



STATE OF NORTH CAROLINA  
DEPARTMENT OF TRANSPORTATION

MICHAEL F. EASLEY  
GOVERNOR

LYNDO TIPPETT  
SECRETARY

December 13, 2004

MEMORANDUM TO: Mr. Jon G. Nance, P.E.  
Division 5 Engineer

FROM: Philip S. Harris, III, P.E., Manager *PHS*  
Office of the Natural Environment  
Project Development and  
Environmental Analysis Branch

SUBJECT: Wake County; Division 5; Construction of the Northern Wake  
Expressway (I-540) from US 1 to US 64; State Project No. 8.2401701;  
TIP Project No. R-2000 F&G

Attached is the modification to WQC Project No. 030114.

PSH/gyb

Attachment

cc: Mr. Art McMillan, P.E.  
Mr. Omar Sultan  
Mr. Jay Bennett, P.E.  
Mr. David Chang, P.E.  
Mr. Randy Garris, P.E.  
Mr. Greg Perfetti, P.E.  
Mr. Mark Staley  
Mr. John F. Sullivan, III, FHWA  
Mr. Chris Murray, Division 5 DEO  
Ms. Cathy Houser, PE

# PROJECT COMMITMENTS

Northern Wake Expressway (I-540) from US 1 to US 64  
Wake County  
State Project No. 8.2401701  
Federal Aid Project No. F-123-1(1)  
TIP No.: R-2000F&G

In addition to the standard Individual Section 404 and 401 Permit Conditions, State Consistency Conditions, NCDOT's Guidelines for Best Management Practices for Protection of Surface Waters, the following special commitments have been agreed to by NCDOT:

## **Commitments Developed through Permit Modifications**

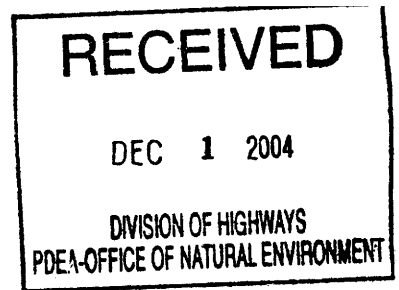
No new special permit conditions are stated in the attached permits. All standard permit conditions apply to this project and all other conditions written into previous Water Quality Certifications and Neuse River Riparian Buffer Certifications for this project still apply.



REPLY TO  
ATTENTION OF:

DEPARTMENT OF THE ARMY  
WILMINGTON DISTRICT, CORPS OF ENGINEERS  
P.O. BOX 1890  
WILMINGTON, NORTH CAROLINA 28402-1890

December 1, 2004



Regulatory Division

Action ID. 199920387

Dr. Gregory J. Thorpe, Ph.D.  
Environmental Management Director, PDEA  
N.C. Department of Transportation  
1548 Mail Service Center  
Raleigh, NC 27699-1548

Dear Dr. Thorpe:

Reference the permit that the Department of the Army issued on October 10, 1996, for the discharge of dredged and fill material in waters of the United States, including wetlands, to facilitate construction of the Northern Wake Expressway (T.I.P. No. R-2000), Sections A, CA, CB, D, E, F and G, crossing Kit Creek, Lower Bartons Creek, Perry Creek, the Neuse River, Beaverdam Creek, unnamed tributaries, and adjacent wetlands, generally northwest and northeast of Raleigh, in Wake and Durham Counties, North Carolina (Action ID. 199601917). Reference also the June 2, 2003 modification to that permit for the final design for Sections F and G, and your written request of September 27, 2004, for additional permit modification for several changes of impacts to waters, from necessary construction modifications and discovered discrepancies between the permit drawings and construction plan sheets. The revisions result in 0.22 acre of additional temporary wetland impacts for one site in Section F, and an additional 0.12 acre of permanent wetland fill at two sites in Section G. NCDOT proposes to mitigate for the additional permanent wetland impacts through the North Carolina Ecosystem Enhancement Program (EEP), for this project that is not listed in Exhibit 2 of the EEP Memorandum of Agreement.

We have reviewed the proposed modifications, and determined that they are minor, and that an additional public notice will not be necessary. Therefore, the permit is hereby modified to include the work as shown on the enclosed revised drawings, subject to the following additional special condition:

Compensatory mitigation for the additional unavoidable permanent impacts to 0.12 acre of riverine wetlands, associated with the September 27, 2004 modification request shall be provided by the Ecosystem Enhancement Program (EEP), as outlined in the letter dated September 15, 2004, from William D. Gilmore, EEP Transition Manager. Pursuant to the EEP Memorandum of Agreement (MOA) between the State of North

Carolina and the US Army Corps of Engineers signed on July 22, 2003, the EEP will provide 0.24 acre of restoration equivalent riverine wetlands, in the Neuse River basin (Hydrologic Cataloging Unit 03020201) by one year of the date of this permit modification. For wetlands, a minimum of 1:1 (impact to mitigation) must be in the form of wetland restoration. The NCDOT shall, within 30 days of the issue date of this permit, certify that sufficient funds have been provided to EEP to complete the required mitigation, pursuant to Paragraph V. of the MOA.

It is understood that all conditions of the original permit remain applicable and that the expiration date is unchanged.

If you have questions, please contact Eric Alsmeyer of the Raleigh Regulatory Field Office, at telephone (919) 876-8441, extension 23.

Sincerely,



<sup>for</sup> Charles R. Alexander, Jr.  
Colonel, U.S. Army  
District Engineer

Enclosure

Copies Furnished (without enclosure):

Mr. John Hennessey  
Water Quality Section  
Division of Environmental Management  
North Carolina Department of Environment,  
Health and Natural Resources  
Post Office Box 29535  
Raleigh, NC 27626-0535

Mr. Jon Nance  
Division Engineer  
NCDOT  
2612 North Duke St  
Durham, NC 27704

Mr. Chris Murray  
Division Environmental Officer  
NCDOT  
2612 North Duke St  
Durham, NC 27704

Mr. William D. Gilmore, P.E.  
Transition Manager  
Division of Ecosystem Enhancement  
North Carolina Department  
of Environment and Natural Resources  
1652 Mail Service Center  
Raleigh, NC 27699-1652

**Subject: Permit mod drawings; TIP R-2000F&G; N. Wake Expr.; AID 199920387**

**Date:** Mon, 6 Dec 2004 12:55:17 -0600

**From:** "Alsmeyer, Eric C SAW" <Eric.C.Alsmeier@saw02.usace.army.mil>

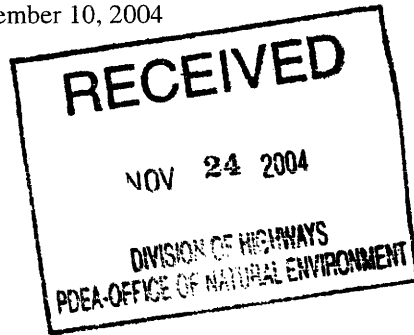
**To:** "Rachelle Beauregard (E-mail)" <rbeauregard@dot.state.nc.us>

Rachelle: Per our discussion today, The modified permit drawings that NCDOT submitted on October 26, 2004 and November 4, 2004 for the subject project, specifically Sheets 39b&c of 50, revised on 10/25/04, for Site 14, and Sheet 7 of 90, revised 11/3/04 for Site 2, should be substituted in the corresponding permit drawings for this project. A formal modification of the permit will not be necessary because the 404 impacts have not changed.

Eric Alsmeyer  
Project Manager  
US Army Corps of Engineers  
Raleigh Regulatory Field Office  
Tel: (919) 876-8441, ext 23  
Fax: (919) 876-5823



November 10, 2004



Dr. Gregory J. Thorpe, PhD., Manager  
 Planning and Environmental Branch  
 North Carolina Department of Transportation  
 1548 Mail Service Center  
 Raleigh, North Carolina, 27699-1548

Dear Dr. Thorpe:

Re: Modification to the 401 Water Quality Certification Pursuant to Section 401 of the Federal Clean Water Act, Construction of the Northern Wake Expressway (I-540) from US 1 to US 64 in Wake County. TIP-R2000 F&G, WQC Project No. 030114 (DWQ No. for original application 960319)

Attached hereto is a copy of a modification to Certification No. 3081 issued to The North Carolina Department of Transportation dated September 17, 1996. This certification authorizes the NCDOT for the following impacts:

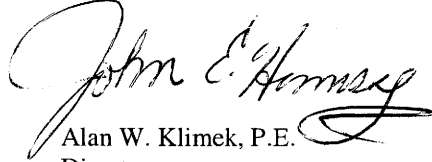
**Wetland, Surface Water and Protected Riparian Buffer Impacts**

Section	Permanent Wetland Impacts	Temporary Wetland Impacts	Streams (Linear Feet)	Buffer Zone 1 (acres)	Buffer Zone 2 (acres)
R-2000 F&G (Original 401 WQC)	18.68	0.59	5,865	16.67	8.86
R-2000 F&G (Additional Impacts with this Modification)	+0.12	+0.22	0	+0.25	+0.35
<b>Total</b>	<b>18.80</b>	<b>0.81</b>	<b>5,865</b>	<b>16.92</b>	<b>9.21</b>
<b>Net Total for Wetland Impacts</b>	<b>19.61</b>				
<b>Net Total for Buffer Impacts</b>				<b>26.13</b>	

This modification also approves the latest design changes submitted on October 27, 2004 and November 4, 2004, specifically adjustments to the lateral base ditch at Site 14 and a pipe shift at Site 2. This certification modifies only segments F & G of the construction of the Northern Wake Expressway (I-540) from US 1 to US 64 in Wake County and shall be constructed pursuant to the application dated received on September 28, 2004 and supplemental information dated received on October 27, 2004 and November 4, 2004. All the authorized activities and conditions of the certification associated with the original Water Quality Certification dated September 17, 1996 and all subsequent modifications still apply except where superceded by this certification.

If we can be of further assistance, do not hesitate to contact Nicole Thomson at 919-715-3415.

Sincerely,

A handwritten signature in black ink, appearing to read "John E. Homsey".

Alan W. Klimek, P.E.  
Director

Attachments

cc: Wilmington District US Army Corps of Engineers  
Mr. Eric Alsmeyer, Corps of Engineers Raleigh Field Office  
Mr. Christopher Militscher, US Environmental Protection Agency – Region IV  
Mr. William Gilmore, P.E. Transition Manager, NC DENR Ecosystem Enhancement Program  
Mr. Jon G. Nance, P.E. Division 5 Engineer, 2612 N. Duke St., Durham NC 27704  
Mr. Chris Murray, Division 5 Environmental Officer, 2612 N. Duke St., Durham NC 27704  
NC DWQ Raleigh Regional Office  
Central Files  
File Copy



**Modification of APPROVAL OF 401 Water Quality Certification and ADDITIONAL CONDITIONS  
and Neuse River Buffer Rules**

**THIS CERTIFICATION** is issued in conformity with the requirements of Section 401 Public Laws 92-500 and 95-217 of the United States and subject to the North Carolina Division of Water Quality (DWQ) Regulations in 15 NCAC 2H, Section .0500, and 15 NCAC 2B .0233. This certification authorizes the NCDOT for the following impacts:

**Wetland, Surface Water and Protected Riparian Buffer Impacts**

<b>Section</b>	<b>Permanent Wetland Impacts</b>	<b>Temporary Wetland Impacts</b>	<b>Streams (Linear Feet)</b>	<b>Buffer Zone 1 (acres)</b>	<b>Buffer Zone 2 (acres)</b>
R-2000 F&G (Original 401 WQC)	18.68	0.59	5,865	16.67	8.86
R-2000 F&G (Additional Impacts with this Modification)	+0.12	+0.22	0	+0.25	+0.35
<b>Total</b>	<b>18.80</b>	<b>0.81</b>	<b>5,865</b>	<b>16.92</b>	<b>9.21</b>
<b>Net Total for Wetland Impacts</b>	<b>19.61</b>				
<b>Net Total for Buffer Impacts</b>				<b>26.13</b>	

**Impacts to Neuse River Riparian Buffers**

<b>Site</b>	<b>Zone 1 (Sq. Ft.)</b>	<b>Zone 2 (Sq. Ft.)</b>
Section F		
Site 2	1,707	1,141
Site 3	348	305
Site 5	87	0
Site 6	87	261
Site 6 (reduction)	-174	-261
Site 8	6,005	2,483
Section G		
Site 2	3,006	0
<b>Total</b>	<b>11,066</b>	<b>3,929</b>
Impacts Requiring Mitigation	5,148	1,446
Mitigation Ratio	3	1.5
<b>Total Mitigation Required</b>	<b>15,444</b>	<b>2,169</b>
Cost/Square Foot of Impact	0.96	0.96
Mitigation Cost	\$14,826.24	\$2,082.24
<b>Total Mitigation Cost</b>	<b>\$16,908.48</b>	

This certification modifies only segments F & G of the construction of the Northern Wake Expressway (I-540) from US 1 to US 64 in Wake County and shall be constructed pursuant to the application dated received on September 28, 2004 and supplemental information dated received on October 27, 2004 and November 4, 2004. All the authorized

activities and conditions of the certification associated with the original Water Quality Certification dated September 17, 1996 and all subsequent modifications still apply except where superceded by this certification.

The application provides adequate assurance that the discharge of fill material into the waters of the Neuse River Basin in conjunction with the proposed development will not result in a violation of applicable Water Quality Standards and discharge guidelines. Therefore, the State of North Carolina certifies that this activity will not violate the applicable portions of Sections 301, 302, 303, 306, 307 of PL 92-500 and PL 95-217 if conducted in accordance with the application and conditions hereinafter set forth.

This approval is only valid for the purpose and design that you submitted in your application, as described in the Public Notice. Should your project change, you are required to notify the DWQ and submit a new application. If the property is sold, the new owner must be given a copy of this Certification and approval letter, and is thereby responsible for complying with all the conditions. If any additional wetland impacts, or stream impacts, for this project (now or in the future) exceed one acre or 150 linear feet, respectively, additional compensatory mitigation may be required as described in 15A NCAC 2H .0506 (h) (6) and (7). For this approval to remain valid, you are required to comply with all the conditions listed below. In addition, you should obtain all other federal, state or local permits before proceeding with your project including (but not limited to) Sediment and Erosion control, Coastal Stormwater, Non-discharge and Water Supply watershed regulations. This Certification shall expire three years from the date of the cover letter from DWQ or on the same day as the expiration date of the corresponding Corps of Engineers Permit, whichever is sooner.

Condition(s) of Certification:

1. Construction will be conducted in such a manner as to prevent a significant increase in turbidity outside the area of construction or construction-related discharge. Erosion and sediment control practices must be in full compliance with all specifications governing the proper design, installation and operation and maintenance of such Best Management Practices in order to assure compliance with the appropriate turbidity water quality standard.
  - a. The erosion and sediment control measures for the project must equal or exceed the proper design, installation, operation and maintenance outlined in the most recent version of the North Carolina Sediment and Erosion Control Planning and Design Manual. These devices shall be maintained on all construction sites, borrow sites, and waste pile (spoil) projects, including contractor-owned or leased borrow pits associated with the project.
  - b. For borrow pit sites, the erosion and sediment control measures must equal or exceed the proper design, installation, operation and maintenance outlined in the most recent version of the North Carolina Surface Mining Manual. The reclamation measures and implementation must comply with the reclamation in accordance with the requirements of the Sedimentation Pollution Control Act.
2. All sediment and erosion control measures shall not be placed in wetlands or waters to the maximum extent practicable. If placement of sediment and erosion control devices in wetlands and waters is unavoidable, they shall be removed and the natural grade restored after the Division of Land Resources has released the project.
3. Pursuant to NCAC15A 2B.0233(6), sediment and erosion control devices shall not be placed in Zone 1 of any Neuse Buffer without prior approval by the NCDWQ. At this time, the NCDWQ has approved no sediment and erosion control devices in Zone 1, outside of the approved project impacts, anywhere on this project. Moreover, sediment and erosion control devices shall be allowed in Zone 2 of the buffers provided that Zone 1 is not compromised and that discharge is released as diffuse flow.
4. If an environmental document is required, this Certification is not valid until a FONSI or ROD is issued by the State Clearinghouse. All water quality-related conditions of the FONSI or ROD shall become conditions of this Certification.
5. No live or fresh concrete shall come into contact with waters of the state until the concrete has hardened.

6. There shall be no excavation from or waste disposal into jurisdictional wetlands or waters associated with this permit without appropriate modification of this permit. Should waste or borrow sites be located in wetlands or stream, compensatory mitigation will be required since it is a direct impact from road construction activities.
7. Upon completion of the project, the NCDOT shall complete and return the enclosed "Certification of Completion Form" to notify DWQ when all work included in the 401 Certification has been completed. The responsible party shall complete the attached form and return it to the 401/Wetlands Unit of the Division of Water Quality upon completion of the project.
8. Placement of culverts and other structures in waters, streams, and wetlands must be placed below the elevation of the streambed to allow low flow passage of water and aquatic life unless it can be shown to DWQ that providing passage would be impractical. Design and placement of culverts and other structures including temporary erosion control measures shall not be conducted in a manner that may result in disequilibrium of wetlands or streambeds or banks, adjacent to or upstream and down stream of the above structures. The applicant is required to provide evidence that the equilibrium shall be maintained if requested in writing by DWQ.
9. The Ecosystem Enhancement Program (EEP) previously provided wetland mitigation for Sections F and G at the initial 404 and 401 permit issuance. The additional amounts of impact requiring mitigation are 0.12 acres riverine wetlands in the Neuse River Basin (Cataloging Unit 03020201). Compensatory mitigation for impacts to riverine wetlands shall be done for 0.12 acres. Applying a replacement ratio of 2:1, total mitigation for .24 acres of riverine wetlands shall be provided by EEP through the Cataloging Unit 03020201 of the Neuse River Basin.
10. Compensatory mitigation for the additional impacts to 5,148 square feet in Zone 1 and 1,446 square feet in Zone 2 of Neuse River Riparian Buffers shall be provided for as described below.

Zone of Impact	Impacts (Square Feet)	Replacement Ratio	Total Square Feet of Mitigation Required
Zone 1	5,148	3:1	15,444
Zone 2	1,446	1.5:1	2,169
Total	6,594		17,613

We understand that you have chosen to perform compensatory mitigation for impacts to protected buffers through an in lieu payment to the North Carolina Ecosystem Enhancement Program (NCEEP), and that the EEP has agreed to implement the mitigation for the project. Mitigation for unavoidable impacts to Neuse River Riparian Buffers shall be provided through an in-lieu payment to the North Carolina Ecosystem Enhancement Program (NCEEP) at a rate of \$0.96 per square foot. Therefore, a total payment of \$16,908.48 shall be submitted to the NCEEP to offset the impacts. No construction activities in Neuse River Riparian buffers shall begin until payment for buffer mitigation is made and the Ecosystem Enhancement Program receives and clears your check (made payable to DENR – Ecosystem Enhancement Program).

11. All stormwater runoff shall be directed to sheetflow through stream buffers at nonerosive velocities, unless approved otherwise by this certification.
12. During the construction of the project, no staging of equipment of any kind is permitted in waters of the U.S., or protected riparian buffers.
13. All temporary fills in wetlands and surface waters shall be removed upon completion of the project. In addition, the post-construction removal of any temporary bridge structures or fill will need to return the

project site to its preconstruction contours and elevations. The revegetation of the impacted areas with appropriate native species will be required.

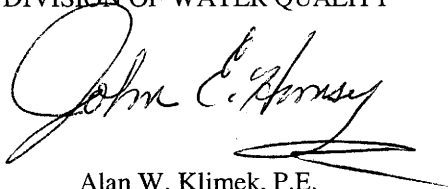
14. Riparian vegetation must be reestablished within the construction limits of the project by the end of the growing season following completion of construction.
15. The dimension, pattern and profile of the stream above and below the crossing should not be modified by widening the stream channel or reducing the depth of the stream. Disturbed floodplains and streams should be restored to natural geomorphic conditions.
16. Any riprap used must not interfere with thalweg performance and aquatic life passage during low flow conditions.
17. All mechanized equipment operated near surface waters must be regularly inspected and maintained to prevent contamination of stream waters from fuels, lubricants, hydraulic fluids, or other toxic materials.
18. Discharging hydroseed mixtures and washing out hydroseeders and other equipment in or adjacent to surface waters is prohibited.
19. All protected riparian buffers impacted by the placement of temporary fill or clearing activities shall be restored to the preconstruction contours and revegetated with native woody species upon completion of the project construction. A post-construction as-built with the restoration activities included shall be submitted to the DWQ no later than 60 days after the project is closed out by the Department of Transportation.
20. The outside buffer, wetland or water boundary located within the construction corridor approved by this authorization shall be clearly marked by orange fabric fencing prior to any land disturbing activities. Impacts to areas within the fencing are prohibited unless otherwise authorized by this certification.
21. NCDOT, and its authorized agents, shall conduct its activities in a manner consistent with State water quality standards (including any requirements resulting from compliance with §303(d) of the Clean Water Act) and any other appropriate requirements of State law and Federal law. If DWQ determines that such standards or laws are not being met (including the failure to sustain a designated or achieved use) or that State or federal law is being violated, or that further conditions are necessary to assure compliance, DWQ may reevaluate and modify this certification to include conditions appropriate to assure compliance with such standards and requirements in accordance with 15A NCAC 2H.0507(d). Before modifying the certification, DWQ shall notify NCDOT and the US Army Corps of Engineers, provide public notice in accordance with 15A NCAC 2H.0503 and provide opportunity for public hearing in accordance with 15A NCAC 2H.0504. Any new or revised conditions shall be provided to NCDOT in writing, shall be provided to the United States Army Corps of Engineers for reference in any permit issued pursuant to Section 404 of the Clean Water Act, and shall also become conditions of the 404 Permit for the project.
22. A copy of this Water Quality Certification shall be posted on the construction site at all times. In addition, the Water Quality Certification (and all subsequent modifications, if any, shall be maintained with the Division Engineer and the on-site project manager.
23. Culverts that are less than 48-inch in diameter should be buried to a depth equal to or greater than 20% of their size to allow for aquatic life passage. Culverts that are 48-inch in diameter or larger should be buried at least 12 inches below the stream bottom to allow natural stream bottom material to become established in the culvert following installation and to provide aquatic life passage during periods of low flow. These measurements must be based on natural thalweg depths.

Violations of any condition herein set forth may result in revocation of this Certification and may result in criminal and/or civil penalties. This Certification shall become null and void unless the above conditions are made conditions of the Federal 404 and/or Coastal Area Management Act Permit. This Certification shall expire upon the expiration of the 404 or CAMA permit.

If this Certification is unacceptable to you have the right to an adjudicatory hearing upon written request within sixty (60) days following receipt of this Certification. This request must be in the form of a written petition conforming to Chapter 150B of the North Carolina General Statutes and filed with the Office of Administrative Hearings, P.O. Box 27447, Raleigh, N.C. 27611-7447. If modifications are made to an original Certification, you have the right to an adjudicatory hearing on the modifications upon written request within sixty (60) days following receipt of the Certification. Unless such demands are made, this Certification shall be final and binding.

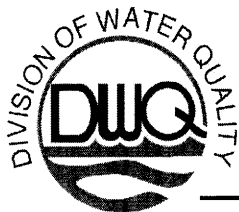
This the 10<sup>th</sup> day of November 2004

DIVISION OF WATER QUALITY

A handwritten signature in black ink, appearing to read "Alan W. Klimek", with a stylized flourish at the end.

Alan W. Klimek, P.E.  
Director

WQC No. 3081



DWQ Project No.: \_\_\_\_\_ County: \_\_\_\_\_

Applicant: \_\_\_\_\_

Project Name: \_\_\_\_\_

Date of Issuance of 401 Water Quality Certification: \_\_\_\_\_

**Certificate of Completion**

Upon completion of all work approved within the 401 Water Quality Certification or applicable Buffer Rules, and any subsequent modifications, the applicant is required to return this certificate to the 401/Wetlands Unit, North Carolina Division of Water Quality, 1621 Mail Service Center, Raleigh, NC, 27699-1621. This form may be returned to DWQ by the applicant, the applicant's authorized agent, or the project engineer. It is not necessary to send certificates from all of these.

**Applicant's Certification**

I, \_\_\_\_\_, hereby state that, to the best of my abilities, due care and diligence was used in the observation of the construction such that the construction was observed to be built within substantial compliance and intent of the 401 Water Quality Certification and Buffer Rules, the approved plans and specifications, and other supporting materials.

Signature: \_\_\_\_\_ Date: \_\_\_\_\_

**Agent's Certification**

I, \_\_\_\_\_, hereby state that, to the best of my abilities, due care and diligence was used in the observation of the construction such that the construction was observed to be built within substantial compliance and intent of the 401 Water Quality Certification and Buffer Rules, the approved plans and specifications, and other supporting materials.

Signature: \_\_\_\_\_ Date: \_\_\_\_\_

**Engineer's Certification**

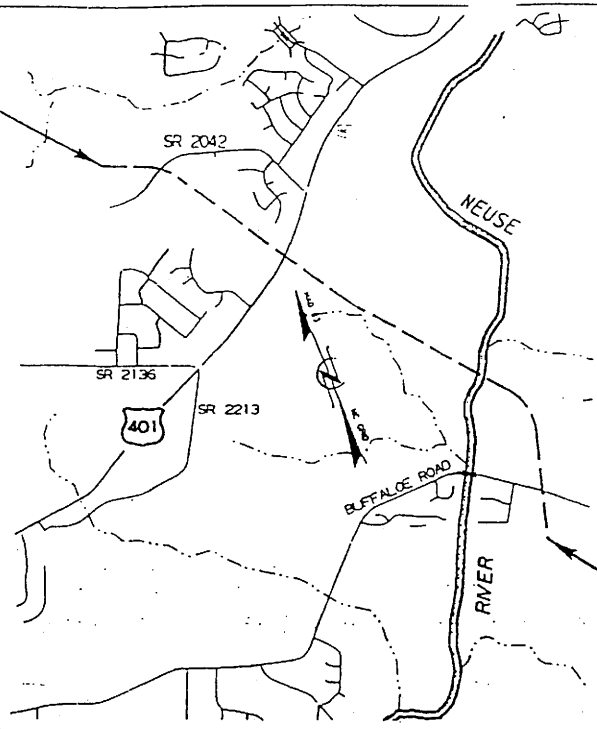
\_\_\_\_\_ Partial \_\_\_\_\_ Final

I, \_\_\_\_\_, as a duly registered Professional Engineer in the State of North Carolina, having been authorized to observe (periodically, weekly, full time) the construction of the project, for the Permittee hereby state that, to the best of my abilities, due care and diligence was used in the observation of the construction such that the construction was observed to be built within substantial compliance and intent of the 401 Water Quality Certification and Buffer Rules, the approved plans and specifications, and other supporting materials.

Signature \_\_\_\_\_ Registration No. \_\_\_\_\_

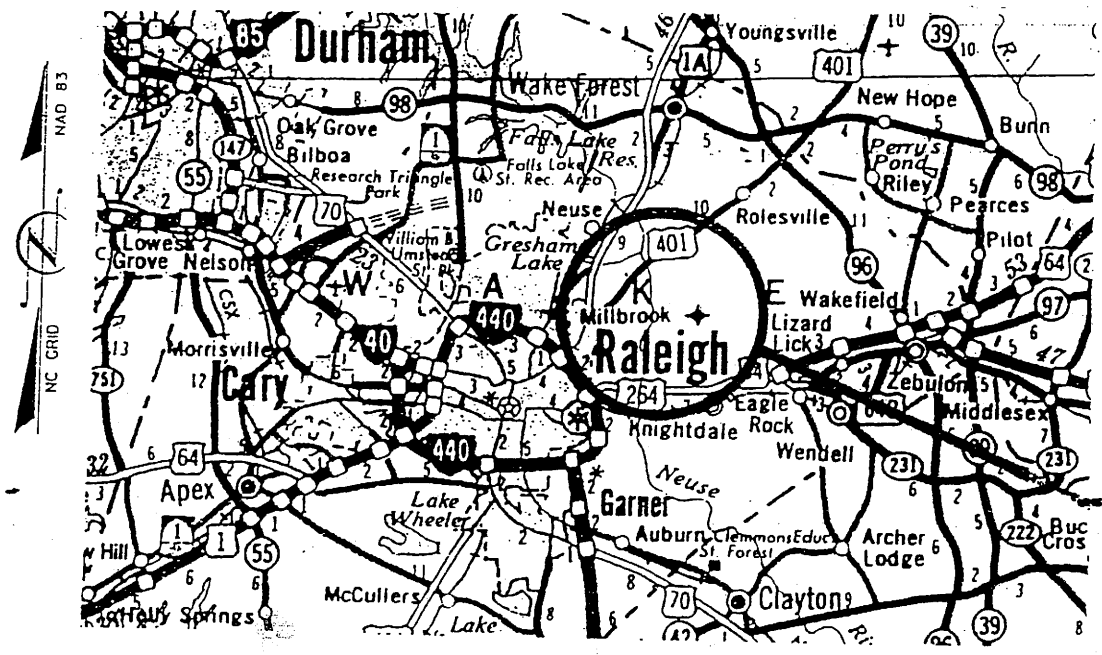
Date \_\_\_\_\_

BEG. PROJ.



END PROJ.

PORTION OF WAKE COUNTY MAP



PROJECT

PORTION OF STATE MAP

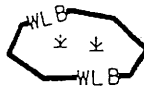
NORTH CAROLINA  
DEPARTMENT OF HIGHWAYS



WAKE COUNTY  
8.U401727 (R-2000F)  
NORTH RALEIGH OUTER LOOP

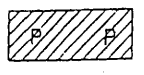
# LEGEND

—WLB— WETLAND BOUNDARY

 WETLAND

 DENOTES FILL IN WETLAND

 DENOTES FILL IN SURFACE WATER

 DENOTES FILL IN SURFACE WATER (POND)

 DENOTES TEMPORARY FILL IN WETLAND

 DENOTES EXCAVATION IN WETLAND

 DENOTES TEMPORARY FILL IN SURFACE WATER

 DENOTES MECHANIZED CLEARING

— FLOW DIRECTION

—TB— TOP OF BANK

—WE— EDGE OF WATER

—C— PROP. LIMIT OF CUT

—F— PROP. LIMIT OF FILL

▲ PROP. RIGHT OF WAY

—NG— NATURAL GROUND

—P— PROPERTY LINE

—TDE— TEMP. DRAINAGE EASEMENT

—PDE— PERMANENT DRAINAGE EASEMENT

—EAB— EXIST. ENDANGERED ANIMAL BOUNDARY

—EPB— EXIST. ENDANGERED PLANT BOUNDARY

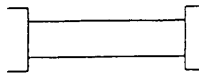
— WATER SURFACE

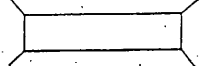
X X X  
X X X  
LIVE STAKES

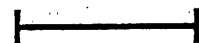
 BOULDER

— — — COIR FIBER ROLLS


5  
ADJACENT PROPERTY OWNER OR PARCEL NUMBER

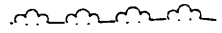
 PROPOSED BRIDGE

 PROPOSED BOX CULVERT

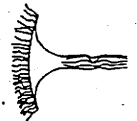
 PROPOSED PIPE CULVERT


(DASHED LINES DENOTE EXISTING STRUCTURES)

 SINGLE TREE

 WOODS LINE

■ DRAINAGE INLET

 ROOTWAD

 VANE

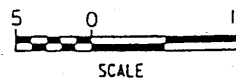
 RIP RAP

 RIP RAP ENERGY DISSIPATOR BASIN

— — — BUFFER ZONE

NORTH CAROLINA  
DEPARTMENT OF HIGHWAYS

WAKE COUNTY  
8.U401727 (R-2000F)  
NORTH RALEIGH OUTER LOOP



6/24/02 SHEET 3 OF 90



DAY LIGHT GRASS SWALE @ EL = 71.10  
SITE 2

PSD 008-95-RW  
C. THOMAS HENDRICKSON  
DB 3911 PG 01

GRASS SWALE			
DA	0.07	ha	0.2
Q2	0.009	m <sup>3</sup> /s	0.33
V2	0.36	m/s	1.18
Q10	0.013	m <sup>3</sup> /s	0.45
V10	0.39	m/s	1.28
LENGTH	100	m	328
SLOPE	0.82%		
SIDE SLOPES	6		

ROCK CHECK DAM (TYP.)

RIP RAP AS PER NCDOT STD. 868.02

GRASS SWALE W/ 3:1 SIDES

FSR 2GI(B)

LEVEL SPREADER CANNOT BE UTILIZED EXISTING GROUND SLOPE = 15%

RIP-RAP AS PER NCDOT STD. 868.02

375 RCP

362+00

375 RCP 362+40

LREV

750 RCP

RIP RAP AS PER NCDOT STD. 868.02

DRAW DOWN STRUCTURE

5m UNDERDRAIN

LEVEL SPREADER 5m(L) 16.40ft(L) DA= 0.48 ha DA= 1.18 ac Q(1" in. R.O.) = 0.004 cms 0.14 cfs

TOE PROTECTION

0.6m BASE TAIL DITCH CLASS "B" RIP RAP


DRY DETENTION BASIN

NORTH CAROLINA DEPARTMENT OF HIGHWAYS

WAKE COUNTY  
8.U4017121 (R-2000F)  
NORTH RALEIGH OUTER LOOP

REV. 11/03/04

LEGEND

-  DENOTES MECHANIZED CLEARING
- NBZ1 - NEUSE BUFFER - ZONE 1
- NBZ2 - NEUSE BUFFER - ZONE 2



SCALE AS SHOWN

SHEET 7 OF 20

DATE: 11/03/04  
DRAWN: [unclear]  
CHECKED: [unclear]

MATCH LINE 3A

3

FORMERLY CLINE ASSOC.  
PB 1989 PG 1126  
DB 3282 PG 902  
PSD 037-92-RW

LREV

369+00

369+40

S 41° 14' 26.6" E

450 RCP

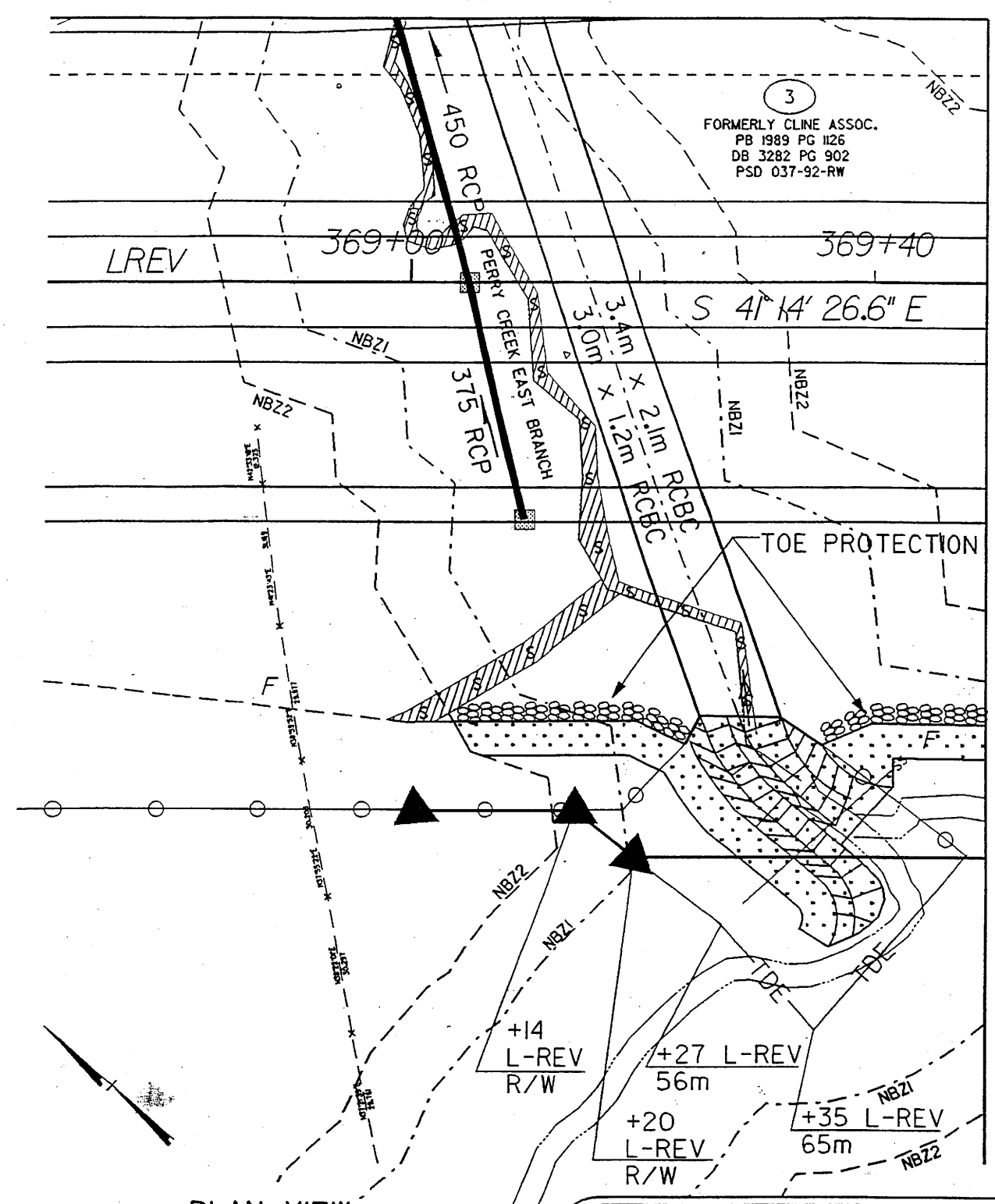
375 RCP

PERRY CREEK  
EAST BRANCH

3.0m x 1.2m RCBC  
3.0m x 2.1m RCBC



TOE PROTECTION

MATCH LINE 3B



PLAN VIEW  
SITE 3

LEGEND

- WLB — WETLAND
-  DENOTES SURFACE WATER LOSS
-  DENOTES MECHANIZED CLEARING
- NBZ1 — NEUSE BUFFER - ZONE 1
- NBZ2 — NEUSE BUFFER - ZONE 2



**NORTH CAROLINA**  
**DEPARTMENT OF HIGHWAYS**

WAKE COUNTY  
8.U401727 (R-2000F)  
NORTH RALEIGH OUTER LOOP

REV. 05/17/04

SCALE AS SHOWN

SHEET 9 OF 90

DATE  
BY  
FILE

PLAN VIEW  
SITE 3



1.2 BASE DITCH

NBZ2

NBZ1

C  
A

2

D.O.T.  
PB 1989 PG 1126  
DB 3282 PG 902  
PSD 037-92-RW

MATCH LINE 3E

0+00

U4 RPB

TRIB TO PERRY  
CREEK EAST BRANCH

NBZ1

NBZ2

370+40

LREV


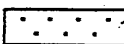
371+00

S 41° 14' 26.6" E

600 RCP

MATCH LINE 3F

LEGEND

- WLB — WETLAND
-  DENOTES SURFACE WATER LOSS
-  DENOTES MECHANIZED CLEARING
- NBZ1 — NEUSE BUFFER - ZONE 1
- NBZ2 — NEUSE BUFFER - ZONE 2



NORTH CAROLINA  
DEPARTMENT OF HIGHWAYS

WAKE COUNTY  
8.U401727 (R-2000F)  
NORTH RALEIGH OUTER LOOP

REV. 05/05/04

SCALE AS SHOWN

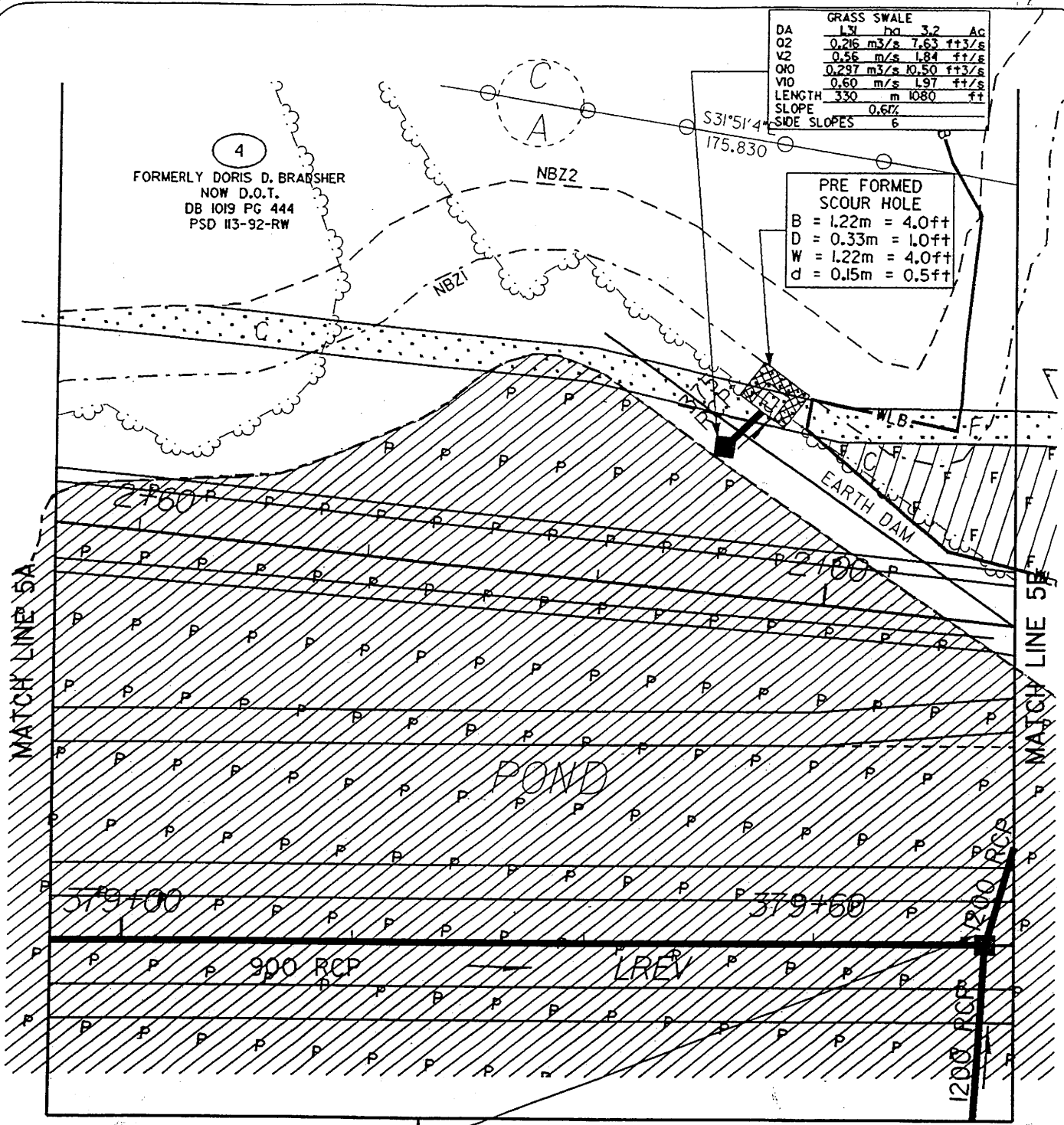
SHEET 14 OF 90

FILE

GRASS SWALE				
DA	1.31	ha	3.2	AC
Q2	0.216	m <sup>3</sup> /s	7.63	ft <sup>3</sup> /s
V2	0.56	m/s	1.84	ft/s
Q10	0.297	m <sup>3</sup> /s	10.50	ft <sup>3</sup> /s
V10	0.60	m/s	1.97	ft/s
LENGTH	330	m	1080	ft
SLOPE	0.6%			
SIDE SLOPES	6			

**PRE FORMED SCOUR HOLE**  
 B = 1.22m = 4.0ft  
 D = 0.33m = 1.0ft  
 W = 1.22m = 4.0ft  
 d = 0.15m = 0.5ft

4  
 FORMERLY DORIS D. BRANSHER  
 NOW D.O.T.  
 DB 1019 PG 444  
 PSD 113-92-RW

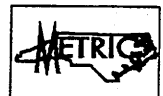


PLAN VIEW  
 SITE 5

**LEGEND**

- WL.B — WETLAND
- DENOTES SURFACE WATER LOSS (POND)
- DENOTES FILL IN WETLAND
- DENOTES MECHANIZED CLEARING
- NBZ1 — NEUSE BUFFER - ZONE 1
- NBZ2 — NEUSE BUFFER - ZONE 2

GRASS SWALE				
DA	0.07	ha	0.2	AC
Q2	0.04	m <sup>3</sup> /s	0.49	ft <sup>3</sup> /s
V2	0.41	m/s	1.34	ft/s
Q10	0.019	m <sup>3</sup> /s	0.67	ft <sup>3</sup> /s
V10	0.44	m/s	1.44	ft/s
LENGTH	100	m	328	ft
SLOPE	1.65%			
SIDE SLOPES	6			



**NORTH CAROLINA  
 DEPARTMENT OF HIGHWAYS**

WAKE COUNTY  
 8.U401727 (R-2000F)  
 NORTH RALEIGH OUTER LOOP

REV. 05/05/04

SCALE AS SHOWN

SHEET 21 OF 90

MATCH LINE 5C

MATCH LINE 5C

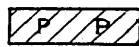
GRASS SWALE			
DA	0.53	ha	1.3 Ac
Q2	0.105	m <sup>3</sup> /s	3.71 ft <sup>3</sup> /s
V2	0.44	m/s	1.44 ft/s
Q10	0.144	m <sup>3</sup> /s	5.10 ft <sup>3</sup> /s
V10	0.48	m/s	1.57 ft/s
LENGTH	165	m	541 ft
SLOPE	0.53%		
SIDE SLOPES	6		

GRASS SWALE			
DA	0.28	ha	0.7 Ac
Q2	0.056	m <sup>3</sup> /s	1.96 ft <sup>3</sup> /s
V2	0.51	m/s	1.67 ft/s
Q10	0.076	m <sup>3</sup> /s	2.69 ft <sup>3</sup> /s
V10	0.55	m/s	1.80 ft/s
LENGTH	145	m	476 ft
SLOPE	2.6%		
SIDE SLOPES	6		

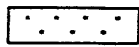
FILL ABANDONED POND TO NATURAL GROUND

PLAN VIEW  
SITE 5

**LEGEND**



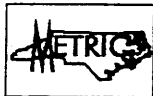
DENOTES SURFACE WATER LOSS (POND)



DENOTES MECHANIZED CLEARING

— NBZ1 — NEUSE BUFFER - ZONE 1

— NBZ2 — NEUSE BUFFER - ZONE 2



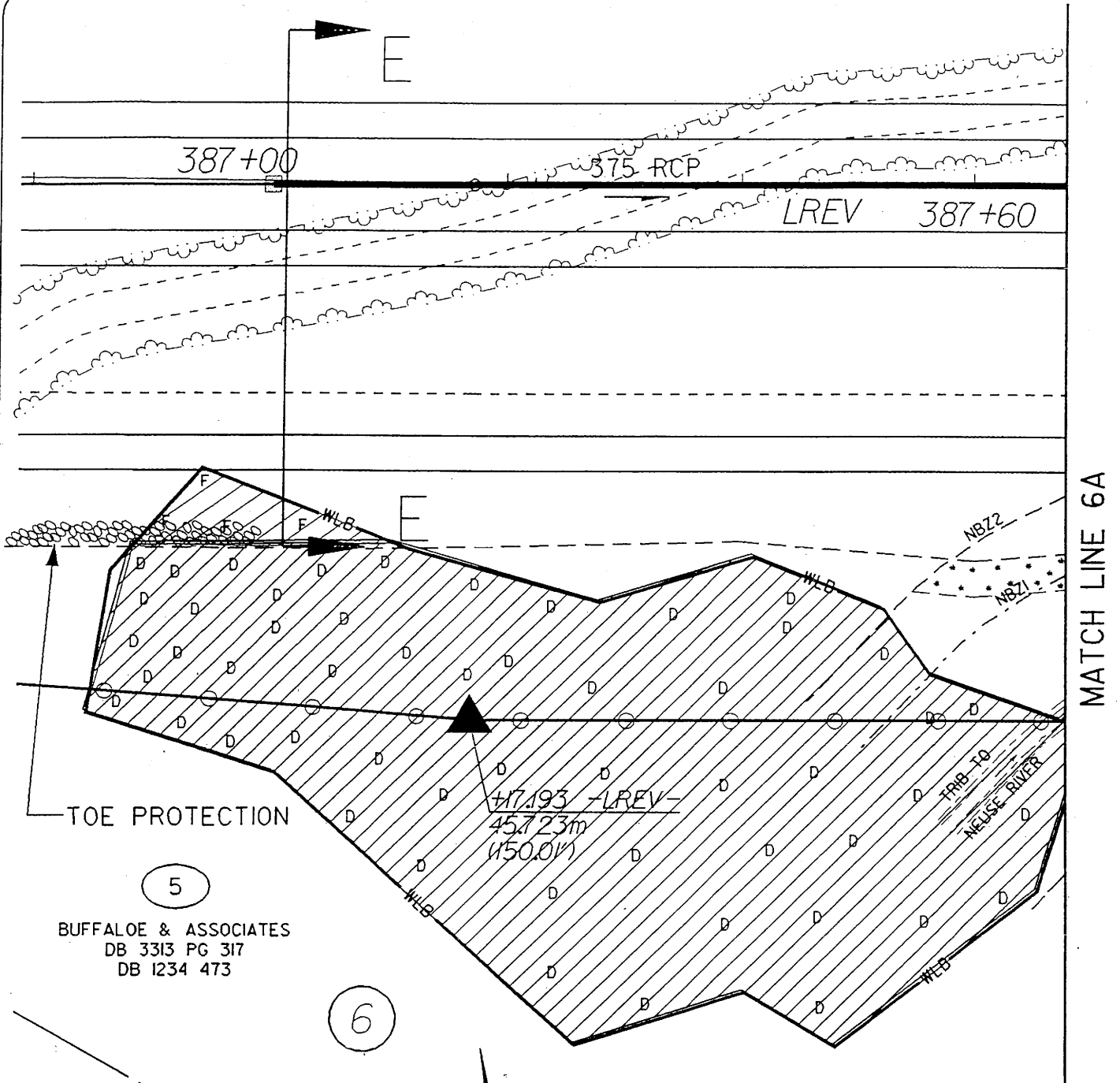
**NORTH CAROLINA  
DEPARTMENT OF HIGHWAYS**

WAKE COUNTY  
8.U401727 (R-2000F)  
NORTH RALEIGH OUTER LOOP

REV. 05/05/04

SCALE AS SHOWN

SHEET 23 OF 90

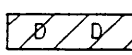
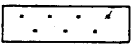


5  
 BUFFALO & ASSOCIATES  
 DB 3313 PG 317  
 DB 1234 473

6

PLAN VIEW  
 SITE 6

LEGEND

- WLB — WETLAND
-  DENOTES DRAINED WETLAND
- DENOTES FILL IN WETLAND
-  DENOTES MECHANIZED CLEARING
- NBZ1 — NEUSE BUFFER - ZONE 1
- NBZ2 — NEUSE BUFFER - ZONE 2



NORTH CAROLINA  
 DEPARTMENT OF HIGHWAYS

WAKE COUNTY  
 8.U401727 (R-2000F)  
 NORTH RALEIGH OUTER LOOP

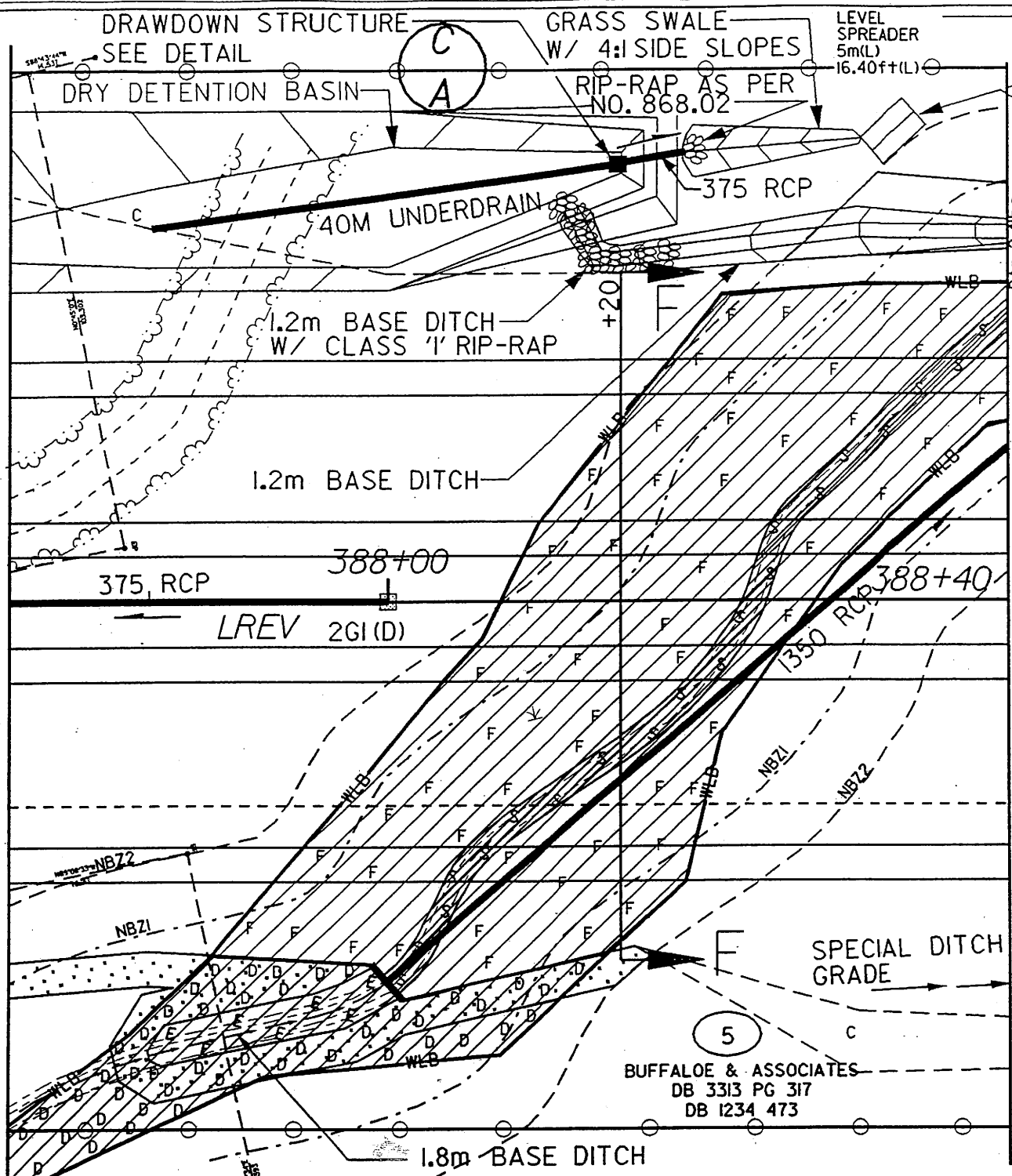
REV. 05/05/04

SCALE AS SHOWN

SHEET 29 OF 40

MATCH LINE 6A

FILES



MATCH LINE 6A

MATCH LINE 6B

DRAWDOWN STRUCTURE SEE DETAIL  
 GRASS SWALE W/ 4:1 SIDE SLOPES  
 LEVEL SPREADER 5m(L) 16.40ft+(L)

DRY DETENTION BASIN  
 RIP-RAP AS PER NO. 868.02  
 375 RCP

40M UNDERDRAIN

1.2m BASE DITCH W/ CLASS '1' RIP-RAP

1.2m BASE DITCH

375, RCP

388+00

LREV 2GI (D)

388+40

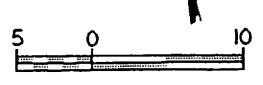
1350 RCP

SPECIAL DITCH GRADE

1.8m BASE DITCH

**LEGEND**

- WLB — WETLAND
- DENOTES DRAINED WETLAND
- DENOTES FILL IN WETLAND
- DENOTES SURFACE WATER LOSS
- DENOTES EXCAVATION IN WETLAND
- DENOTES MECHANIZED CLEARING
- NBZ1 — NEUSE BUFFER - ZONE 1
- NBZ2 — NEUSE BUFFER - ZONE 2



**PLAN VIEW  
 SITE 6**

**NORTH CAROLINA  
 DEPARTMENT OF HIGHWAYS**

WAKE COUNTY  
 8.U401727 (R-2000F)  
 NORTH RALEIGH OUTER LOOP

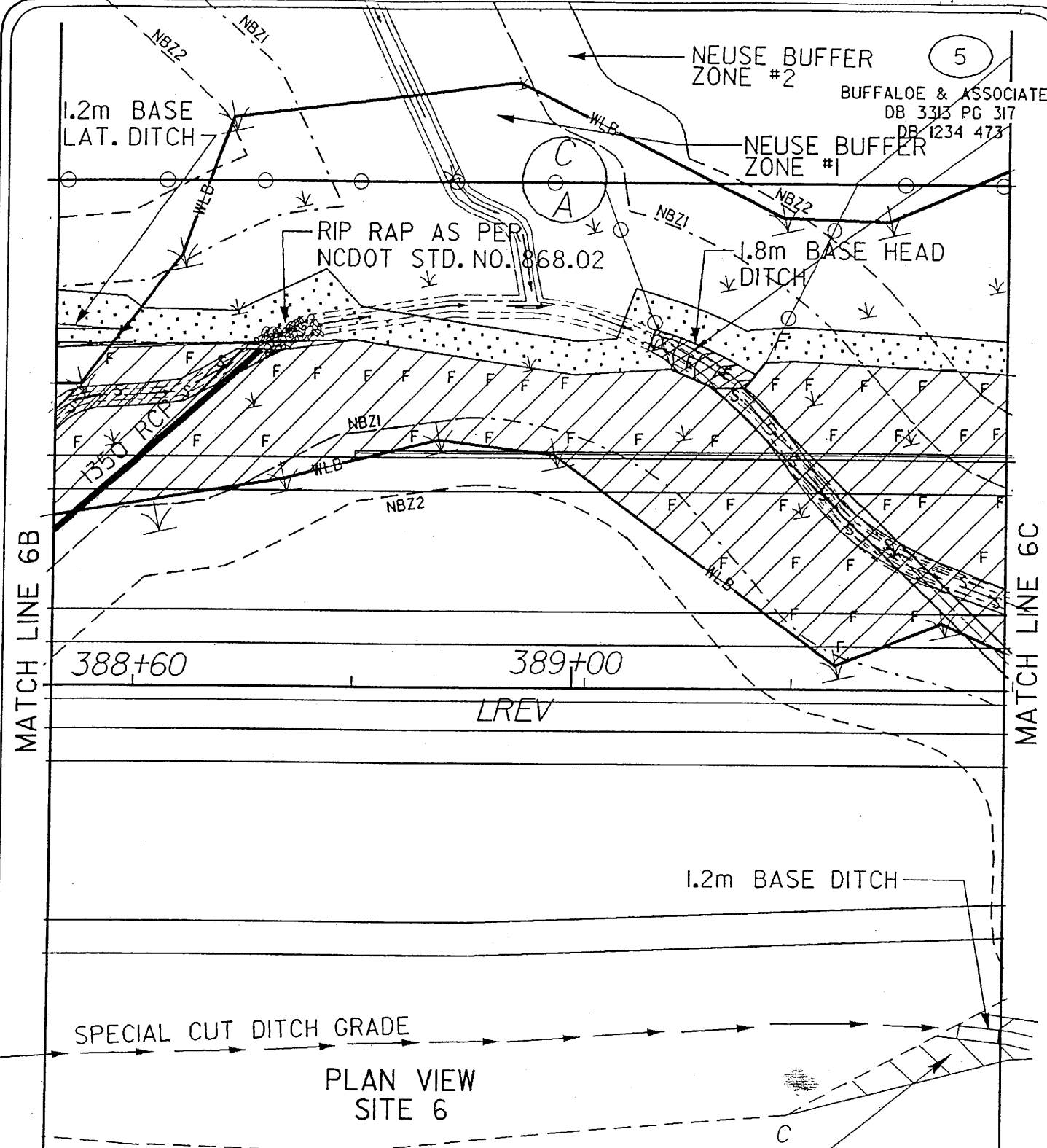
REV. 05/14/04

SCALE AS SHOWN

SHEET 30 OF 90

DA = 2.41m  
 DA = 5.95 ac  
 0(1" In. R.O.) =  
 0.004 cms. 0.14 cfs

DATE  
 OTHER  
 FILE



**LEGEND**

- WLB — WETLAND
- DENOTES FILL IN WETLAND
- DENOTES SURFACE WATER LOSS
- DENOTES EXCAVATION IN WETLAND
- DENOTES MECHANIZED CLEARING
- NBZ1 — NEUSE BUFFER - ZONE 1
- NBZ2 — NEUSE BUFFER - ZONE 2

5 0 10

**NORTH CAROLINA**  
**DEPARTMENT OF HIGHWAYS**

WAKE COUNTY  
 8.U401727 (R-2000F)  
 NORTH RALEIGH OUTER LOOP

REV. 08/04/04

SCALE AS SHOWN

SHEET 31 OF 90

ADATES  
 17/10/04  
 AFLEA



5

BUFFALO & ASSOCIATES  
DB 3313 PG 317  
DB 1234 473

STA 389+42.2 L-REV  
1.8m(W) X 2.1m(H) RCBC

PRE FORMED  
SCOUR HOLE  
B = 1.22m = 4.0ft  
D = 0.33m = 1.0ft  
W = 1.22m = 4.0ft  
d = 0.15m = 0.5ft

375 RCP

GRASS SWALE  
200M(L)  
656FT(L)  
DA=0.42HA  
DA=1.0AC  
TREATMENT  
PROVIDED

MATCH LINE 6C

389+60

390+00

FSM

LREV

RIP RAP AS  
PER NCDOT  
STD. NO.  
868.02

TOE PROTECTION  
SEE DETAIL V

+42



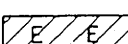
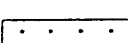
+70

+70

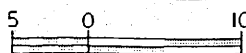
1.8m BASE  
DITCH  
9m @ 1.0%

PLAN VIEW  
SITE 6

LEGEND

- WLB — WETLAND
-  DENOTES FILL IN WETLAND
-  DENOTES SURFACE WATER LOSS
-  DENOTES EXCAVATION IN WETLAND
-  DENOTES MECHANIZED CLEARING
- NBZ1 — NEUSE BUFFER - ZONE 1
- NBZ2 — NEUSE BUFFER - ZONE 2

LEVEL SPREADER  
13m(L)  
42.65ft(L)  
DA= 0.50ha  
DA= 1.23ac  
Q10= 0.091cms  
3.21cfs



NORTH CAROLINA  
DEPARTMENT OF HIGHWAYS

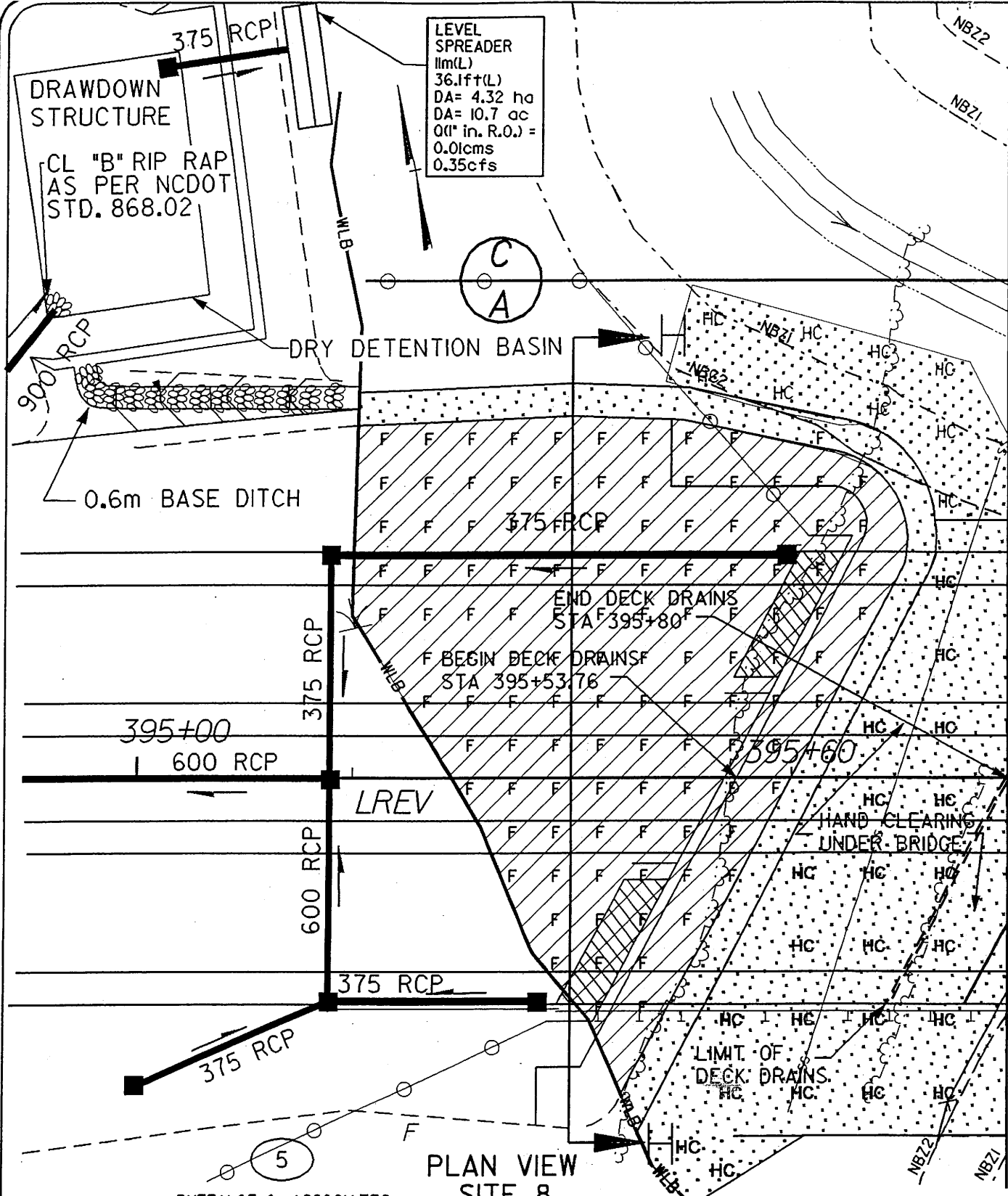
WAKE COUNTY  
8.U401727 (R-2000F)  
NORTH RALEIGH OUTER LOOP

08/04/04

SHEET 32 OF 90

SCALE AS SHOWN

DATE  
BY  
FILES



LEVEL SPREADER  
 11m(L)  
 36.1ft+(L)  
 DA= 4.32 ha  
 DA= 10.7 ac  
 0(1" in. R.O.) =  
 0.01cms  
 0.35cfs

DRAWDOWN STRUCTURE  
 CL "B" RIP RAP  
 AS PER NCDOT  
 STD. 868.02

DRY DETENTION BASIN

0.6m BASE DITCH

END DECK DRAINS  
 STA 395+80

BEGIN DECK DRAINS  
 STA 395+53.76

395+00  
 600 RCP

HAND CLEARING  
 UNDER BRIDGE

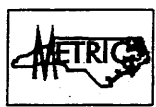
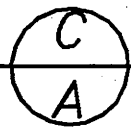
LIMIT OF  
 DECK DRAINS

PLAN VIEW  
 SITE 8

BUFFALO & ASSOCIATES  
 DB 3313 PG 317  
 DB 1234 473

LEGEND

- WLB— WETLAND
- DENOTES FILL IN WETLAND
- DENOTES HAND CLEARING
- DENOTES MECHANIZED CLEARING
- NBZ1 — NEUSE BUFFER - ZONE 1
- NBZ2 — NEUSE BUFFER - ZONE 2



NORTH CAROLINA  
 DEPARTMENT OF HIGHWAYS

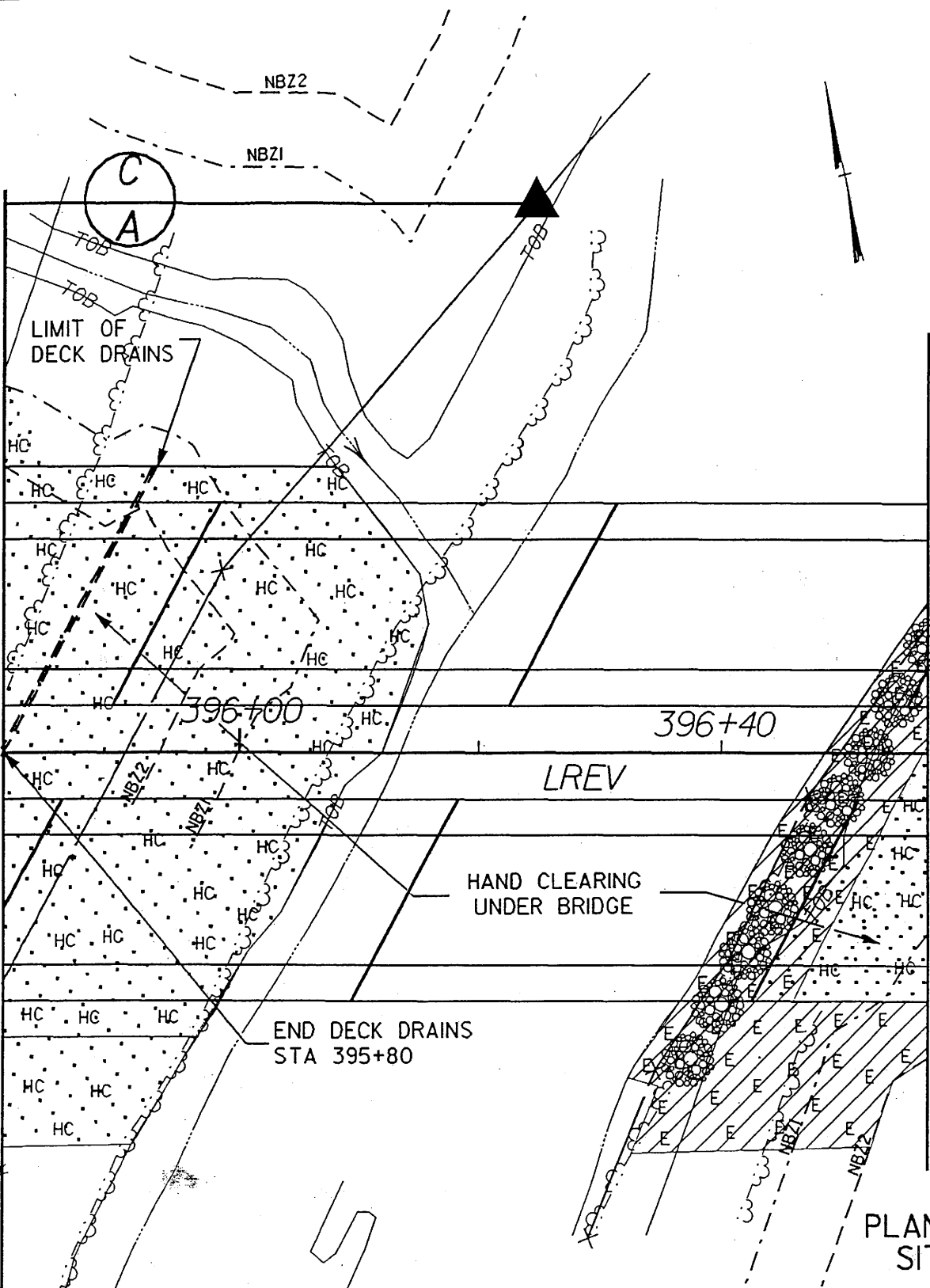
WAKE COUNTY  
 8.U401727 (R-2000F)  
 NORTH RALEIGH OUTER LOOP

REV. 07/07/04

SCALE AS SHOWN

SHEET 41 OF 90

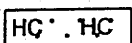
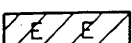
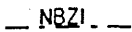

DATE: 07/07/04  
 DRAWN: [unclear]  
 FILE: [unclear]



MATCH LINE 8A

MATCH LINE 8B

**LEGEND**

-  DENOTES HAND CLEARING
-  DENOTES EXCAVATION IN RIPARIAN BUFFER ZONES
-  NEUSE BUFFER - ZONE 1
-  NEUSE BUFFER - ZONE 2



**NORTH CAROLINA  
DEPARTMENT OF HIGHWAYS**

WAKE COUNTY  
8.U401727 (R-2000F)  
NORTH RALEIGH OUTER LOOP

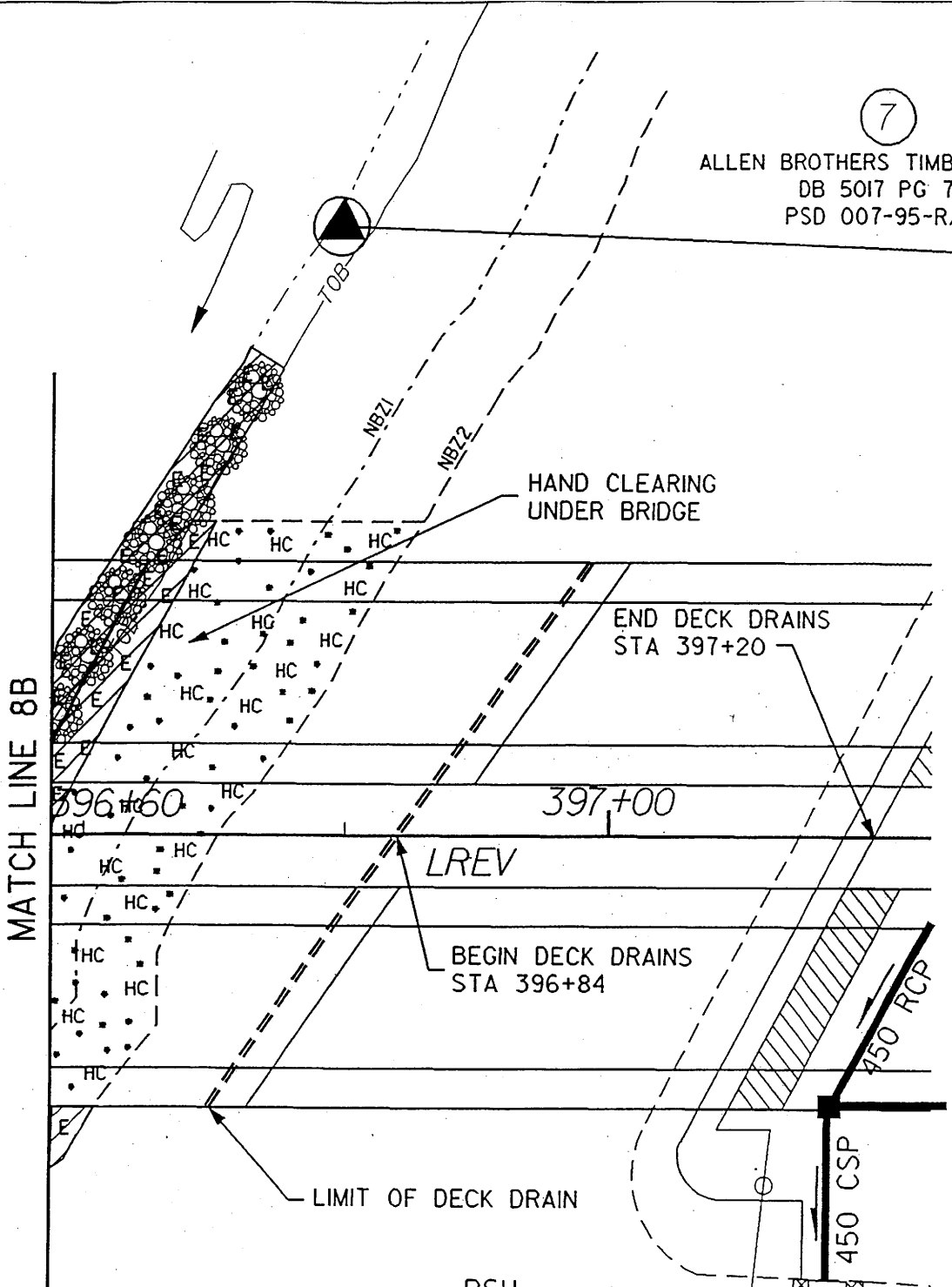
REV. 07/19/04

SHEET 42 OF 90

DATE  
SCALE  
BY


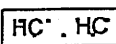

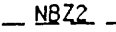
7

ALLEN BROTHERS TIMBER CO., INC  
DB 5017 PG 717  
PSD 007-95-R/W



PLAN VIEW  
SITE 8

LEGEND

-  DENOTES EXCAVATION IN RIPARIAN BUFFER ZONES
-  DENOTES HAND CLEARING
-  NBZ1 NEUSE BUFFER - ZONE 1
-  NBZ2 NEUSE BUFFER - ZONE 2



PSH  
 B = 1.52m (5ft)  
 D = 0.30m (1ft)  
 W = 1.22m (4ft)

NORTH CAROLINA  
DEPARTMENT OF HIGHWAYS

WAKE COUNTY  
 8.U401727 (R-2000F)  
 NORTH RALEIGH OUTER LOOP

REV. 07/19/04

SHEET 43 OF 90

DATE  
TIME  
SCALE

BOULES  
STAKES  
PILES

7

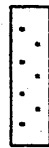


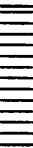
ALLEN BROTHERS TIMBER CO., INC  
DB 5017 PG 717  
PSD 007-95-R/W

END BRIDGE  
STA 397+20.285 -L-

BEGIN CLASS 3<sup>rd</sup> RIP RAP  
Structures Pay Item

# PLAN VIEW SITE 8

## LEGEND

-  DENOTES MECHANIZED CLEARING
-  NBZ1 NEUSE BUFFER - ZONE 1
-  NBZ2 NEUSE BUFFER - ZONE 2
-  TIMBER MATS



NORTH CAROLINA  
DEPARTMENT OF HIGHWAYS

WAKE COUNTY

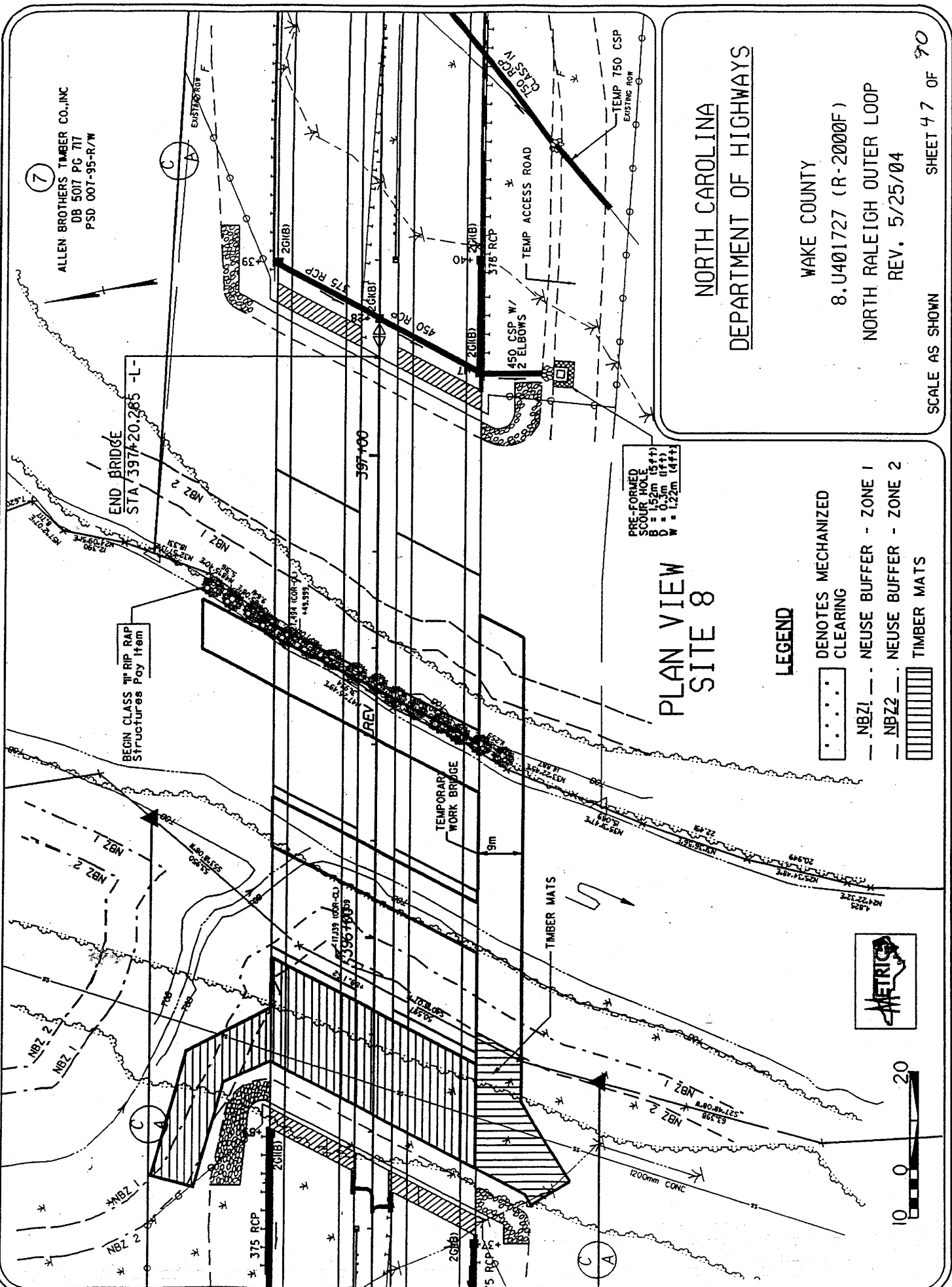
8. U401727 (R-2000F)

NORTH RALEIGH OUTER LOOP

REV. 5/25/04

SCALE AS SHOWN

SHEET 47 OF 70



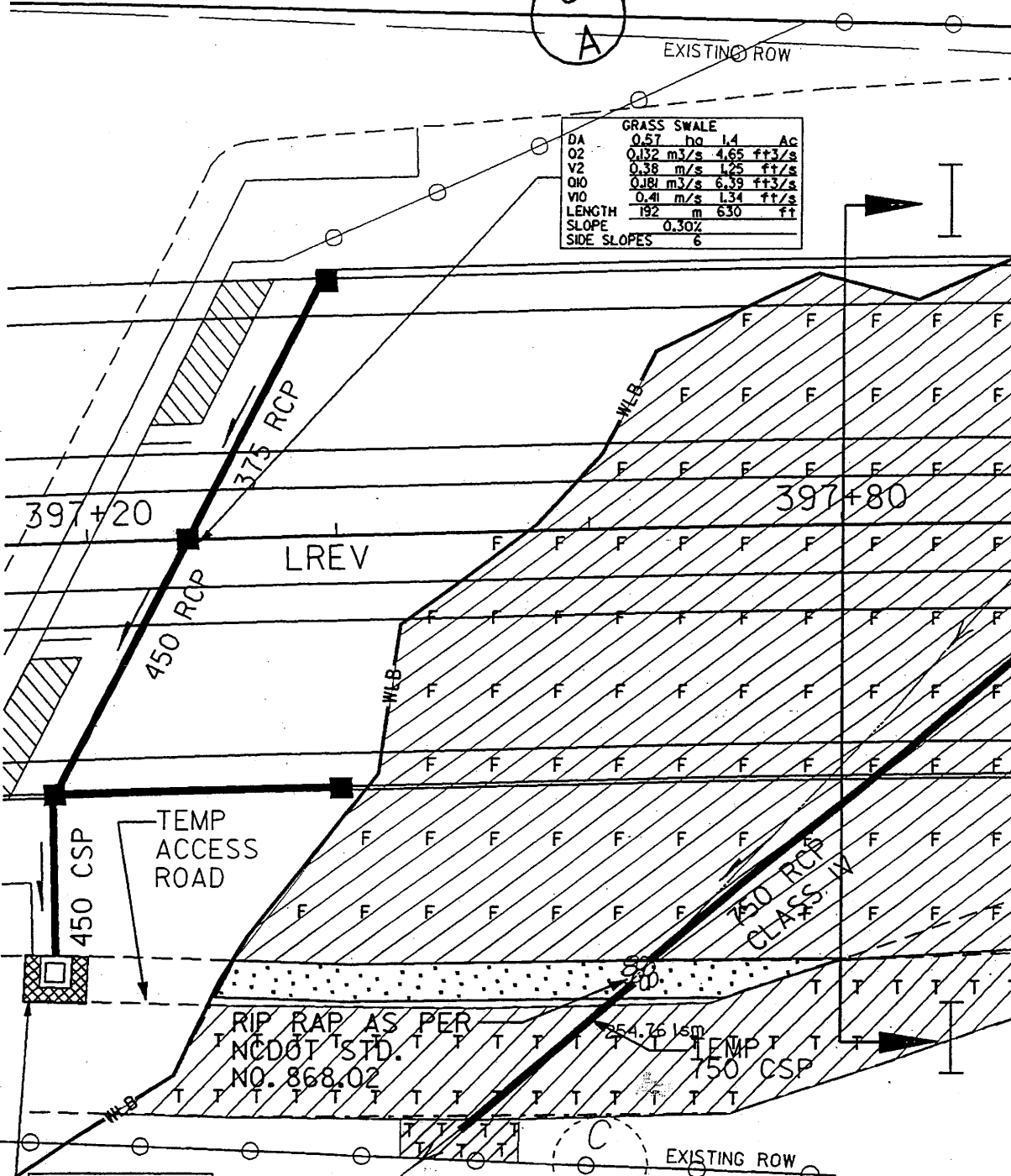
6

ALLEN BROTHERS TIMBER CO., INC  
DB 5017 PG 717  
PSD 007-95-RW

C  
A

EXISTING ROW

GRASS SWALE				
DA	0.57	sq	1.4	Ac
O2	0.132	m <sup>3</sup> /s	4.65	ft <sup>3</sup> /s
V2	0.38	m/s	1.25	ft/s
Q10	0.181	m <sup>3</sup> /s	6.39	ft <sup>3</sup> /s
V10	0.41	m/s	1.34	ft/s
LENGTH	192	m	630	ft
SLOPE	0.30%			
SIDE SLOPES	6			



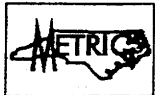
MATCH LINE 9

PRE FORMED SCOUR HOLE  
 B = 1.52m = 5.0ft  
 D = 0.33m = 1.0ft  
 W = 1.22m = 4.0ft  
 d = 0.15m = 0.5ft

PLAN VIEW  
SITE 9

LEGEND

- WLB — WETLAND
- DENOTES FILL IN WETLAND
- DENOTES TEMPORARY FILL IN WETLAND
- DENOTES MECHANIZED CLEARING



**NORTH CAROLINA**  
**DEPARTMENT OF HIGHWAYS**

WAKE COUNTY  
8. U401727 (R-2000F)  
NORTH RALEIGH OUTER LOOP

REV. 05/17/04

SHEET 48 OF 90

SCALE AS SHOWN

DATE: 01/11/04  
OTHER: 01/11/04  
FILE: 01/11/04

PLAN VIEW  
SITE 12

II

LAMONT M. & DELORIS W. INGE  
DB 6285 PG 426

SPECIAL  
DITCH  
GRADE

LEVEL SPREADER  
CANNOT BE UTILIZED  
LENGTH = 331m

NON EROSION  
VELOCITIES EXIST  
FOR THE 2 & 10-YR  
EVENT  
SEE SHEET 87

NB22

NBZ1

NBZ1

9

LEVEL  
SPREADER  
12m(L)  
39.4ft(L)  
DA= 0.48 ha  
DA= 1.18 ac  
Q10=0.087cms  
Q10=3.07cfs

PAUL K. HESTER  
PB 1947 PG 4  
PSD 009-95-R/W

NORTH CAROLINA  
DEPARTMENT OF HIGHWAYS

WAKE COUNTY  
8.U401727 (R-2000F)  
NORTH RALEIGH OUTER LOOP

6/12/03

PRE-FORMED  
SCOUR HOLE  
B = 1.40m = 4.59ft  
D = 0.30m = 0.98ft  
W = 1.20m = 4.72ft  
d = 0.15 = 0.5ft

LEVEL SPREADER  
CANNOT BE UTILIZED  
LENGTH = 150m

0.6 m LAT  
BASE DITCH

RIP RAP AS PER  
NCDOT STD. NO. 868.02

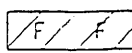
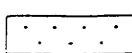
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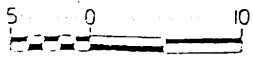
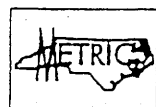
LAT "V"  
DITCH

LEVEL  
SPREADER  
5m(L)  
16.40ft(L)  
DA= 0.21ha  
DA= 0.52ac  
Q10=0.038cms  
Q10=1.34cfs

+80

LEGEND

- WLB — WETLAND
-  DENOTES FILL IN WETLAND
-  DENOTES MECHANIZED CLEARING
- NBZ1 — NEUSE BUFFER - ZONE 1
- NBZ2 — NEUSE BUFFER - ZONE 2



DATE PLOTTED: 06/12/03

# R-2000F PERMIT MODIFICATION IMPACTS

SITE	PROJECT STATION	STRUCTURE TYPE	WETLAND IMPACTS			SURFACE WATER IMPACTS							FILL / EXCAVATION IN BUFFERS						
			FILL IN WETLANDS (acre)	TEMPORARY FILL IN WETLANDS (acre)	EXCAVATION IN WETLANDS (acre)	MECHANIZED CLEARING IN WETLANDS (METHOD)	FILL IN SURFACE WATERS (NATURAL) (acre)	FILL IN SURFACE WATERS (POND) (acre)	TEMP FILL IN SW (acre)	LENGTH OF CHANNEL IMPACTED (ft)	RELOCATED CHANNEL (ft)	ENCLOSED CHANNEL (ft)	ZONE 1 (acre)	ZONE 2 (acre)	MECH CLEAR (acre)				
2	361+95 L-REV ORG.	750 RCP																	
2	361+95 L-REV ADD.	750 RCP																	
2	361+95 L-REV NEW	750 RCP																	
3	369+80 L-REV ORG.		0.166			0.018		0.253					779	459	279		1.169	0.729	0.357
3	369+80 L-REV ADD.																		0.015
3	369+80 L-REV NEW																		0.638
5	378+60 L-REV ORG.	1200 RCP	0.069		0.158	0.038		0.017	2.60943283				164				3.480	0.425	0.181
5	378+60 L-REV ADD.	1200 RCP																	0.002
5	378+60 L-REV NEW	1200 RCP																	0.183
6	387+00 L-REV ORG.	1350 RCP 1.8 x 2.1 RCBC	1.347		0.674	0.102		0.099					447	69	360		1.002	0.318	0.132
6	387+00 L-REV ADD.	1350 RCP 1.8 x 2.1 RCBC															-0.004	-0.006	0.009
6	387+00 L-REV NEW	1350 RCP 1.8 x 2.1 RCBC															0.998	0.312	0.245
8	395+40 L-REV ORG.	Reuse	0.465	0.208 **		0.076 *											0.000		
8	395+40 L-REV ADD.	Reuse		0.121 **													0.166 E		
8	395+40 L-REV NEW	Reuse		0.329 **													0.166 E		0.007
8	395+40 L-REV ORG.	Trib																	
8	395+40 L-REV ADD.	Trib		0.084 **															
8	395+40 L-REV NEW	Trib		0.084 **															
9	397+80 L-REV ORG.	750 RCP	1.228	0.158		0.063													
9	397+80 L-REV ADD.	750 RCP		0.008															
9	397+80 L-REV NEW	750 RCP		0.166															

\* ADDITIONAL 0.82 ACRE HAND CLEARED, NOT A JURISDICTIONAL ACTION. AN ADDITIONAL 0.09 AC. WILL BE HAND CLEARED FOR THE EXTENSION OF THE TIMBER MAT IN WETLANDS AND BUFFERS. NEW TOTAL HAND CLEARING = 0.71 AC.  
 \*\* TEMPORARY IMPACT FOR TIMBER MATS IN WETLANDS  
 ALLOWABLE IMPACTS FOR TIMBER MATS IN RIPARIAN BUFFERS: ZONE 1 = 0.027 ACRE ZONE 2 = 0.057 ACRE E= Excavation

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Revised  
8/6/04





# R-2000F PERMIT MODIFICATION IMPACTS

SITE	PROJECT STATION	STRUCTURE TYPE	WETLAND IMPACTS			SURFACE WATER IMPACTS							FILL / EXCAVATION IN BUFFERS						
			FILL IN WETLANDS (ha)	TEMPORARY FILL IN WETLANDS (ha)	EXCAVATION IN WETLANDS (ha)	MECHANIZED CLEARING IN WETLANDS (METHOD)	FILL IN SURFACE WATERS (NATURAL) (ha)	FILL IN SURFACE WATERS (POND) (ha)	TEMP FILL IN SW (ha)	LENGTH OF EXISTING CHANNEL IMPACTED (m)	RELOCATED CHANNEL (m)	ENCLOSED CHANNEL (m)	ZONE 1 (ha)	ZONE 2 (ha)	MCH CLEAR (ha)				
2	361+95 L-REV ORG.	750 RCP																	
2	361+95 L-REV ADD.	750 RCP																	
2	361+95 L-REV NEW	750 RCP																	
3	369+80 L-REV ORG.		0.067			0.010		0.102					323	140	85		0.145	0.086	0.053
3	369+80 L-REV ADD.																0.613	0.295	0.252
3	369+80 L-REV NEW																		0.006
5	378+60 L-REV ORG.	1200 RCP	0.028		0.064	0.016		0.007	1.056				50				1.408	0.172	0.073
5	378+60 L-REV ADD.	1200 RCP																	0.001
5	378+60 L-REV NEW	1200 RCP																	0.074
6	387+00 L-REV ORG.	1350 RCP 1.8 x 2.1 RCBC	0.545		0.280	0.079		0.040					217	21	178		0.405	0.232	0.095
6	387+00 L-REV ADD.	1350 RCP 1.8 x 2.1 RCBC															-0.002	-0.002	0.004
6	387+00 L-REV NEW	1350 RCP 1.8 x 2.1 RCBC															0.403	0.230	0.099
8	395+40 L-REV ORG.	Neuse	0.188	0.084 **		0.031 *											0.000		
8	395+40 L-REV ADD.	Neuse		0.049 **													0.067 E		
8	395+40 L-REV NEW	Neuse		0.133 **													0.067 E		
8	395+40 L-REV ORG.	Trib																	0.003
8	395+40 L-REV ADD.	Trib		0.034 **															
8	395+40 L-REV NEW	Trib		0.034 **															
9	397+80 L-REV ORG.	750 RCP	0.497	0.064		0.025													
9	397+80 L-REV ADD.	750 RCP		0.003															
9	397+80 L-REV NEW	750 RCP		0.067															

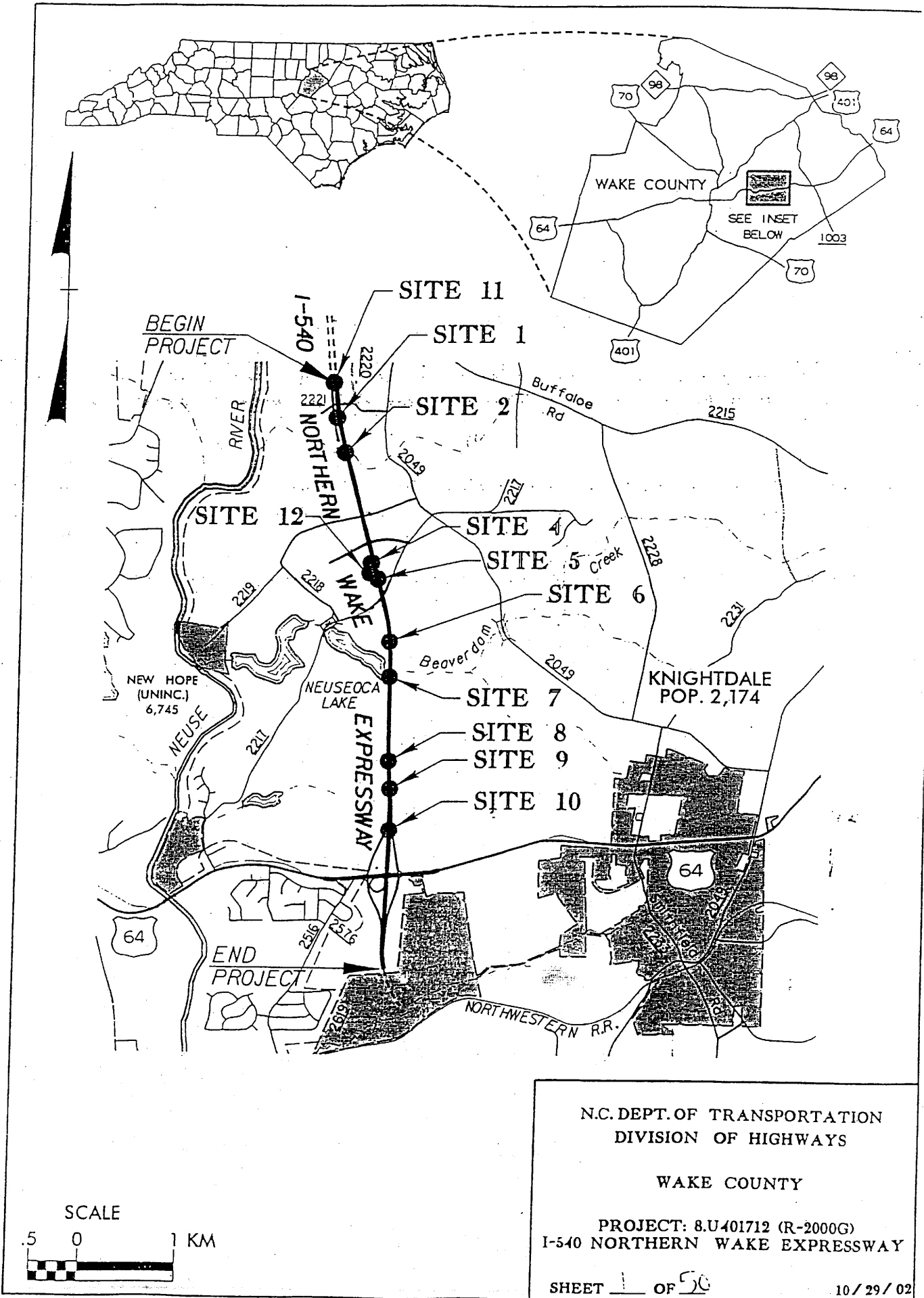
\* ADDITIONAL 0.26 HA HAND CLEARED, NOT A JURISDICTIONAL ACTION. AN ADDITIONAL 0.037 HA WILL BE HAND CLEARED FOR THE EXTENSION OF THE TIMBER MAT IN WETLANDS AND BUFFERS. NEW TOTAL HAND CLEARING = 0.287 HA  
 \*\* TEMPORARY IMPACT FOR TIMBER MATS IN WETLANDS  
 ALLOWABLE IMPACTS FOR TIMBER MATS IN RIPARIAN BUFFERS: ZONE 1 = 0.011 HA ZONE 2 = 0.023 HA

Sheet 76 B of 90

Revised







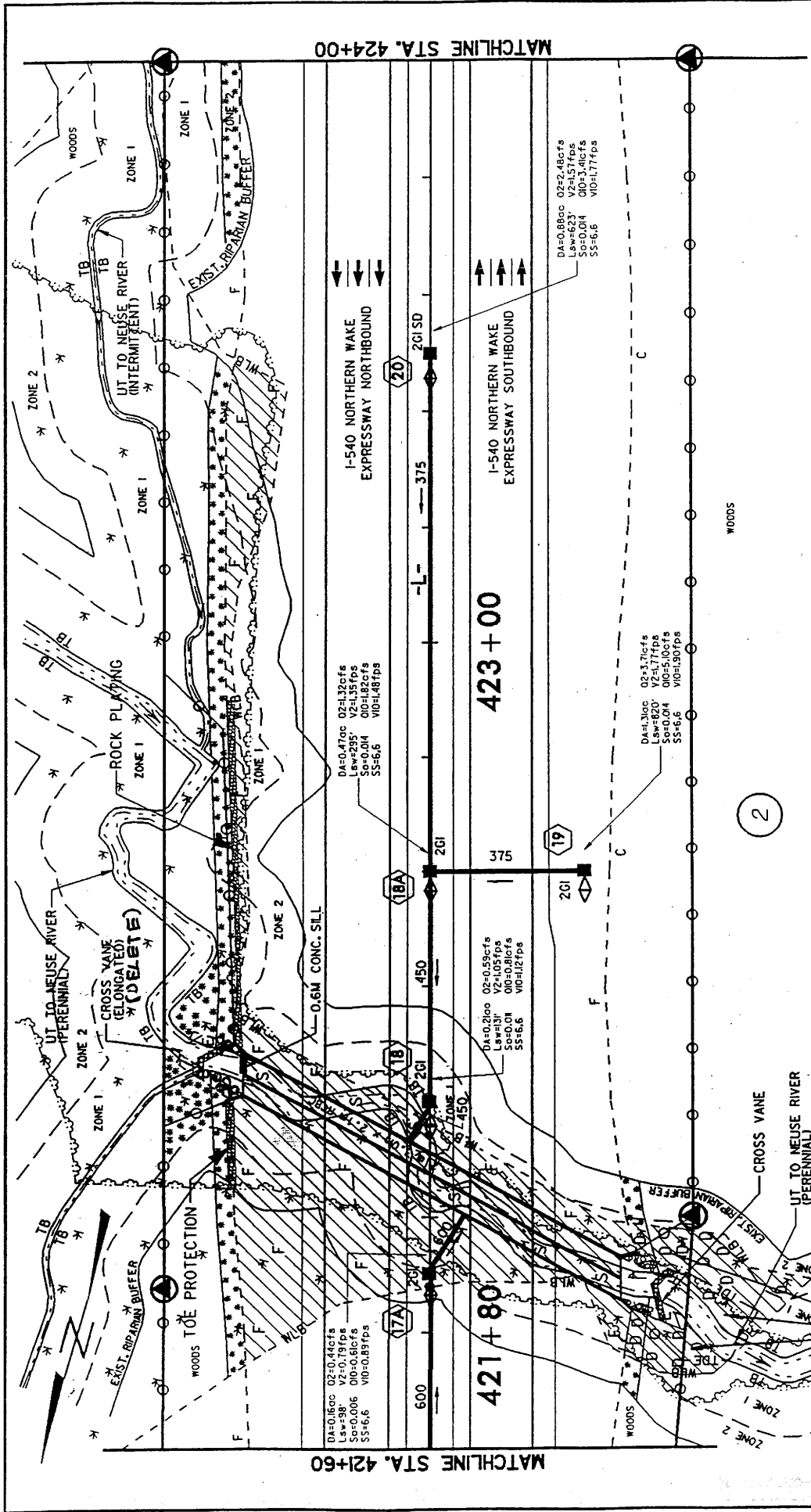
N.C. DEPT. OF TRANSPORTATION  
DIVISION OF HIGHWAYS

WAKE COUNTY

PROJECT: 8.U401712 (R-2000G)  
I-540 NORTHERN WAKE EXPRESSWAY

SHEET 1 OF 50

10/29/02



**N.C. DEPT. OF TRANSPORTATION**  
**DIVISION OF HIGHWAYS**  
**WAKE COUNTY**

**PROJECT: 8.U401712 (R-2000G)**  
**I-540 NORTHERN WAKE EXPRESSWAY**

Rev. 50  
 05 / 27 / 04

- DENOTES MECHANIZED CLEARING
- DENOTES EXCAVATION IN WETLANDS
- DENOTES FILL IN WETLANDS
- DENOTES FILL IN SURFACE WATERS
- DENOTES DRAINED WETLANDS

**PLAN VIEW**  
**SITE 2**

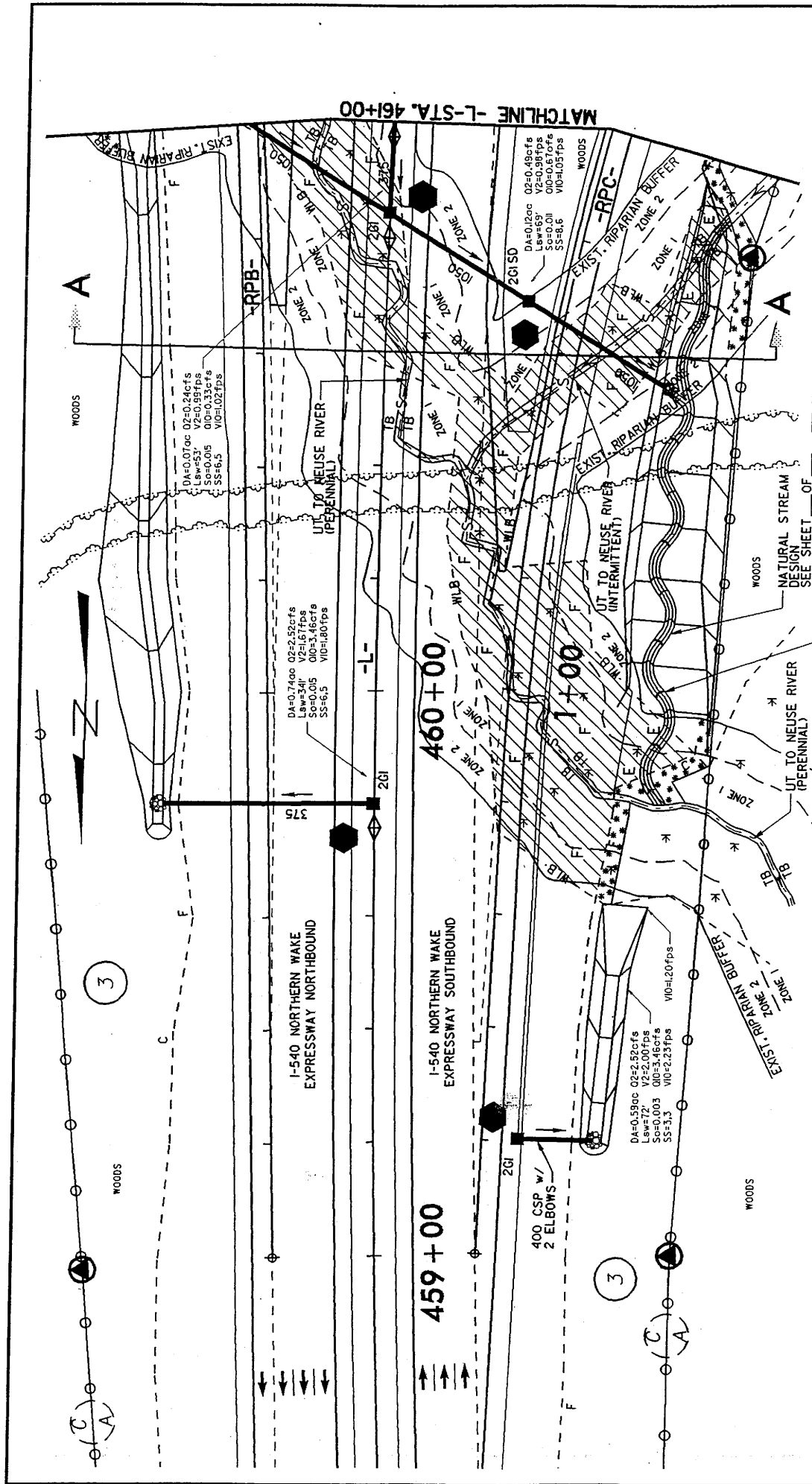
THE PORTION OF THE WETLAND BOUNDARY FROM THE MECHANIZED CLEARING LINE OUT TO THE C/A FENCE INCLUDING THE LIMITS OF THE TDE ARE ACCOUNTED FOR AS IMPACTS TO BUFFER ZONE ONE. (0.021ha)











MATCHLINE - L-STA. 461+00

# PLAN VIEW SITE 10

- \*\*\*\*\*  
DENOTES MECHANIZED CLEARING
- F F  
DENOTES FILL IN WETLANDS
- E E  
DENOTES EXCAVATION IN WETLANDS
- S S  
DENOTES FILL IN SURFACE WATERS



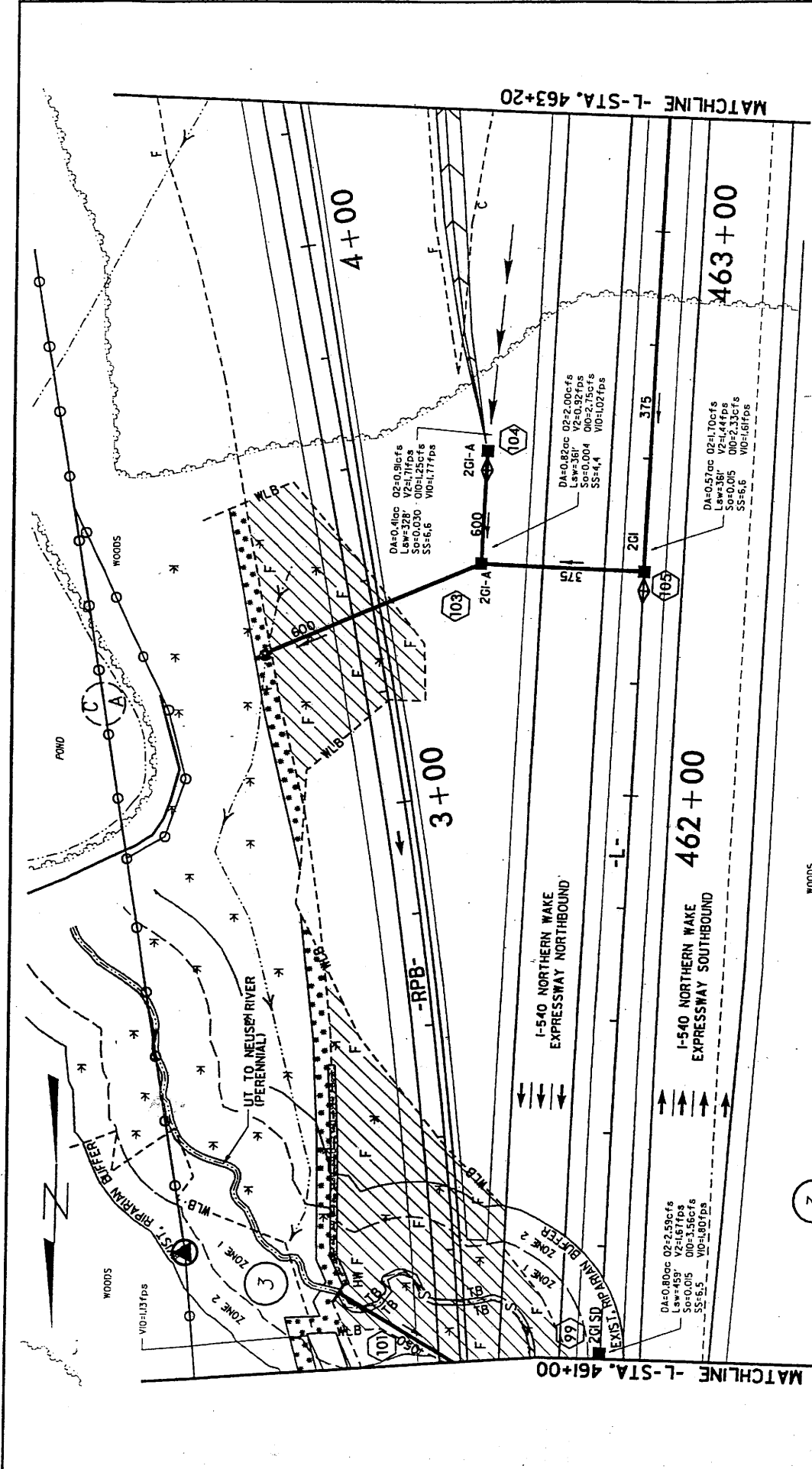
N.C. DEPT. OF TRANSPORTATION  
DIVISION OF HIGHWAYS

WAKE COUNTY

PROJECT: 8.U401712 (R-2000G)  
I-540 NORTHERN WAKE EXPRESSWAY

SHEET 31 OF 50

09 / 16 / 04

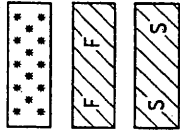


N.C. DEPT. OF TRANSPORTATION  
DIVISION OF HIGHWAYS

WAKE COUNTY

PROJECT: 8.U401712 (R-2000G)  
I-540 NORTHERN WAKE EXPRESSWAY

REV 1/14/04  
10/29/02  
SHEET 32 OF 50



DENOTES MECHANIZED CLEARING  
DENOTES FILL IN WETLANDS  
DENOTES FILL IN SURFACE WATERS

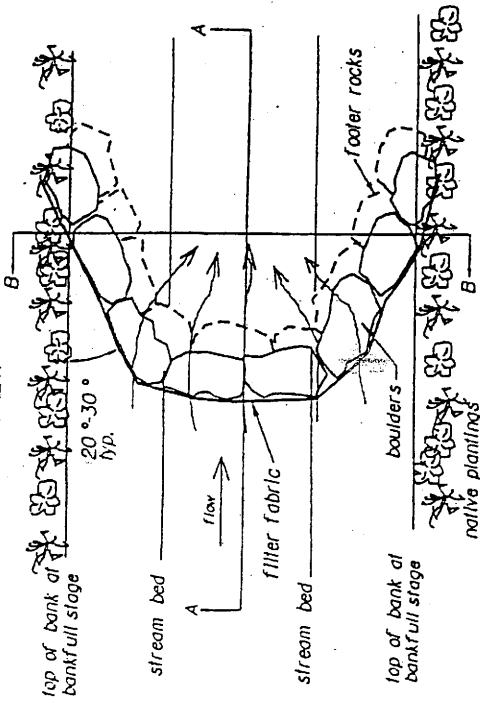
PLAN VIEW  
SITE 10



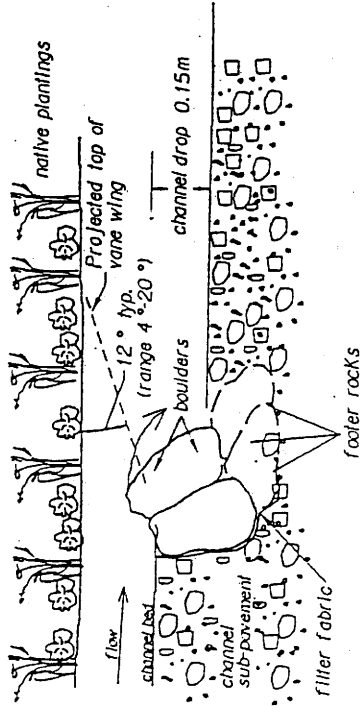
3

# CROSS VANE ROCK WEIR DETAIL

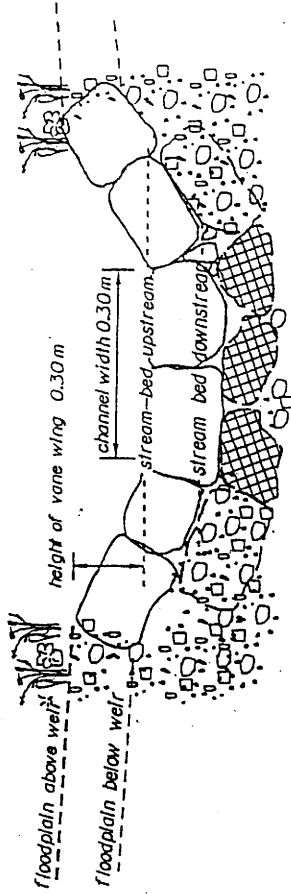
PLAN VIEW



SECTION A-A



SECTION B-B



Note: Boulders should be native stone or shot rock, angular and oblong with axis approximately 0.30m in length

Note: Rocks should fit tightly. Trim filter fabric flush with top of rocks. When drop between upstream floodplain and downstream flood plain exceeds 0.3m, a boulder sill is recommended in the floodplain.

N.C. DEPT. OF TRANSPORTATION  
DIVISION OF HIGHWAYS

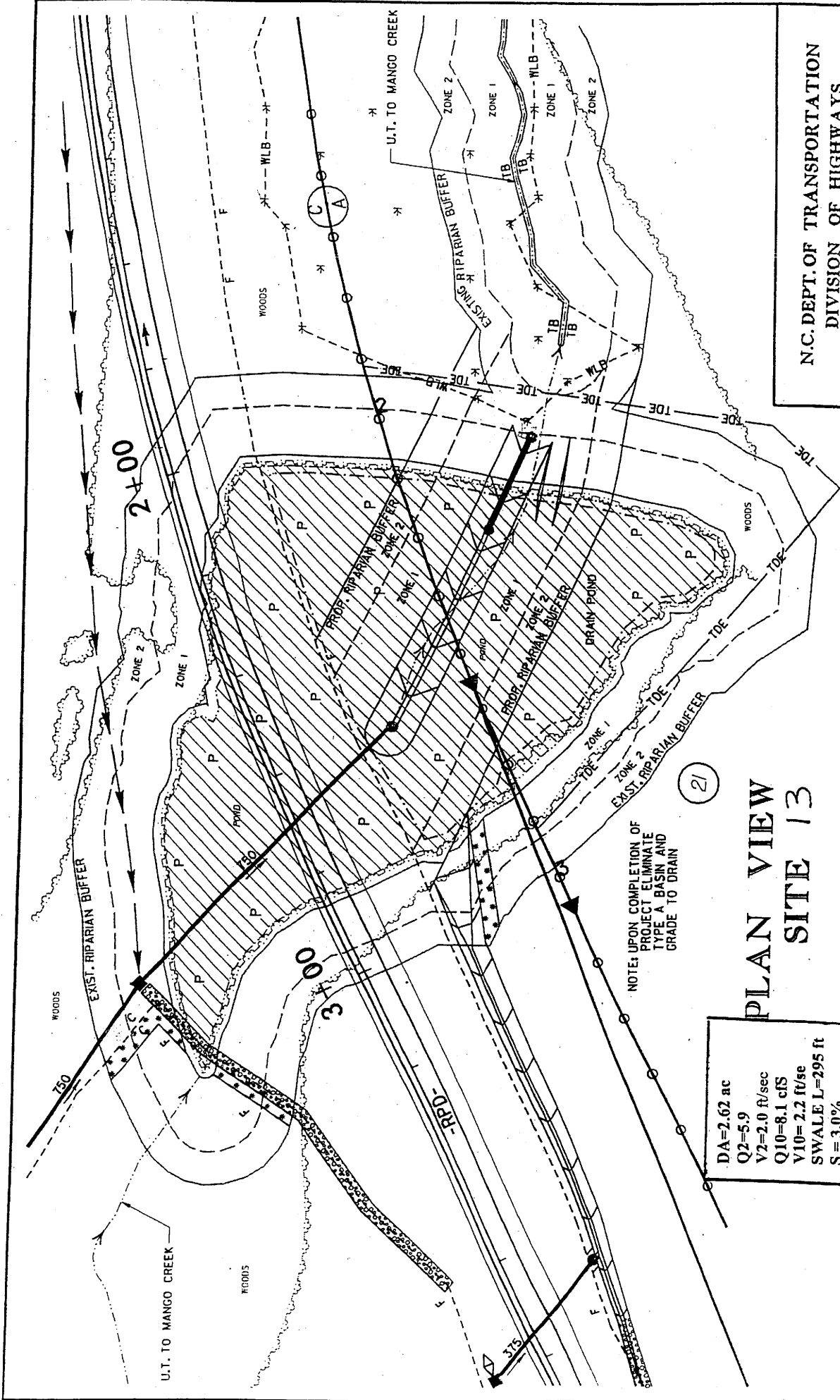
WAKE COUNTY

PROJECT: 8.U401712 (R-2000G)  
I-540 NORTHERN WAKE EXPRESSWAY

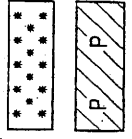
SHEET 39 OF 50

8/27/03

SITE 10



N.C. DEPT. OF TRANSPORTATION  
 DIVISION OF HIGHWAYS  
 WAKE COUNTY  
 PROJECT: 8U401712 (R-2000G)  
 I-540 NORTHERN WAKE EXPRESSWAY  
 SHEET 39a OF 50 7/3/03

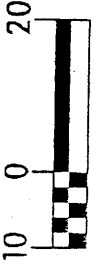


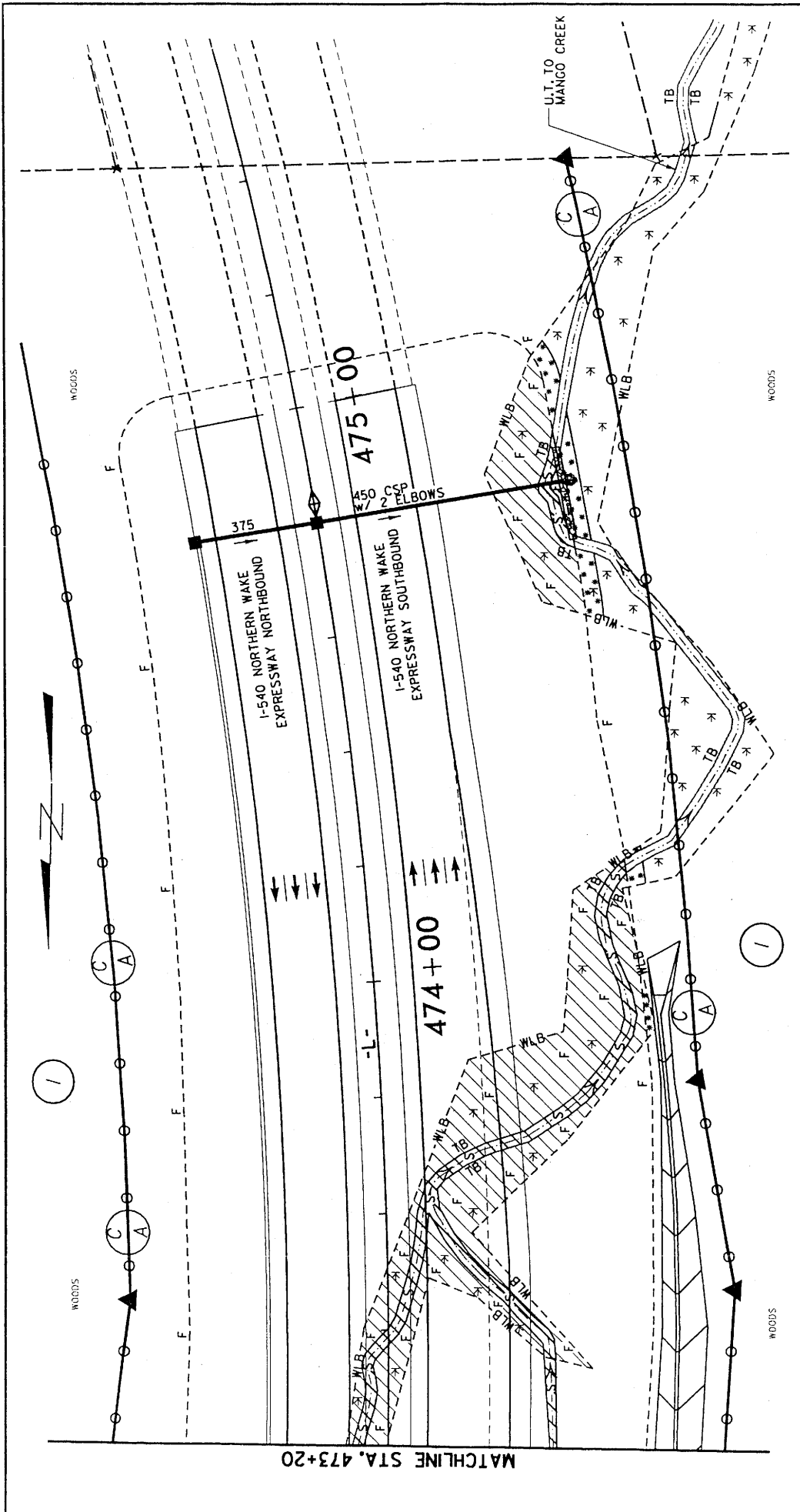
DENOTES MECHANIZED CLEARING  
 DENOTES FILL IN SURFACE WATER (POND)

NOTE: UPON COMPLETION OF PROJECT ELIMINATE TYPE A BASIN AND GRADE TO DRAIN

PLAN VIEW  
 SITE 13



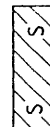
DA=2.62 ac  
 Q2=5.9  
 V2=2.0 ft/sec  
 Q10=8.1 cfs  
 V10=2.2 ft/se  
 SWALE L=295 ft  
 S = 3.0%  
 SS = 3:1





# PLAN VIEW SITE 14

NOTE: LATERAL BASE DITCH RIGHT OF  
 -L- TO BE LINED WITH PERMANENT  
 SOIL REINFORCEMENT MATTING (PSRM)

-  DENOTES MECHANIZED CLEARING
-  DENOTES FILL IN WETLANDS
-  DENOTES FILL IN SURFACE WATERS

N.C. DEPT. OF TRANSPORTATION  
 DIVISION OF HIGHWAYS

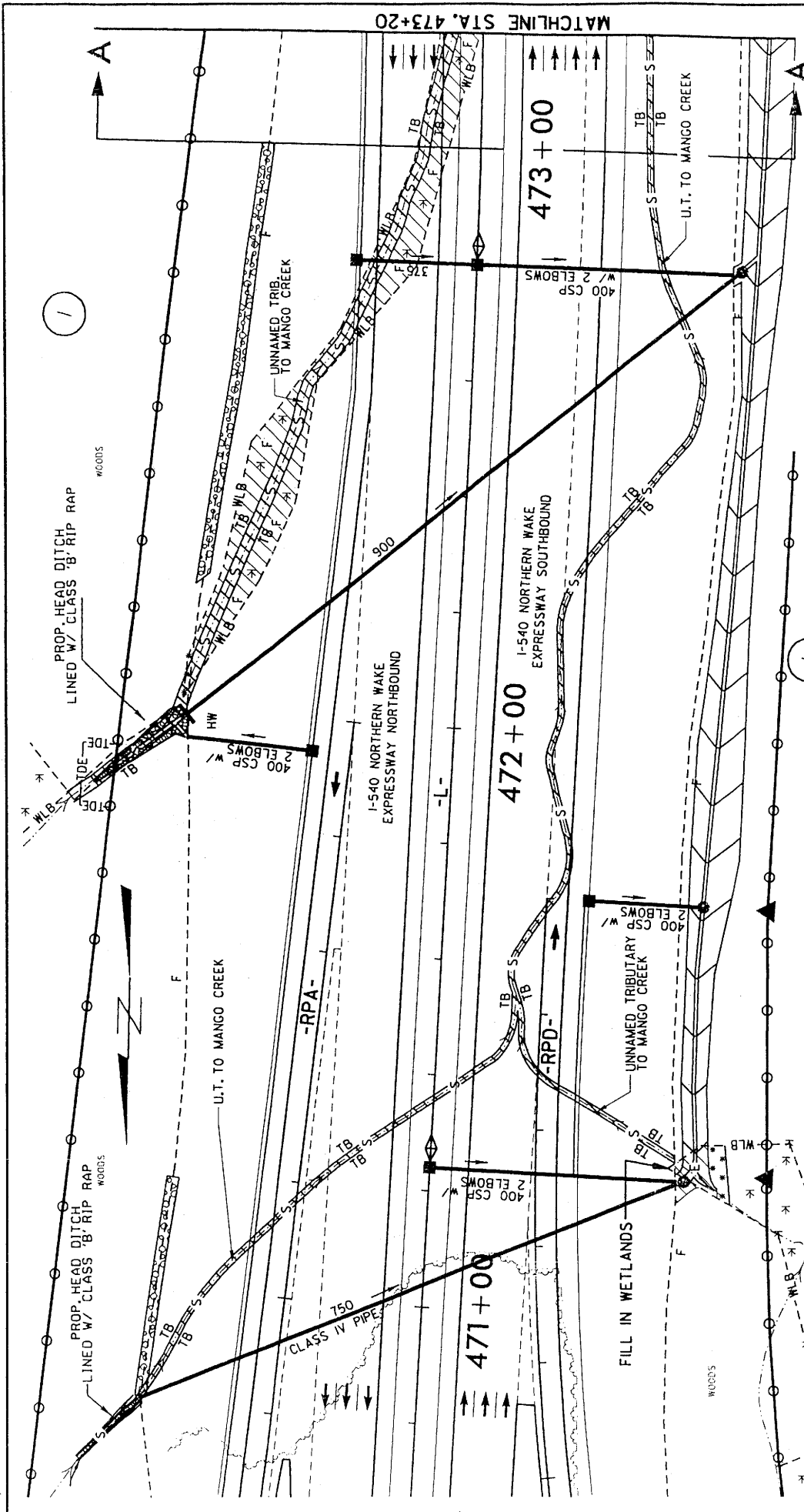
WAKE COUNTY

PROJECT:



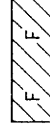
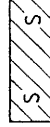
SHEET 39b OF 50

7/3/03

REVISED 10/25/04

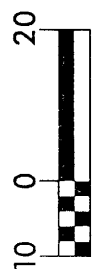


N.C. DEPT. OF TRANSPORTATION  
 DIVISION OF HIGHWAYS  
 WAKE COUNTY  
 PROJECT:  
 SHEET 37c OF 50  
 REV. 05/14/04  
 7/3/03  
 REVISED 10/25/04

-  DENOTES MECHANIZED CLEARING
-  DENOTES EXCAVATION IN WETLANDS
-  DENOTES FILL IN WETLANDS
-  DENOTES FILL IN SURFACE WATERS

PLAN VIEW  
 SITE 14

NOTE: LATERAL BASE DITCH RIGHT OF WAY  
 -L- TO BE LINED WITH PERMANENT  
 SOIL REINFORCEMENT MATTING (PSRM)



**IMPACT SUMMARY**

Site No.	Station (From / To)	Structure Size	WETLAND IMPACTS				SURFACE WATER IMPACTS					BUFFER IMPACTS		
			Fill In Wetlands (ha)	Temp. Fill In Wetlands (ha)	Excavation In Wetlands (ha)	Isolated Wetland (ha)	Mechanized Clearing (Method III) (ha)	Fill In SW (Natural) (ha)	Fill In SW (Pond) (ha)	Temp. Fill In SW (ha)	Existing Channel Impacted (m)	Relocated Channel (m)	Enclosed Channel (m)	Zone 1 (ha)
2	-L-421+85L / -L-423+51L	2 @ 3.0 x 2.1 RCBC Approved Site Impacts	0.251 <sup>1</sup>	—	0.013	—	0.035	—	85.2	—	73.3	0.168	0.164	0.004
2	-L-421+85L / -L-423+51L	2 @ 3.0 x 2.1 RCBC Additional Site Impacts	—	—	—	—	—	—	—	—	—	—	—	0.038
2	-L-421+85L / -L-423+51L	2 @ 3.0 x 2.1 RCBC Total Revised Site Impacts	—	—	—	—	—	—	—	—	—	—	—	0.042
6	-L-441+33L / -L-422+78L	1350, 1650 Approved Site Impacts	0.013	—	—	—	—	0.852	—	—	—	0.374	0.263	0.021
6	-L-441+33L / -L-422+78L	1350, 1650 Additional Site Impacts	0.010	—	—	—	—	—	—	—	—	—	—	—
6	-L-441+33L / -L-422+78L	1350, 1650 Total Revised Site Impacts	0.023	—	—	—	—	—	—	—	—	—	—	—

<sup>1</sup> - This quantity contains 0.039 ha. of "Drained Wetlands".

Note: The additional 0.038 ha of mechanized clearing is exactly the same for wetlands and buffers. For mitigation purposes, 0.038 ha should be used for the additional wetland mitigation since wetlands take precedence over buffers.

N.C. DEPT. OF TRANSPORTATION  
DIVISION OF HIGHWAYS

WAKE COUNTY

PROJECT: 8.U401712  
NCDOT T.I.P. NO: R-2000G

SHEET 40 OF 50

Rev  
5/26/04

**IMPACT SUMMARY**

Site No.	Station (From / To)	Structure Size	WETLAND IMPACTS				SURFACE WATER IMPACTS					BUFFER IMPACTS			
			Fill In Wetlands (acre)	Temp. Fill In Wetlands (acre)	Excavation In Wetlands (acre)	Isolated Wetland (acre)	Mechanized Clearing (Method III) (acre)	Fill In SW (Natural) (acre)	Fill In SW (Pond) (acre)	Temp. Fill In SW (acre)	Existing Channel Impacted (ft)	Relocated Channel (ft)	Enclosed Channel (ft)	Zone 1 (acre)	Zone 2 (acre)
2	-L-421+85L / -L-423+51L	2 @ 3.0 x 2.1 RCBC Approved Site Impacts	0.620 <sup>1</sup>	--	0.032	--	0.141	0.086	--	279.5	--	240.5	0.465	0.405	0.010
2	-L-421+85L / -L-423+51L	2 @ 3.0 x 2.1 RCBC Additional Site Impacts	--	--	--	--	0.094	--	--	--	--	--	--	--	0.094
2	-L-421+85L / -L-423+51L	2 @ 3.0 x 2.1 RCBC Total Revised Site Impacts	0.620	--	0.032	--	0.235	--	--	--	--	--	--	--	0.104
6	-L-441+33L / -L-422+78L	1350, 1650 Approved Site Impacts	0.032	--	--	--	0.005	--	2.105	--	--	--	0.924	0.650	0.052
6	-L-441+33L / -L-422+78L	1350, 1650 Additional Site Impacts	0.025	--	--	--	--	--	--	--	--	--	--	--	--
6	-L-441+33L / -L-422+78L	1350, 1650 Total Revised Site Impacts	0.057	--	--	--	--	--	--	--	--	--	--	--	--

<sup>1</sup> - This quantity contains 0.096 acre of "Drained Wetlands".

Note: The additional 0.094 acre of mechanized clearing is exactly the same for wetlands and buffers.

N.C. DEPT. OF TRANSPORTATION  
DIVISION OF HIGHWAYS

WAKE COUNTY

PROJECT: 8.U401712  
NCDOT T.I.P. NO: R-2000G

SHEET 40 A OF 50

Rev. 5/26/2004



**IMPACT SUMMARY**

Site No.	Station	Structure Size	WETLAND IMPACTS					SURFACE WATER IMPACTS					BUFFER IMPACTS				
			Fill In Wetlands (ha)	Temp. Fill In Wetlands (ha)	Excavation In Wetlands (ha)	Isolated Wetland (ha)	Mechanized Clearing (Method III) (ha)	Fill In SW (Natural) (ha)	Fill In SW (Pond) (ha)	Temp. Fill In SW (ha)	Existing Channel Impacted (m)	Relocated Channel (m)	Enclosed Channel (m)	Zone 1 (ha)	Zone 2 (ha)	Mechanized Clearing (Method III) (ha)	
9	(From TO) L-458-64L7 L-457-4TR	1 @ 2.7 x 2.1 RCBC	0.185	—	—	—	0.007	—	0.212	—	—	—	—	—	0.155	0.100	0.015
10	L-458-61R7 L-462-5HR	1050, 750	0.607	—	0.042	0.082	0.085	—	—	388.2	95.0	158.5	0.601	0.364	0.030	—	
13	Y5 RPA 4+1TR Y5 RPA 4+1L	600	—	—	—	—	—	0.004	—	87.8	—	43.3	—	—	—	—	
	Y5 RPD 2+0OR Y5 RPD 3+04L	750	—	—	—	—	—	—	0.582	—	—	—	0.372	0.278	0.018	—	
14	L-471-20R L-474-1TR	1 @ 750, 1 @ 900	0.171	—	0.003	—	0.004	—	—	624.700	—	221.5	—	—	—	—	
	L-474-5TR L-475-2TR	—	0.035	0.006	—	—	0.012	—	—	18.000	—	—	—	—	—	—	
SHEET SUB TOTALS:			0.998	0.008	0.045	0.082	0.108	0.145	0.774	1088.8	95.0	423.300	1.128	0.742	0.062	—	
PROJECT TOTALS:			2.423	0.008	0.274	0.082	0.327	0.224	2.550	1815.2	95.0	820.100	3.256	2.231	0.398	—	

DENOTES DRAINING OF POND IMPACT.  
 DENOTES NO DEFINED CHANNEL.

N.C. DEPT. OF TRANSPORTATION  
 DIVISION OF HIGHWAYS

WAKE COUNTY

PROJECT: 8.U401712  
 NCDOT T.I.P. NO: R-2000G

NCDOT Project No. 8.U401712  
T.I.P. No. R-2000G  
Wake County, NC  
I-540 Northern Wake Expressway

**NATURAL STREAM DESIGN  
UNNAMED TRIBUTARY TO THE  
NEUSE RIVER**

Right of -L- Project Station 460+30

Prepared by:  
TranSite Consulting Engineers, Inc.  
1300 Paddock Drive, Suite G-10  
Raleigh, NC 27609

NATURAL STREAM DESIGN  
UNNAMED TRIBUTARY TO THE NEUSE RIVER

Right of -L- Project Station 460+30

The construction of I-540 (Northern Wake Expressway) from South of SR 2215 (Buffaloe Road) to South of US 64E, near Knightdale will require that a portion of an unnamed tributary to the Neuse River be relocated right of -L- Project Station 460+30. The proposed stream will be 85 meters (279') in length starting right of -L- Sta. 460+53 at the outlet of the proposed 750mm (30") RCP and continue downstream intersecting the existing stream right of -L- Sta. 459+80. The proposed stream is designed according to "Natural Channel" design principles proposed by Dave Rosgen.

This unnamed tributary to the Neuse River drains 19.4 hectares (47.9 acres) in eastern Wake County. Existing land use in the area is predominantly agricultural with some low density residential and commercial along existing US 64. Based on the Wake County Land Use Plan, future land uses within the drainage basin are expected to be commercial along US 64 with the remainder of the area low to medium density residential.

There is no hydraulic data available on this stream. Discharges were estimated using procedures outlined in The North Carolina Department of Transportation Metric Guidelines for Drainage Studies dated January 1995.

**EXISTING STREAM**

Two reaches of the existing stream were surveyed in detail to determine its morphological characteristics. Those characteristics include bankfull discharge, width, depth and area. The first reach surveyed was 50 meters (164') in length located upstream of a small confluence and downstream of an existing farm pond. The second reach surveyed was 60 meters (197') in length located just downstream of a soil road and 450mm (18") RCP. These reaches were chosen since they are portions of the stream that

will be lost due to construction of the proposed roadway. Normal flows in both stream reaches are controlled by the aforementioned farm pond. Of the total 19.4 hectare (47.9 acre) drainage area, 14.3 hectares (35.3 acres) drain through the 0.38 hectare (0.94 acre) pond. Due to the small size of the drainage area, it was determined that the NC Stream Restoration Institute's regional equations were not applicable to this site.

Based on the field survey data gathered, both stream reaches were classified as E5 streams. Pebble counts were not conducted for either stream reach since the bed material was found to be a fine to medium sand. The HEC-RAS computer model was used to determine the hydraulic characteristics of the stream such as velocity, shear stress and stream power. As a result the upstream pond and the relatively short distance to the area of concern, sediment loads in the stream are greatly reduced over what would be normally expected.

### **REFERENCE REACH**

The proposed stream design is based on parameters from the existing stream reach and the reference stream reach for Sal's Branch. Due to the difference between the drainage area size of the existing reach and Sal's Branch, the ratios from Sal's Branch were primarily used in conjunction with the data from the existing reach to ensure that our design falls within the range of an E5b stream. Sal's Branch is located in western Wake County with a drainage area of 128 acres and a Rosgen Stream Classification of E4. Design and morphological data for the Existing, Reference and Proposed Streams are shown in "Morphological Measurement Table".

### **PROPOSED STREAM**

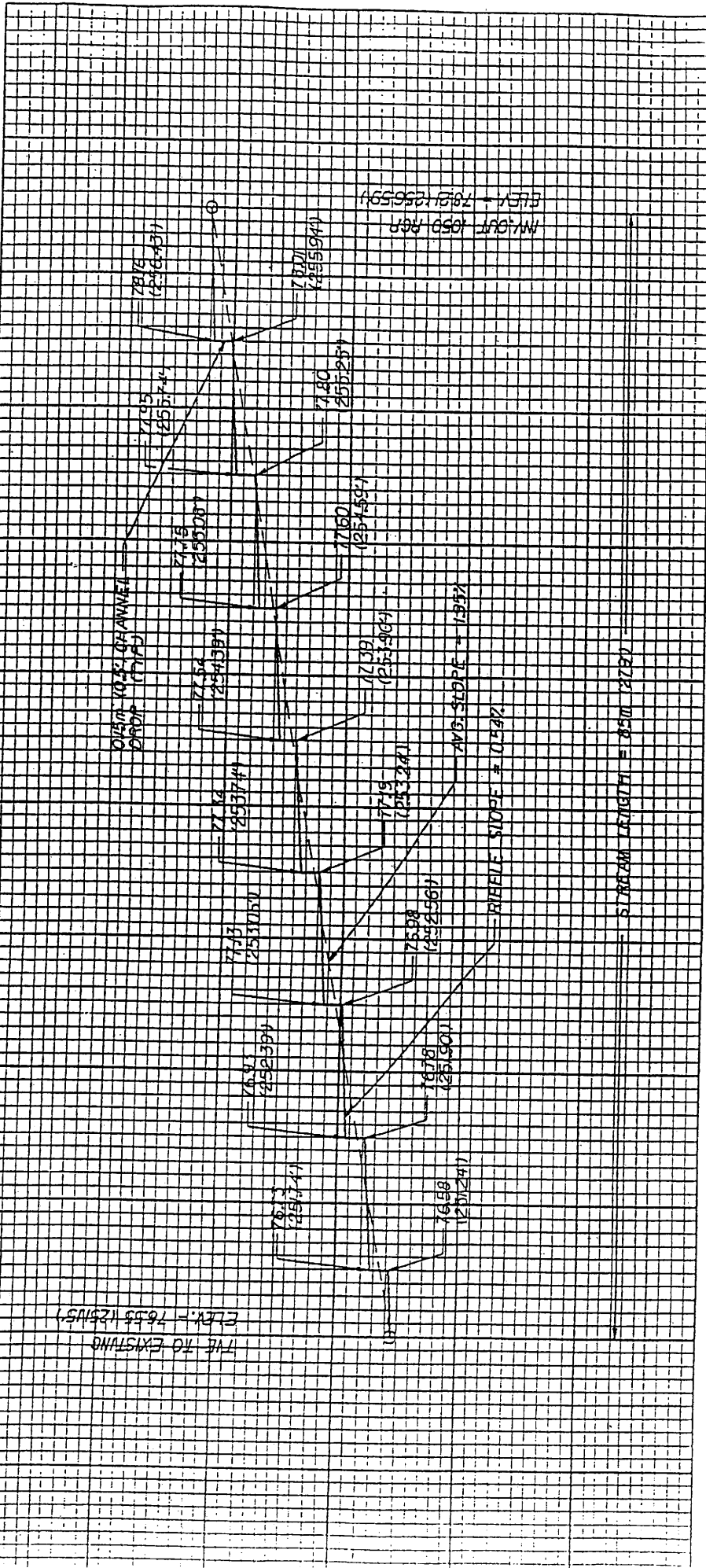
The proposed stream was designed to have an E5b classification. The gradient for the proposed stream is controlled upstream by the outlet elevation of the proposed 1050mm

(42") RCP right of -L- Sta. 460+53 and downstream by the tie to the existing stream right of -L- Sta. 459+80. The proposed stream was designed to have an average bankfull depth of 0.30m (1.0') and an average pool depth of 0.45m (1.5'). While these depths are greater than those of the existing stream, they provide a channel section that is reasonable to construct, stabilize and maintain. In addition to excavating the proposed stream, a flood prone area will also be excavated. This area will serve as a flood plain for the stream as well as provide hydraulic connectivity for a wetland cut off by the proposed roadway. Proposed stream bank stabilization is shown on the attached detail sheet and will be grass with coir fiber matting along the entire length of both banks. The flood prone area and other disturbed areas will be stabilized with native woody vegetation. The streambed will match the characteristics of the existing channel. To aid in stability and reduce the stream gradient, cross vane rock weirs with 0.15m (0.5') channel drops will be placed in the lower third of each glide.

### SEDIMENT TRANSPORT ANALYSIS

The proposed stream has a bankfull stream power of 0.25 lb/ft-s and a shear stress of 0.17 lb/ft<sup>2</sup> as compared to 0.46 lb/ft-s and 0.24 lb/ft<sup>2</sup> for the existing stream. While these values are greater than those of the existing stream, they indicate that the proposed stream will transport the current sediment load without aggrading or degrading the streambed or banks. Additionally, 2-yr and 10-yr velocities and shear stresses were evaluated and found to be within acceptable limits.

# PROPOSED THALWEG PROFILE



N.C. DEPT. OF TRANSPORTATION  
 DIVISION OF HIGHWAYS  
 WAKE COUNTY  
 PROJECT: 8.U401712 (R-2000G)  
 I-540 NORTHERN WAKE EXPWY.  
 SHEET 48A OF 50  
 8/27/03

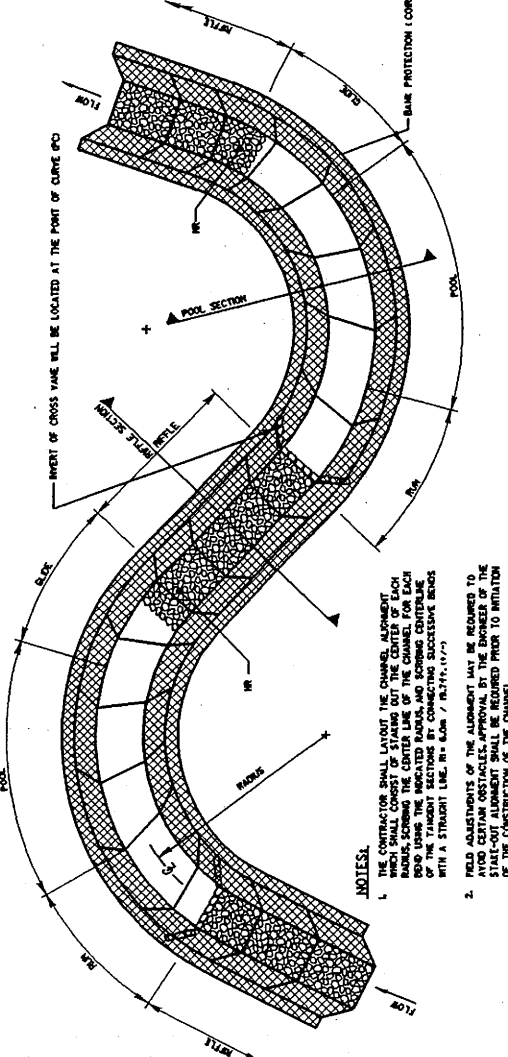
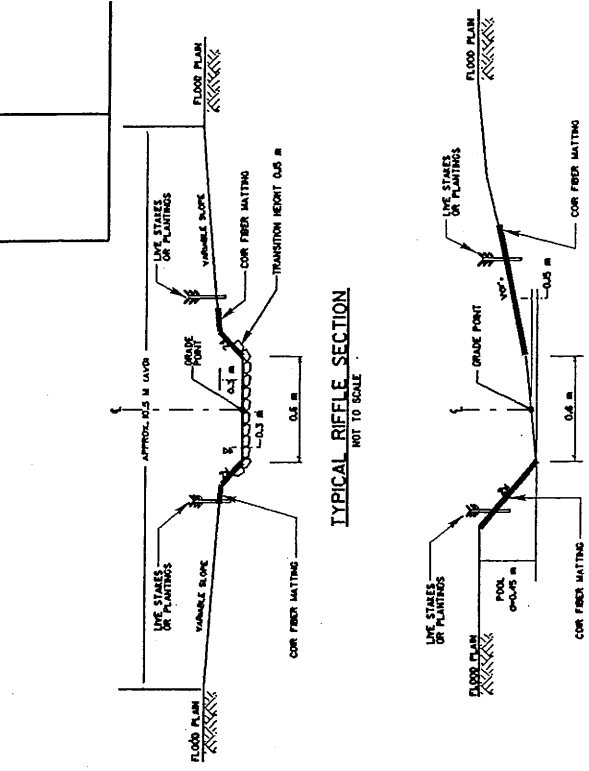
NOTE: ELEVATIONS IN ( ) ARE IN FEET. ALL OTHER STATION AND ELEVATION DATA IS IN METERS.

## Appendix B

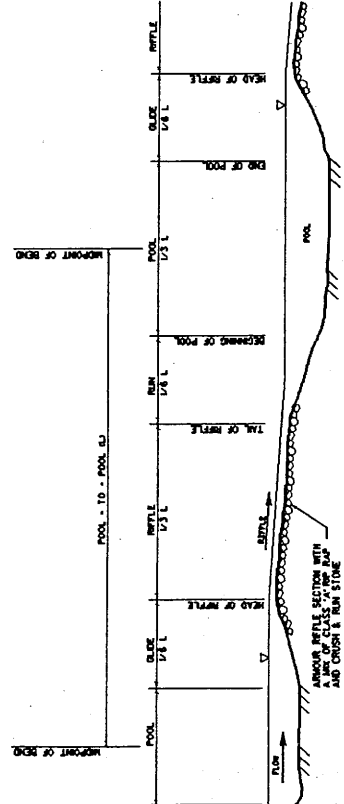
Morphological Measurement Table  
R-2000G, Wake Co.

Variables	Existing Channel	Proposed Reach	USGS Station	Reference Reach Sal's Branch
1. Stream Type	E5	E5b	N/A	E4
2. Drainage Area (D.A.)	14.3 ha / 35.3 ac	19.4 ha / 47.9 ac	-	128 ac
3. Bankfull Width ( $W_{bkd}$ )	0.76 m / 2.49 ft	1.80 m / 6.00 ft	-	8.7 ft
4. Bankfull Mean Depth ( $d_{bkd}$ )	0.13 m / 0.43 ft	0.20 m / 0.67 ft	-	1.2 ft
5. Width/Depth Ratio ( $W_{bkd}/d_{bkd}$ )	5.84	9.00	-	7.30
6. Bankfull Cross-Sectional Area ( $A_{bkd}$ )	0.10 m <sup>2</sup> / 1.08 ft <sup>2</sup>	0.37 m <sup>2</sup> / 4.00 ft <sup>2</sup>	-	10.4 ft <sup>2</sup>
7. Bankfull Mean Velocity ( $V_{bkd}$ )	0.60 m/s / 1.97ft/s	0.44 m/s / 1.44 ft/s	-	3.8 ft/s
8. Bankfull Discharge ( $Q_{bkd}$ )	0.06 m <sup>3</sup> /s / 2.12 ft <sup>3</sup> /s	0.16 m <sup>3</sup> /s / 5.7 ft <sup>3</sup> /s	-	40.0 ft <sup>3</sup> /s
9. Bankfull Max Depth ( $d_{mbkd}$ )	0.15 m / 0.49 ft	0.30 m / 1.00 ft	-	2.4 ft
10. Width of Floodprone Area ( $W_{fpa}$ )	6.1 m / 20.0 ft (avg.)	10.9 m / 35.9 ft (avg.)	-	33.0 ft
11. Entrenchment Ratio ( $W_{fpa}/W_{bkd}$ )	8.03	6.06	-	3.30
12. Meander Length ( $L_m$ )	16.7 m / 54.8 ft (avg.)	18.0 m / 59.1 ft	-	47.0 ft
13. Ratio of Meander Length to Bankfull Width ( $L_m/W_{bkd}$ )	21.97	10.00	-	5.40
14. Radius of Curvature ( $R_c$ )	1.84 m / 6.04 ft	6.00 m / 19.68 ft	-	12 ft - 35 ft
15. Ratio of Radius of Curvature to Bankfull Width ( $R_c/W_{bkd}$ )	2.41	3.33	-	1.2 - 3.5
16. Belt Width ( $W_{br}$ )	4.3 m / 14.1 ft (avg.)	5.0 m / 16.4 ft	-	28 ft - 41 ft
17. Meander Width Ratio ( $W_{br}/W_{bkd}$ )	5.64	3.13	-	2.8 - 4.1
18. Sinuosity (K) (stream length/valley length)	1.25	1.26	-	1.70
19. Valley Slope (VS)	1.11%	2.46%	-	2.80%
20. Average Slope (CS)	0.89%	1.95%	-	1.60%
21. Pool Slope	0.86%	0.00%	-	0.00%
22. Ratio of Pool Slope to Average Slope	0.79	0.00	-	0.00
23. Maximum Pool Depth ( $dp_{max}$ )	0.15 m / 0.49 ft	0.45 m / 1.50 ft	-	2.2
24. Ratio of Pool Depth to Average Bankfull Depth ( $dp/d_{bkd}$ )	2.38	2.25	-	4.0
25. Pool Width ( $W_p$ )	0.78 m / 2.56 ft	2.70 m / 8.86 ft	-	8 - 11
26. Ratio of Pool Width to Bankfull Width ( $W_p/W_{bkd}$ )	1.03	1.50	-	0.8 - 1.1
27. Pool to Pool Spacing	10.5 m / 34.4 ft (avg.)	9.0 m / 29.5 ft	-	38 - 48
28. Ratio of Pool to Pool Spacing to Bankfull Width	13.21	5.00	-	3.8 - 4.8
29. Ratio of Lowest Bnk Height to Bankfull Height (or Max Bankfull Depth) ( $Bh_{low}/d_{max}$ )	0.54	0.67	-	

PROJECT REFERENCE NO. R-20000  
 SHEET NO. 10  
 DIVISION OF HIGHWAYS  
 WAKE COUNTY



- NOTES:**
1. THE CONTRACTOR SHALL LAYOUT THE CHANNEL ALIGNMENT WHICH SHALL CONSIST OF STAKES OUT THE CENTER OF EACH RIFFLE, SHOWING THE CENTER LINE OF THE CHANNEL FOR EACH RIFFLE. THE CENTER LINE OF THE CHANNEL SHALL BE LAYOUT WITH A STRAIGHT LINE. (R = 5.0m / 16.7ft, 10.0m / 33.4ft, 15.0m / 49.2ft)
  2. POOL ALIGNMENTS OF THE CHANNEL SHALL BE REQUIRED TO PROVIDE ADEQUATE CLEARANCE BETWEEN THE CHANNEL AND THE STAKE-OUT ALIGNMENT SHALL BE REQUIRED PRIOR TO INITIATION OF THE CONSTRUCTION OF THE CHANNEL.
  3. LOCATE INVERT OF POOL CROSS VAINS AT THE POINT OF CURVE (PC)



- NOTES:**
1. THE POOL TO POOL SPACING (L) SHALL BE MEASURED AS THE DISTANCE FROM THE MIDPOINT OF THE UPSTREAM BEND TO THE MIDPOINT OF THE DOWNSTREAM BEND.
  2. REFER TO MORPHOLOGICAL MEASUREMENT TABLE AND PLAN SHEET FOR DIMENSIONS.  
 NOTE THAT POOL TO POOL SPACING VARIES.

**MORPHOLOGICAL MEASUREMENT TABLE**

VARIABLES	EXISTING CHANNEL	PROPOSED REACH	UPON STATION REACH
1. CHANNEL TYPE	ST	ST	ST
2. CHANNEL AREA	52.7m <sup>2</sup> / 182.0m <sup>2</sup>	54.7m <sup>2</sup> / 189.2m <sup>2</sup>	55.0m <sup>2</sup> / 187.5m <sup>2</sup>
3. CHANNEL VELOCITY	1.5m / 4.92ft	1.5m / 4.92ft	1.5m / 4.92ft
4. CHANNEL SLOPE	0.00	0.00	0.00
5. CHANNEL WIDTH	5.0m	5.0m	5.0m
6. CHANNEL LENGTH	148.0m / 485.6ft	148.0m / 485.6ft	148.0m / 485.6ft
7. CHANNEL VELOCITY	0.00	0.00	0.00
8. CHANNEL SLOPE	0.00	0.00	0.00
9. CHANNEL AREA	52.7m <sup>2</sup> / 182.0m <sup>2</sup>	54.7m <sup>2</sup> / 189.2m <sup>2</sup>	55.0m <sup>2</sup> / 187.5m <sup>2</sup>
10. CHANNEL VELOCITY	1.5m / 4.92ft	1.5m / 4.92ft	1.5m / 4.92ft
11. CHANNEL SLOPE	0.00	0.00	0.00
12. CHANNEL WIDTH	5.0m	5.0m	5.0m
13. CHANNEL LENGTH	148.0m / 485.6ft	148.0m / 485.6ft	148.0m / 485.6ft
14. CHANNEL VELOCITY	0.00	0.00	0.00
15. CHANNEL SLOPE	0.00	0.00	0.00
16. CHANNEL AREA	52.7m <sup>2</sup> / 182.0m <sup>2</sup>	54.7m <sup>2</sup> / 189.2m <sup>2</sup>	55.0m <sup>2</sup> / 187.5m <sup>2</sup>
17. CHANNEL VELOCITY	1.5m / 4.92ft	1.5m / 4.92ft	1.5m / 4.92ft
18. CHANNEL SLOPE	0.00	0.00	0.00
19. CHANNEL WIDTH	5.0m	5.0m	5.0m
20. CHANNEL LENGTH	148.0m / 485.6ft	148.0m / 485.6ft	148.0m / 485.6ft
21. CHANNEL VELOCITY	0.00	0.00	0.00
22. CHANNEL SLOPE	0.00	0.00	0.00
23. CHANNEL AREA	52.7m <sup>2</sup> / 182.0m <sup>2</sup>	54.7m <sup>2</sup> / 189.2m <sup>2</sup>	55.0m <sup>2</sup> / 187.5m <sup>2</sup>
24. CHANNEL VELOCITY	1.5m / 4.92ft	1.5m / 4.92ft	1.5m / 4.92ft
25. CHANNEL SLOPE	0.00	0.00	0.00
26. CHANNEL WIDTH	5.0m	5.0m	5.0m
27. CHANNEL LENGTH	148.0m / 485.6ft	148.0m / 485.6ft	148.0m / 485.6ft
28. CHANNEL VELOCITY	0.00	0.00	0.00
29. CHANNEL SLOPE	0.00	0.00	0.00
30. CHANNEL AREA	52.7m <sup>2</sup> / 182.0m <sup>2</sup>	54.7m <sup>2</sup> / 189.2m <sup>2</sup>	55.0m <sup>2</sup> / 187.5m <sup>2</sup>
31. CHANNEL VELOCITY	1.5m / 4.92ft	1.5m / 4.92ft	1.5m / 4.92ft
32. CHANNEL SLOPE	0.00	0.00	0.00
33. CHANNEL WIDTH	5.0m	5.0m	5.0m
34. CHANNEL LENGTH	148.0m / 485.6ft	148.0m / 485.6ft	148.0m / 485.6ft
35. CHANNEL VELOCITY	0.00	0.00	0.00
36. CHANNEL SLOPE	0.00	0.00	0.00
37. CHANNEL AREA	52.7m <sup>2</sup> / 182.0m <sup>2</sup>	54.7m <sup>2</sup> / 189.2m <sup>2</sup>	55.0m <sup>2</sup> / 187.5m <sup>2</sup>
38. CHANNEL VELOCITY	1.5m / 4.92ft	1.5m / 4.92ft	1.5m / 4.92ft
39. CHANNEL SLOPE	0.00	0.00	0.00
40. CHANNEL WIDTH	5.0m	5.0m	5.0m
41. CHANNEL LENGTH	148.0m / 485.6ft	148.0m / 485.6ft	148.0m / 485.6ft
42. CHANNEL VELOCITY	0.00	0.00	0.00
43. CHANNEL SLOPE	0.00	0.00	0.00
44. CHANNEL AREA	52.7m <sup>2</sup> / 182.0m <sup>2</sup>	54.7m <sup>2</sup> / 189.2m <sup>2</sup>	55.0m <sup>2</sup> / 187.5m <sup>2</sup>
45. CHANNEL VELOCITY	1.5m / 4.92ft	1.5m / 4.92ft	1.5m / 4.92ft
46. CHANNEL SLOPE	0.00	0.00	0.00
47. CHANNEL WIDTH	5.0m	5.0m	5.0m
48. CHANNEL LENGTH	148.0m / 485.6ft	148.0m / 485.6ft	148.0m / 485.6ft
49. CHANNEL VELOCITY	0.00	0.00	0.00
50. CHANNEL SLOPE	0.00	0.00	0.00
51. CHANNEL AREA	52.7m <sup>2</sup> / 182.0m <sup>2</sup>	54.7m <sup>2</sup> / 189.2m <sup>2</sup>	55.0m <sup>2</sup> / 187.5m <sup>2</sup>
52. CHANNEL VELOCITY	1.5m / 4.92ft	1.5m / 4.92ft	1.5m / 4.92ft
53. CHANNEL SLOPE	0.00	0.00	0.00
54. CHANNEL WIDTH	5.0m	5.0m	5.0m
55. CHANNEL LENGTH	148.0m / 485.6ft	148.0m / 485.6ft	148.0m / 485.6ft
56. CHANNEL VELOCITY	0.00	0.00	0.00
57. CHANNEL SLOPE	0.00	0.00	0.00
58. CHANNEL AREA	52.7m <sup>2</sup> / 182.0m <sup>2</sup>	54.7m <sup>2</sup> / 189.2m <sup>2</sup>	55.0m <sup>2</sup> / 187.5m <sup>2</sup>
59. CHANNEL VELOCITY	1.5m / 4.92ft	1.5m / 4.92ft	1.5m / 4.92ft
60. CHANNEL SLOPE	0.00	0.00	0.00
61. CHANNEL WIDTH	5.0m	5.0m	5.0m
62. CHANNEL LENGTH	148.0m / 485.6ft	148.0m / 485.6ft	148.0m / 485.6ft
63. CHANNEL VELOCITY	0.00	0.00	0.00
64. CHANNEL SLOPE	0.00	0.00	0.00
65. CHANNEL AREA	52.7m <sup>2</sup> / 182.0m <sup>2</sup>	54.7m <sup>2</sup> / 189.2m <sup>2</sup>	55.0m <sup>2</sup> / 187.5m <sup>2</sup>
66. CHANNEL VELOCITY	1.5m / 4.92ft	1.5m / 4.92ft	1.5m / 4.92ft
67. CHANNEL SLOPE	0.00	0.00	0.00
68. CHANNEL WIDTH	5.0m	5.0m	5.0m
69. CHANNEL LENGTH	148.0m / 485.6ft	148.0m / 485.6ft	148.0m / 485.6ft
70. CHANNEL VELOCITY	0.00	0.00	0.00
71. CHANNEL SLOPE	0.00	0.00	0.00
72. CHANNEL AREA	52.7m <sup>2</sup> / 182.0m <sup>2</sup>	54.7m <sup>2</sup> / 189.2m <sup>2</sup>	55.0m <sup>2</sup> / 187.5m <sup>2</sup>
73. CHANNEL VELOCITY	1.5m / 4.92ft	1.5m / 4.92ft	1.5m / 4.92ft
74. CHANNEL SLOPE	0.00	0.00	0.00
75. CHANNEL WIDTH	5.0m	5.0m	5.0m
76. CHANNEL LENGTH	148.0m / 485.6ft	148.0m / 485.6ft	148.0m / 485.6ft
77. CHANNEL VELOCITY	0.00	0.00	0.00
78. CHANNEL SLOPE	0.00	0.00	0.00
79. CHANNEL AREA	52.7m <sup>2</sup> / 182.0m <sup>2</sup>	54.7m <sup>2</sup> / 189.2m <sup>2</sup>	55.0m <sup>2</sup> / 187.5m <sup>2</sup>
80. CHANNEL VELOCITY	1.5m / 4.92ft	1.5m / 4.92ft	1.5m / 4.92ft
81. CHANNEL SLOPE	0.00	0.00	0.00
82. CHANNEL WIDTH	5.0m	5.0m	5.0m
83. CHANNEL LENGTH	148.0m / 485.6ft	148.0m / 485.6ft	148.0m / 485.6ft
84. CHANNEL VELOCITY	0.00	0.00	0.00
85. CHANNEL SLOPE	0.00	0.00	0.00
86. CHANNEL AREA	52.7m <sup>2</sup> / 182.0m <sup>2</sup>	54.7m <sup>2</sup> / 189.2m <sup>2</sup>	55.0m <sup>2</sup> / 187.5m <sup>2</sup>
87. CHANNEL VELOCITY	1.5m / 4.92ft	1.5m / 4.92ft	1.5m / 4.92ft
88. CHANNEL SLOPE	0.00	0.00	0.00
89. CHANNEL WIDTH	5.0m	5.0m	5.0m
90. CHANNEL LENGTH	148.0m / 485.6ft	148.0m / 485.6ft	148.0m / 485.6ft
91. CHANNEL VELOCITY	0.00	0.00	0.00
92. CHANNEL SLOPE	0.00	0.00	0.00
93. CHANNEL AREA	52.7m <sup>2</sup> / 182.0m <sup>2</sup>	54.7m <sup>2</sup> / 189.2m <sup>2</sup>	55.0m <sup>2</sup> / 187.5m <sup>2</sup>
94. CHANNEL VELOCITY	1.5m / 4.92ft	1.5m / 4.92ft	1.5m / 4.92ft
95. CHANNEL SLOPE	0.00	0.00	0.00
96. CHANNEL WIDTH	5.0m	5.0m	5.0m
97. CHANNEL LENGTH	148.0m / 485.6ft	148.0m / 485.6ft	148.0m / 485.6ft
98. CHANNEL VELOCITY	0.00	0.00	0.00
99. CHANNEL SLOPE	0.00	0.00	0.00
100. CHANNEL AREA	52.7m <sup>2</sup> / 182.0m <sup>2</sup>	54.7m <sup>2</sup> / 189.2m <sup>2</sup>	55.0m <sup>2</sup> / 187.5m <sup>2</sup>

**SITE 10**

**NCDOT**  
 DIVISION OF HIGHWAYS  
 WAKE COUNTY  
 PROJECT: 8U401712 (R-2000G)  
 I-640 NORTHERN WAKE EXPWY  
 SHEET 50 OF 50  
 Rev.