA = 3.2 sq. mi.
USGS Urban Coastal Plain
Imperv. = 35.8%
Q50 = 2220 cfs
Existing
Double
12' x 10' RCBC
w/1' Buried
Q/B = 92.5
HW/D = 1.15

Crossing 2

CHART 9B

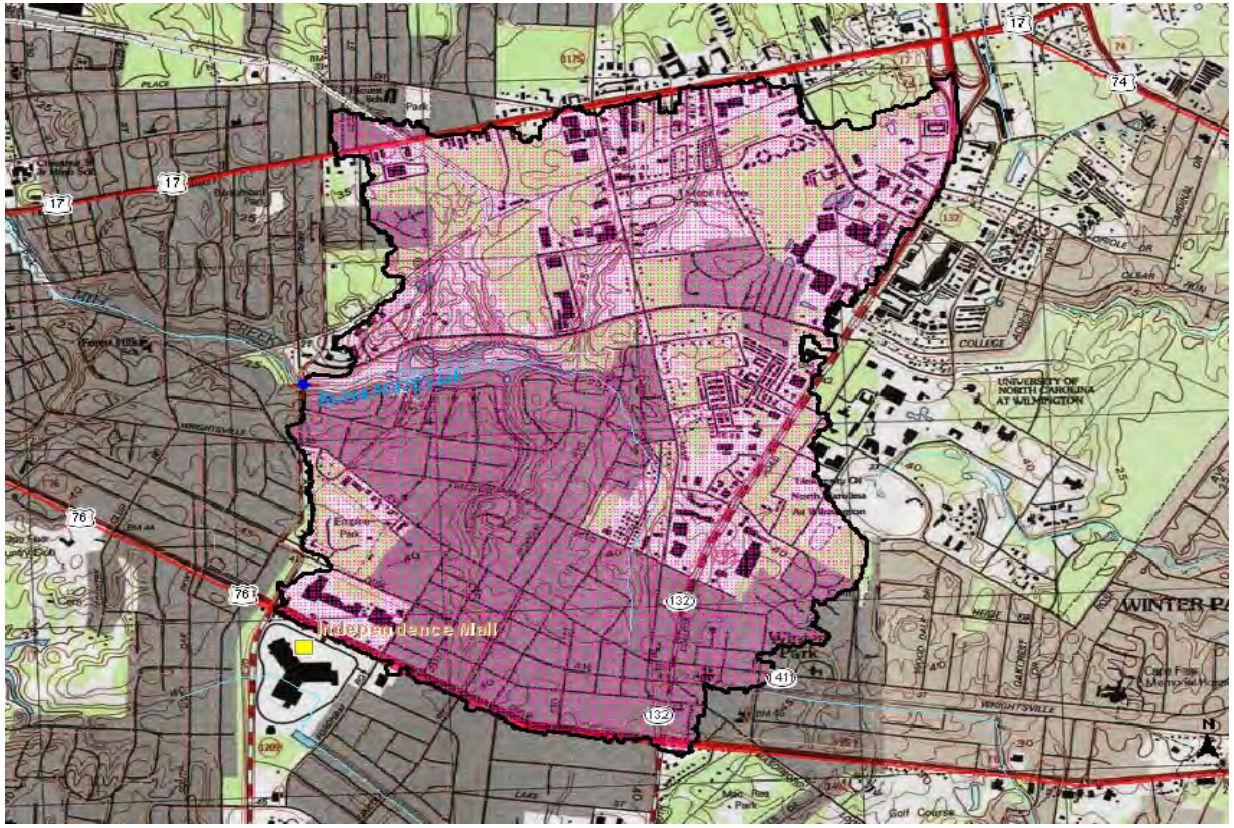


HEADWATER DEPTH FOR INLET CONTROL
RECTANGULAR BOX CULVERTS
FLARED WINGWALLS 18° TO 33.7° & 45°
WITH BEVELED EDGE AT TOP OF INLET

USGS North Carolina StreamStats

U-4434

Crossing 2



Explanation

- GlobalWatershedPoint
- Slp1085Point
- NCDOTPoints
- LocalGages
- Gaging Station, Continuous Record
- Low Flow, Partial Record
- Peak Flow, Partial Record
- Peak and Low Flow, Partial Record
- Stage Only
- Low Flow, Partial Record, Stage
- Miscellaneous Record
- Unknown
- LocalNHD2
- LongestFlowpath3D
- Stream Grid
- GlobalWatershed
- Pilot Study Area
- hucpoly

1/23/2014 9:39:47 AM

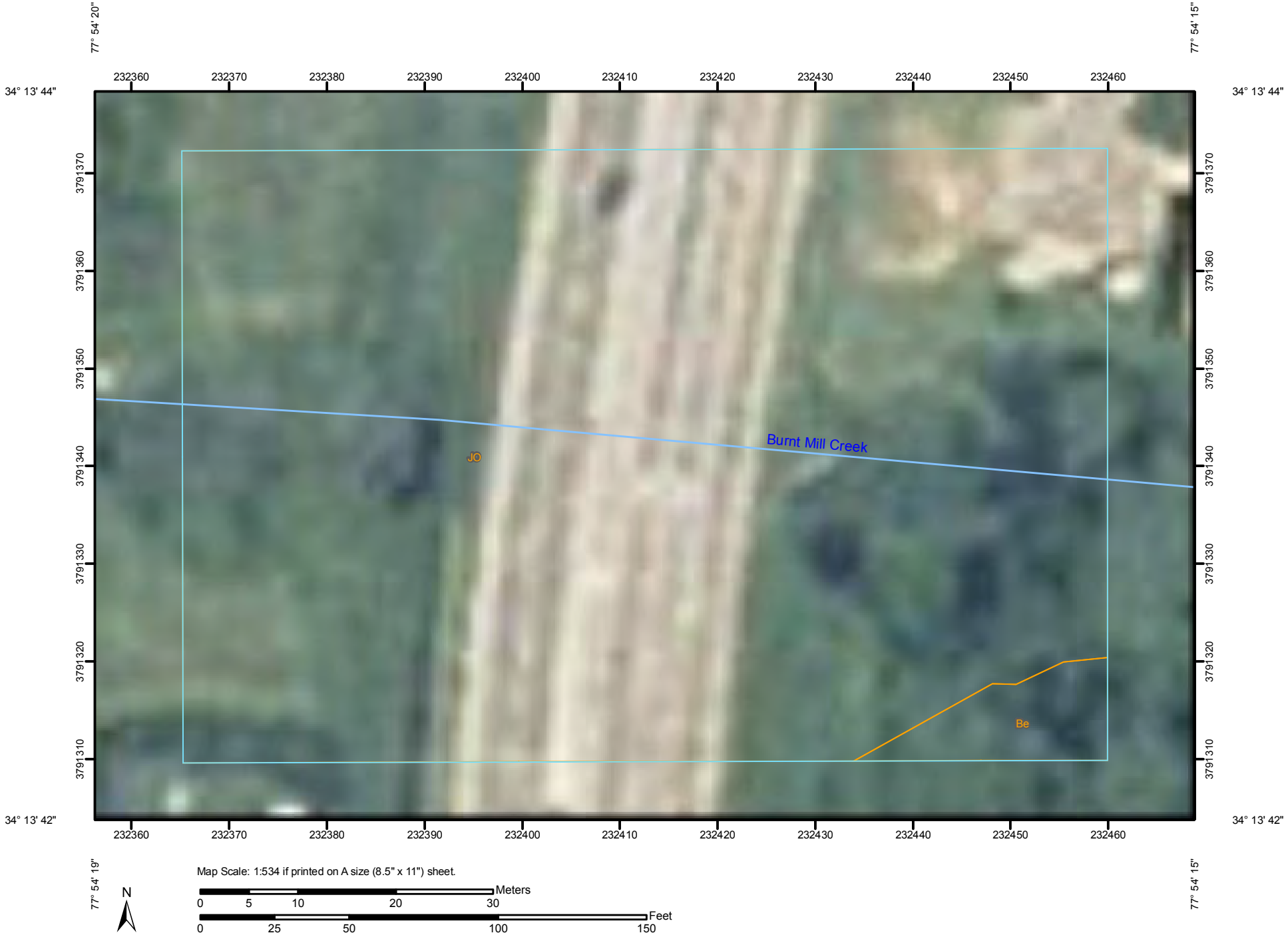
Crossing 2

Basin Characteristics Report

Date: Thu Jan 23 2014 09:38:42 Mountain Standard Time
NAD27 Latitude: 34.2286 (34 13 43)
NAD27 Longitude: -77.9055 (-77 54 20)
NAD83 Latitude: 34.2287 (34 13 43)
NAD83 Longitude: -77.9052 (-77 54 19)

Parameter	Value
Area in square miles	3.3
Percent of area covered by hydrologic region 1	0.000
Percent of area covered by hydrologic region 2	0.000
Percent of area covered by hydrologic region 3	0.000
Percent of area covered by hydrologic region 4	100.000
Percent of area covered by hydrologic region 5	0.000
Mean basin slope, based on slope percent grid	1.46
Percent of area covered by barren rock using 2006 NLCD	0.000
Percent of area in cultivation using 2006 NLCD	1.716
Percent of area covered by all densities of developed land using 2006 NLCD	82.828
Percent of area covered by forest using 2006 NLCD	8.608
Percent of area covered by grassland/herbaceous using 2006 NLCD	0.715
Percent of area covered by impervious surface 2006 NLCD	35.81
Percent of area covered by shrubland using 2006 NLCD	3.900
Percent of area in hydric soil 'A' defined by SSURGO	20.9
Percent of area in hydric soil 'B' defined by SSURGO	60.2
Percent of area in hydric soil 'C' defined by SSURGO	7.23
Percent of area in hydric soil 'D' defined by SSURGO	4.25
Percent of area covered by water using 2006 NLCD	1.090
Percent of area covered by wetland using 2006 NLCD	1.143

Soil Map—New Hanover County, North Carolina
(Crossing 2)



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Crossing 3

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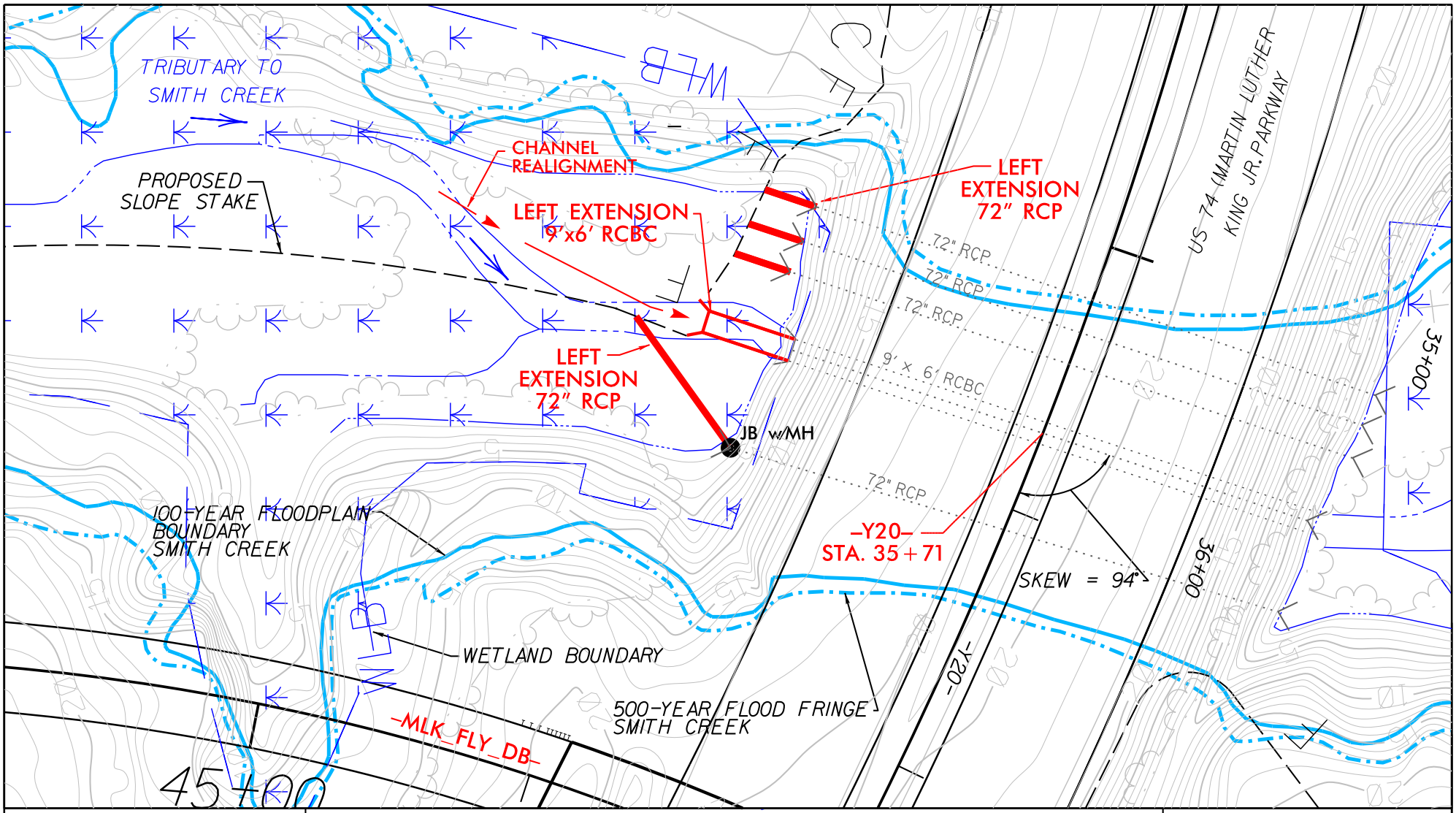

25′ 0 25′ 50′

1″ = 50 FT.

RECOMMENDED CULVERT FOR CROSSING 3

PRELIMINARY HYDRAULIC ANALYSIS

NEW HANOVER COUNTY

PROJECT: U-4434

INDEPENDENCE BOULEVARD EXTENSION

MAY 2014

NAD 83

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PRELIMINARY DESIGN AND ASSESSMENT OF STREAM CROSSINGS AND ENCROACHMENTS

COUNTY New Hanover PROJECT NUMBER U-4434

STREAM Trib to Smith Creek ROUTE US74 (MLK Jr. Blvd) Crossing 3

ASSESSMENT PREPARED BY CGW/MAD DATE 1/19/2012

HYDROLOGIC EVALUATION

NEAREST GAGING STATION ON THIS STREAM _____ (NONE X) _____

ARE FLOOD STUDIES AVAILABLE ON THIS STREAM: No - backwater from Smith Creek

FLOOD DATA:

Q_{10} 390 CFS EST. BKWTR. 5.3 FT. Q_{25} 600 CFS EST. BKWTR. ___ FT.

Q_{50} 720 CFS EST. BKWTR. 7.3 FT. Q_{100} 830 CFS EST. BKWTR. 8.4 FT.

Q_{500} 960 CFS OR OVERTOPPING CFS EST. BKWTR. 10.7FT.

DRAINAGE AREA 0.63 sq. mi. METHOD USED TO COMPUTE Q USGS Urban Regression

PROPERTY RELATED EVALUATIONS

DAMAGE POTENTIAL: LOW X MODERATE _____ HIGH _____

COULD THIS BE SIGNIFICANTLY INCREASED BY PROPOSED

ENCROACHMENT: YES X NO _____

EXPLANATION: proposed design fill could impede the existing drainage flow

LIST BUILDINGS IN FLOOD PLAIN N/A LOCATION N/A

FLOOR ELEVATION N/A

UPSTREAM LAND USE High density residential, park

ANTICIPATE ANY CHANGE? No

ANY FLOOD ZONING? (FIA STUDIES, ETC.) YES X NO _____

TYPE OF STUDY Detailed study of Smith Creek

BASE FLOOD ELEVATION 8.4' (100 YEAR)

REGULATORY FLOODWAY WIDTH -- (AS NOTED IN FIA STUDIES)

COMMENTS: upstream on a tributary to the Smith Creek detailed study

TRAFFIC RELATED EVALUATIONS

PRESENT YEAR 2012 TRAFFIC COUNT 33,900 VPD % TRUCKS 9%

DESIGN YEAR 2040 TRAFFIC COUNT 82,500 VPD % TRUCKS 9%

EMERGENCY ROUTE X SCHOOL BUS ROUTE _____ MAIL ROUTE _____

DETOUR AVAILABLE? No LENGTH OF DETOUR -- MILES

DOES THE LEVEL OF TRAFFIC SERVICE OF AN EXISTING CROSSING VARY GREATLY FROM STANDARD DESIGN LEVELS? No

IS THE TRAFFIC VOLUME, TYPE, USAGE SUCH TO WARRANT CONSIDERATION FOR VARIANCE FROM STANDARDS OR EXISTING LEVEL OF INTERRUPTION? No

COMMENTS: _____

HIGHWAY AND BRIDGE (CULVERT) RELATED EVALUATIONS

NOTE ANY OUTSIDE FEATURES WHICH MIGHT AFFECT STAGE, DISCHARGE OR FREQUENCY.

LEVEES -- AGGRADATION/DEGRADATION -- RESERVOIRS --

DIVERSIONS -- DRAINAGE DISTRICT -- NAVIGATION --

BACKWATER FROM ANOTHER SOURCE Smith Creek

EXPLANATION: _____

ROADWAY OVERFLOW SECTION (NONE X) LENGTH _____ ELEVATION _____

EMBANKMENT: SOIL TYPE Johnston soil TYPE SLOPE COVER Vegetation

COMMENTS: _____

ENVIRONMENTAL CONSIDERATIONS

LIST SPECIAL CONDITIONS OR CONSIDERATIONS WHICH AFFECT HYDRAULIC DESIGN (NONE _____)
Wetlands; Mapped FEMA AE, X Flood Zones

MISCELLANEOUS COMMENTS

IS THERE UNUSUAL SCOUR POTENTIAL? YES __ NO X PROTECTION NEEDED No

ARE BANKS STABLE? Yes PROTECTION NEEDED No

DOES STREAM CARRY APPRECIABLE AMOUNT OF LARGE DEBRIS? No

COMMENTS:
Wetlands present upstream and downstream of crossing

ALTERNATIVES

RECOMMENDED DESIGN Extension of existing culverts, between 20' and 35' on u/s end

DETOUR STRUCTURE None

LOW ROADWAY GRADE 0.21% DETOUR GRADE _____

BRIDGE WATERWAY OPENING _____ CULVERT OPENING 158 sf total eff.

WERE OTHER HYDRAULIC ALTERNATES CONSIDERED? YES _____ NO X

DISCUSSION: _____

THIS SITE ASSESSMENT INDICATES THE DESIGN SHOULD FOLLOW:

(1) _____ NORMAL PROCESS

(2) X NORMAL PROCESS WITH SPECIAL SPECIFIC CONSIDERATION FOR Wetlands, FEMA AE Flood Zone

(3) _____ SPECIFIC DESIGN PROCESS WITH APPROPRIATE RISK/ECONOMIC EVALUATION ADDRESSING: _____

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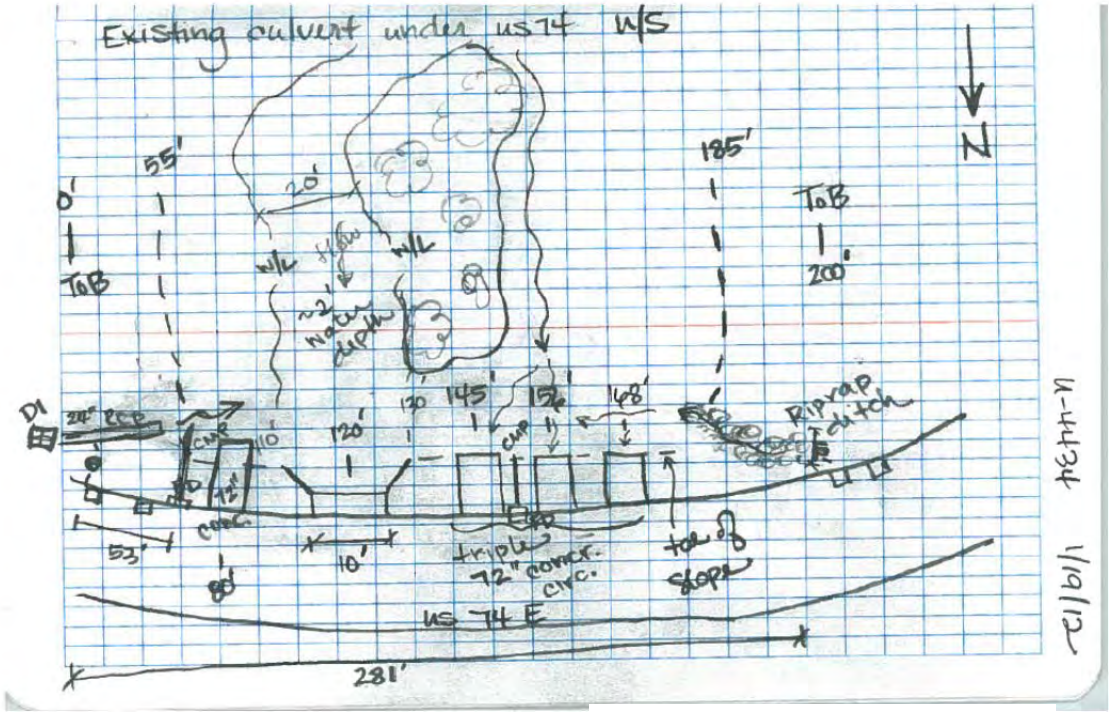
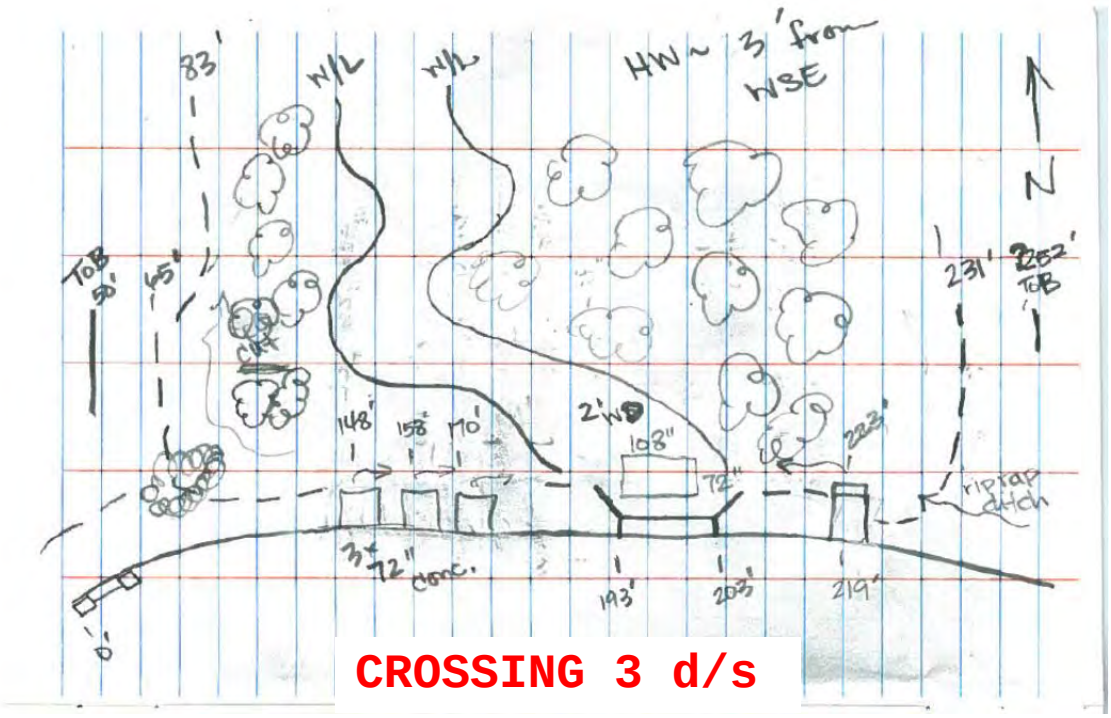
CROSSING 3

Field Notes



CROSSING 3 u/s



CROSSING 3 d/s

STIP NO:	U-4434
COUNTY:	New Hanover
DATE:	1/19/2012

CROSSING 3, LOOKING UPSTREAM (SOUTH)

CROSSING 3, LOOKING DOWNSTREAM (NORTH)

STIP NO:	U-4434
COUNTY:	New Hanover
DATE:	1/19/2012

CROSSING 3, UPSTREAM END LOOKING WEST

CROSSING 3, DOWNSTREAM END LOOKING EAST

STIP NO:	U-4434
COUNTY:	New Hanover
DATE:	1/31/2012

CROSSING 3, UPSTREAM (SOUTH) CULVERT FACE

CROSSING 3, UPSTREAM (SOUTH) FACE

Crossing 3
Peak Discharge

Project Name:	U-4434 - Independence Blvd. Preliminary Hydraulic Analysis		
Project No.:	31823722		
Design Engineer:	C. Williams	**Date:**	1/24/2012

Crossing 3 - Existing Multiple Culverts under US74 (Martin Luther King Jr. Blvd.)

North Carolina Rural Flood-Frequency Equations [1]

Drainage Area = 0.63 sq. mi.

Rural Flood-Recurrence Interval (years)	Coastal Plain	RQ (cfs)
2	$64.7 * DA^{0.673}$	47
5	$129 * DA^{0.635}$	96
10	$188 * DA^{0.615}$	141
25	$281 * DA^{0.593}$	214
50	$367 * DA^{0.579}$	281
100	$468 * DA^{0.566}$	360
500	$773 * DA^{0.539}$	603

North Carolina Urban Flood-Frequency Equations [1]

Drainage Area = 0.63 sq. mi.
Impervious Area = 20.3 %

Recurrence Interval (years)	Urban Flood-Frequency Equation	Q (cfs)
2	$26.9 * DA^{0.722} * IA^{0.686}$	160
5	$68.2 * DA^{0.655} * IA^{0.572}$	290
10	$109 * DA^{0.625} * IA^{0.515}$	390
25	$209 * DA^{0.570} * IA^{0.436}$	600
50	$280 * DA^{0.558} * IA^{0.396}$	720
100	$363 * DA^{0.547} * IA^{0.358}$	830

1. The National Flood-Frequency Program - Methods for Estimating Flood Magnitude and Frequency in Rural and Urban Areas in North Carolina, 2001. 2002. U.S. Geological Survey Fact Sheet 007-00.

No equation for Q500 so use ratio between Q50 and Q100 to find Q500 based on Q100

$$\frac{Q100}{Q50} = \frac{830.0}{720.0} = 1.2$$

Q500 = 1.15 * Q100 = 960 cfs

Crossing 3 Existing vs Proposed Comparison

HY8 Analysis Summary

Total Discharge	Headwater Elevation		Tailwater Elevation		Outlet Velocity	
cfs	ft		ft		ft/sec	
	Existing	Proposed	Existing	Proposed	Existing	Proposed
160 (Q10)	5.9	6.1	2.6	2.6	1.5	1.5
240	6.4	6.6	2.8	2.8	1.8	1.8
320	6.9	7.1	2.9	2.9	2.0	2.0
400	7.3	7.5	3.1	3.1	2.2	2.2
480	7.6	7.8	3.2	3.2	2.3	2.3
560	7.9	8.1	3.3	3.3	2.5	2.5
640	8.3	8.5	3.4	3.4	2.6	2.6
720 (Q50)	8.6	8.8	3.5	3.5	2.7	2.7
800	8.9	9.1	3.6	3.6	2.8	2.8
880	9.2	9.4	3.7	3.7	2.9	2.9
960 (Q500)	9.4	9.6	3.8	3.8	3.0	3.0

Note: All elevations estimated from LIDAR data.

Overtopping Discharge

Existing	3060 cfs
Proposed	3031 cfs

Note:
0.2 foot rise in headwater not expected to impact surrounding insurable structures.
Detailed flood modeling will be required to dtermine impacts of proposed channel fill.

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 160 cfs

Design Flow: 720 cfs

Maximum Flow: 960 cfs

Table 1 - Summary of Culvert Flows at Crossing: Crossing 3 Existing

Headwater Elevation (ft)	Total Discharge (cfs)	Triple 72" RCP Discharge (cfs)	9' x 6' RCBC Discharge (cfs)	72" RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
5.88	160.00	19.95	111.64	28.29	0.00	5
6.41	240.00	49.32	145.19	45.39	0.00	4
6.85	320.00	83.26	174.80	61.92	0.00	4
7.25	400.00	119.29	203.25	77.41	0.00	4
7.60	480.00	158.04	229.75	92.07	0.00	3
7.94	560.00	197.36	255.55	107.14	0.00	3
8.26	640.00	235.53	281.27	122.97	0.00	3
8.57	720.00	274.33	306.29	139.17	0.00	3
8.87	800.00	314.27	330.27	155.31	0.00	3
9.16	880.00	355.40	353.28	171.25	0.00	3
9.43	960.00	397.78	375.43	186.88	0.00	3
20.00	3057.03	1569.23	941.76	546.04	0.00	Overtopping

Table 2 - Culvert Summary Table: Triple 72" RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
160.00	19.95	5.88	0.878	0.0*	1-S2n	0.386	0.667	0.386	0.619	5.682	1.505
240.00	49.32	6.41	1.415	0.0*	1-S2n	0.673	1.057	0.673	0.789	9.136	1.765
320.00	83.26	6.85	1.851	0.0*	1-S2n	0.877	1.384	0.877	0.937	10.536	1.977
400.00	119.29	7.25	2.248	0.0*	1-S2n	1.092	1.664	1.092	1.071	11.307	2.157
480.00	158.04	7.60	2.602	0.0*	1-S2n	1.234	1.926	1.281	1.195	11.802	2.316
560.00	197.36	7.94	2.935	0.0*	1-S2n	1.378	2.160	1.447	1.310	12.415	2.459
640.00	235.53	8.26	3.261	0.0*	1-S2n	1.517	2.367	1.590	1.419	13.058	2.590
720.00	274.33	8.57	3.573	0.0*	1-S2n	1.654	2.564	1.725	1.522	13.561	2.711
800.00	314.27	8.87	3.871	0.122	1-S2n	1.764	2.757	1.858	1.621	13.998	2.824
880.00	355.40	9.16	4.157	0.407	1-S2n	1.877	2.941	1.991	1.716	14.401	2.930
960.00	397.78	9.43	4.435	0.700	1-S2n	1.994	3.116	2.124	1.808	14.783	3.030

* Full Flow Headwater elevation is below inlet invert.

****

Straight Culvert

Inlet Elevation (invert): 5.00 ft, Outlet Elevation (invert): 2.00 ft

Culvert Length: 210.02 ft, Culvert Slope: 0.0143

****

Site Data - Triple 72" RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 5.00 ft

Outlet Station: 210.00 ft

Outlet Elevation: 2.00 ft

Number of Barrels: 3

Culvert Data Summary - Triple 72" RCP

Barrel Shape: Circular

Barrel Diameter: 6.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: NONE

Table 3 - Culvert Summary Table: 9' x 6' RCBC

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
160.00	111.64	5.88	2.878	0.822	1-S2n	1.564	1.684	1.564	0.619	7.929	1.505
240.00	145.19	6.41	3.414	1.240	1-S2n	1.866	2.007	1.866	0.789	8.644	1.765
320.00	174.80	6.85	3.851	1.609	1-S2n	2.125	2.271	2.128	0.937	9.125	1.977
400.00	203.25	7.25	4.248	1.968	1-S2n	2.357	2.511	2.357	1.071	9.582	2.157
480.00	229.75	7.60	4.601	2.308	1-S2n	2.568	2.725	2.580	1.195	9.895	2.316
560.00	255.55	7.94	4.935	2.647	1-S2n	2.772	2.926	2.772	1.310	10.244	2.459
640.00	281.27	8.26	5.261	2.993	1-S2n	2.965	3.119	2.965	1.419	10.541	2.590
720.00	306.29	8.57	5.573	3.338	1-S2n	3.153	3.301	3.162	1.522	10.761	2.711
800.00	330.27	8.87	5.870	3.676	1-S2n	3.330	3.471	3.337	1.621	10.998	2.824
880.00	353.28	9.16	6.157	4.010	5-S2n	3.495	3.630	3.495	1.716	11.230	2.930
960.00	375.43	9.43	6.434	4.338	5-S2n	3.654	3.781	3.654	1.808	11.415	3.030

****

Straight Culvert

Inlet Elevation (invert): 3.00 ft, Outlet Elevation (invert): 2.00 ft

Culvert Length: 193.00 ft, Culvert Slope: 0.0052

****

Site Data - 9' x 6' RCBC

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 3.00 ft

Outlet Station: 193.00 ft

Outlet Elevation: 2.00 ft

Number of Barrels: 1

Culvert Data Summary - 9' x 6' RCBC

Barrel Shape: Concrete Box

Barrel Span: 9.00 ft

Barrel Rise: 6.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge (90º) Headwall

Inlet Depression: NONE

Table 4 - Culvert Summary Table: 72" RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
160.00	28.29	5.88	1.878	0.0*	1-S2n	1.001	1.398	1.001	0.619	9.002	1.505
240.00	45.39	6.41	2.415	0.0*	1-S2n	1.266	1.782	1.316	0.789	9.780	1.765
320.00	61.92	6.85	2.852	0.219	1-S2n	1.488	2.092	1.540	0.937	10.744	1.977
400.00	77.41	7.25	3.248	0.548	1-S2n	1.681	2.349	1.736	1.071	11.378	2.157
480.00	92.07	7.60	3.602	0.855	1-S2n	1.830	2.573	1.907	1.195	11.875	2.316
560.00	107.14	7.94	3.936	1.172	1-S2n	1.983	2.790	2.072	1.310	12.348	2.459
640.00	122.97	8.26	4.261	1.500	1-S2n	2.144	2.998	2.237	1.419	12.791	2.590
720.00	139.17	8.57	4.574	1.837	1-S2n	2.289	3.193	2.397	1.522	13.181	2.711
800.00	155.31	8.87	4.871	2.184	1-S2n	2.427	3.382	2.556	1.621	13.515	2.824
880.00	171.25	9.16	5.156	2.536	1-S2n	2.564	3.561	2.704	1.716	13.850	2.930
960.00	186.88	9.43	5.434	2.890	1-S2n	2.699	3.729	2.847	1.808	14.137	3.030

* Full Flow Headwater elevation is below inlet invert.

****

Straight Culvert

Inlet Elevation (invert): 4.00 ft, Outlet Elevation (invert): 2.00 ft

Culvert Length: 210.01 ft, Culvert Slope: 0.0095

****

Site Data - 72" RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 4.00 ft

Outlet Station: 210.00 ft

Outlet Elevation: 2.00 ft

Number of Barrels: 1

Culvert Data Summary - 72" RCP

Barrel Shape: Circular

Barrel Diameter: 6.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: NONE

Table 5 - Downstream Channel Rating Curve (Crossing: Crossing 3 Existing)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
160.00	2.62	0.62	1.50	0.15	0.34
240.00	2.79	0.79	1.77	0.20	0.35
320.00	2.94	0.94	1.98	0.23	0.36
400.00	3.07	1.07	2.16	0.27	0.37
480.00	3.19	1.19	2.32	0.30	0.38
560.00	3.31	1.31	2.46	0.33	0.38
640.00	3.42	1.42	2.59	0.35	0.39
720.00	3.52	1.52	2.71	0.38	0.39
800.00	3.62	1.62	2.82	0.40	0.40
880.00	3.72	1.72	2.93	0.43	0.40
960.00	3.81	1.81	3.03	0.45	0.40

Tailwater Channel Data - Crossing 3 Existing

Tailwater Channel Option: Irregular Channel

Channel Slope: 0.0040

User Defined Channel Cross-Section:

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	0.00	19.00	0.1200
2	33.00	18.00	0.1200
3	60.00	12.00	0.1200
4	92.00	11.00	0.1100
5	116.00	2.00	0.0450
6	286.00	2.00	0.1100
7	330.00	16.00	0.1200
8	402.00	18.00	0.0000

Roadway Data for Crossing: Crossing 3 Existing

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 402.00 ft

Crest Elevation: 20.00 ft

Roadway Surface: Paved

Roadway Top Width: 170.00 ft

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HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 160 cfs

Design Flow: 720 cfs

Maximum Flow: 960 cfs

Table 1 - Summary of Culvert Flows at Crossing: Crossing 3 Proposed Extension

Headwater Elevation (ft)	Total Discharge (cfs)	Triple 72" RCP Discharge (cfs)	9' x 6' RCBC Discharge (cfs)	72" RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
6.10	160.00	25.95	113.18	20.83	0.00	5
6.63	240.00	57.59	146.48	35.89	0.00	4
7.07	320.00	93.12	175.90	50.94	0.00	4
7.45	400.00	130.38	203.63	65.97	0.00	4
7.81	480.00	169.86	230.22	79.80	0.00	3
8.14	560.00	209.80	256.16	93.88	0.00	3
8.47	640.00	248.76	282.30	108.93	0.00	4
8.78	720.00	288.49	307.17	124.12	0.00	3
9.08	800.00	329.26	331.04	139.54	0.00	3
9.36	880.00	371.08	353.89	154.94	0.00	3
9.64	960.00	413.84	375.87	170.27	0.00	3
20.00	3030.67	1561.90	934.26	534.51	0.00	Overtopping

Table 2 - Culvert Summary Table: Triple 72" RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
160.00	25.95	6.10	1.003	0.0*	1-S2n	0.519	0.763	0.519	0.619	6.779	1.505
240.00	57.59	6.63	1.534	0.0*	1-S2n	0.733	1.145	0.733	0.789	9.374	1.765
320.00	93.12	7.07	1.966	0.0*	1-S2n	0.954	1.466	1.006	0.937	9.812	1.977
400.00	130.38	7.45	2.352	0.0*	1-S2n	1.148	1.742	1.187	1.071	10.887	2.157
480.00	169.86	7.81	2.707	0.0*	1-S2n	1.297	1.999	1.349	1.195	11.779	2.316
560.00	209.80	8.14	3.043	0.0*	1-S2n	1.448	2.230	1.511	1.310	12.453	2.459
640.00	248.76	8.47	3.373	0.0*	1-S2n	1.595	2.437	1.651	1.419	13.118	2.590
720.00	288.49	8.78	3.684	0.0*	1-S2n	1.718	2.634	1.787	1.522	13.566	2.711
800.00	329.26	9.08	3.980	0.138	1-S2n	1.834	2.826	1.924	1.621	13.982	2.824
880.00	371.08	9.36	4.264	0.430	1-S2n	1.953	3.007	2.056	1.716	14.400	2.930
960.00	413.84	9.64	4.539	0.730	1-S2n	2.075	3.179	2.190	1.808	14.780	3.030

* Full Flow Headwater elevation is below inlet invert.

****

Straight Culvert

Inlet Elevation (invert): 5.10 ft, Outlet Elevation (invert): 2.00 ft

Culvert Length: 231.02 ft, Culvert Slope: 0.0134

****

Site Data - Triple 72" RCP

Site Data Option: Culvert Invert Data

Inlet Station: 236.00 ft

Inlet Elevation: 5.10 ft

Outlet Station: 467.00 ft

Outlet Elevation: 2.00 ft

Number of Barrels: 3

Culvert Data Summary - Triple 72" RCP

Barrel Shape: Circular

Barrel Diameter: 6.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: NONE

Table 3 - Culvert Summary Table: 9' x 6' RCBC

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
160.00	113.18	6.10	2.904	0.648	1-S2n	1.564	1.700	1.564	0.619	8.043	1.505
240.00	146.48	6.63	3.434	1.067	1-S2n	1.859	2.019	1.859	0.789	8.754	1.765
320.00	175.90	7.07	3.866	1.438	1-S2n	2.112	2.281	2.112	0.937	9.253	1.977
400.00	203.63	7.45	4.252	1.794	1-S2n	2.336	2.515	2.345	1.071	9.650	2.157
480.00	230.22	7.81	4.607	2.141	1-S2n	2.546	2.729	2.555	1.195	10.010	2.316
560.00	256.16	8.14	4.943	2.489	1-S2n	2.749	2.930	2.749	1.310	10.355	2.459
640.00	282.30	8.47	5.273	2.847	1-S2n	2.942	3.126	2.942	1.419	10.661	2.590
720.00	307.17	8.78	5.583	3.198	1-S2n	3.126	3.307	3.134	1.522	10.892	2.711
800.00	331.04	9.08	5.880	3.543	1-S2n	3.302	3.477	3.302	1.621	11.141	2.824
880.00	353.89	9.36	6.164	3.882	5-S2n	3.463	3.635	3.473	1.716	11.323	2.930
960.00	375.87	9.64	6.439	4.217	5-S2n	3.619	3.784	3.630	1.808	11.506	3.030

****

Straight Culvert

Inlet Elevation (invert): 3.20 ft, Outlet Elevation (invert): 2.00 ft

Culvert Length: 225.00 ft, Culvert Slope: 0.0053

****

Site Data - 9' x 6' RCBC

Site Data Option: Culvert Invert Data

Inlet Station: 225.00 ft

Inlet Elevation: 3.20 ft

Outlet Station: 450.00 ft

Outlet Elevation: 2.00 ft

Number of Barrels: 1

Culvert Data Summary - 9' x 6' RCBC

Barrel Shape: Concrete Box

Barrel Span: 9.00 ft

Barrel Rise: 6.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge (90º) Headwall

Inlet Depression: NONE

Table 4 - Culvert Summary Table: 72" RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
160.00	20.83	6.10	1.603	0.0*	1-S2n	0.835	1.194	0.835	0.619	8.449	1.505
240.00	35.89	6.63	2.134	0.0*	1-S2n	1.137	1.577	1.172	0.789	9.166	1.765
320.00	50.94	7.07	2.566	0.0*	1-S2n	1.339	1.892	1.392	0.937	10.150	1.977
400.00	65.97	7.45	2.952	0.0*	1-S2n	1.541	2.163	1.578	1.071	11.084	2.157
480.00	79.80	7.81	3.308	0.115	1-S2n	1.704	2.388	1.740	1.195	11.690	2.316
560.00	93.88	8.14	3.644	0.415	1-S2n	1.847	2.600	1.900	1.310	12.164	2.459
640.00	108.93	8.47	3.974	0.738	1-S2n	1.999	2.815	2.063	1.419	12.627	2.590
720.00	124.12	8.78	4.284	1.062	1-S2n	2.153	3.012	2.218	1.522	13.074	2.711
800.00	139.54	9.08	4.581	1.392	1-S2n	2.290	3.197	2.373	1.621	13.398	2.824
880.00	154.94	9.36	4.864	1.734	1-S2n	2.422	3.378	2.518	1.716	13.749	2.930
960.00	170.27	9.64	5.139	2.085	1-S2n	2.553	3.551	2.657	1.808	14.084	3.030

* Full Flow Headwater elevation is below inlet invert.

****

Straight Culvert

Inlet Elevation (invert): 4.50 ft, Outlet Elevation (invert): 2.00 ft

Culvert Length: 261.61 ft, Culvert Slope: 0.0096

****

Site Data - 72" RCP

Site Data Option: Culvert Invert Data

Inlet Station: 199.40 ft

Inlet Elevation: 4.50 ft

Outlet Station: 461.00 ft

Outlet Elevation: 2.00 ft

Number of Barrels: 1

Culvert Data Summary - 72" RCP

Barrel Shape: Circular

Barrel Diameter: 6.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: NONE

Table 5 - Downstream Channel Rating Curve (Crossing: Crossing 3 Proposed Extension)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
160.00	2.62	0.62	1.50	0.15	0.34
240.00	2.79	0.79	1.77	0.20	0.35
320.00	2.94	0.94	1.98	0.23	0.36
400.00	3.07	1.07	2.16	0.27	0.37
480.00	3.19	1.19	2.32	0.30	0.38
560.00	3.31	1.31	2.46	0.33	0.38
640.00	3.42	1.42	2.59	0.35	0.39
720.00	3.52	1.52	2.71	0.38	0.39
800.00	3.62	1.62	2.82	0.40	0.40
880.00	3.72	1.72	2.93	0.43	0.40
960.00	3.81	1.81	3.03	0.45	0.40

Tailwater Channel Data - Crossing 3 Proposed Extension

Tailwater Channel Option: Irregular Channel

Channel Slope: 0.0040

User Defined Channel Cross-Section:

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	0.00	19.00	0.1200
2	33.00	18.00	0.1200
3	60.00	12.00	0.1200
4	92.00	11.00	0.1100
5	116.00	2.00	0.0450
6	286.00	2.00	0.1100
7	330.00	16.00	0.1200
8	402.00	18.00	0.0000

Roadway Data for Crossing: Crossing 3 Proposed Extension

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 402.00 ft

Crest Elevation: 20.00 ft

Roadway Surface: Paved

Roadway Top Width: 170.00 ft

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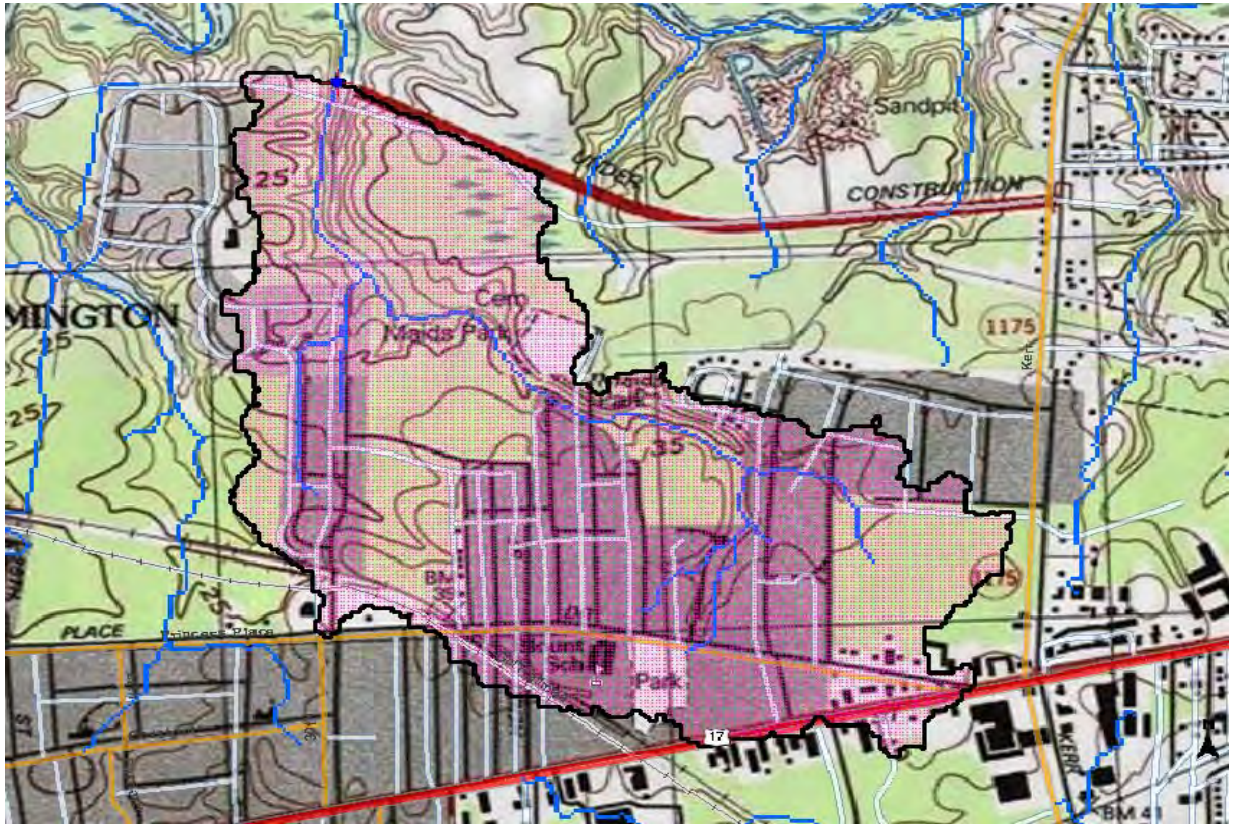
USGS North Carolina StreamStats

U-4434

Crossing 3



Explanation

- GlobalWatershedPoint
- Slp1085Point
- NCDOTPoints
- LocalGages
- Gaging Station, Continuous Record
- Low Flow, Partial Record
- Peak Flow, Partial Record
- Peak and Low Flow, Partial Record
- Stage Only
- Low Flow, Partial Record, Stage
- Miscellaneous Record
- Unknown
- LocalNHD2
- LongestFlowpath3D
- Stream Grid
- GlobalWatershed
- Pilot Study Area
- hucpoly

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USGS North Carolina StreamStats

Basin Characteristics Report

Date: Thu Jan 23 2014 10:30:22 Mountain Standard Time
NAD27 Latitude: 34.2569 (34 15 25)
NAD27 Longitude: -77.9069 (-77 54 25)
NAD83 Latitude: 34.2570 (34 15 25)
NAD83 Longitude: -77.9066 (-77 54 24)

Parameter	Value
Area in square miles	0.65
Percent of area covered by hydrologic region 1	0.000
Percent of area covered by hydrologic region 2	0.000
Percent of area covered by hydrologic region 3	0.000
Percent of area covered by hydrologic region 4	100.000
Percent of area covered by hydrologic region 5	0.000
Mean basin slope, based on slope percent grid	2.18
Percent of area covered by barren rock using 2006 NLCD	0.000
Percent of area in cultivation using 2006 NLCD	0.000
Percent of area covered by all densities of developed land using 2006 NLCD	62.569
Percent of area covered by forest using 2006 NLCD	17.480
Percent of area covered by grassland/herbaceous using 2006 NLCD	0.740
Percent of area covered by impervious surface 2006 NLCD	20.29
Percent of area covered by shrubland using 2006 NLCD	13.205
Percent of area in hydric soil 'A' defined by SSURGO	13.1
Percent of area in hydric soil 'B' defined by SSURGO	66.3
Percent of area in hydric soil 'C' defined by SSURGO	13.9
Percent of area in hydric soil 'D' defined by SSURGO	6.44
Percent of area covered by water using 2006 NLCD	0.000
Percent of area covered by wetland using 2006 NLCD	6.006

Soil Map—New Hanover County, North Carolina
(U-4434 (Crossing 3))

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Crossing 4

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PRELIMINARY DESIGN AND ASSESSMENT OF STREAM CROSSINGS AND ENCROACHMENTS

COUNTY New Hanover PROJECT NUMBER U-4434

STREAM Trib to Smith Creek ROUTE US74 (MLK Jr. Blvd)

ASSESSMENT PREPARED BY CGW/MAD Crossing 4 DATE 1/19/2012

HYDROLOGIC EVALUATION

NEAREST GAGING STATION ON THIS STREAM _____ (NONE X) _____

ARE FLOOD STUDIES AVAILABLE ON THIS STREAM: No

FLOOD DATA:

Q_{10} 8 CFS EST. BKWTR. ___ FT. Q_{25} 11 CFS EST. BKWTR. ___ FT.

Q_{50} 15 CFS EST. BKWTR. ___ FT. Q_{100} 18 CFS EST. BKWTR. ___ FT.

Q_{500} ____ CFS OR OVERTOPPING CFS EST. BKWTR. ___ FT.

DRAINAGE AREA 42 acres METHOD USED TO COMPUTE Q NC Highway Charts

PROPERTY RELATED EVALUATIONS

DAMAGE POTENTIAL: LOW X MODERATE _____ HIGH _____

COULD THIS BE SIGNIFICANTLY INCREASED BY PROPOSED

ENCROACHMENT: YES _____ NO X

EXPLANATION: _____

LIST BUILDINGS IN FLOOD PLAIN N/A LOCATION N/A

FLOOR ELEVATION N/A

UPSTREAM LAND USE Park

ANTICIPATE ANY CHANGE? No

ANY FLOOD ZONING? (FIA STUDIES, ETC.) YES _____ NO X

TYPE OF STUDY N/A

BASE FLOOD ELEVATION N/A (100 YEAR)

REGULATORY FLOODWAY WIDTH N/A (AS NOTED IN FIA STUDIES)

COMMENTS: _____

_____

TRAFFIC RELATED EVALUATIONS

PRESENT YEAR 2012 TRAFFIC COUNT 33,900 VPD % TRUCKS 9%

DESIGN YEAR 2040 TRAFFIC COUNT 82,500 VPD % TRUCKS 9%

EMERGENCY ROUTE X SCHOOL BUS ROUTE _____ MAIL ROUTE _____

DETOUR AVAILABLE? No LENGTH OF DETOUR _____ MILES

DOES THE LEVEL OF TRAFFIC SERVICE OF AN EXISTING CROSSING VARY GREATLY FROM STANDARD DESIGN LEVELS? No

_____

IS THE TRAFFIC VOLUME, TYPE, USAGE SUCH TO WARRANT CONSIDERATION FOR VARIANCE FROM STANDARDS OR EXISTING LEVEL OF INTERRUPTION? No

_____

COMMENTS: _____

_____

HIGHWAY AND BRIDGE (CULVERT) RELATED EVALUATIONS

NOTE ANY OUTSIDE FEATURES WHICH MIGHT AFFECT STAGE, DISCHARGE OR FREQUENCY.

LEVEES -- AGGRADATION/DEGRADATION -- RESERVOIRS --

DIVERSIONS -- DRAINAGE DISTRICT -- NAVIGATION --

BACKWATER FROM ANOTHER SOURCE Smith Creek

EXPLANATION: _____

_____

ROADWAY OVERFLOW SECTION (NONE X) LENGTH _____ ELEVATION _____

EMBANKMENT: SOIL TYPE Leon sand TYPE SLOPE COVER Vegetation

COMMENTS: _____

_____

ENVIRONMENTAL CONSIDERATIONS

LIST SPECIAL CONDITIONS OR CONSIDERATIONS WHICH AFFECT HYDRAULIC DESIGN (NONE _____)
Wetlands located upstream and downstream of the proposed crossing

MISCELLANEOUS COMMENTS

IS THERE UNUSUAL SCOUR POTENTIAL? YES __ NO X PROTECTION NEEDED __
ARE BANKS STABLE? See Comments PROTECTION NEEDED __
DOES STREAM CARRY APPRECIABLE AMOUNT OF LARGE DEBRIS? N/A
COMMENTS:
Existing 42" RCP

ALTERNATIVES

RECOMMENDED DESIGN Not determined - out of scope
DETOUR STRUCTURE _____
LOW ROADWAY GRADE _____ DETOUR GRADE _____
BRIDGE WATERWAY OPENING _____ CULVERT OPENING _____
WERE OTHER HYDRAULIC ALTERNATES CONSIDERED? YES _____ NO _____
DISCUSSION: _____

THIS SITE ASSESSMENT INDICATES THE DESIGN SHOULD FOLLOW:

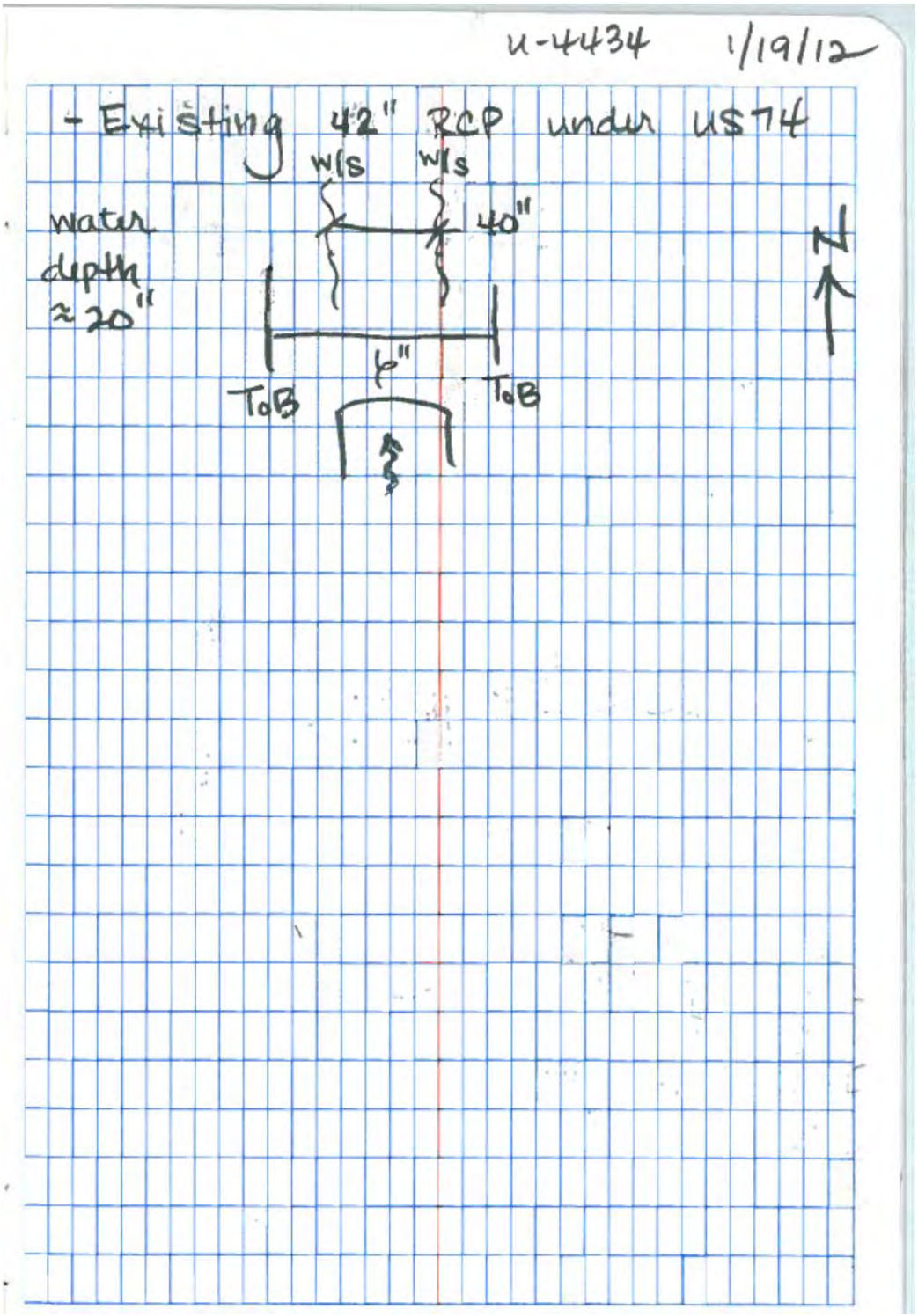
(1) _____ NORMAL PROCESS

(2) X NORMAL PROCESS WITH SPECIAL SPECIFIC CONSIDERATION FOR Wetlands

(3) _____ SPECIFIC DESIGN PROCESS WITH APPROPRIATE RISK/ECONOMIC EVALUATION ADDRESSING: _____

CROSSING 4

Field Notes



STIP NO:	U-4434
COUNTY:	New Hanover
DATE:	1/31/2014

CROSSING 4, LOOKING DOWNSTREAM (NORTH)

CROSSING 4, LOOKING UPSTREAM (SOUTH)

STIP NO:	U-4434
COUNTY:	New Hanover
DATE:	1/31/2014

CROSSING 4, UPSTREAM (NORTH) FACE

CROSSING 4, DOWNSTREAM (NORTH) FACE

Crossing 4

U-4434
Crossing 4
DA = 42.4 ac.
Imperv. = 7.7%
Q50 = 15 cfs
Q5 = 6 cfs
Q10 = 8 cfs
Q25 = 11 cfs
Q100 = 18 cfs

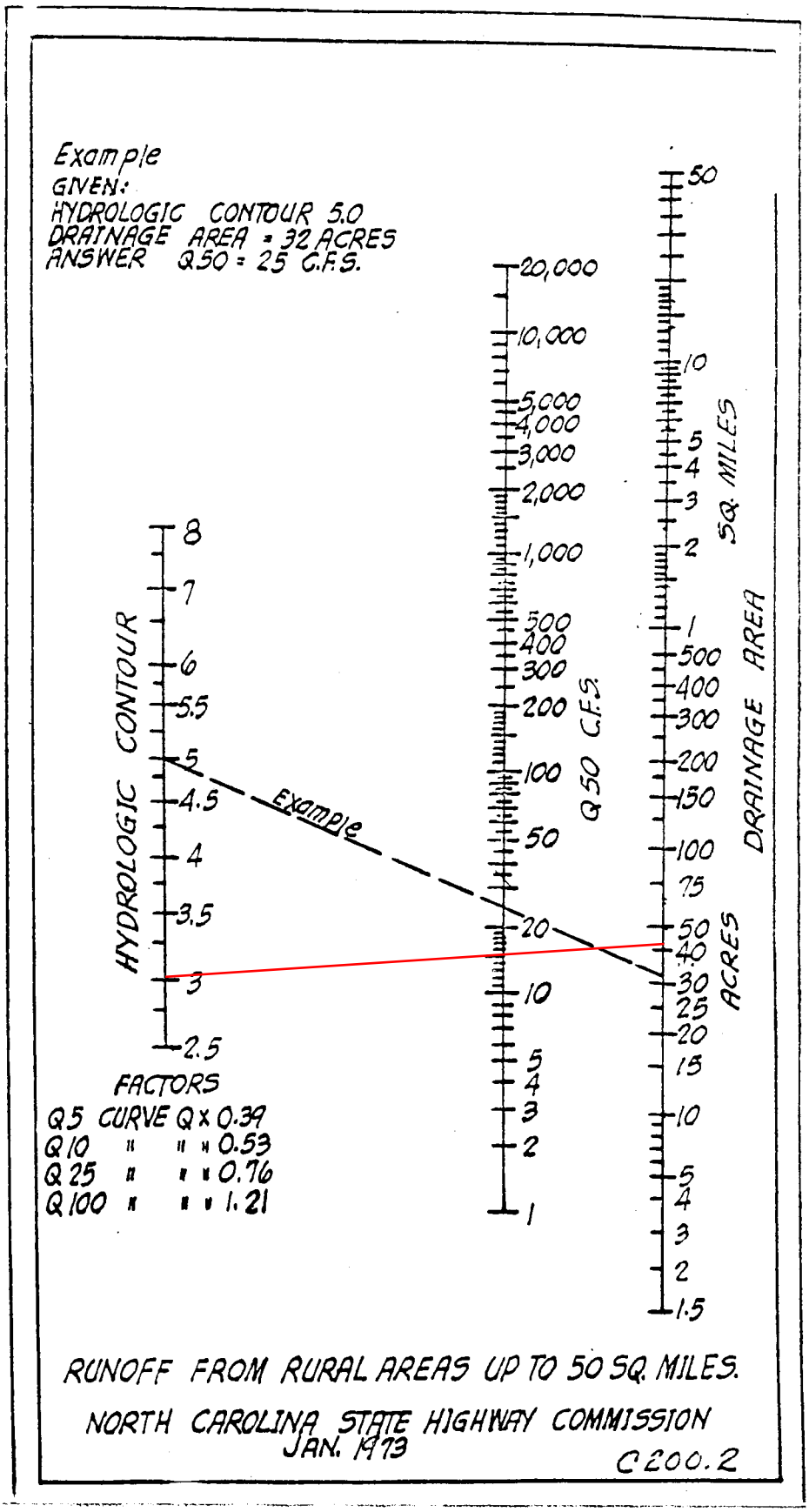


CHART C 200.2

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Crossing 5

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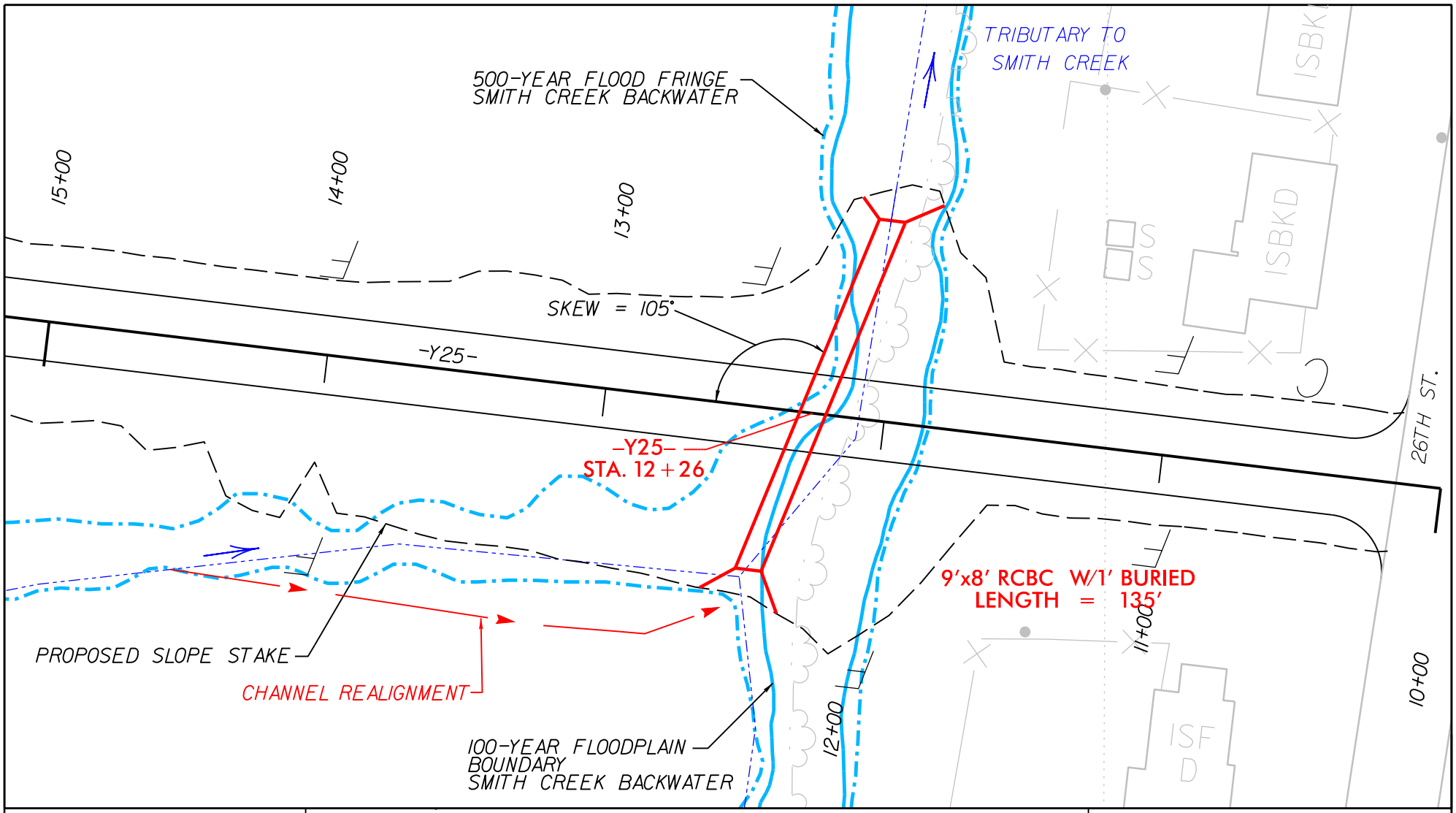

RECOMMENDED CULVERT FOR CROSSING 5

PRELIMINARY HYDRAULIC ANALYSIS

NEW HANOVER COUNTY

PROJECT: U-4434

INDEPENDENCE BOULEVARD EXTENSION

FEBRUARY 2014

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PRELIMINARY DESIGN AND ASSESSMENT OF STREAM CROSSINGS AND ENCROACHMENTS

COUNTY New Hanover PROJECT NUMBER U-4434

STREAM Trib to Smith Creek ROUTE -Y25- Crossing 5

ASSESSMENT PREPARED BY MAD DATE 8/01/2013

HYDROLOGIC EVALUATION

NEAREST GAGING STATION ON THIS STREAM _____ (NONE X) _____

ARE FLOOD STUDIES AVAILABLE ON THIS STREAM: No - backflow from Smith Creek

FLOOD DATA:

Q_{10} 380 CFS EST. BKWTR. 5.3 FT. Q_{25} 590 CFS EST. BKWTR. ___ FT.

Q_{50} 700 CFS EST. BKWTR. 7.4 FT. Q_{100} 820 CFS EST. BKWTR. 8.3 FT.

Q_{500} 970 CFS OR OVERTOPPING CFS EST. BKWTR. 10.7 FT.

DRAINAGE AREA 0.66 sq. mi. METHOD USED TO COMPUTE Q USGS Urban Regression

PROPERTY RELATED EVALUATIONS

DAMAGE POTENTIAL: LOW X MODERATE _____ HIGH _____

COULD THIS BE SIGNIFICANTLY INCREASED BY PROPOSED

ENCROACHMENT: YES X NO _____

EXPLANATION: proposed design fill could impede the existing drainage flow

LIST BUILDINGS IN FLOOD PLAIN N/A LOCATION N/A

FLOOR ELEVATION N/A

UPSTREAM LAND USE High density residential, park

ANTICIPATE ANY CHANGE? No

ANY FLOOD ZONING? (FIA STUDIES, ETC.) YES X NO _____

TYPE OF STUDY Detailed study of Smith Creek

BASE FLOOD ELEVATION 8.3' (100 YEAR)

REGULATORY FLOODWAY WIDTH ___--_____ (AS NOTED IN FIA STUDIES)

COMMENTS: Backwater from Smith Creek detailed study

TRAFFIC RELATED EVALUATIONS (At Kornegay Ave.)

PRESENT YEAR 2012 TRAFFIC COUNT 7 VPD % TRUCKS 9%

DESIGN YEAR NA TRAFFIC COUNT NA VPD % TRUCKS NA

EMERGENCY ROUTE _____ SCHOOL BUS ROUTE _____ MAIL ROUTE _____

DETOUR AVAILABLE? NA LENGTH OF DETOUR -- MILES

DOES THE LEVEL OF TRAFFIC SERVICE OF AN EXISTING CROSSING VARY GREATLY FROM STANDARD DESIGN LEVELS? No

IS THE TRAFFIC VOLUME, TYPE, USAGE SUCH TO WARRANT CONSIDERATION FOR VARIANCE FROM STANDARDS OR EXISTING LEVEL OF INTERRUPTION? No

COMMENTS: _____

HIGHWAY AND BRIDGE (CULVERT) RELATED EVALUATIONS

NOTE ANY OUTSIDE FEATURES WHICH MIGHT AFFECT STAGE, DISCHARGE OR FREQUENCY.

LEVEES -- AGGRADATION/DEGRADATION -- RESERVOIRS --

DIVERSIONS -- DRAINAGE DISTRICT -- NAVIGATION --

BACKWATER FROM ANOTHER SOURCE Smith Creek

EXPLANATION: _____

ROADWAY OVERFLOW SECTION (NONE X) LENGTH _____ ELEVATION _____

EMBANKMENT: SOIL TYPE Leon sand, Kureb Sand TYPE SLOPE COVER Vegetation

COMMENTS: _____

ENVIRONMENTAL CONSIDERATIONS

LIST SPECIAL CONDITIONS OR CONSIDERATIONS WHICH AFFECT HYDRAULIC DESIGN (NONE _____)
Mapped FEMA AE, X Flood Zones

MISCELLANEOUS COMMENTS

IS THERE UNUSUAL SCOUR POTENTIAL? YES __ NO X PROTECTION NEEDED No

ARE BANKS STABLE? Yes PROTECTION NEEDED Yes

DOES STREAM CARRY APPRECIABLE AMOUNT OF LARGE DEBRIS? No

COMMENTS:
Beaver dam seen in channel near crossing location during field investigation.
Class I rip rap on stream banks at outlet end.

ALTERNATIVES

RECOMMENDED DESIGN !@9'x8' RCBC w/ 1' Buried, Length approx. 135'

DETOUR STRUCTURE None

LOW ROADWAY GRADE 1.41% DETOUR GRADE _____

BRIDGE WATERWAY OPENING _____ CULVERT OPENING 64 sf (eff)

WERE OTHER HYDRAULIC ALTERNATES CONSIDERED? YES _____ NO X

DISCUSSION: _____

THIS SITE ASSESSMENT INDICATES THE DESIGN SHOULD FOLLOW:

(1) _____ NORMAL PROCESS

(2) X NORMAL PROCESS WITH SPECIAL SPECIFIC CONSIDERATION FOR FEMA AE Flood Zone

(3) _____ SPECIFIC DESIGN PROCESS WITH APPROPRIATE RISK/ECONOMIC EVALUATION ADDRESSING: _____

U-4434 1/19/12

- possible culvert crossing
  @ MLK ramp
  - small ditch, V-ditch
    ~ 10' top width
    ~ 1.5' depth

- possible culvert crossing
  @ 26th St btwn.
  Bunche & Robeson
  - channel about 25' down from existing ground on east side
  - beaver dam just d/s of deep head cut from back of 1501 N. 26th St.
  - west side looks to be about 5'-10' above W/S
  - channel ~ 10' wide? (W/S)

CROSSING 5

Field Notes

STIP NO:	U-4434
COUNTY:	New Hanover
DATE:	1/19/2012

CROSSING 5, LOOKING UPSTREAM (SOUTH)

CROSSING 5, LOOKING DOWNSTREAM (NORTH)

Crossing 5
Peak Discharge

Project Name:	U-4434 - Independence Blvd. Preliminary Hydraulic Analysis		
Project No.:	31823722		
Design Engineer:	M. Diaz	**Date:**	8/10/2013

Crossing 5 - Proposed New Location From Kornegay Ave.

North Carolina Rural Flood-Frequency Equations [1]

Drainage Area = 0.66 sq. mi.

Rural Flood-Recurrence Interval (years)	Coastal Plain	RQ (cfs)
2	$64.7 * DA^{0.673}$	49
5	$129 * DA^{0.635}$	99
10	$188 * DA^{0.615}$	146
25	$281 * DA^{0.593}$	220
50	$367 * DA^{0.579}$	289
100	$468 * DA^{0.566}$	370
500	$773 * DA^{0.539}$	618

North Carolina Urban Flood-Frequency Equations [1]

Drainage Area = 0.66 sq. mi.
Impervious Area = 18 %

Recurrence Interval (years)	Urban Flood-Frequency Equation	Q (cfs)
2	$26.9 * DA^{0.722} * IA^{0.686}$	150
5	$68.2 * DA^{0.655} * IA^{0.572}$	280
10	$109 * DA^{0.625} * IA^{0.515}$	380
25	$209 * DA^{0.570} * IA^{0.436}$	590
50	$280 * DA^{0.558} * IA^{0.396}$	700
100	$363 * DA^{0.547} * IA^{0.358}$	820

1. The National Flood-Frequency Program - Methods for Estimating Flood Magnitude and Frequency in Rural and Urban Areas in North Carolina, 2001. 2002. U.S. Geological Survey Fact Sheet 007-00.

No equation for Q500 so use ratio between Q50 and Q100 to find Q500 based on Q100

$$\frac{Q100}{Q50} = \frac{820.0}{700.0} = 1.2$$

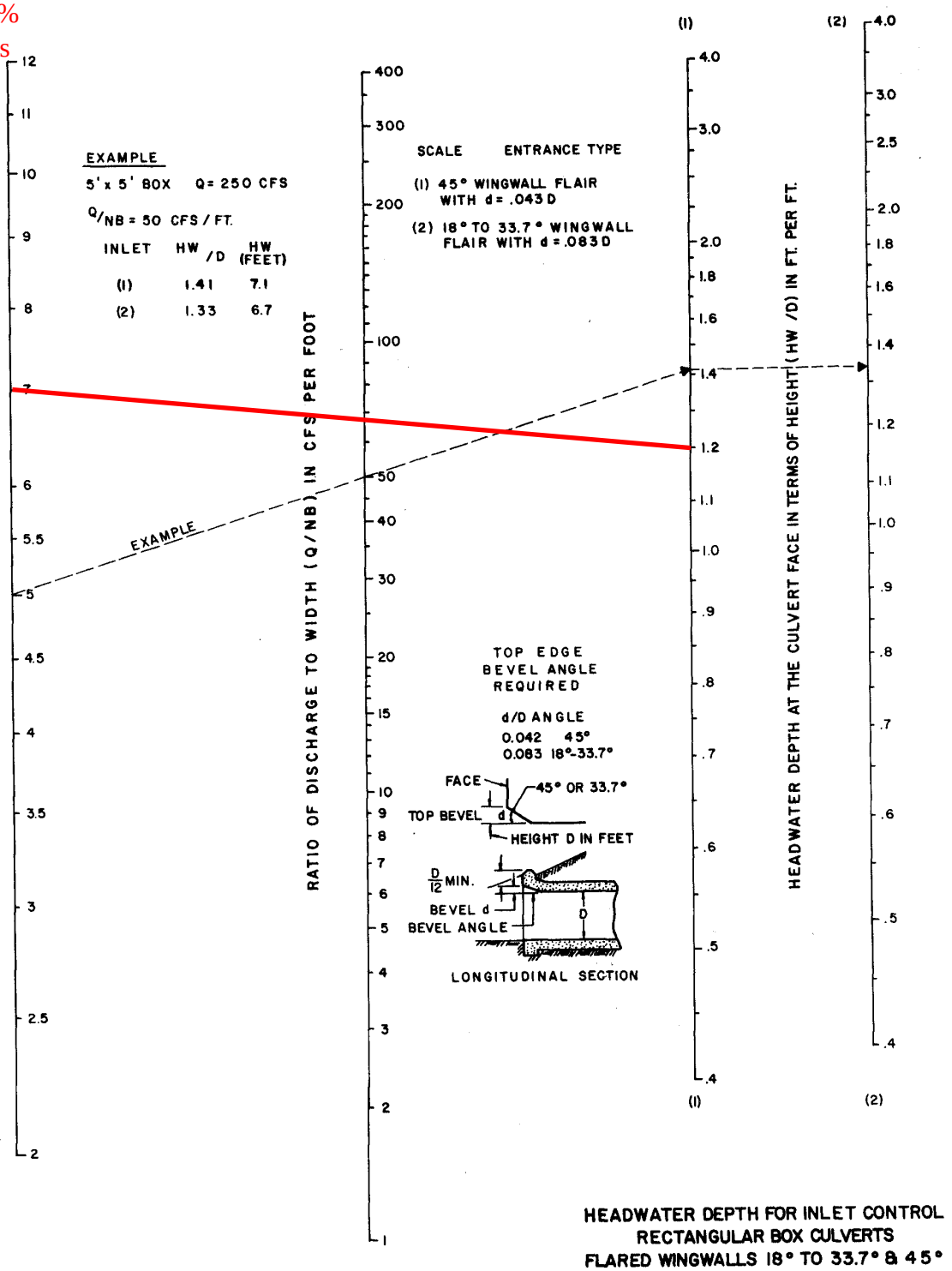
Q500 = 1.17 * Q100 = 970 cfs

U-4434
Crossing 5
DA = 0.66 sq. mi.
USGS Urban Coastal Plain
Imperv. = 18%
Q25 = 590 cfs

Design
HW/D = 1.2
Q/B= 68 cfs/ft
9' x 8' RCBC
w/ 1' buried
Length=170'

Crossing 5

CHART 9B

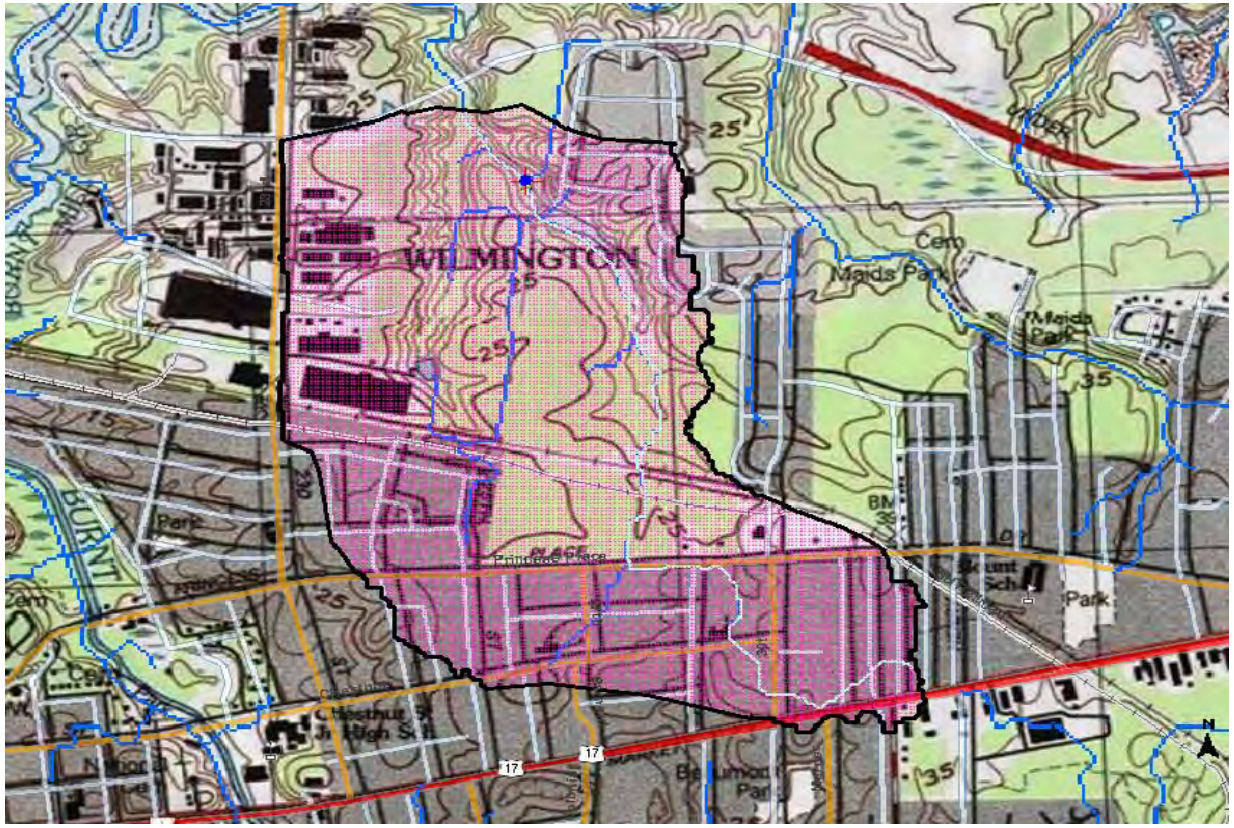


HEADWATER DEPTH FOR INLET CONTROL
RECTANGULAR BOX CULVERTS
FLARED WINGWALLS 18° TO 33.7° & 45°
WITH BEVELED EDGE AT TOP OF INLET

USGS North Carolina StreamStats

U-4434

Crossing 5



Explanation

- GlobalWatershedPoint
- Slp1085Point
- NCDOTPoints
- LocalGages
- Gaging Station, Continuous Record
- Low Flow, Partial Record
- Peak Flow, Partial Record
- Peak and Low Flow, Partial Record
- Stage Only
- Low Flow, Partial Record, Stage
- Miscellaneous Record
- Unknown
- LocalNHD2
- LongestFlowpath3D
- Stream Grid
- GlobalWatershed
- Pilot Study Area
- hucpoly

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Basin Characteristics Report

Date: Fri Jan 24 2014 09:35:19 Mountain Standard Time
NAD27 Latitude: 34.2533 (34 15 12)
NAD27 Longitude: -77.9137 (-77 54 49)
NAD83 Latitude: 34.2535 (34 15 12)
NAD83 Longitude: -77.9134 (-77 54 48)

Basin has been edited

Parameter	Value
Area in square miles	0.66
Percent of area covered by hydrologic region 1	0.000
Percent of area covered by hydrologic region 2	0.000
Percent of area covered by hydrologic region 3	0.000
Percent of area covered by hydrologic region 4	100.000
Percent of area covered by hydrologic region 5	0.000
Mean basin slope, based on slope percent grid	2.23
Percent of area covered by barren rock using 2006 NLCD	0.000
Percent of area in cultivation using 2006 NLCD	0.000
Percent of area covered by all densities of developed land using 2006 NLCD	52.080
Percent of area covered by forest using 2006 NLCD	31.999
Percent of area covered by grassland/herbaceous using 2006 NLCD	0.559
Percent of area covered by impervious surface 2006 NLCD	17.37
Percent of area covered by shrubland using 2006 NLCD	10.931
Percent of area in hydric soil 'A' defined by SSURGO	23.2
Percent of area in hydric soil 'B' defined by SSURGO	50.5
Percent of area in hydric soil 'C' defined by SSURGO	19
Percent of area in hydric soil 'D' defined by SSURGO	7.19
Percent of area covered by water using 2006 NLCD	0.000
Percent of area covered by wetland using 2006 NLCD	4.432

Soil Map—New Hanover County, North Carolina
(U-4434 Crossing 5)

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