



STATE OF NORTH CAROLINA  
DEPARTMENT OF TRANSPORTATION

MICHAEL F. EASLEY  
GOVERNOR

LYNDO TIPPETT  
SECRETARY

August 27, 2004

MEMORANDUM TO: Mr. S. P. Ivey, P.E.  
Division 9 Engineer

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

SUBJECT: Davidson County, Replace Bridges No. 74 & 76 over SR 1242  
and Michael's Branch; Federal Project No. BRSTP-29(10); TIP  
Number B-3157

Attached are the U. S. Army Corps of Engineers 404 Individual Permit and the Division of Water Quality 401 Water Quality Certification for the above referenced project. All environmental permits have been received for the construction of this project.

PSH/ma

Attachment

cc: Mr. Art McMillan, P.E.  
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. Omar Sultan  
Ms. Diane Hampton, P.E., Division 9 DEO

**MAILING ADDRESS:**  
NC DEPARTMENT OF TRANSPORTATION  
PROJECT DEVELOPMENT AND ENVIRONMENTAL ANALYSIS  
1598 MAIL SERVICE CENTER  
RALEIGH NC 27699-1598

TELEPHONE: 919-733-3141  
FAX: 919-733-9794  
**WEBSITE:** [WWW.DOT.ORG](http://WWW.DOT.ORG)

**LOCATION:**  
TRANSPORTATION BUILDING  
1 SOUTH WILMINGTON STREET  
RALEIGH NC

## PROJECT COMMITMENTS

Davidson County  
Replace Bridges No. 74 & 76 over SR 1242 and Michael's Branch  
Federal Aid Project BRSTP-29(10)  
State Project 8.1601401  
TIP No. B-3157

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 Project Development and Design**

#### **Division 9 Construction**

Maintain continuous access to Childers Park.

### **Commitments Developed through Permitting**

#### **Division 9**

Onsite Stream Relocation/Restoration AS-BUILT SURVEY: The permittee shall complete an as-built channel survey within sixty days of completion of the stream relocation/restoration construction. The permittee shall document changes in the dimension, pattern, profile, vegetation plantings, and structures installed, of the relocated/restored channel from the proposed design. The permittee shall also include in the as-built survey: photo documentation at representative segments and structures; and a plan view diagram.

#### **Roadside Environmental Unit**

Onsite Stream Relocation/Restoration MONITORING SCHEDULE: The permittee shall perform the following components of Level I monitoring each year for the 5-year monitoring period: Reference photos; plant survival (i.e., identify specific problem areas (missing, stressed, damaged or dead plantings), estimated causes, and proposed/required remedial action); visual inspection of channel stability. Physical measurements of channel stability/morphology will not be required. The permittee shall submit the monitoring reports to the Corps of Engineers, Raleigh Regulatory Field Office Project Manager, within sixty days after completing the monitoring. If less than two bankfull events occur during the first 5 years, the permittee shall continue monitoring until the second bankfull event is documented. The bankfull events must occur during separate monitoring years. In the event that the required bankfull events do not occur during the five-year monitoring period, the Corps of Engineers, in consultation with the resource agencies, may determine that further monitoring is not required. It is suggested that all bankfull occurrences be monitored and reported through the required monitoring period. The permittee shall perform and submit photo documentation twice each year (summer and winter) for the 5-year monitoring period, and for any subsequently required monitoring period.

Onsite Stream Relocation/Restoration MONITORING DATA/REPORT: The permittee shall include the following information in the Level I monitoring report for the site: reference photos; plant survival notes and recommendations, as appropriate; and a report on the visual inspection of channel stability. Physical measurements of channel stability/morphology will not be required. The permittee shall complete the Monitoring Data Record, Sections 1, 2 and 3 (pages 1, 2 and 3, attached), for each representative segment of the channel, and for each year of monitoring (twice each year, summer and winter, for reference photos). The permittee shall include in the monitoring reports a discussion of any deviations from as-built and an evaluation of the significance of these deviations and whether they are indicative of a stabilizing or destabilizing situation.

Onsite Stream Relocation/Restoration STREAM MITIGATION SUCCESS CRITERIA: The mitigation success criteria, and required remediation actions, will be generally based on the attached Appendix II, and the Photo Documentation, Ecological Function, and Channel Stability criteria in the "Stream Mitigation Guidelines", dated April, 2003 (available on the internet at [http://www.saw.usace.army.mil/wetlands/Mitigation/stream\\_mitigation.html](http://www.saw.usace.army.mil/wetlands/Mitigation/stream_mitigation.html)), pages 24 and 25, under "Success Criteria: ".

#### **Roadside Environmental Unit/Project Development and Environmental Analysis**

Prior to incurring impacts anywhere on the project, a revised natural channel design shall be submitted to, and approved by, the NC Division of Water Quality. The revised plan shall include proposed construction plans that describe how DOT plans to conduct phased construction of the new stream channel and control downstream transport of sediment in Michaels Branch. Please describe how the phased construction of the stream relocation, the stream meanders, and the bank stabilization and vegetation will be conducted in a dry work area as detailed in Condition 8 of the General Conditions. The revised plan shall be submitted to the NC Division of Water Quality within thirty (30) days of the issuance of this Certification. A copy of the revised stream design and construction plan shall also be submitted to the NC Wildlife Resources Commission.

#### **Roadside Environmental Unit/Division 9 Construction**

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. All stream relocation and restoration activities shall comply with the final natural channel design plans approved by the NC Division of Water Quality.

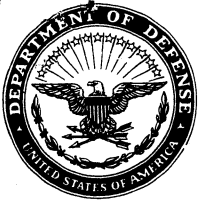
All channel relocations will be constructed in a dry work area, and stabilized before stream flows are diverted. Channel relocations will be completed and stabilized prior to diverting water into the new channel. Whenever possible, channel relocations shall be allowed to stabilize for an entire growing season. Vegetation used for bank stabilization shall be limited to native woody species, and should include establishment of a 30 foot wide wooded and an adjacent 20 foot wide vegetated buffer on both sides of the relocated channel to the maximum extent practical. A transitional phase incorporating coir fiber and seedling establishment is allowable. Also, rip-rap may be allowed if it is necessary to maintain the physical integrity of the stream, but the applicant must provide written justification and any calculations used to determine the extent of rip-rap coverage requested.

Onsite Stream Relocation/Restoration IMPLEMENTATION: The permittee shall mitigate for 876 linear feet of permanent, unavoidable impact to streams with important aquatic function, associated with the bridge replacement and roadway improvement portions of this project, by completing 404 linear feet of onsite stream relocation, and 472 linear feet of stream restoration, as described in the permit application. The stream relocation/restoration shall be constructed in accordance with the North Carolina Wildlife Resources Commission's (NCWRC) "Stream Relocation Guidelines." NCDOT shall consult with NCWRC on the stream relocation/restoration and implement all practicable recommendations in the design of specific site requirements for re-establishment of bank vegetation, and placement of meanders and habitat structures. Vegetation shall be used to the maximum extent practicable to stabilize banks, and riprap and other man-made structural measures shall be minimized. The permittee shall construct all channel relocations/restoration work in a dry work area, and stabilize the new channel before stream flows are diverted. Whenever possible, the permittee shall allow new channels to stabilize for an entire growing season.

**Division 9 Construction/PDEA-Office of Natural Environment**

The Project Development and Environmental Analysis, Office of Natural Environment Engineering Unit shall provide assistance with construction for any on-site wetland mitigation, stream mitigation, or stream relocation. Prior to construction, the Natural Environment Engineering Unit shall be contacted.





REPLY TO  
ATTENTION OF:

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

August 24, 2004

Regulatory Division

SUBJECT: Action ID 200020843, TIP No. B-3157

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:

In accordance with your written request of May 11, 2004, and the resulting administrative record, enclosed are two copies of a Department of the Army permit to authorize the discharge of dredged and fill material into waters of the United States, for construction of the replacement of Bridge Nos. 74 and 76, and improvement of the US29-64-70/I-85 Business interchange at SR 1242 (West Center Street), including necessary re-location of existing utility lines (T.I.P. No. B-3157).

You should acknowledge that you accept the terms and conditions of the enclosed permit by signing and dating each copy in the spaces provided ("Permittee" on page 3). Your signature, as permittee, shows that, as consideration for the issuance of this permit, you voluntarily accept and agree to comply with all of the terms and conditions of this permit. All pages of both copies of the signed permit with drawings should then be returned to this office for final authorization. A self-addressed envelope is enclosed for your convenience.

In addition, I have enclosed a copy of the Notification of Administrative Appeal Process and Options and Request for Appeal. Please carefully read Section "B" of this form for information regarding the appeal process for proffered permits.

After the permit is authorized in this office, the original copy will be returned to you; the duplicate copy will be permanently retained in this office. Should you have questions, contact Mr. Eric Alsmeyer of my Raleigh Field Office regulatory staff at telephone (919) 876-8441, extension 23.

Sincerely,

A handwritten signature in black ink, appearing to read "E. David Franklin". The signature is written in a cursive style with a prominent initial "E".

E. David Franklin  
Chief, NCDOT Team

Enclosures

## DEPARTMENT OF THE ARMY PERMIT

NC Department of Transportation

Permittee \_\_\_\_\_

200020843

Permit No. \_\_\_\_\_

USAED, Wilmington

Issuing Office \_\_\_\_\_

**NOTE:** The term "you" and its derivatives, as used in this permit, means the permittee or any future transferee. The term "this office" refers to the appropriate district or division office of the Corps of Engineers having jurisdiction over the permitted activity or the appropriate official of that office acting under the authority of the commanding officer.

You are authorized to perform work in accordance with the terms and conditions specified below.

### Project Description:

Place fill material impacting 1,379 linear feet of stream, for construction of the replacement of Bridge Nos. 74 and 76, and improvement of the US29-64-70/I-85 Business interchange at SR 1242 (West Center Street) (T.I.P. No. B-3157).

**Project Location** Crossing Michael Branch, northwest of Lexington, in Davidson County, North Carolina.

### Permit Conditions:

#### General Conditions:

December 31, 2007

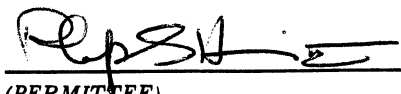
1. The time limit for completing the work authorized ends on \_\_\_\_\_ . If you find that you need more time to complete the authorized activity, submit your request for a time extension to this office for consideration at least one month before the above date is reached.
2. You must maintain the activity authorized by this permit in good condition and in conformance with the terms and conditions of this permit. You are not relieved of this requirement if you abandon the permitted activity, although you may make a good faith transfer to a third party in compliance with General Condition 4 below. Should you wish to cease to maintain the authorized activity or should you desire to abandon it without a good faith transfer, you must obtain a modification of this permit from this office, which may require restoration of the area.
3. If you discover any previously unknown historic or archeological remains while accomplishing the activity authorized by this permit, you must immediately notify this office of what you have found. We will initiate the Federal and state coordination required to determine if the remains warrant a recovery effort or if the site is eligible for listing in the National Register of Historic Places.

- e. Damage claims associated with any future modification, suspension, or revocation of this permit.
4. **Reliance on Applicant's Data:** The determination of this office that issuance of this permit is not contrary to the public interest was made in reliance on the information you provided.
5. **Reevaluation of Permit Decision.** This office may reevaluate its decision on this permit at any time the circumstances warrant. Circumstances that could require a reevaluation include, but are not limited to, the following:
- a. You fail to comply with the terms and conditions of this permit.
  - b. The information provided by you in support of your permit application proves to have been false, incomplete, or inaccurate (See 4 above).
  - c. Significant new information surfaces which this office did not consider in reaching the original public interest decision.

Such a reevaluation may result in a determination that it is appropriate to use the suspension, modification, and revocation procedures contained in 33 CFR 325.7 or enforcement procedures such as those contained in 33 CFR 326.4 and 326.5. The referenced enforcement procedures provide for the issuance of an administrative order requiring you to comply with the terms and conditions of your permit and for the initiation of legal action where appropriate. You will be required to pay for any corrective measures ordered by this office, and if you fail to comply with such directive, this office may in certain situations (such as those specified in 33 CFR 209.170) accomplish the corrective measures by contract or otherwise and bill you for the cost.

6. **Extensions.** General condition 1 establishes a time limit for the completion of the activity authorized by this permit. Unless there are circumstances requiring either a prompt completion of the authorized activity or a reevaluation of the public interest decision, the Corps will normally give favorable consideration to a request for an extension of this time limit.

Your signature below, as permittee, indicates that you accept and agree to comply with the terms and conditions of this permit.

  
 \_\_\_\_\_  
 (PERMITTEE)

8/25/04  
 \_\_\_\_\_  
 (DATE)

**NC DEPARTMENT OF TRANSPORTATION**

This permit becomes effective when the Federal official, designated to act for the Secretary of the Army, has signed below.

\_\_\_\_\_  
 (DISTRICT ENGINEER)

\_\_\_\_\_  
 (DATE)

**CHARLES R. ALEXANDER, JR. COLONEL**

When the structures or work authorized by this permit are still in existence at the time the property is transferred, the terms and conditions of this permit will continue to be binding on the new owner(s) of the property. To validate the transfer of this permit and the associated liabilities associated with compliance with its terms and conditions, have the transferee sign and date below.

\_\_\_\_\_  
 (TRANSFEE)

\_\_\_\_\_  
 (DATE)



7-000-0845

Michael F. Easley, Governor  
William G. Ross Jr., Secretary  
North Carolina Department of Environment and Natural Resources

Alan W. Klimek, P.E. Director  
Division of Water Quality  
Coleen H. Sullins, Deputy Director  
Division of Water Quality

July 28, 2004

AUG 02 2004

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

Dear Dr. Thorpe:

Re: 401 Water Quality Certification Pursuant to Section 401 of the Federal Clean Water Act,  
Proposed Replacement of Bridge Nos. 74 and 76 and Interchange Improvements Over SR 1242 and  
Michaels Branch, TIP No. B-3157  
Individual WQC No. 3467  
Davidson County

Attached hereto is a copy of Certification No. 3467 issued to The North Carolina Department of  
Transportation dated July 28, 2004.

If we can be of further assistance, do not hesitate to contact us.

Sincerely,

Alan W. Klimek, P.E.  
Director

Attachments

cc: Eric Alsmeyer, Corps of Engineers Raleigh Field Office  
DWQ Winston-Salem Regional Office  
Central Files  
File Copy





Condition(s) of Certification:

Project Specific Conditions

1. Prior to incurring impacts anywhere on the project, a revised natural channel design shall be submitted to, and approved by, the NC Division of Water Quality. The revised plan shall include proposed construction plans that describe how DOT plans to conduct phased construction of the new stream channel and control downstream transport of sediment in Michael Branch. Please describe how the phased construction of the stream relocation, the stream meanders, and the bank stabilization and vegetation will be conducted in a dry work area as detailed in Condition 8. of the General Conditions. The revised plan shall be submitted to the NC Division of Water Quality within thirty (30) days of the issuance of this Certification. A copy of the revised stream design and construction plan shall also be submitted to the NC Wildlife Resources Commission.
2. 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. All stream relocation and restoration activities shall comply with the final natural channel design plans approved by the NC Division of Water Quality.

General Conditions of Certification:

3. 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.
4. 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.
5. 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.



Michael F. Easley, Governor  
William G. Ross Jr., Secretary  
North Carolina Department of Environment and Natural Resources

Alan W. Klimek, P.E. Director  
Division of Water Quality  
Coleen H. Sullins  
Division of Water Quality

15. 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.
16. Discharging hydroseed mixtures and washing out hydroseeders and other equipment in or adjacent to surface waters is prohibited.
17. Two copies of the final construction drawings shall be furnished to NCDWQ prior to the pre-construction meeting. Written verification shall be provided that the final construction drawings comply with the attached permit drawings contained in the application dated May 11, 2004.
18. 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.
19. 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.
20. 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.
21. 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.



Michael F. Easley, Governor  
William G. Ross Jr., Secretary  
North Carolina Department of Environment and Natural Resources

Alan W. Klimek, P.E. Director  
Division of Water Quality  
Coleen H. Sullins  
Division of Water Quality

DWQ Project No.: 3467

County: Davidson

**Applicant:** NC Department of Transportation

**Project Name:** Replacement of Bridge Nos. 74 and 76 and Interchange Improvements Over SR 1242 and Michael Branch

**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, 1650 Mail Service Center, Raleigh, NC, 27699-1650. 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: \_\_\_\_\_



**SPECIAL CONDITIONS (Action ID. 200020843; NCDOT/TIP B-3157)**

**Work Limits**

a. All work authorized by this permit must be completed in strict compliance with the attached plans, which are a part of this permit. The permittee will ensure that the construction design plans for this project do not deviate from the permit plans attached to this authorization. Any deviation in the construction design plans will be brought to the attention of the U.S. Army Corps of Engineers (USACE), Raleigh Regulatory Field Office, prior to any active construction in waters or wetlands, and any modification to the permit plans must be approved by the USACE prior to implementation.

b. Except as authorized by this permit or any USACE approved modification to this permit, no excavation, fill, or mechanized land-clearing activities shall take place at any time in the construction or maintenance of this project, within waters or wetlands, or any activities that cause the degradation of waters or wetlands, except as authorized by this permit, or any modification to this permit. This permit does not authorize temporary placement or double handling of excavated or fill material within waters or wetlands outside the permitted area. There shall be no excavation from, waste disposal into, or degradation of, jurisdictional waters or wetlands associated with this permit without appropriate modification of this permit, including appropriate compensatory mitigation. This prohibition applies to all borrow and fill activities connected with this project.

c. Except as specified in the plans attached to this permit, no excavation, fill or mechanized land-clearing activities shall take place at any time in the construction or maintenance of this project, in such a manner as to impair normal flows and circulation patterns within waters or wetlands or to reduce the reach of waters or wetlands.

**Related Laws**

d. The North Carolina Division of Water Quality has issued a conditioned Water Quality Certification for your project; the conditions of that certification are hereby incorporated as special conditions of this permit. For your convenience, a copy of the certification is attached if it contains such conditions.

e. All mechanized equipment will be regularly inspected and maintained to prevent contamination of waters and wetlands from fuels, lubricants, hydraulic fluids, or other toxic materials. In the event of a spill of petroleum products or any other hazardous waste, the permittee shall immediately report it to the N.C. Division of Water Quality at (919) 733-5083, Ext. 526 or (800) 662-7956 and provisions of the North Carolina Oil Pollution and Hazardous Substances Control Act will be followed.

## **Project Maintenance**

f. Unless otherwise authorized by this permit, all fill material placed in waters or wetlands shall be generated from an upland source and will be clean and free of any pollutants except in trace quantities. Metal products, organic materials (including debris from land clearing activities), or unsightly debris will not be used.

g. The permittee shall require its contractors and/or agents to comply with the terms and conditions of this permit in the construction and maintenance of this project, and shall provide each of its contractors and/or agents associated with the construction or maintenance of this project with a copy of this permit, and any authorized modifications. A copy of this permit, and any authorized modifications, including all conditions, shall be available at the project site during construction and maintenance of this project

h. The permittee shall employ all sedimentation and erosion control measures necessary to prevent an increase in sedimentation or turbidity within waters and wetlands outside the permit area. This shall include, but is not limited to, the immediate installation of silt fencing or similar appropriate devices around all areas subject to soil disturbance or the movement of earthen fill, and the immediate stabilization of all disturbed areas. Additionally, the project must remain in full compliance with all aspects of the Sedimentation Pollution Control Act of 1973 (North Carolina General Statutes Chapter 113A Article 4).

i. The permittee, upon receipt of a notice of revocation of this permit or upon its expiration before completion of the work will, without expense to the United States and in such time and manner as the Secretary of the Army or his authorized representative may direct, restore the water or wetland to its pre-project condition.

## **Enforcement**

j. Violations of these conditions or violations of Section 404 of the Clean Water Act must be reported in writing to the Wilmington District U.S. Army Corps of Engineers within 24 hours of the permittee's discovery of the violation.

## **Onsite Stream Relocation/Restoration**

k. IMPLEMENTATION: The permittee shall mitigate for 876 linear feet of permanent, unavoidable impact to streams with important aquatic function, associated with the bridge replacement and roadway improvement portions of this project, by completing 404 linear feet of onsite stream relocation, and 472 linear feet of stream restoration, as described in the permit application. The stream relocation/restoration shall be constructed in accordance with the North Carolina Wildlife Resources Commission's (NCWRC) "Stream Relocation Guidelines." NCDOT shall consult with NCWRC on the stream relocation/restoration and implement all practicable recommendations in the design of specific site requirements for re-establishment of bank vegetation, and placement of meanders and habitat structures. Vegetation shall be used to the maximum extent practicable to stabilize banks, and riprap and other man-made structural measures shall be minimized. The permittee shall construct all channel relocations/restoration

work in a dry work area, and stabilize the new channel before stream flows are diverted. Whenever possible, the permittee shall allow new channels to stabilize for an entire growing season.

l. AS-BUILT SURVEY: The permittee shall complete an as-built channel survey within sixty days of completion of the stream relocation/restoration construction. The permittee shall document changes in the dimension, pattern, profile, vegetation plantings, and structures installed, of the relocated/restored channel from the proposed design. The permittee shall also include in the as-built survey: photo documentation at representative segments and structures; and a plan view diagram.

m. MONITORING SCHEDULE: The permittee shall perform the following components of Level I monitoring each year for the 5-year monitoring period: Reference photos; plant survival (i.e., identify specific problem areas (missing, stressed, damaged or dead plantings), estimated causes, and proposed/required remedial action); visual inspection of channel stability. Physical measurements of channel stability/morphology will not be required. The permittee shall submit the monitoring reports to the Corps of Engineers, Raleigh Regulatory Field Office Project Manager, within sixty days after completing the monitoring. If less than two bankfull events occur during the first 5 years, the permittee shall continue monitoring until the second bankfull event is documented. The bankfull events must occur during separate monitoring years. In the event that the required bankfull events do not occur during the five-year monitoring period, the Corps of Engineers, in consultation with the resource agencies, may determine that further monitoring is not required. It is suggested that all bankfull occurrences be monitored and reported through the required monitoring period. The permittee shall perform and submit photo documentation twice each year (summer and winter) for the 5-year monitoring period, and for any subsequently required monitoring period.

n. MONITORING DATA/REPORT: The permittee shall include the following information in the Level I monitoring report for the site: reference photos; plant survival notes and recommendations, as appropriate; and a report on the visual inspection of channel stability. Physical measurements of channel stability/morphology will not be required. The permittee shall complete the Monitoring Data Record, Sections 1, 2 and 3 (pages 1, 2 and 3, attached), for each representative segment of the channel, and for each year of monitoring (twice each year, summer and winter, for reference photos). The permittee shall include in the monitoring reports a discussion of any deviations from as-built and an evaluation of the significance of these deviations and whether they are indicative of a stabilizing or destabilizing situation.

o. STREAM MITIGATION SUCCESS CRITERIA: The mitigation success criteria, and required remediation actions, will be generally based on the attached Appendix II, and the Photo Documentation, Ecological Function, and Channel Stability criteria in the "Stream Mitigation Guidelines", dated April, 2003 (available on the internet at [http://www.saw.usace.army.mil/wetlands/Mitigation/stream\\_mitigation.html](http://www.saw.usace.army.mil/wetlands/Mitigation/stream_mitigation.html)), pages 24 and 25, under "Success Criteria: ".

p. Failure to institute and carry out the details of special conditions a. - o., above, may result in a directive to cease all ongoing and permitted work within waters and/or wetlands associated with TIP B-3157, or such other remedy as the District Engineer or his authorized representatives may seek.

### **Pre-Construction**

q. Prior to commencing construction within jurisdictional waters of the United States, the permittee shall forward the latest version of project construction drawings to the USACE, Raleigh Regulatory Field Office NCDOT Regulatory Project Manager. Half-size drawings are acceptable.

r. The permittee shall schedule an environmental preconstruction meeting between its representatives, the contractor's representatives, and the USACE, Raleigh Regulatory Field Office NCDOT Regulatory Project Manager, prior to any work within jurisdictional waters and wetlands to ensure that there is a mutual understanding of all of the terms and conditions contained within this Department of the Army Permit. The permittee shall provide the USACE, Raleigh Regulatory Field Office NCDOT Regulatory Project Manager, with a copy of the final plans at least two weeks prior to the preconstruction meeting along with a description of any changes that have been made to the project's design, construction methodology or construction timeframe. The permittee shall schedule the environmental preconstruction meeting for a time when the USACE and North Carolina Division of Water Quality (NCDWQ) Project Managers can attend. The permittee shall invite the USACE and NCDWQ Project Managers a minimum of four weeks in advance of the scheduled meeting in order to provide those individuals with ample opportunity to schedule and participate in the required meeting.

s. To ensure that all borrow and waste activities occur on high ground and do not result in the degradation of adjacent wetlands and streams, except as authorized by this permit, the permittee shall require its contractors and/or agents to identify all areas to be used to borrow material, or to dispose of dredged, fill, or waste material. The permittee shall provide the USACE with appropriate maps indicating the locations of proposed borrow or waste sites as soon as the permittee has that information. The permittee will coordinate with the USACE before approving any borrow or waste sites that are within 400 feet of any streams or wetlands. The permittee shall ensure that all such areas comply with condition (b.) of this permit, and shall require and maintain documentation of the location and characteristics of all borrow and disposal sites associated with this project. This information will include data regarding soils, vegetation and hydrology sufficient to clearly demonstrate compliance with the preceding condition (b.). All information will be available to the USACE upon request. NCDOT shall require its contractors to complete and execute reclamation plans for each waste and borrow site and provide written documentation that the reclamation plans have been implemented and all work is completed. This documentation will be provided to the Corps of Engineers within 30 days of the completion of the reclamation work.

Channel Mitigation Monitoring Sheets I, II, III, AND IV

Monitoring Data Record

Project Title: \_\_\_\_\_ COE Action ID: 200221216

Stream Name: \_\_\_\_\_ DWQ Number: \_\_\_\_\_

City, County and other Location Information: \_\_\_\_\_

Date Construction Completed: \_\_\_\_\_ Monitoring Year: ( ) of 5

Ecoregion: \_\_\_\_\_ 8 digit HUC unit \_\_\_\_\_

USGS Quad Name and Coordinates: \_\_\_\_\_

**Rosgen Classification:** \_\_\_\_\_

Length of Project: \_\_\_\_\_ Urban or Rural: \_\_\_\_\_ Watershed Size: \_\_\_\_\_

Monitoring DATA collected by: \_\_\_\_\_ Date: \_\_\_\_\_

Applicant Information:

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

Address: \_\_\_\_\_

Telephone Number: \_\_\_\_\_ Email address: \_\_\_\_\_

Consultant Information:

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

Address: \_\_\_\_\_

Telephone Number: \_\_\_\_\_ Email address: \_\_\_\_\_

**Project Status:** \_\_\_\_\_

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Monitoring Level required by COE and DWQ (404 permit/ 401 Cert.): **Level** 1 2 3

Monitoring Level 1 requires completion of *Section 1, Section 2 and Section 3*

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Section 1. PHOTO REFERENCE SITES

*(Monitoring at all levels must complete this section)*

**Attach site map showing the location and angle of all reference photos with a site designation (name, number, letter, etc.) assigned to each reference photo location.** Photos should be provided for all structures and cross section locations, should show both banks and include an upstream and downstream view. Photos taken to document physical stability should be taken in winter. Photos taken to document vegetation should be taken in summer (at representative locations). Attach photos and a description of each reference photo or location. We recommend the use of a photo identification board in each photo to identify location.

**Total number of reference photo locations at this site:** \_\_\_\_\_

**Dates reference photos have been taken at this site:** \_\_\_\_\_

**Individual from whom additional photos can be obtained (name, address, phone):** \_\_\_\_\_

**Other Information relative to site photo reference:** \_\_\_\_\_

**If required to complete Level 3 monitoring only stop here; otherwise, complete section 2.**

**Section 2. PLANT SURVIVAL**

**Attach plan sheet indicating reference photos.**

Identify specific problem areas (missing, stressed, damaged or dead plantings):

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Estimated causes, and proposed/required remedial action: \_\_\_\_\_

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ADDITIONAL COMMENTS: \_\_\_\_\_

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**If required to complete Level 1 and Level 2 monitoring only stop here; otherwise, complete section 3.**

**Section 3. CHANNEL STABILITY**

**Visual Inspection:** The entire stream project as well as each in-stream structure and bank stabilization/revetment structure must be evaluated and problems addressed.

Report on the visual inspection of channel stability. Physical measurements of channel stability/morphology will not be required. Include a discussion of any deviations from as-built and an evaluation of the significance of these deviations and whether they are indicative of a stabilizing or destabilizing situation.

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Date Inspected	Station Number	Station Number	Station Number	Station Number	Station Number
Structure Type					
Is water piping through or around structure?					
Head cut or down cut present?					
Bank or scour erosion present?					
Other problems noted?					

**NOTE:** Attach separate narrative sheets to each monitoring report describing/discussing the overall monitoring results. Include the identification of specific problem areas/channel failures, estimated cause and proposed/required remedial action. This should include a brief discussion of any parameter that has changed significantly from as-built.

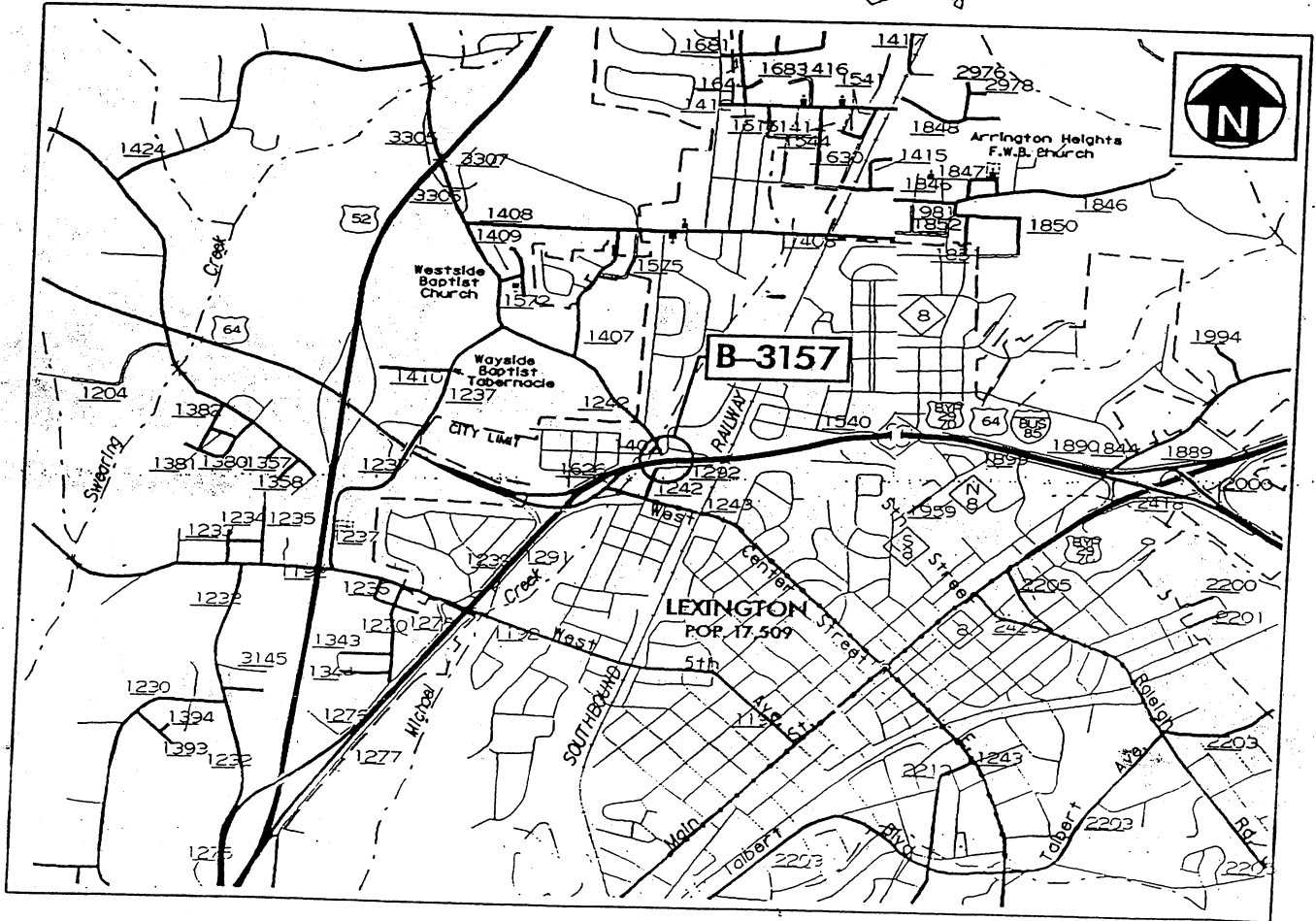
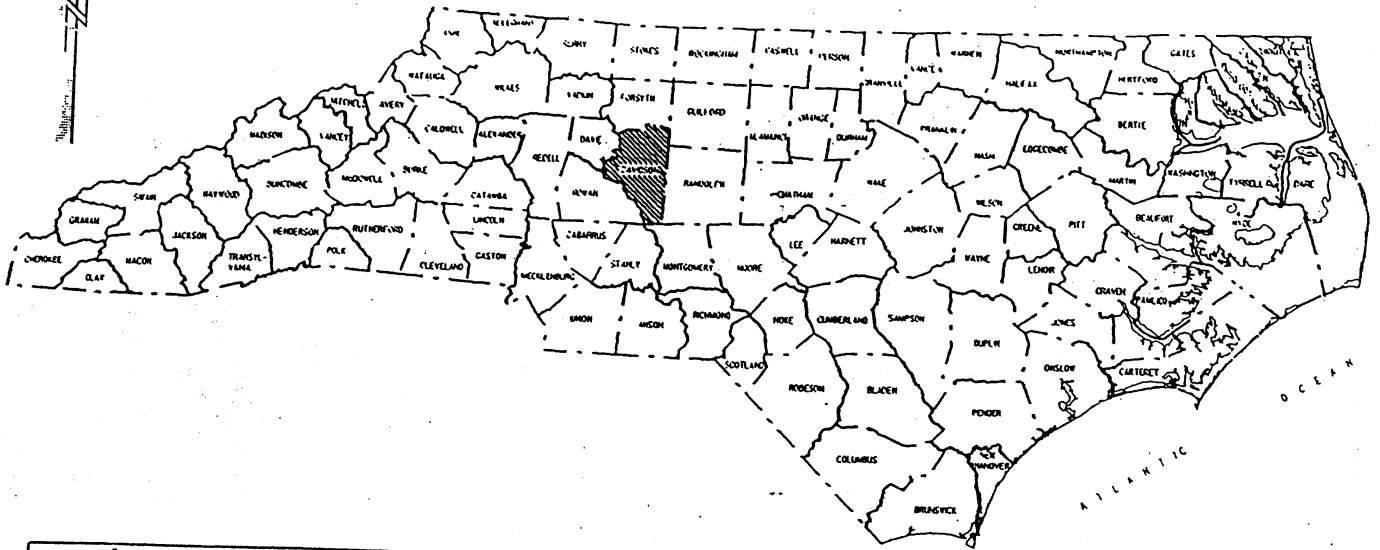
Appendix II. General criteria used to evaluate the success or failure of activities at mitigation sites and required remedial actions to be implemented should monitoring indicate failure of a component.

Mitigation Component	Success (requires no action)	Failure →	Action
(1.) <u>Photo Reference Sites</u> Longitudinal photos Lateral photos	No substantial* aggradation, degradation or bank erosion.	Substantial aggradation, degradation or bank erosion.	When substantial aggradation, degradation or bank erosion occurs, remedial actions will be planned, approved, and implemented.
(2.) <u>Plant Survival</u> Survival plots Stake counts Tree counts	≥ 75% Coverage in Photo Plots Survival and growth of at least 320 trees/acre through year 3, then 10% mortality allowed in year 4 (288 trees/acre) and additional 10% mortality in year 5 for 260 trees/acre through year 5.	< 75% coverage in photo plots for herbaceous cover. Survival of less than 320 trees per acre through year 3 and then less than the success criteria for years 4 and 5.	Areas of less than 75% coverage will be re-seeded and or fertilized, live stakes and bare rooted trees will be planted to achieve desired densities.
(3.) <u>Channel Stability</u> Cross-sections Longitudinal profiles Pebble counts	Minimal evidence of instability (down-cutting, deposition, bank erosion, increase in sands or finer substrate material).	Substantial* evidence of instability.	When Substantial evidence of instability occurs, remedial actions will be planned, approved, and implemented.
(4.) <u>Biological Indicators</u> Invertebrate populations Fish populations	Population measurements remain the same or improve, and species composition indicates a positive trend.	Population measurements and species composition indicate a negative trend.	Reasons for failure will be evaluated and remedial action plans developed, approved, and implemented.

\*Substantial or subjective determinations of success will be made by the mitigation sponsor and confirmed by COE and review agencies.  
Monitoring Level 1 will include items 1, 2, and 3, and may include item 4 based on the project review.  
Monitoring Level 2 will include items 1 and 2, and may include item 3 based on the project review.  
Monitoring Level 3 will include only item 1.

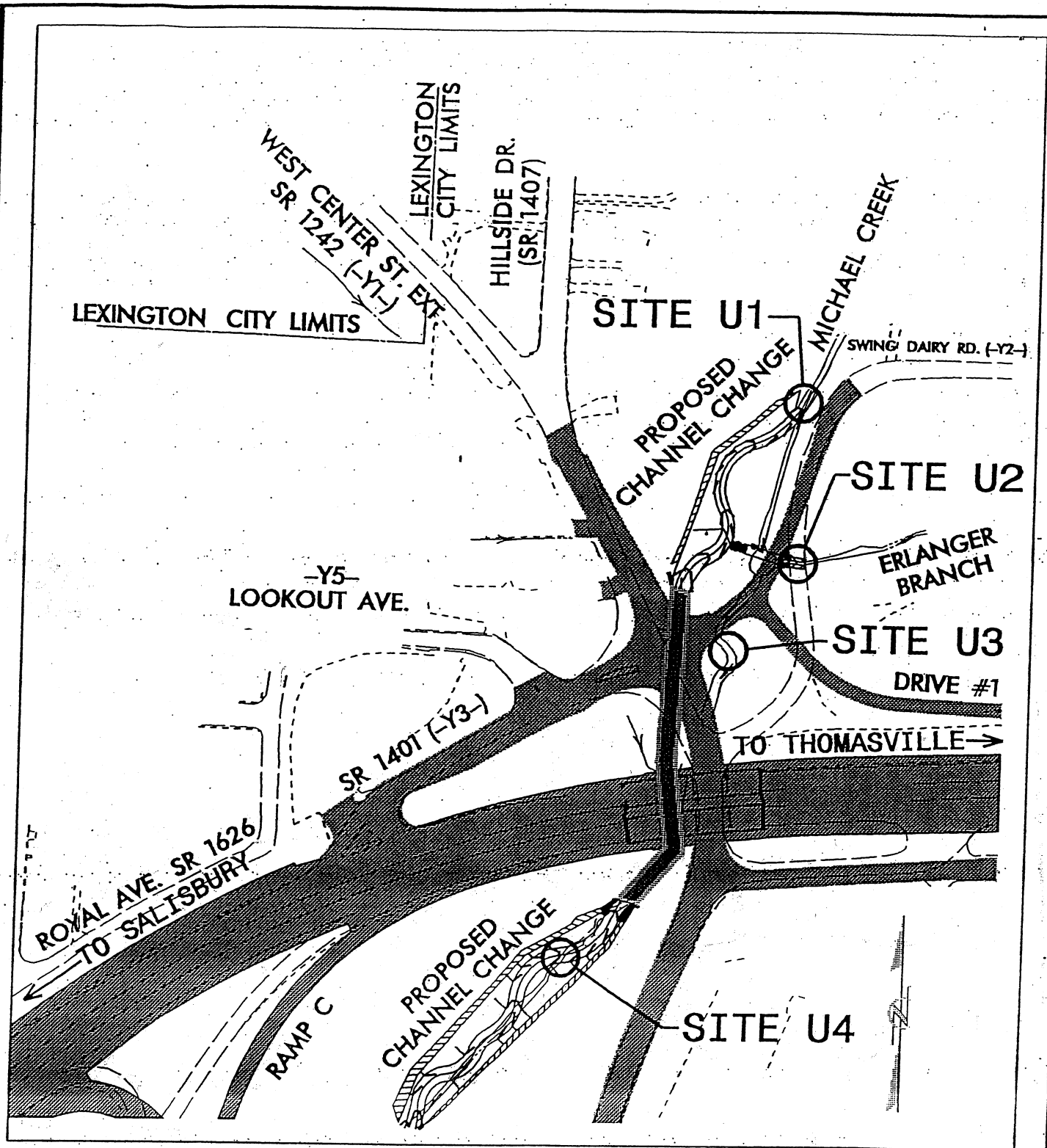


# NORTH CAROLINA



PROJECT VICINITY MAPS  
DAVIDSON COUNTY  
LEXINGTON, N.C.

N. C. DEPT. OF TRANSPORTATION  
DIVISION OF HIGHWAYS  
DAVIDSON COUNTY  
PROJECT 8.1601402  
Bridge No. 74 and 76 over SR1242  
and Michael Creek and approaches  
on US 29/64/70 and I-85 Business  
SHEET 1 OF 7

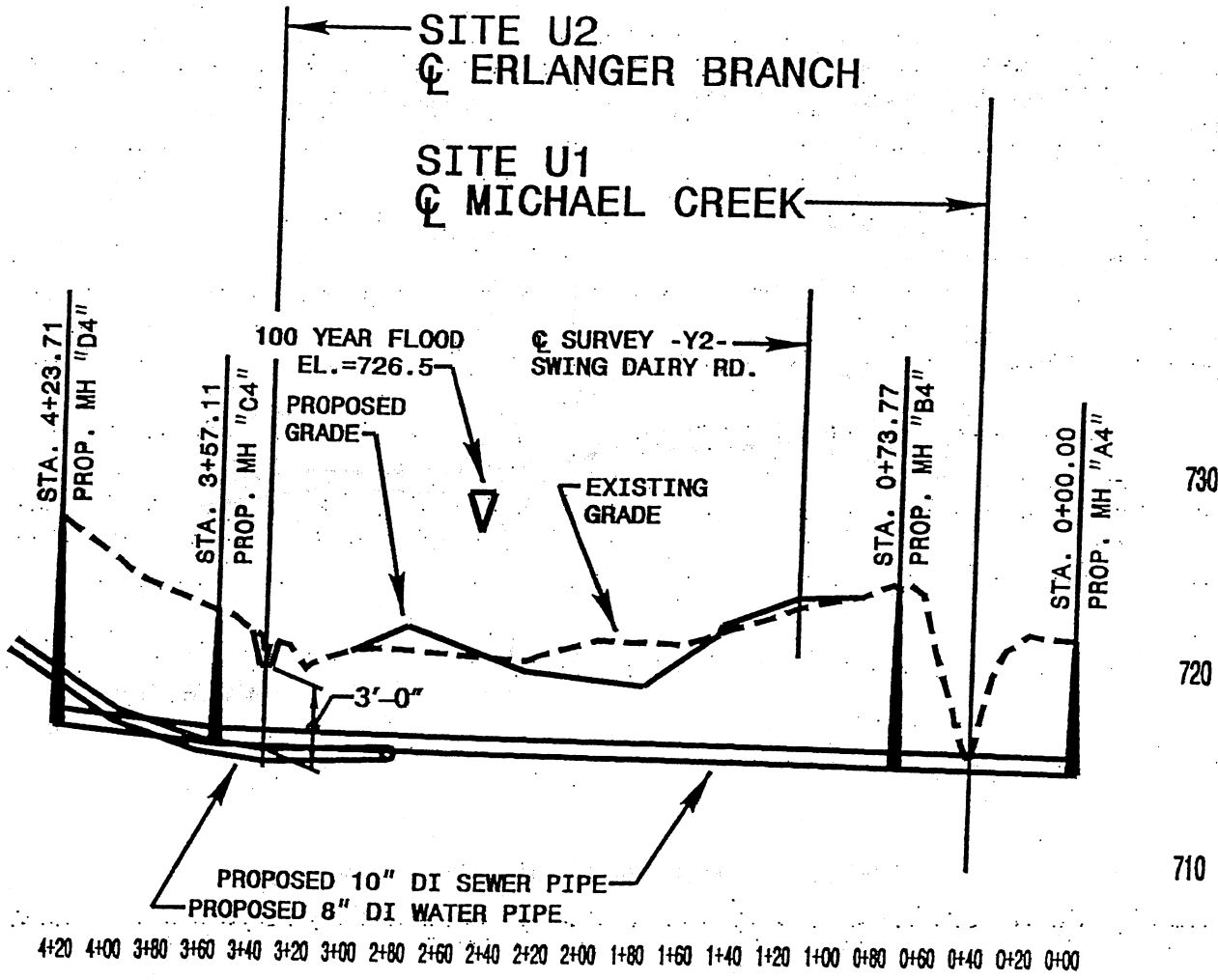


# SITE MAP

(NOT TO SCALE)

N. C. DEPT. OF TRANSPORTATION  
 DIVISION OF HIGHWAYS  
 DAVIDSON COUNTY  
 PROJECT 8.1601402

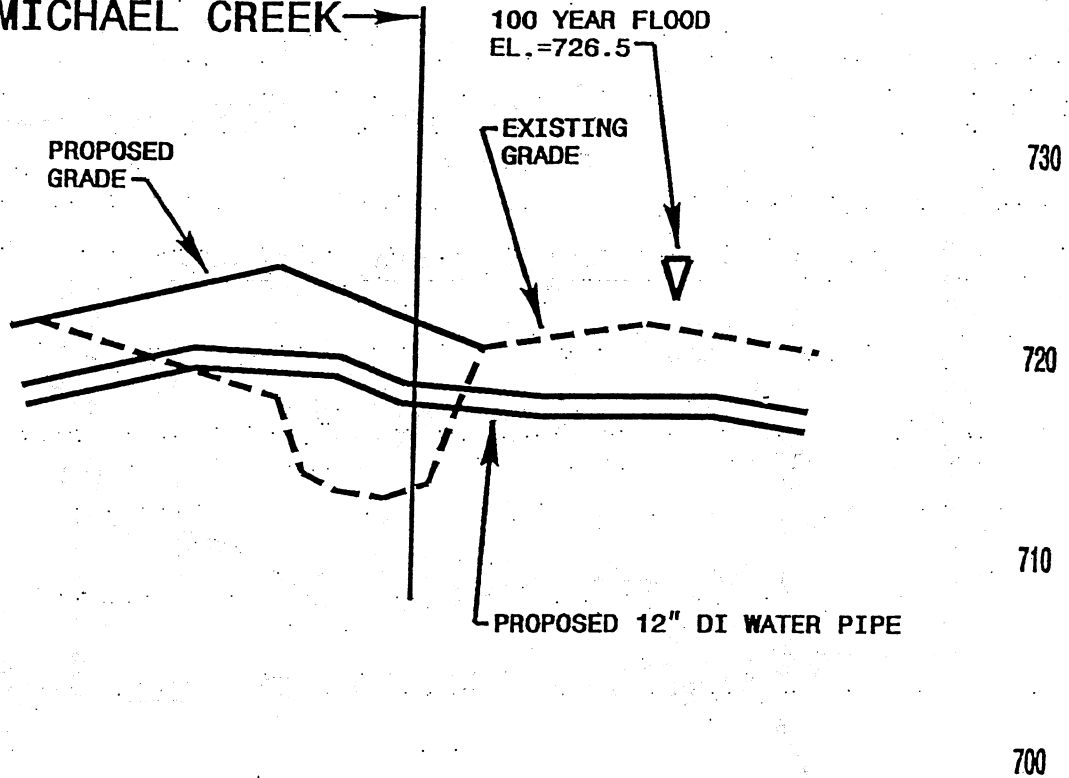
Bridge No. 74 and 76 over SR1242  
 and Michael Creek and approaches  
 on US 29/64/70 and I-85 Business  
 SHEET 2 OF 7



SITE U1 AND U2-ELEVATION VIEW  
 SEWER LINE AND WATER LINE RELOCATION AT ERLANGER BRANCH AND MICHAEL CREEK

N. C. DEPT. OF TRANSPORTATION  
 DIVISION OF HIGHWAYS  
 DAVIDSON COUNTY  
 PROJECT 8.1601402  
 Bridge No. 74 and 76 over SR1242  
 and Michael Creek and approaches  
 on US 29/64/70 and I-85 Business  
 SHEET 3 OF 7

SITE U3  
CL MICHAEL CREEK



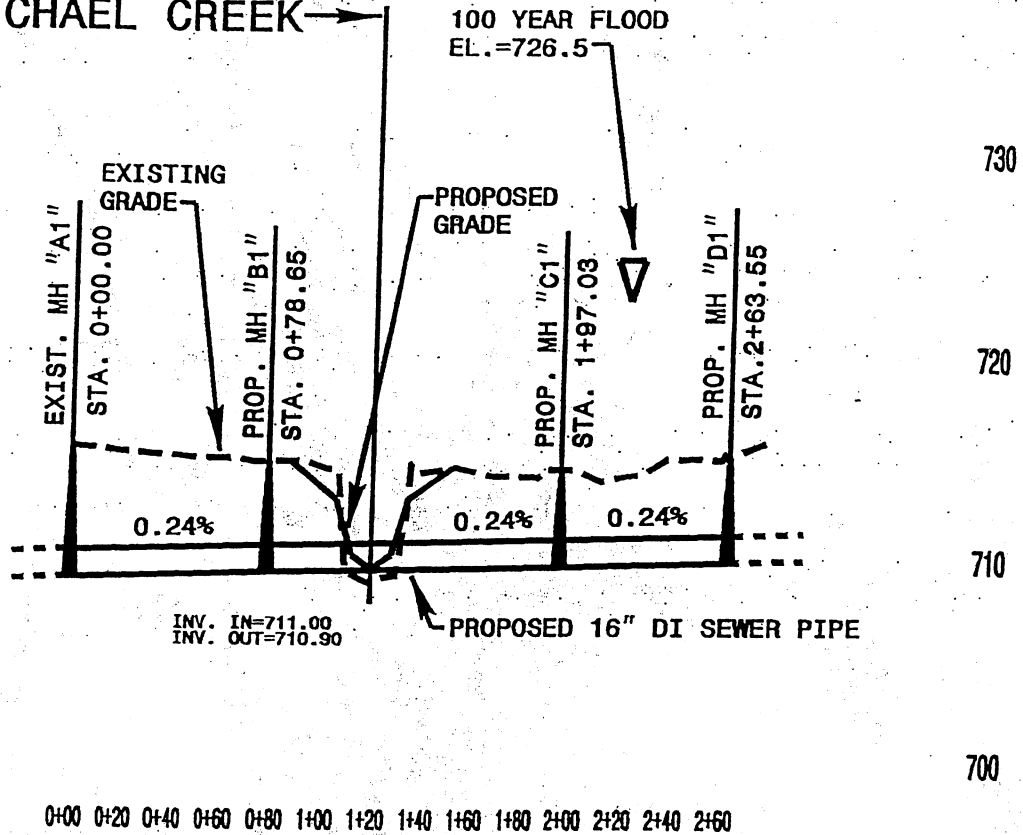
SITE U3-ELEVATION VIEW  
SEWER LINE RELOCATION AT MICHAEL CREEK

N. C. DEPT. OF TRANSPORTATION  
DIVISION OF HIGHWAYS  
DAVIDSON COUNTY  
PROJECT 8.1601402

Bridge No. 74 and 76 over SR1242  
and Michael Creek and approaches  
on US 29/84/70 and I-85 Business

SHEET 4 OF 7

**SITE U4  
 @ MICHAEL CREEK**

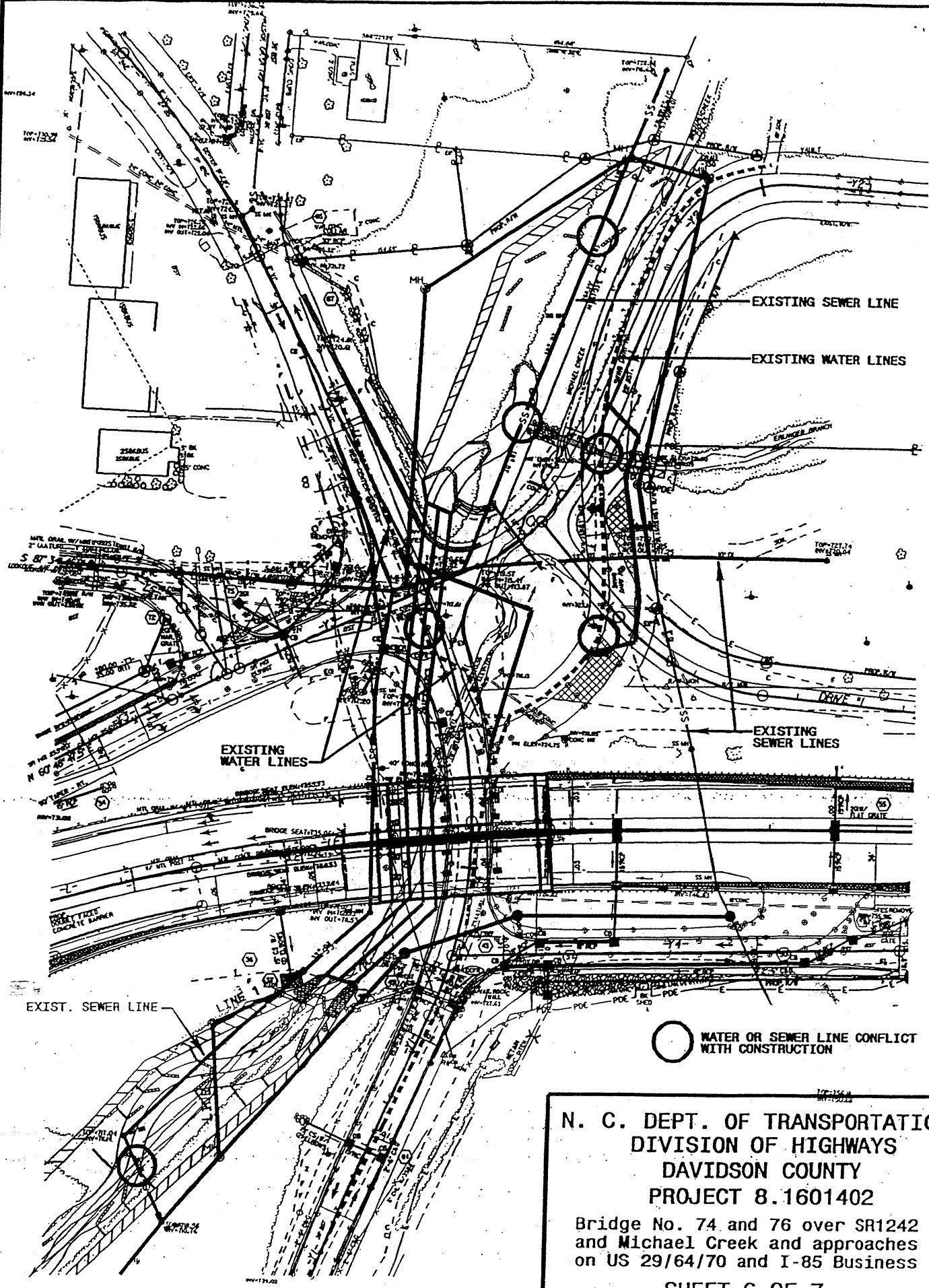


**SITE U4-ELEVATION VIEW  
 SEWER LINE RELOCATION AT MICHAEL CREEK**

**N. C. DEPT. OF TRANSPORTATION  
 DIVISION OF HIGHWAYS  
 DAVIDSON COUNTY  
 PROJECT 8.1601402**

Bridge No. 74 and 76 over SR1242  
 and Michael Creek and approaches  
 on US 29/64/70 and I-85 Business

**SHEET 5 OF 7**



N. C. DEPT. OF TRANSPORTATION  
 DIVISION OF HIGHWAYS  
 DAVIDSON COUNTY  
 PROJECT 8.1601402  
 Bridge No. 74 and 76 over SR1242  
 and Michael Creek and approaches  
 on US 29/64/70 and I-85 Business  
 SHEET 6 OF 7

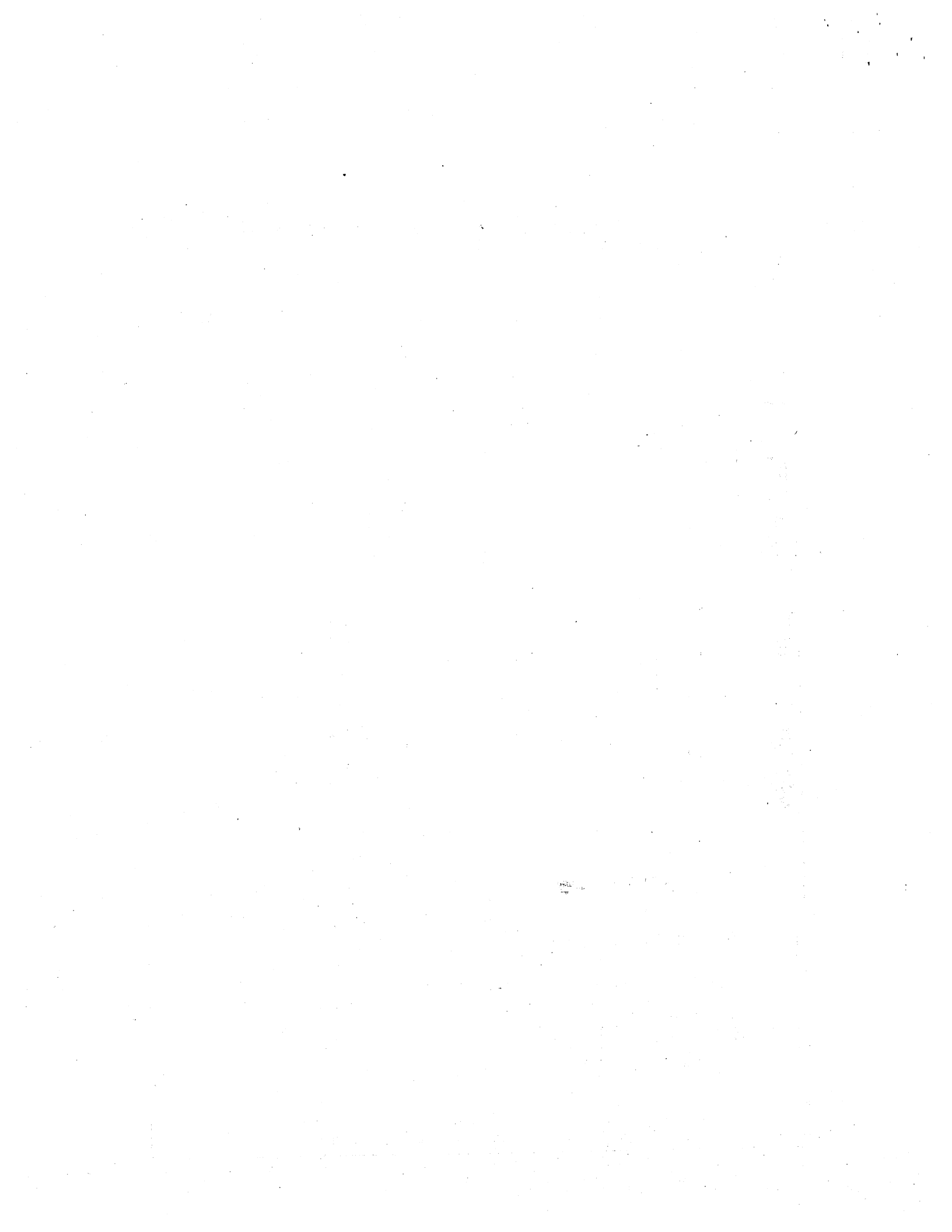
## WETLANDS IMPACT PERMIT SUMMARY

Site No.	Station (From/To)	Structure Size / Type	Fill In Wetlands (ac)	Temp. Fill In Wetlands (ac)	Excavation In Wetlands (ac)	Mechanized Clearing (Method III) (ac)	Fill In SW (Natural) (ac)	Fill In SW (Pond) (ac)	Impact Due To Mitigation (ft)	Existing Channel Impacted (ft)	Natural Stream Design (ft)
1	20+81.5-Y6-	1 @ 10' X 10' RCBC, & 72" SMOOTH STEEL 2 @ 12' X 9' RCBC 60" RCP					0.02		484	114	546
1	17+48-Y1-						0.17			743	404
2	12+05-Y2-						<.01			19	
			0	0	0	0	0.19	0	484	876	950
TOTALS:											

\*10 feet of stream restoration deleted for utility easement

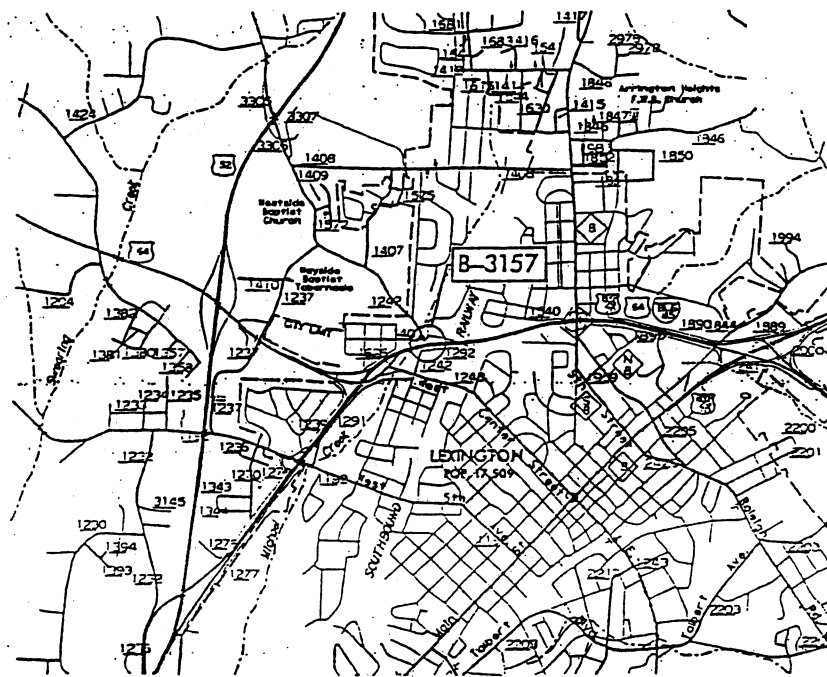
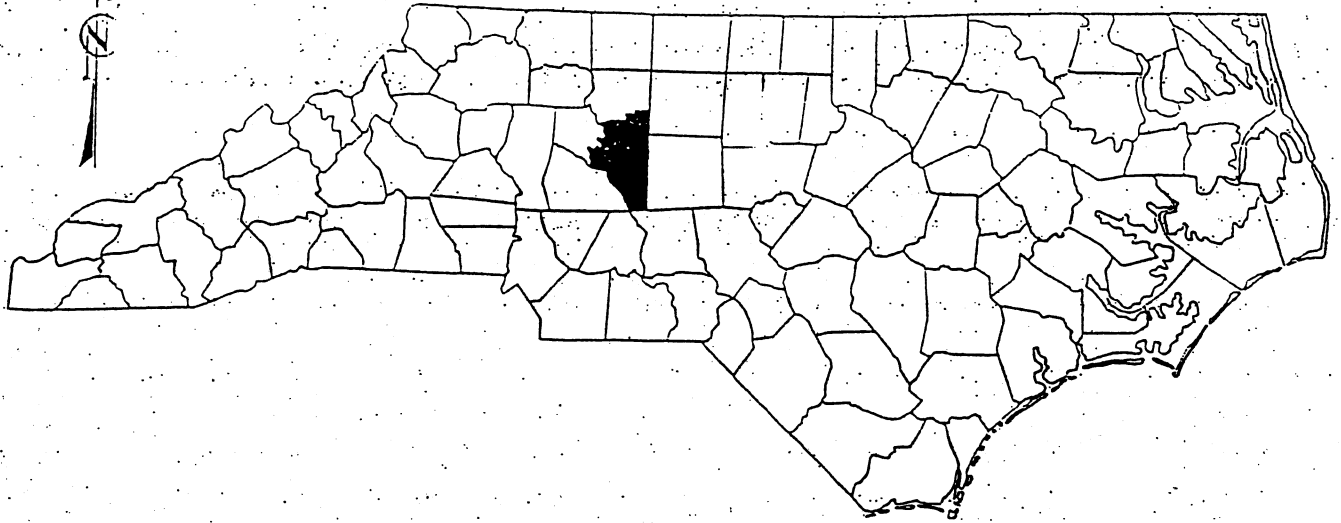
# NCDOT

DIVISION OF HIGHWAYS  
DAVIDSON COUNTY  
PROJECT 8.1631403 (B-3157)  
BRIDGE NOS. 74 & 76 OVER SR1242 AND  
MICHAEL CREEK AND APPROACHES  
ON US 29/64/70 AND I-85 BUSINESS





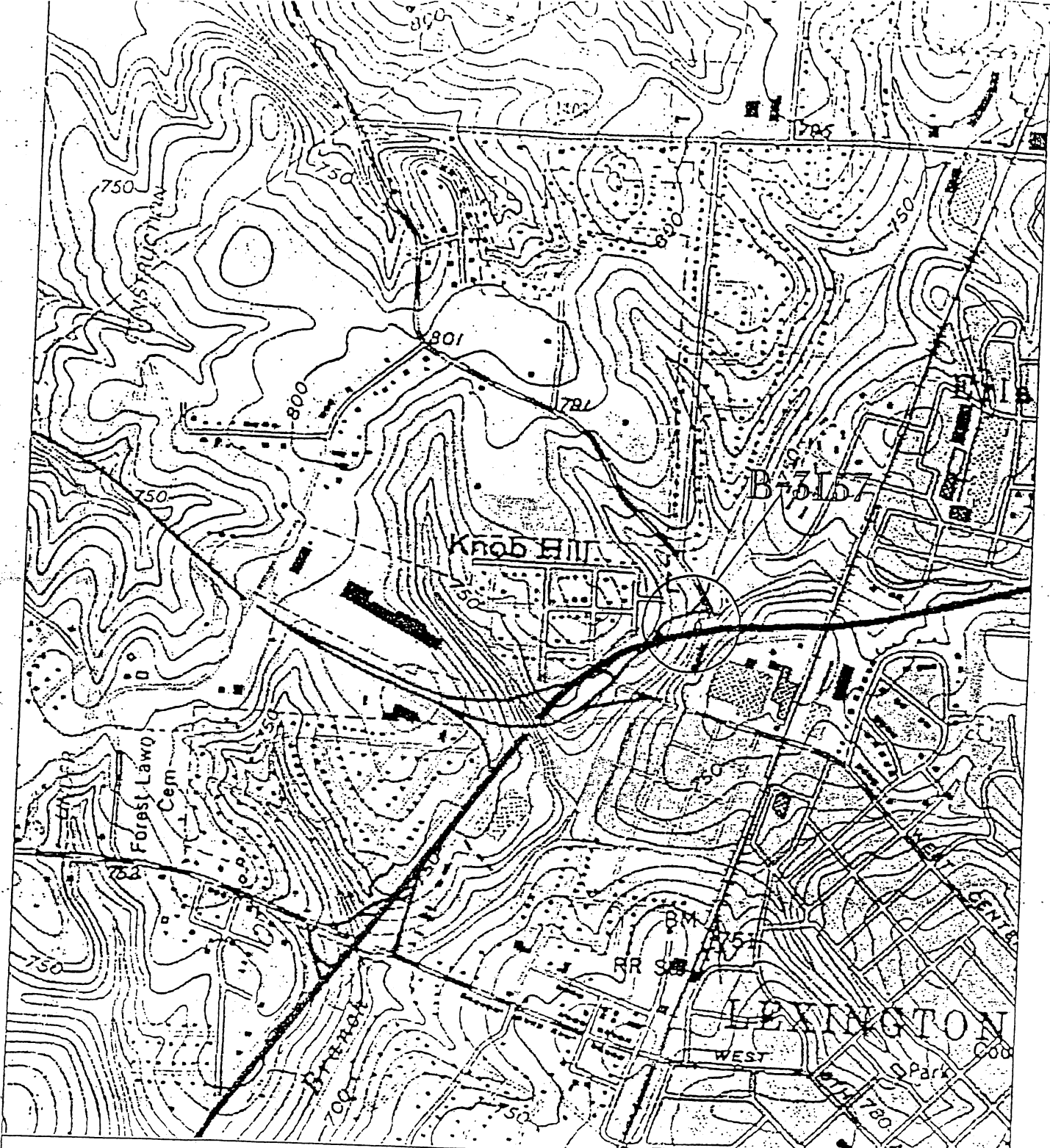
# NORTH CAROLINA



## VICINITY MAPS

NCDOT  
DIVISION OF HIGHWAYS  
DAVIDSON COUNTY  
PROJECT: 8.1651405 (B-3157)

BRIDGE NOS. 74 & 76 OVER SR1242 AND  
MICHAEL CREEK AND APPROACHES  
ON US 29/64/70 AND I-85 BUSINESS



TOPO  
MAP

SCALE 1" = 2000'

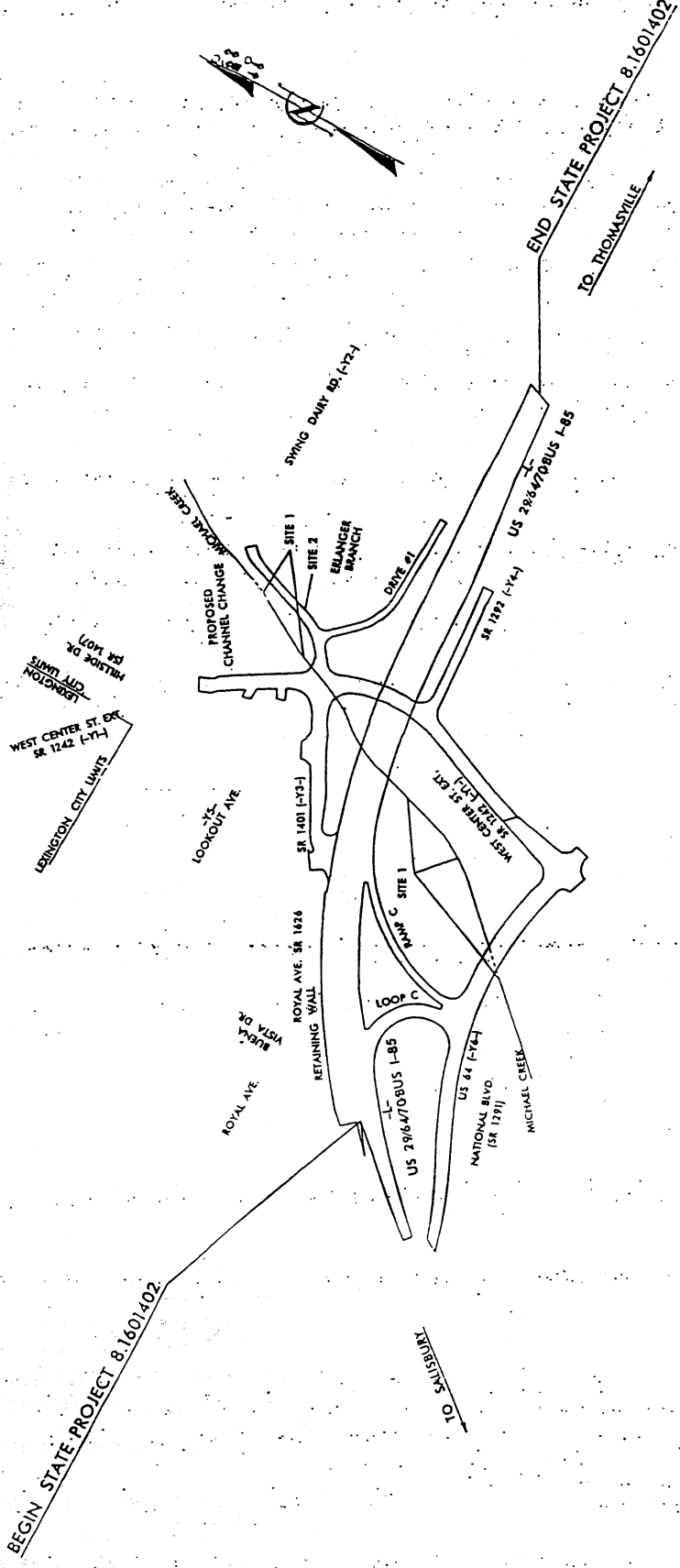
NCDOT

DIVISION OF HIGHWAYS  
DAVIDSON COUNTY  
PROJECT: 8.1631403 (B-5157)

BRIDGE NOS. 74 & 76 OVER SR1242 AND  
MICHAEL CREEK AND APPROACHES  
ON US 29/64/70 AND I-85 BUSINESS

SHEET 2 OF 31

5/27/05



# SITE MAP

**NCDOT**  
 DIVISION OF HIGHWAYS  
 DAVIDSON COUNTY  
 PROJECT: 8.1631403 (B-3157)

BRIDGE NOS. 74 & 76 OVER SR 1242 AND  
 MICHAEL CREEK AND APPROACHES  
 ON US 29/64/70 AND I-85 BUSINESS

SHEET 3 OF 31

10/28/05

# PROPERTY OWNERS

## NAMES AND ADDRESSES

PARCEL NO.	NAMES	ADDRESSES
1	LAWRENCE EDWARD LANNING	421 ROWE RD. LEXINGTON, NC 27292
2	FRANK & SONS INC.	P.O. BOX 276 CHARLOTTESVILLE, VA 22902

**NCDOT**

**DIVISION OF HIGHWAYS**

**DAVIDSON COUNTY**

**PROJECT: 8.1631403 (B-3157)**

**BRIDGE NOS. 74 & 76 OVER SR1242 AND  
MICHAEL CREEK AND APPROACHES  
ON US 29/64/70 AND I-85 BUSINESS**

**SHEET 4 OF 31**

**5/27/03**

## WETLANDS IMPACT PERMIT SUMMARY

Site No.	Station (From/To)	Structure Size / Type	Fill In Wetlands (ac)	Temp. Fill In Wetlands (ac)	Excavation In Wetlands (ac)	Mechanized Clearing (Method III) (ac)	Fill In SW (Natural) (ac)	Fill In SW (Pond) (ac)	Impact Due To Mitigation (ft)	Existing Channel Impacted (ft)	Natural Stream Design (ft)
1	20+81.5-Y6	1 @ 10' X 10' RCBC, & 72" SMOOTH STEEL					0.02		484	114	546
1	17+48-Y1	2 @ 12x9' RCBC					0.17			743	404
2	12+05-Y2	60" RCP					<.01			19	
TOTALS:			0	0	0	0	0.19	0	484	876	950

\*10 feet of stream restoration deleted for utility easement

# NCDOT

DIVISION OF HIGHWAYS  
 DAVIDSON COUNTY  
 PROJECT 8.1631403 (B-3157)  
 BRIDGE NOS. 74 & 76 OVER SR1242 AND  
 MICHAEL CREEK AND APPROACHES  
 ON US 29/64/70 AND I-85 BUSINESS

Form Revised 3/22/01

SHEET 5 OF 31

10/28/2003

**Natural Channel Design Summary**  
**Michael's Branch**  
**TIP No. B-3157**  
**State Project No. 8.1601403**  
**Lexington, Davidson County, North Carolina**

Prepared by Mulkey Engineers and Consultants

June 2003

This natural channel design summary is presented to the North Carolina Department of Transportation (NCDOT) as part of on-site compensatory mitigation for the proposed replacement of bridges number 74 and 76 over SR 1242 (West Center Street) and Michael's Creek on US 29/64/70 and I-85 Business. The proposed project extends from east of US 64 West to just west of the Winston Salem Southern Railroad. Michael's Branch, which flows through the entire project from north to south, will be relocated westward from its existing location parallel to Swing Dairy Road to the proposed culvert under SR 1242 (West Center Street). The stream will be restored utilizing priority two restoration from downstream of SR 1242 to the existing culvert under US 64 (-Y6-). Michael's Branch has been identified as a perennial stream and is part of the Yadkin - Pee Dee River Subbasin 03-07-07 (USGS Hydrologic Unit 03040103). The stream has been subdivided into three segments due to changes in drainage area and slopes. Segment one begins at the upstream project limits and extends to the confluence of Erlanger Branch. Segment two begins at the confluence of Erlanger Branch and extends to the new culvert under SR 1242 (West Center Street) and segment three runs from the outlet of the new culvert under SR 1242 to the existing culvert under US 64 Ramp (-Y6-). Morphological tables for each segment complete with existing channel, reference reach, and proposed reach characteristics is attached. In addition, proposed design and detail sheets are also included with this summary. The project is within the Piedmont physiographic province.

The headwaters associated with Michael's Branch originate at the intersection of SR 1412 and US 52. Michael's Branch flows in a southerly direction approximately 3.2 mi (5.1 km) before converging with Swearing Creek, then another 4.5 mi (7.2 km) to the south to unite with backwater from High Rock Lake. The drainage area at segment one is approximately 0.77 sq. mi (2.0 sq. km) and increases to 1.04 sq. mi (2.7 sq. km) with the confluence of Erlanger Branch. The drainage area for Michael's Branch is heavily urbanized with a combination of dense residential and commercial/industrial development. The proposed project will require the stream to be relocated due to existing fill slope design requirements upstream of SR 1242 and priority two restoration for on-site mitigation downstream of SR 1242. Overall stream length will be reduced and slope will be increased upstream of SR 1242 in order to correctly align the new channel with its modified valley type; however, downstream of SR 1242, the stream length will be increased and slope decreased due to the addition of more pattern.

Discharges for various return intervals were calculated using USGS report 96-4084 titled "Estimation of Flood-Frequency Characteristics of Small Urban Streams in North Carolina". Bankfull discharge was calculated based on field surveys of bankfull cross sectional area, longitudinal slope, and roughness factor. The calculated bankfull discharge was compared to the USGS discharges to determine an approximate return interval. The calculated bankfull discharge falls between the 1 and 2 year return interval storms; therefore, we conclude that field estimated bankfull is correct.

## Existing Channel

### **Segment 1**

A 300-foot (91.4-meter) section of the single thread channel associated with Michael's Branch was surveyed during April 2001. This section is located parallel to Swing Dairy Road (Y2) from the northern terminus of the project area to the confluence with Erlanger Branch. The surveyed reach exhibited channel characteristics similar to a G5c stream type, even though the ratios match an E stream type, as noted by the Rosgen Classification of Natural Rivers. The G5c stream type is an entrenched, moderately steep, step/pool channel deeply incised in sandy materials with relatively low sinuositities and width/depth ratios. This stream type is in degradation mode derived from near continuous channel adjustment due to excessive bank erosion. Bank erosion and bedload transport rates are typically high and the ratio of bedload to total sediment load often exceeds 50%. These stream types are very sensitive to disturbance and tend to make significant adverse channel adjustments to changes flow regime and sediment supply from the watershed (Rosgen and Silvey, 1998). The existing channel at this location has an entrenchment ratio of 2.3, but is in such a degraded state that it is functioning as a G. The channel has incised, actively widening and trying to develop pattern as observed by extremely undercut banks. Segment 1 of Michael's Branch exhibited a bankfull cross sectional area of 27 sq. ft (2.51 sq. m), an average slope of 0.006 ft/ft, and a D50 of 0.7mm. A detailed summary of existing channel conditions is presented in attached morphological table.

### **Segment 2**

A 250-foot (76.2-meter) section of the single thread channel associated with Michael's Branch was surveyed during April 2001. This section is located parallel to Swing Dairy Road (Y2) from the confluence with Erlanger Branch to the existing double pipes under SR 1242. The surveyed reach exhibited channel characteristics similar to an E5/4 stream type as noted by the Rosgen Classification of Natural Rivers. The E5/4 stream type are systems with low to moderate sinuositities, gentle to moderately steep gradients, with very low width/depth ratios. The E5/4 stream type is typically seen as riffle/pool systems with streambanks composed of materials finer than that of the dominant channel materials, and are typically stabilized with extensive riparian vegetation. E5/4 stream types are hydraulically efficient channel forms and they maintain a high sediment transport capacity. These stream types are very sensitive to disturbance and tend to make significant adverse channel adjustments to changes flow regime and sediment supply from the watershed (Rosgen and Silvey, 1998). The existing channel at this location depicts geomorphic ratios similar to an E type, but is in such a degraded state that it is functioning as a G. The channel has incised and is actively widening and trying to develop pattern as observed by extremely undercut banks. Segment 2 of Michael's Branch exhibited a bankfull cross sectional area of 47 sq. ft. (4.37 sq. m), an average slope of 0.006 ft/ft and a D50 of 3mm. A detailed summary of existing channel conditions is presented in attached morphological table.

### **Segment 3**

A 700-foot (213-meter) section of the single thread channel associated with Michael's Branch was surveyed during December 2002. This section is located between SR 1242 (West Center Street) and US 64 Ramp (Y6). The surveyed reach exhibited channel characteristics similar to a G5c stream type, even though the geomorphic ratios are similar to an E stream type, as noted by the Rosgen Classification of Natural Rivers. The G5c stream type is an entrenched, moderately steep, step/pool channel deeply incised

in sandy materials with relatively low sinuosities and width/depth ratios. This stream type is in degradation mode derived from near continuous channel adjustment due to excessive bank erosion. Bank erosion and bedload transport rates are typically high and the ratio of bedload to total sediment load often exceeds 50%. These stream types are very sensitive to disturbance and tend to make significant adverse channel adjustments to changes flow regime and sediment supply from the watershed (Rosgen and Silvey, 1998). As mentioned before, this stream exhibits and entrenchment ratio of 2.3; however, it is functioning as a G type. The channel has incised and is actively widening and trying to develop pattern as observed by extremely undercut banks. Segment 3 of Michael's Branch exhibited a bankfull cross sectional area of 50.3 sq. ft. (4.65 sq. m), an average slope of 0.004 ft/ft, and a D50 of 1.8mm. A detailed summary of existing channel conditions is presented in attached morphological table.

### Reference Reach

Due to the urban nature of the existing stream's watershed a suitable reference reach was difficult to locate. Two stable streams, UT Lake Jeanette in Guilford County and an UT to SW Prong Beaverdam Creek in Wake County were selected as the reference reaches. UT to Lake Jeanette was selected based on its location within the same eco-region as the restoration, its watershed components, stream type, and other general characteristics. The reference reach channel is situated in Guilford County and classifies as a C4. It exhibits a drainage area of 0.25 sq. mi (0.65 sq. km) and a bankfull cross sectional area of 7.7 sq. ft (0.72 sq. m.). Based on surveys, the channel is stable and exhibits very low bank height ratios. UT to SW Prong Beaverdam Creek was selected based on its urban watershed, stream type, and other general characteristics. The reference reach channel is situated in Wake County and classifies as a C5. It exhibits a drainage area of 0.28 sq. mi (0.73 sq. km) and a bankfull cross sectional area of 13.0 sq. ft (1.21 sq. m.). Based on surveys, the channel is stable and exhibits very low bank height ratios. Both stream's valley characteristics are very comparable with the existing channel. Little to no bank erosion was noted at either reference reach during the survey. A detailed summary of reference conditions are also presented in the attached morphological table.

### Proposed Channel

#### **Segment 1**

The proposed channel was based on dimensionless ratios derived from the reference reach survey, existing channel survey, and data interpretation. The bankfull width will be increased from 13.0 ft (4.0 m) to 21.0 ft (6.4 m) and the bankfull mean depth will be reduced from 2.07 ft (0.63 m) to 1.40 ft (0.43 m). As a result, the width/depth ratio will increase to approximately 15 from the existing 6.3 ratio. A decrease in the bankfull mean velocity will occur with the new channel. The design stream will exhibit additional floodprone area to aid in stress reduction in the channel. Slopes will be increased due to a change in the valley; however, an excess energy will be dissipated via riffle/pool morphology characteristic and planform associated with the C stream type. Rock cross vanes will be the primary method influencing the riffle/pool morphology. These cross vanes will be established throughout the channel in riffle sections and used to provide grade control, center the thalweg, and protect the stream banks on both sides of the new channel until vegetation is established. The cross vanes will also decrease shear



stresses throughout the reach. The riparian zone adjacent to the channel will be planted with native vegetation conducive to wetter, floodplain areas.

Proposed channel stabilization characteristics are presented on the attached detail sheet. It is anticipated that the riparian zone will be planted with native trees and shrubs above bankfull depth and herbaceous species within the channel.

### **Segment 2**

The proposed channel was based on dimensionless ratios derived from the reference reach survey, existing channel survey, and data interpretation. The bankfull width will be increased from 22.5 ft (6.9 m) to 26 ft (7.9 m) and the bankfull mean depth will be reduced from 2.09 ft (0.64 m) to 1.70 ft (0.52 m). As a result, the width/depth ratio will increase to approximately 15.3 from the existing 9.7 ratio. An increase in bankfull velocity will occur due to the steeper gradient of the stream; therefore, the bankfull area is slightly reduced in the proposed condition. The design stream will exhibit additional floodprone area to aid in stress reduction in the channel. Slopes will be increased due to a change in the valley; however, an excess energy will be dissipated via riffle/pool morphology characteristic and planform associated with the C stream type. Rock cross vanes will be the primary method influencing the riffle/pool morphology. These cross vanes will be established throughout the channel in riffle sections and used to provide grade control, center the thalweg, and protect the stream banks on both sides of the new channel until vegetation is established. The cross vanes will also decrease shear stresses throughout the reach. The riparian zone adjacent to the channel will be planted with native vegetation conducive to wetter, floodplain areas.

Proposed channel stabilization characteristics are presented on the attached detail sheet. It is anticipated that the riparian zone will be planted with native trees and shrubs above bankfull depth and herbaceous species within the channel.

### **Segment 3**

The proposed channel was based on dimensionless ratios derived from the reference reach survey, existing channel survey, and data interpretation. The bankfull width will be increased from 21.0 ft (6.4 m) to 28.0 ft (8.5 m) and the bankfull mean depth will be reduced from 2.51 ft (0.77 m) to 2.25 ft (0.68 m). As a result, the width/depth ratio will increase to approximately 12.4 from the existing 8.0 ratio. A decrease in the bankfull mean velocity will occur with the new channel. The design stream will exhibit additional floodprone area to aid in stress reduction in the channel. Slopes will be increased due to a change in the valley; however, an excess energy will be dissipated via riffle/pool morphology characteristic and planform associated with the C stream type. Rock cross vanes will be the primary method influencing the riffle/pool morphology. These cross vanes will be established throughout the channel in riffle sections and used to provide grade control, center the thalweg, and protect the stream banks on both sides of the new channel until vegetation is established. The cross vanes will also decrease shear stresses throughout the reach. The riparian zone adjacent to the channel will be planted with native vegetation conducive to wetter, floodplain areas.

Proposed channel stabilization characteristics are presented on the attached detail sheet. It is anticipated that the riparian zone will be planted with native trees and shrubs above bankfull depth and herbaceous species within the channel.

## Sediment Transport

### **Segment 1**

Based on pebble counts and bar samples taken along the existing channel, the D50 averages 0.7 mm and the D84 averages approximately 30.0 mm. The existing channel exhibits a critical shear stress of 0.55 lbs/ft<sup>2</sup> which may entrain up to a 35 mm particle. Based on the design, the proposed channel will exhibit a critical shear stress of 0.66 lbs/ft<sup>2</sup> entraining up to a 40 mm particle. This increase in entrainment will not induce degradation as the active bed sample produced a D84 of 38mm. In addition, cross vanes will be installed throughout the riffle sections to further reduce the possibility of additional channel degradation.

### **Segment 2**

Based on pebble counts and bar samples taken along the existing channel, the D50 averages 0.7 mm and the D84 averages approximately 30.0 mm. The existing channel exhibits a critical shear stress of 0.65 lbs/ft<sup>2</sup> which may entrain up to a 40 mm particle. Based on the design, the proposed channel will exhibit a critical shear stress of 0.78 lbs/ft<sup>2</sup> entraining up to a 48 mm particle. This increase in entrainment will not induce degradation as the active bed sample produced a D84 of 40mm. In addition, cross vanes will be installed throughout the riffle sections to further reduce the possibility of additional channel degradation.

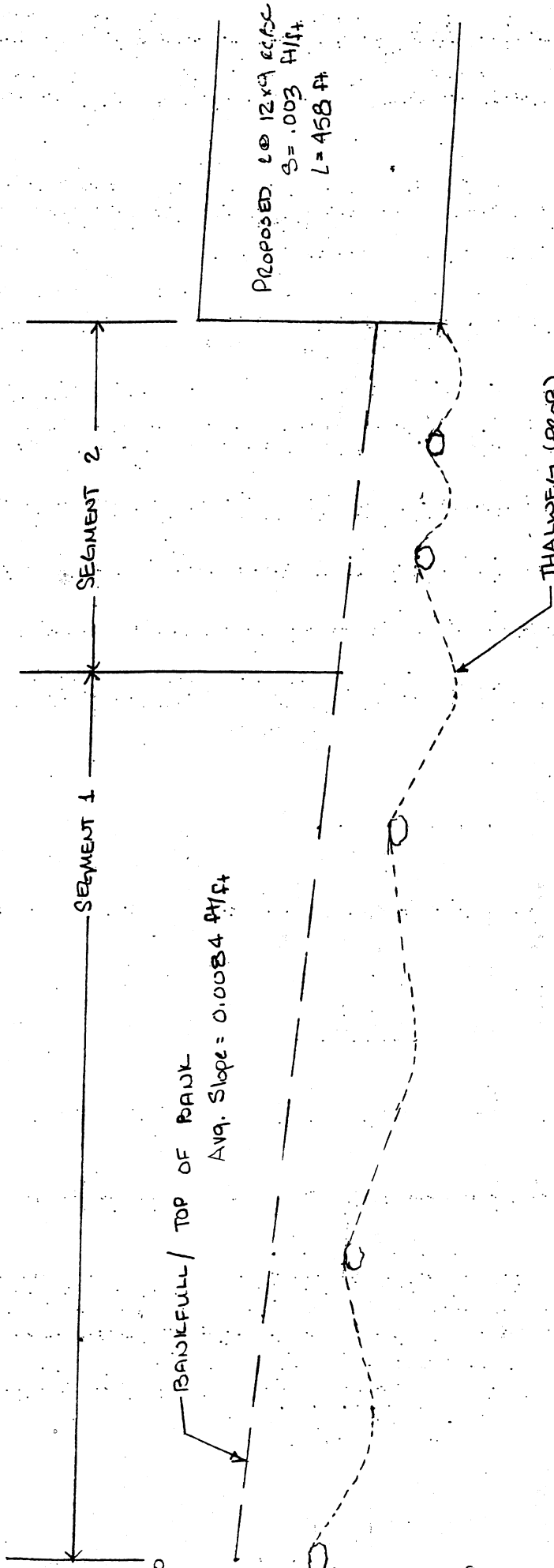
### **Segment 3**

Based on pebble counts and bar samples taken along the existing channel, the D50 averages 0.8 mm and the D84 averages approximately 10.0 mm. The existing channel exhibits a critical shear stress of 0.50 lbs/ft<sup>2</sup> which may entrain up to a 32 mm particle. Based on the design, the proposed channel will exhibit a critical shear stress of 0.33 lbs/ft<sup>2</sup> entraining up to a 18 mm particle. This increase in entrainment will not induce degradation as the active bed sample produced a D84 of 18mm. In addition, cross vanes will be installed throughout the riffle sections to further reduce the possibility of additional channel degradation.

### **References**

North Carolina Department of Environment and Natural Resources (NCDENR), 1998. Yadkin/Pee Dee Basinwide Water Quality Management Plan.

Rosgen, D. and L. Silvey, 1998. Field Guide for Stream Classification. Wildland Hydrology, Inc.



B-3151 - MICHAEL'S BLAWIE  
 PROPOSED CHANNEL PROFILE  
 SEGMENTS 1 & 2

LEWINGTON  
 DAVIDSON CO.

0 100 200 300 400 500

Sheet 11 of 31

0122103

SEGMENT 3

PROPOSED  
2012.19 R.P.C.  
S = 0.003 ft/ft  
L = 450'

BANKFULL TOP OF BANK  
AVG. SLOPE = 0.0028 ft/ft

PROPOSED THAWERS

EXISTING  
BEDROCK

800

900

1000

1100

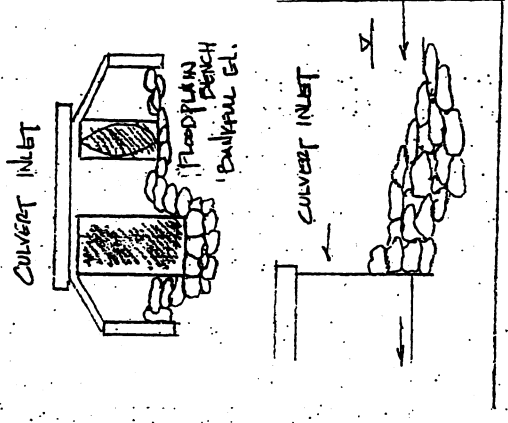
1200

1300

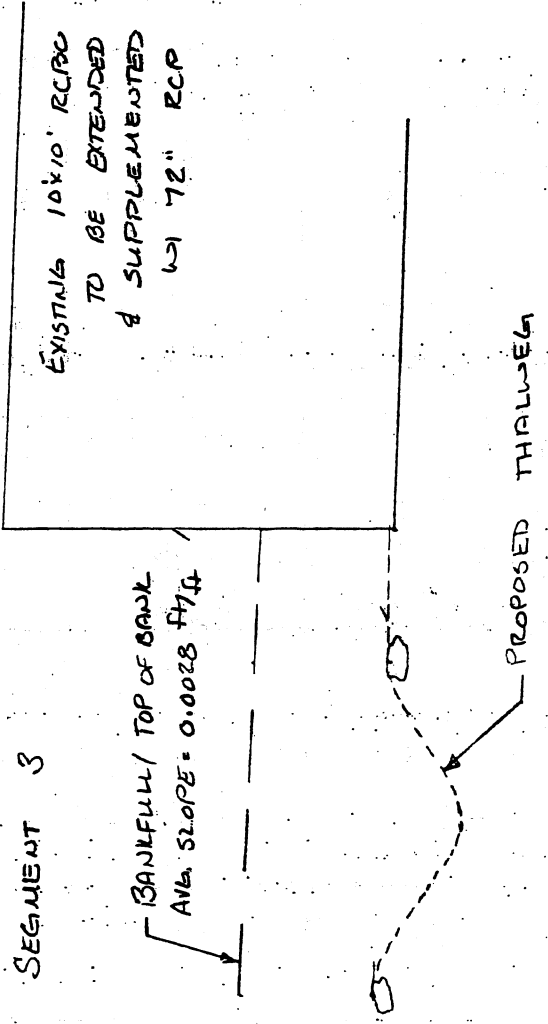
B-3157 - MICHAEL'S BRANCH  
PROPOSED CHANNEL PROFILE  
SEGMENT 3  
LEXINGTON, DAVIDSON CO.

Sheet 12 of 31

W127103



DETAIL OF CULVERT  
INLET w/ SUPPLEMENTAL PIPE



B-3157- MICHAEL'S BRAND  
PROPOSED CHANNEL PROFILE  
SEGMENT 3  
LEXINGTON, DAVIDSON CO.

4/27/03

Sheet 13 of 31

1000

1500

1400

1300

Appendix B

Morphological Measurement Table (Seg. #1)

Variables	Existing Channel	Proposed Reach	Reference Reach	Reference Reach
1. Stream type	G5*	C4/5	C5-Urban	C4
2. Drainage area	0.77 sq.mi.	0.77 sq. mi.	0.28 sq. mi.	0.26 sq. mi.
3. Bankfull width	13 ft.	21 ft.	12.5 ft.	9.5 ft.
4. Bankfull mean depth	2.07 ft.	1.4 ft.	0.9 ft.	0.8 ft.
5. Width/depth ratio	6.28	15	13.8	11.7
6. Bankfull cross-sectional area	27 sq. ft.	30 sq. ft.	11.4 sq. ft.	7.7 sq. ft.
7. Bankfull mean velocity	6.32 ft/s	5.6 ft/s		
8. Bankfull discharge, cfs	170 cfs	170 cfs		
9. Bankfull max depth	3.48 ft.	2.1 ft.	1.3 ft.	1.3 ft.
10. Width of floodprone area	30 ft.	100 ft.	90 ft.	36 ft.
11. Entrenchment ratio	2.3	4.76	7.1	3.8
12. Meander length	116 ft.	230	Range:33-144 ft. Avg: 71 ft.	Range: 29-69 ft. Avg: 50.2 ft.
13. Ratio of meander length to bankfull width	8.92	10.9	5.7	5.3
14. Radius of curvature	32.0 ft.	Range: 55-135 ft. Avg: 89 ft.	Range: 11.1-38 ft. Avg: 18 ft.	Range: 5.3-22 ft. Avg: 9.7 ft.
15. Ratio of radius of curvature to bankfull width	2.46	4.2	1.4	1.02
16. Belt width	72.0 ft.	70 ft.	Range: 30-119 ft. Avg: 71 ft.	Range: 26-40 ft. Avg: 33 ft.
17. Meander width ratio	5.5	3.3	6	3.5
18. Sinuosity (stream length/valley length)	107	1.19	2.22	1.35
19. Valley slope	0.60%	1.00%	3%	0.76%
20. Average slope	0.56%	0.84%	1.30%	0.57%
21. Pool slope	0.14%	0.08%	0.11%	0.0005%
22. Ratio of pool slope to average slope	0.25	0.1	0.085	0.082
23. Maximum pool depth	4.2 ft.	4.0 ft.	2.3 ft.	2.9 ft.
24. Ratio of pool depth to average bankfull depth	1.8	2.85	2.56	3.6
25. Pool width	38 ft.	25 ft.	10.7 ft.	10.5 ft.
26. Ratio of pool width to bankfull width	2.9	1.2	0.86	1.1
27. Pool to pool spacing	190 ft.	115 ft.	Range: 18-58 ft. Avg: 36.5 ft.	Range: 20.7-54.8 ft. Avg: 40.2 ft.
28. Ratio of pool to pool spacing to bankfull width	14.6	5.5	2.92	4.23

\*Entrenchment ratio is greater than 2.2 but the stream is functioning as an G type channel.

# Entrainment Calculation Form

Project: B-3157 Segment #1  
 Stream: Michael's Branch  
 Date: 5/19/2003

Location: Lexington, NC  
 Reach: Proposed Channel  
 Observers: JSF, CSC

Critical Dimensionless Shear Stress		
$T_{ci} = 0.0834(d_i/d_{50})^{-0.872}$		
Value	Variable	Definition
38	di mm	D50 from Riffle or Pavement*
38	d50 mm	D50 from Bar Sample or Sub Pavement*
0.0055	Tci	Critical Dimensionless Shear Stress
Bankfull Mean Depth Required for Entrainment of largest particle in Bar Sample $d_r = (T_{ci} \cdot 1.65 \cdot D_i) / S_e$ 1.65 = submerged specific weight of sediment		
38	mm	Largest Bar Sample Particle in mm
0.12	Di ft	Largest Bar Sample Particle in ft
0.0084	Se ft/ft	Bankfull Water Surface Slope
0.14	dr ft.	Bankfull Mean Depth Required
1.40	de ft	Bankfull Mean Depth (From Riffle Cross Section)
de/dr =	10.35	if = 1 <1 >1 Stable aggrading Degrading
Bankfull Water Surface Slope Required for Entrainment of largest particle in Bar Sample $S_r = (T_{ci} \cdot 1.65 \cdot D_i) / d_e$ 1.65 = submerged specific weight of sediment		
0.12	Di ft	Largest Bar Sample Particle
1.40	de ft	Bankfull Mean Depth (From Riffle Cross Section)
0.0008	Sr ft/ft	Bankfull Water Surface Slope Required
Se/Sr =	10.35	if = 1 <1 >1 Stable aggrading Degrading
Sediment Transport Validation - Bankfull Shear Stress $T_c = \gamma R S$		
62.4	$\gamma$ lbs/cu ft	Density of water
1.26	R=A/Wp	
30	A sq ft	Bankfull Cross-Sectional Area
23.8	Wp	Wetted parameter
0.0084	S ft/ft	Bankfull Water Surface Slope (2*1.1)+14
0.660706	Tc lb/sqr ft	$T_c = \gamma R S$
38	Di mm	Largest Bar Sample Particle (mm)
Moveable Particle size (mm) at Bankfull Shear Stress		
40	mm	predicted by the Shields diagram, Red field book: p.190; Blue: p.238
0.62	lb/ft2	Predicted Shear Stress Required to move Di (lb/ft2) predicted by the Shields diagram, Red field book: p.190; Blue: p.238

## Appendix B

## Morphological Measurement Table (Seg. #2)

Variables	Existing Channel	Proposed Reach	Reference Reach	Reference Reach
1. Stream type	E4/5*	C4/5	C5-Urban	C4
2. Drainage area	1.04 sq. mi.	1.04 sq. mi.	0.28 sq. mi.	0.26 sq. mi.
3. Bankfull width	22.5 ft.	26 ft.	12.5 ft.	9.5 ft.
4. Bankfull mean depth	2.09 ft.	1.70 ft.	0.9 ft.	0.8 ft.
5. Width/depth ratio	9.7	15.3	13.8	11.7
6. Bankfull cross-sectional area	47 sq. ft.	44 sq. ft.	11.4 sq. ft.	7.7 sq. ft.
7. Bankfull mean velocity	5.98 ft/s	6.43 ft/s		
8. Bankfull discharge, cfs	280 cfs	280 cfs		
9. Bankfull max depth	3.3 ft.	2.55 ft.	1.3 ft.	1.3 ft.
10. Width of floodprone area	196.0 ft.	100 ft.	90 ft.	36 ft.
11. Entrenchment ratio	8.7	3.85	7.1	3.8
12. Meander length	116.0 ft	180 ft.	Range: 33-144 ft. Avg: 71 ft.	Range: 29-69 ft. Avg: 50.2 ft.
13. Ratio of meander length to bankfull width	5.15	6.9	5.7	5.3
14. Radius of curvature	32.0 ft.	Range: 55-80 ft. Avg: 67.5 ft.	Range: 11.1-38 ft. Avg: 18 ft.	Range: 5.3-22 ft. Avg: 9.7 ft.
15. Ratio of radius of curvature to bankfull width	1.06	2.6	1.4	1.02
16. Belt width	72.0 ft.	72.0 ft.	Range: 30-119 ft. Avg: 71 ft.	Range: 26-40 ft. Avg: 33 ft.
17. Meander width ratio	3.2	2.8	6	3.5
18. Sinuosity (stream length/valley length)	1.07	1.2	2.22	1.35
19. Valley slope	0.60%	1.00%	3.00%	0.76%
20. Average slope	0.56%	0.84%	1.30%	0.57%
21. Pool slope	0.14%	0.08%	0.11%	0.0005%
22. Ratio of pool slope to average slope	0.25	0.1	0.09	0.082
23. Maximum pool depth	4.20 ft.	4.0 ft.	2.30 ft.	2.9 ft.
24. Ratio of pool depth to average bankfull depth	2.00	2.35	2.56	3.6
25. Pool width	38.0 ft.	31 ft.	10.7 ft.	10.5 ft.
26. Ratio of pool width to bankfull width	1.69	1.22	0.86	1.1
27. Pool to pool spacing	190.0 ft.	85 ft.	Range: 18-58 ft. Avg: 36.5 ft.	Range: 20.7-54.8 ft. Avg: 40.2 ft.
28. Ratio of pool to pool spacing to bankfull width	8.44	3.26	2.92	4.23

\*Based on numbers the existing channel classifies as an E; however, the stream is severely incised and unstable.



# Entrainment Calculation Form

Project: B-3157 (segment 2)  
 Stream: Michael's Branch  
 Date: 5/21/2003

Location: Lexington, NC  
 Reach: Proposed Channel  
 Observers: JFS, CLM

Critical Dimensionless Shear Stress		
$T_{ci} = 0.0834(d_i/d_{50})^{0.872}$		
Value	Variable	Definition
0.18	di mm	D50 from Riffle or Pavement* <span style="float: right;">Choose one</span>
0.6	d50 mm	D50 from Bar Sample or Sub Pavement* <span style="float: right;">Choose one</span>
0.0055	Tci	Critical Dimensionless Shear Stress
Bankfull Mean Depth Required for Entrainment of largest particle in Bar Sample $d_r = (T_{ci} \cdot 1.65 \cdot D_i) / S_e$ 1.65 = submerged specific weight of sediment		
38	mm	Largest Bar Sample Particle in mm
0.12	Di ft	Largest Bar Sample Particle in ft
0.0084	Se ft/ft	Proposed Bankfull Water Surface Slope
0.14	dr ft	Bankfull Mean Depth Required
1.70	de ft	Proposed Bankfull Mean Depth (From Riffle Cross Section)
de/dr =	12.57	if = 1 <1 >1 Stable aggrading Degrading
Bankfull Water Surface Slope Required for Entrainment of largest particle in Bar Sample $S_r = (T_{ci} \cdot 1.65 \cdot D_i) / d_e$ 1.65 = submerged specific weight of sediment		
0.12	Di ft	Largest Bar Sample Particle
1.70	de ft	Proposed Bankfull Mean Depth (From Riffle Cross Section)
0.0007	Sr ft/ft	Bankfull Water Surface Slope Required
Se/Sr =	12.57	if = 1 <1 >1 Stable aggrading Degrading
Sediment Transport Validation - Bankfull Shear Stress $T_c = \gamma R S$		
62.4	$\gamma$ lbs/cu ft	Density of water
1.50	R=A/Wp	Hydraulic Radius
44	A sq ft	Proposed Bankfull Cross-Sectional Area
29.4	Wp	Wetted Perimeter
0.0084	S ft/ft	Proposed Bankfull Water Surface Slope (2*1.1)+14
0.784457	Tc lb/sqr ft	$T_c = \gamma R S$
38	Di mm	Largest Bar Sample Particle (mm)
48	mm	Moveable Particle size (mm) at Bankfull Shear Stress predicted by the Sheilds diagram, Red field book: p.190; Blue: p.238
0.62	lb/ft2	Predicted Shear Stress Required to move Di (lb/ft2) predicted by the Sheilds diagram, Red field book: p.190; Blue: p.238

## Appendix B

## Morphological Measurement Table (Seg. #3)

Variables	Existing Channel	Proposed Reach	Reference Reach	Reference Reach
1. Stream type	G5-Urban*	C5	C5-Urban	C4
2. Drainage area	1.04 sq. mi.	1.04 sq. mi.	0.28 sq. mi.	0.26 sq. mi.
3. Bankfull width	21.0 ft.	28 ft.	12.5 ft.	9.5 ft.
4. Bankfull mean depth	2.51 ft.	2.25 ft.	0.9 ft.	0.8 ft.
5. Width/depth ratio	8	12.4	13.8	11.7
6. Bankfull cross-sectional area	50.3 sq. ft.	63 sq. ft.	11.4 sq. ft.	7.7 sq. ft.
7. Bankfull mean velocity	5.43 ft/s	4.45 ft/s		4.55 ft/s
8. Bankfull discharge, cfs	280 cfs	280 cfs		35 cfs
9. Bankfull max depth	3.8 ft.	3.4 ft.	1.3 ft.	1.3 ft.
10. Width of floodprone area	46.0 ft.	95 ft.	90 ft.	36 ft.
11. Entrenchment ratio	2.3	3.4	7.1	3.8
12. Meander length	Not Available	Range: 100-200 ft. Avg: 138 ft.	Range: 33-144 ft. Avg: 71.0 ft.	Range: 29-69 ft. Avg: 50.2 ft.
13. Ratio of meander length to bankfull width	Not Available	4.6	5.7	5.3
14. Radius of curvature	60.0 ft.	Range: 55-87.5 ft. Avg: 69 ft.	Range: 11.1+-38 ft. Avg: 18 ft.	Range: 5.3-22 ft. Avg: 9.7 ft.
15. Ratio of radius of curvature to bankfull width	2.86	2.5	1.4	1.02
16. Belt width	75.0 ft.	Range: 40-70 ft. Avg: 55 ft.	Range: 30-119 ft. Avg: 71 ft.	Range: 26-40 ft. Avg: 33 ft.
17. Meander width ratio	3.57	2.0	6.0	3.5
18. Sinuosity (stream length/valley length)	1.07	1.45	2.22	1.35
19. Valley slope	0.40%	0.40%	3%	0.76%
20. Average slope	0.40%	0.28%	1.30%	0.57%
21. Pool slope	0.17%	0.03%	0.11%	0.0005%
22. Ratio of pool slope to average slope	0.43	0.1	0.09	0.082
23. Maximum pool depth	3.77 ft.	5.5 ft.	2.30 ft.	2.9 ft.
24. Ratio of pool depth to average bankfull depth	1.5	2.4	2.56	3:6
25. Pool width	19.5 ft.	33.6 ft.	10.7 ft.	10.5 ft.
26. Ratio of pool width to bankfull width	0.93	1.2	0.86	1.1
27. Pool to pool spacing	106.8 ft.	Range: 46-107 ft. Avg: 75 ft.	Range: 18-58 ft. Avg: 36.5 ft.	Range: 20.7-54.8 ft. Avg: 40.2 ft.
28. Ratio of pool to pool spacing to bankfull width	5.09	2.67	2.92	4.23

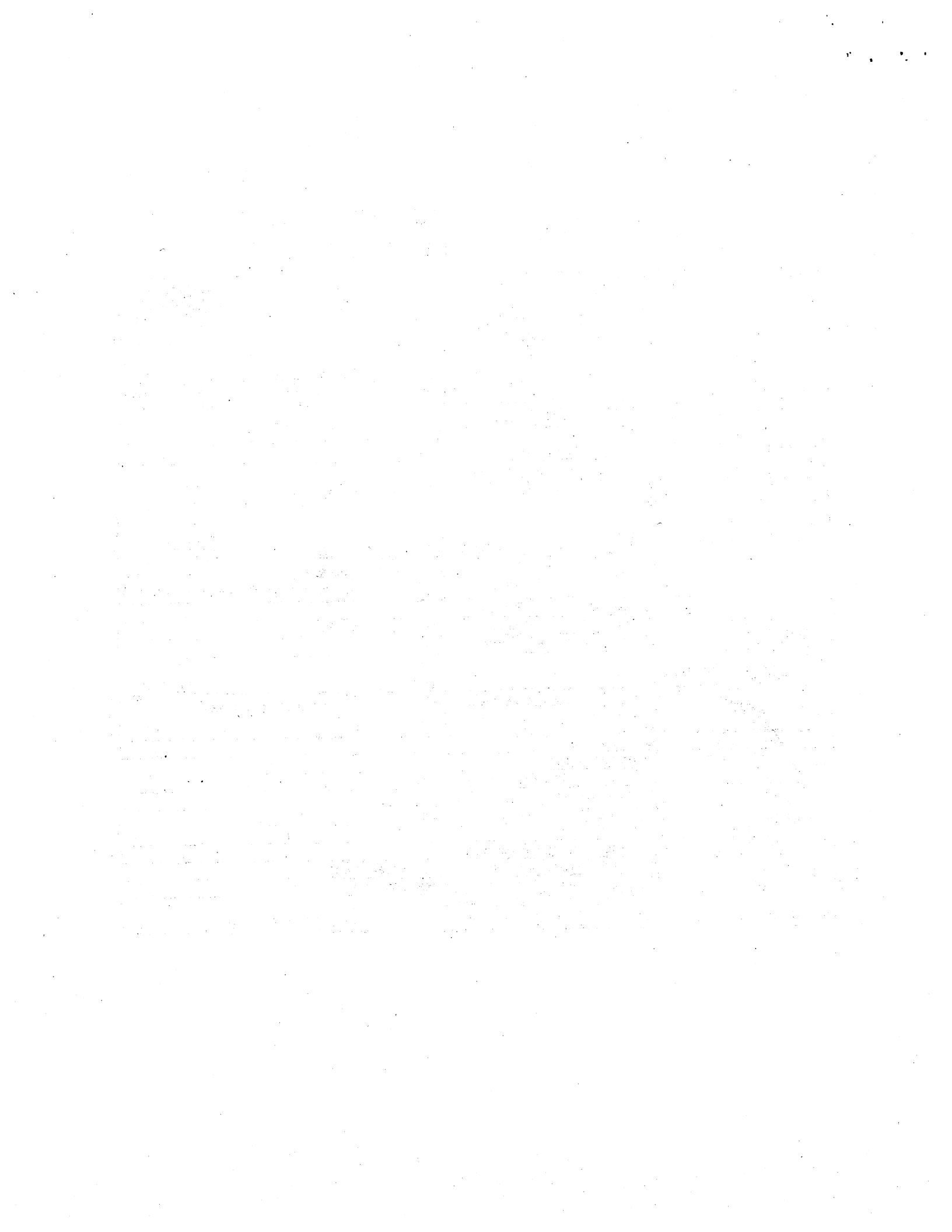
\*Entrenchment ratio is greater the 2.2 but the stream is functioning as a "G".

# Entrainment Calculation Form

Project: B-3157 (Segment 3)  
 Stream: Michael's Branch  
 Date: 5/22/2003

Location: Lexington, NC  
 Reach: Proposed Channel  
 Observers: GLS, TBB, CSC

Critical Dimensionless Shear Stress: $T_{ci} = 0.0834(d_i/d_{50})^{-0.872}$		
Value	Variable	Definition
18	di mm	D50 from Riffle or Pavement*
0.5	d50 mm	D50 from Bar Sample or Sub Pavement*
0.0055	Tci	Critical Dimensionless Shear Stress
<b>Bankfull Mean Depth Required for Entrainment of largest particle in Bar Sample: <math>d_r = (T_{ci} \cdot 1.65 \cdot D_i) / S_e</math> 1.65 = submerged specific weight of sediment</b>		
18	mm	Largest Bar Sample Particle in mm
0.06	Di ft	Largest Bar Sample Particle in ft
0.0028	Se ft/ft	Proposed Bankfull Water Surface Slope
0.20	dr ft	Bankfull Mean Depth Required
2.25	de ft	Proposed Bankfull Mean Depth (From Riffle Cross Section)
de/dr=	11.50	if = 1 <1 >1 Stable aggrading Degrading
<b>Bankfull Water Surface Slope Required for Entrainment of largest particle in Bar Sample: <math>S_r = (T_{ci} \cdot 1.65 \cdot D_i) / d_e</math> 1.65 = submerged specific weight of sediment</b>		
0.06	Di ft	Largest Bar Sample Particle
2.25	de ft	Proposed Bankfull Mean Depth (From Riffle Cross Section)
0.0002	Sr ft/ft	Bankfull Water Surface Slope Required
Se/Sr=	11.50	if = 1 <1 >1 Stable aggrading Degrading
<b>Sediment Transport Validation - Bankfull Shear Stress <math>T_c = \gamma R S</math></b>		
62.4	$\gamma$ lbs/cu ft	Density of water
1.94	R=A/Wp	Hydraulic Radius
63	A sq ft	Proposed Bankfull Cross-Sectional Area
32.5	Wp	Wetted Perimeter
0.0028	S ft/ft	Proposed Bankfull Water Surface Slope (2*1.1)+14
0.33264	Tc lb/sqr ft	$T_c = \gamma R S$
18	Di mm	Largest Bar Sample Particle (mm)
18	mm	Moveable Particle size (mm) at Bankfull Shear Stress predicted by the Shields diagram, Red field book: p.190; Blue: p.238
0.33	lb/ft2	Predicted Shear Stress Required to move Di (lb/ft2) predicted by the Shields diagram, Red field book: p.190; Blue: p.238

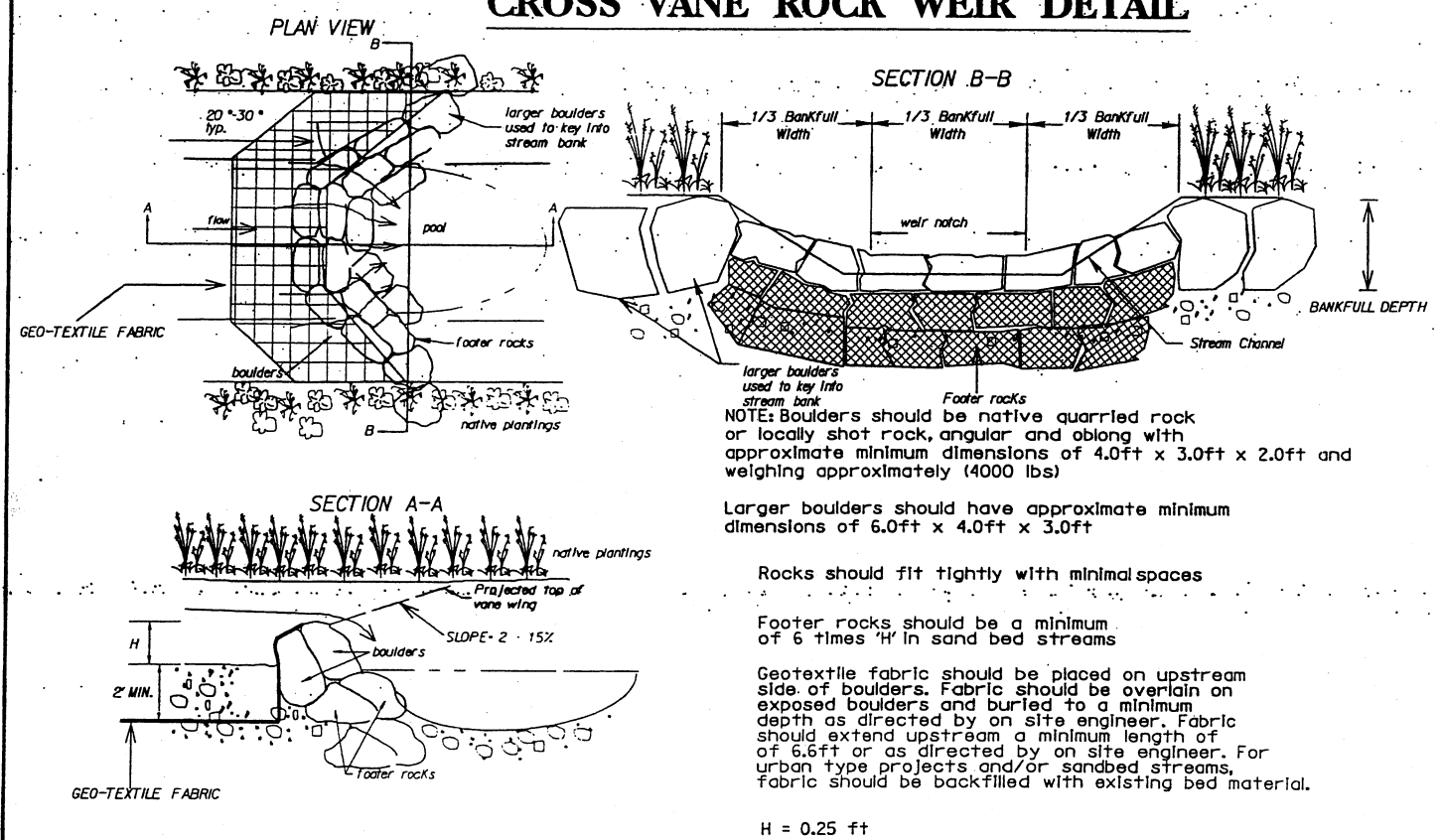


# NATURAL CHANNEL DESIGN TYPICALS

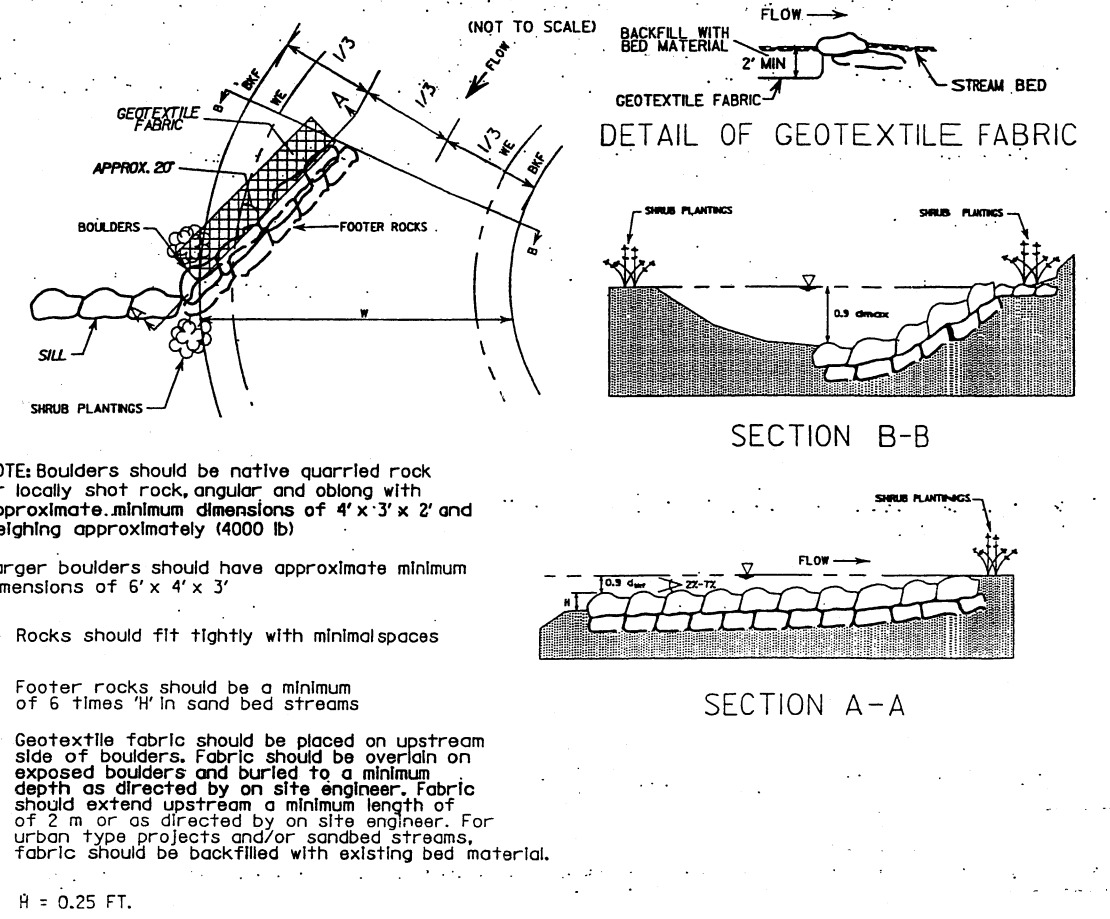
NOT TO SCALE

sheet 20 of 31

## CROSS VANE ROCK WEIR DETAIL



## ROCK VANE



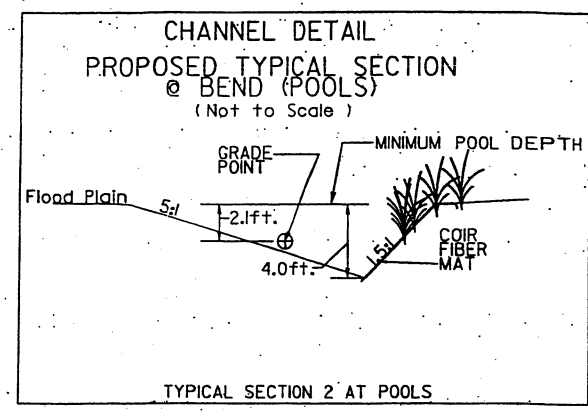
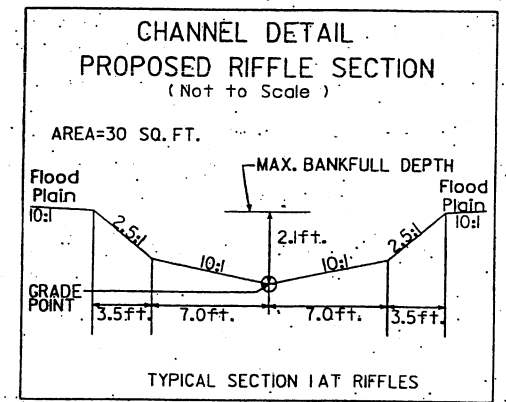
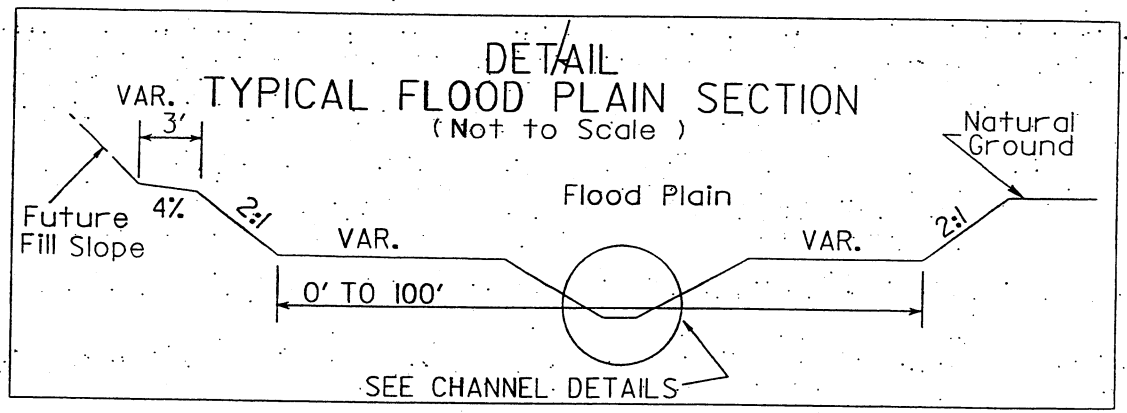
CROSS VANE TYPICAL

ROCK VANE TYPICAL

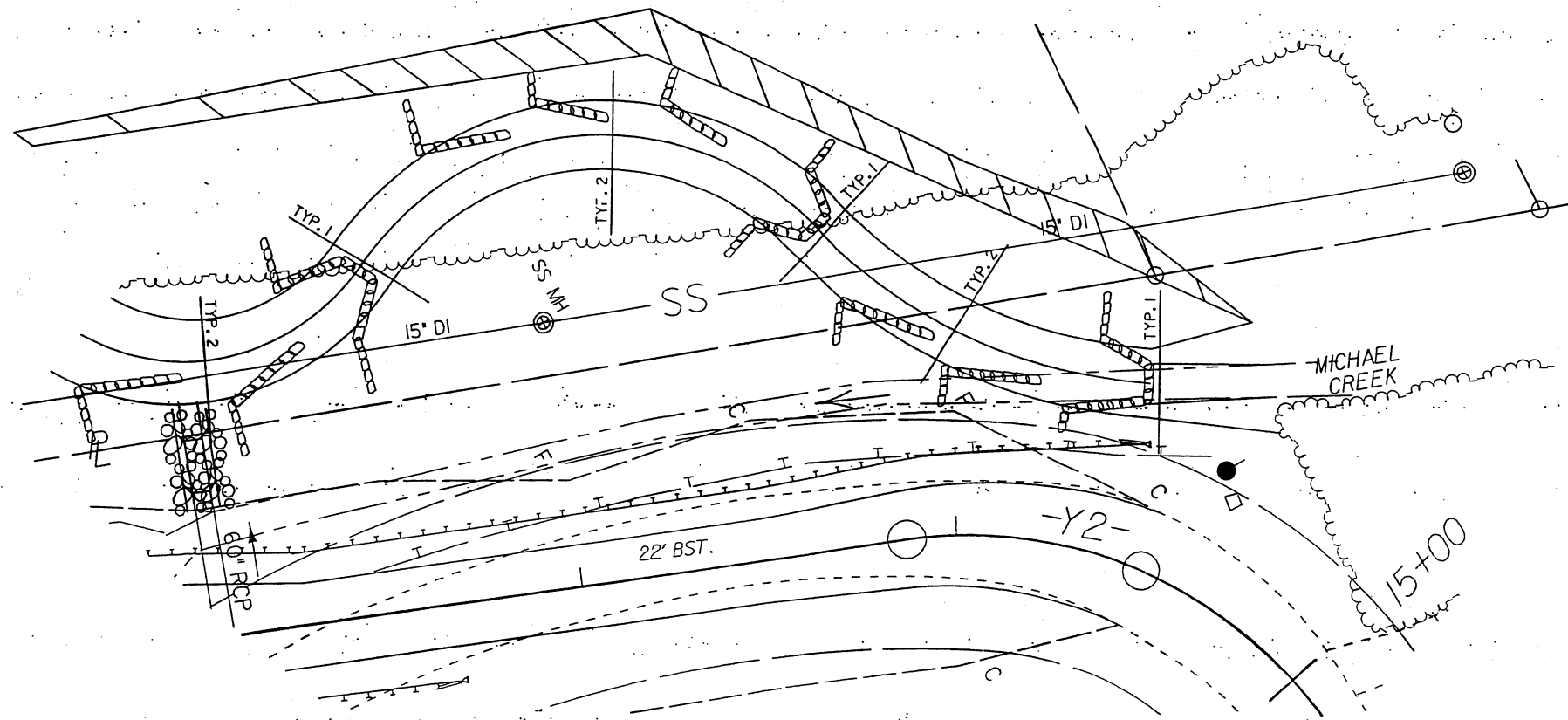
# NATURAL CHANNEL DESIGN TYPICALS

NOT TO SCALE

Sheet 21 of 31



- QUANTITIES**
- DDE = 6500CY
  - BOULDERS = 200@4000LB.  
55@2000LB.
  - COIR FIBER MAT = 300SY
  - GEOTEXTILE FABRIC = 200SY



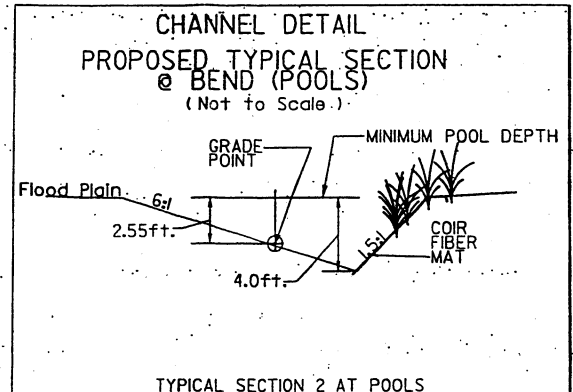
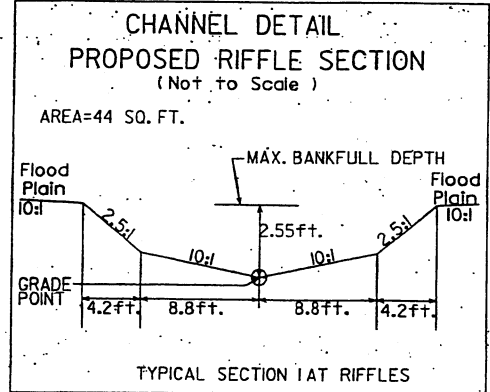
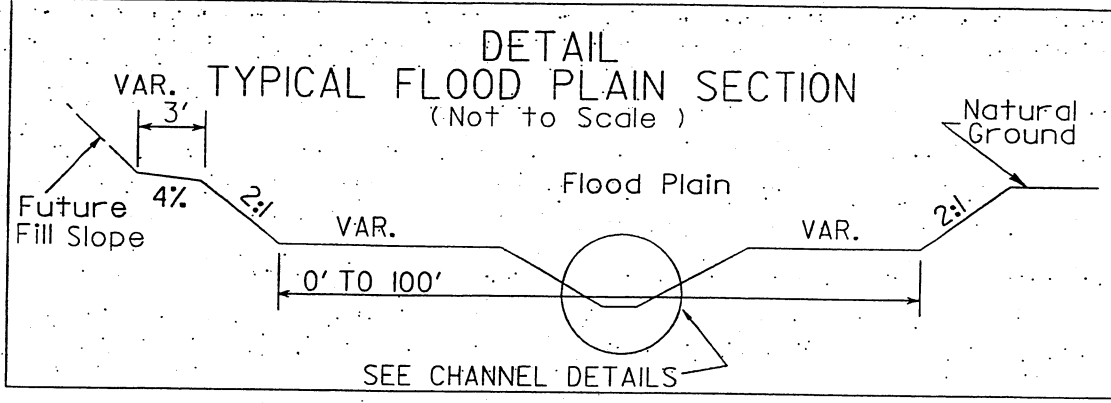
## CHANNEL PLAN VIEW SEGMENT #1

STA. 12+02 TO 14+52 -Y2- LEFT

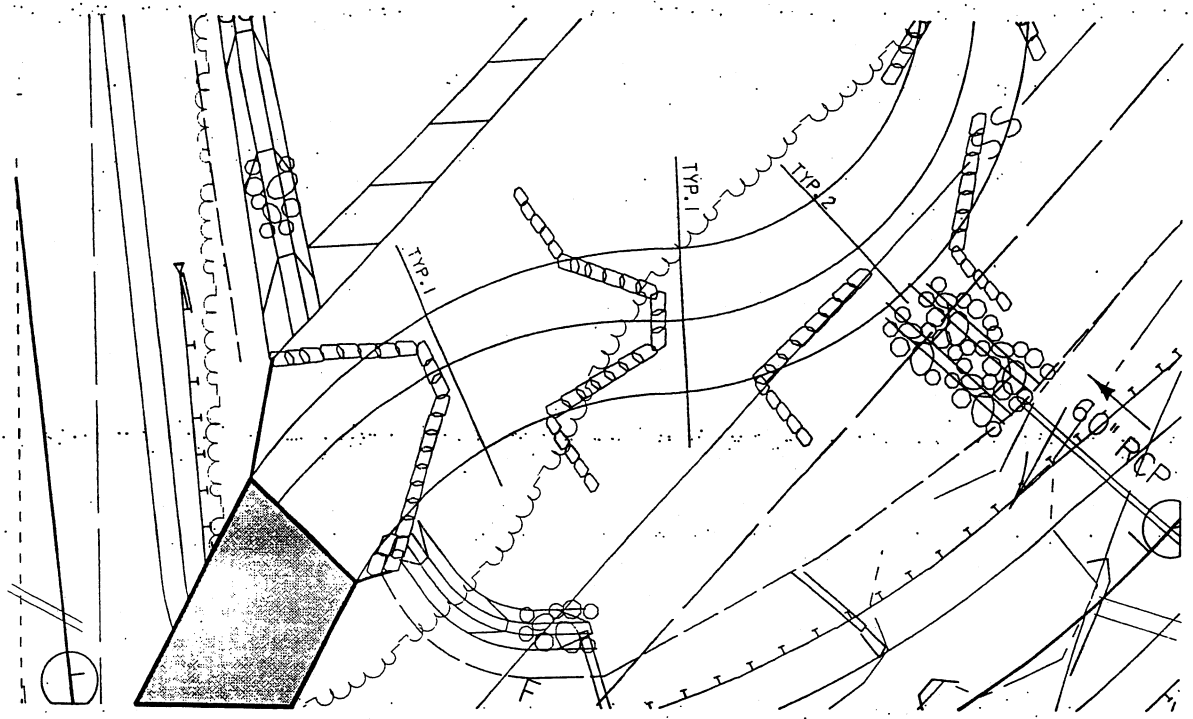
# NATURAL CHANNEL DESIGN TYPICALS

NOT TO SCALE

Sheet 22 of 31



- QUANTITIES**  
 DDE = 3300CY  
 BOULDERS = 100@4000LB.  
 20@2000LB.  
 COIR FIBER MAT = 120SY  
 GEOTEXTILE FABRIC = 90SY



## CHANNEL PLAN VIEW SEGMENT #2

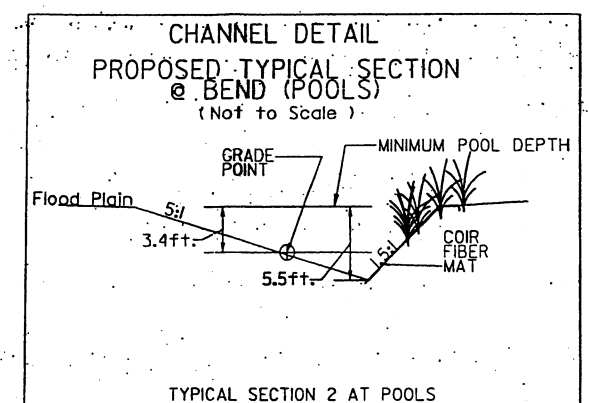
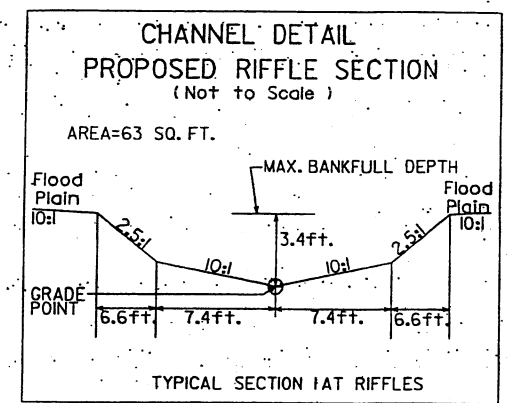
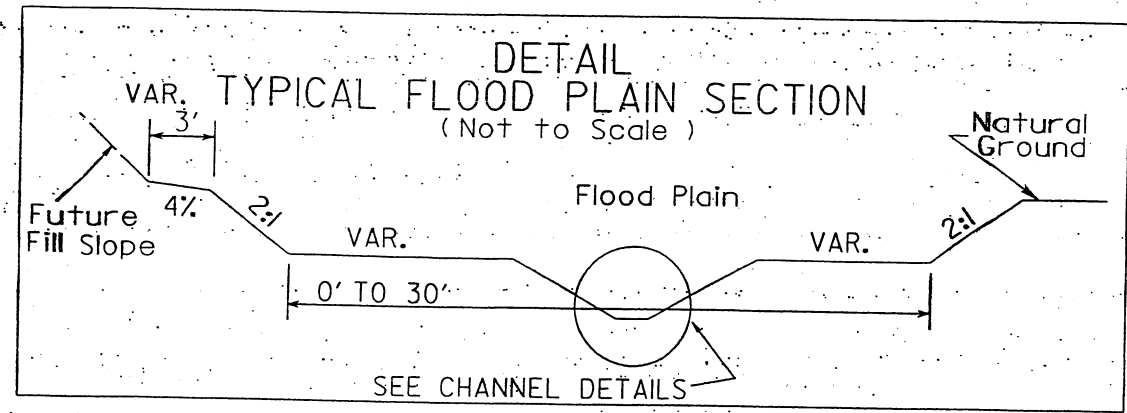
STA. 10+35.6 TO 12+02 -Y2- LEFT

**PRELIMINARY PLANS**  
 DO NOT USE FOR R/W ACQUISITION  
**INCOMPLETE PLANS**  
 DO NOT USE FOR CONSTRUCTION

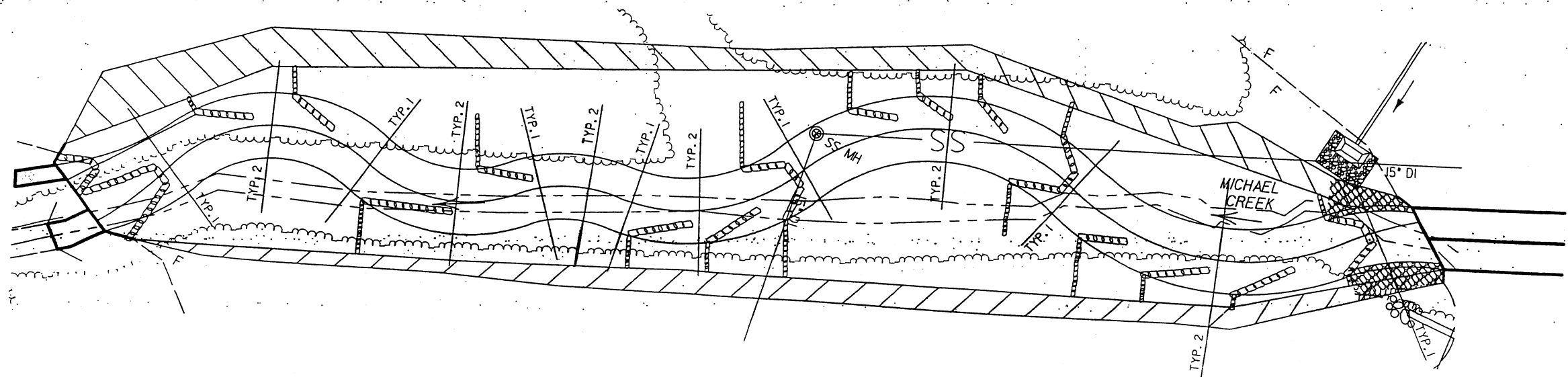
# NATURAL CHANNEL DESIGN TYPICALS

NOT TO SCALE

Sheet 23 of 31



**QUANTITIES**  
 DDE = 14500CY  
 BOULDERS = 300@4000LB.  
 270@2000LB.  
 COIR FIBER MAT = 850SY  
 GEOTEXTILE FABRIC = 600SY



## CHANNEL PLAN VIEW SEGMENT #3

STA. 21+45 TO 25+93.3 -YI- RIGHT





Sheet 24 of 31

# SEGMENT #3

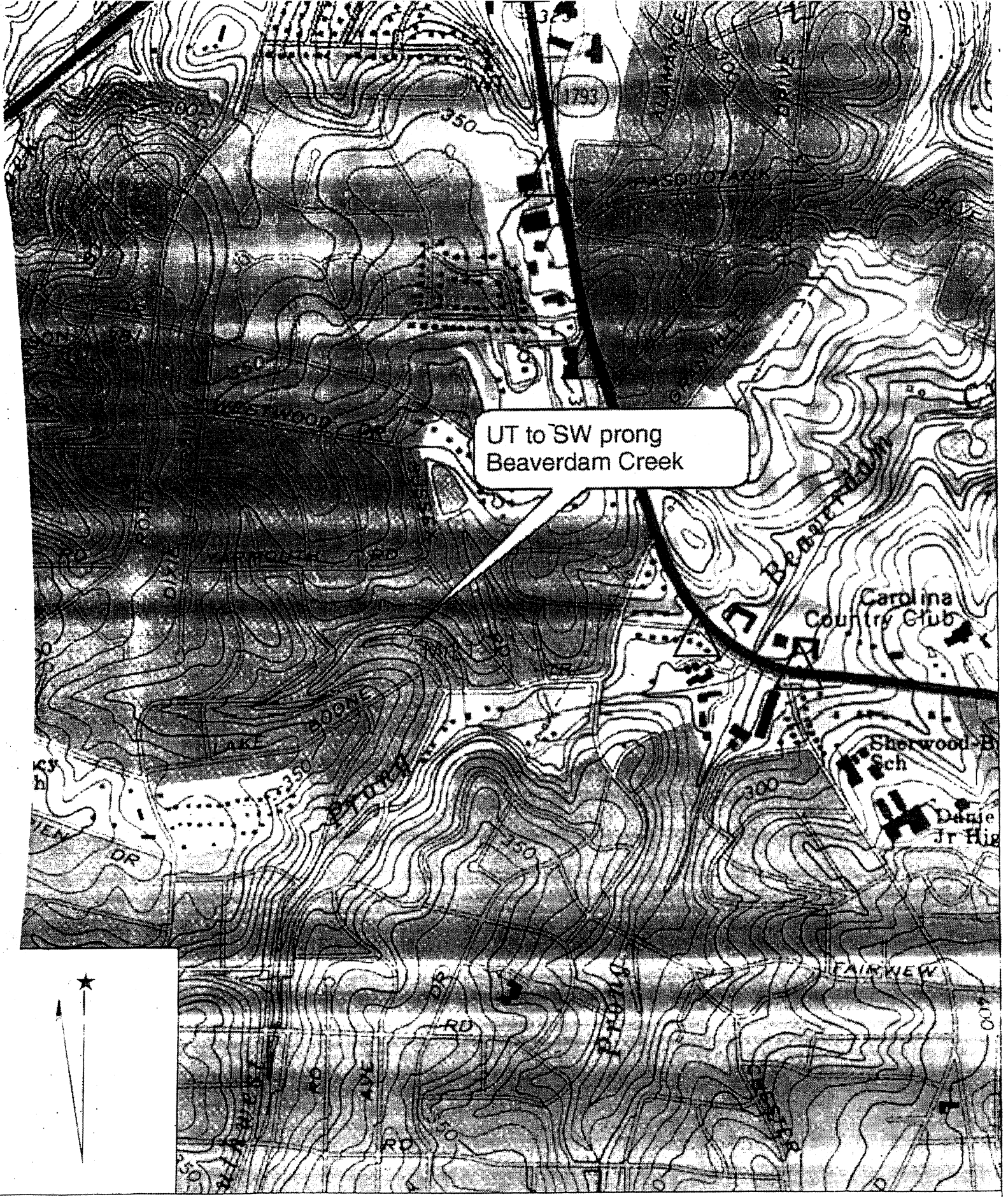
# SEGMENT #1

	STA. (-Y2-)	OFFSET	Rc	Lc	GRADE POINT ELEVATION	BANKFULL ELEVATION
PC	14+37.6	47.0' RT			715.5'	717.8'
PI	13+99.6	43.2' RT	126.5'	100.4'		
PT	13+73.4	84.9' RT			714.6'	716.9'
PC	13+73.4	84.9' RT			714.6'	716.9'
PI	13+16.0	165.3' RT	77.5'	140.4'		
PT	12+51.6	90.3' RT			713.4'	715.7'
PC	12+51.6	90.3' RT			713.4'	715.7'
PI	12+11.8	47.0' RT	55.7'	86.8'		
PT	11+45.0	84.0' RT			712.6'	714.9'

# SEGMENT #2

	STA. (-Y2-)	OFFSET	Rc	Lc	GRADE POINT ELEVATION	BANKFULL ELEVATION
PC	14+45.0	84.0' RT			712.6'	714.9'
PI	10+73.6	99.4' RT	80.0'	76.3'		
PT	10+35.6	68.4' RT			712.0'	714.3'

	STA. (-Y1-)	OFFSET	Rc	Lc	GRADE POINT ELEVATION	BANKFULL ELEVATION
PC	21+45.0	95.1' RT			710.60'	712.90'
PI	21+59.8	98.2' RT	130.0'	30.9'		
PT	21+75.3	97.6' RT			710.40'	712.70'
PC	21+75.3	97.6' RT			710.40'	712.70'
PI	22+41.6	96.1' RT	100.0'	117.5'		
PT	22+66.4	157.2' RT			710.25'	712.55'
PC	22+66.4	157.2' RT			710.25'	712.55'
PI	22+95.7	218.9' RT	80.0'	114.2'		
PT	23+56.7	197.7' RT			710.00'	712.30'
PC	23+56.7	197.7' RT			710.00'	712.30'
PI	23+92.8	190.1' RT	75.0'	72.8'		
PT	24+18.5	218.2' RT			709.70'	712.00'
PC	24+18.5	218.2' RT			709.70'	712.00'
PI	24+30.6	231.9' RT	55.0'	36.5'		
PT	24+47.8	234.7' RT			709.60'	711.90'
PC	24+47.8	234.7' RT			709.60'	711.90'
PI	24+79.9	237.1' RT	60'	63.5'		
PT	24+93.3	269.0' RT			709.40'	711.70'
PC	24+93.3	269.0' RT			709.40'	711.70'
PI	25+10.4	320.3' RT	55.0'	86.2'		
PT	25+56.4	302.0' RT			709.15'	711.45'
PC	25+56.4	302.0' RT			709.15'	711.45'
PI	25+80.0	297.4' RT	150.0'	33.8'		
PT	25+86.1	296.6' RT			709.00'	711.30'

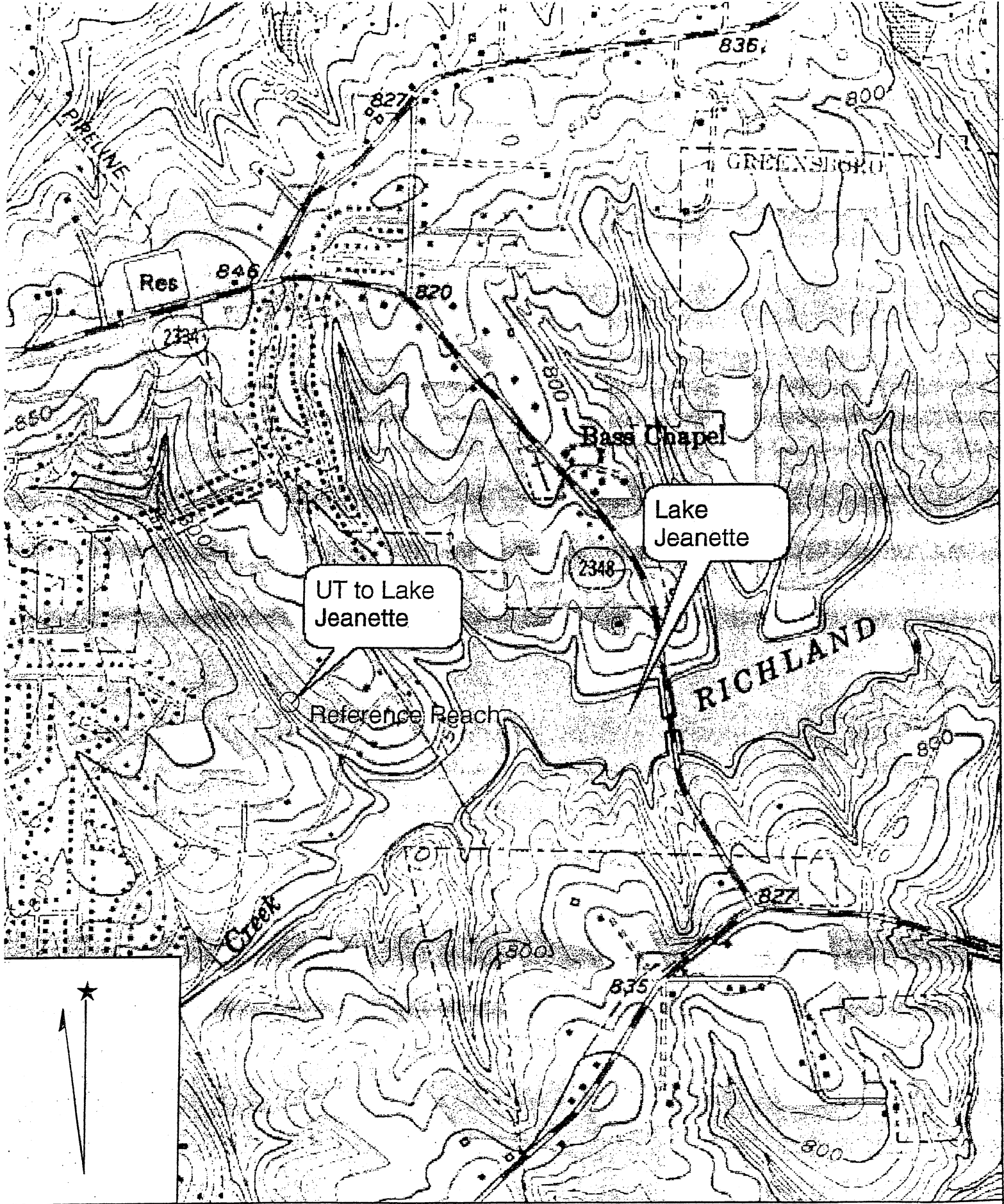


UT to SW prong  
Beaverdam Creek

Name: RALEIGH WEST  
Date: 11/4/2003  
Scale: 1 inch equals 1000 feet

Location: 035° 49' 05.61" N 078° 40' 05.31" W

Sheet 26 of 31



Name: LAKE BRANDT  
Date: 11/4/2003  
Scale: 1 inch equals 1000 feet

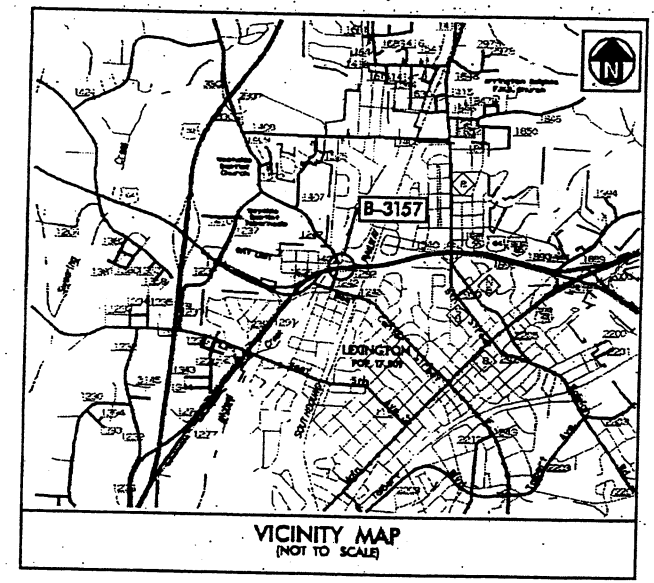
Location: 036° 09' 10.50" N 079° 49' 02.83" W

Sheet 25 of 31

B-3157

PROJECT: 8.1601402

See Sheet 1-A For Index of Sheets  
See Sheet 1-B For Conventional Symbols

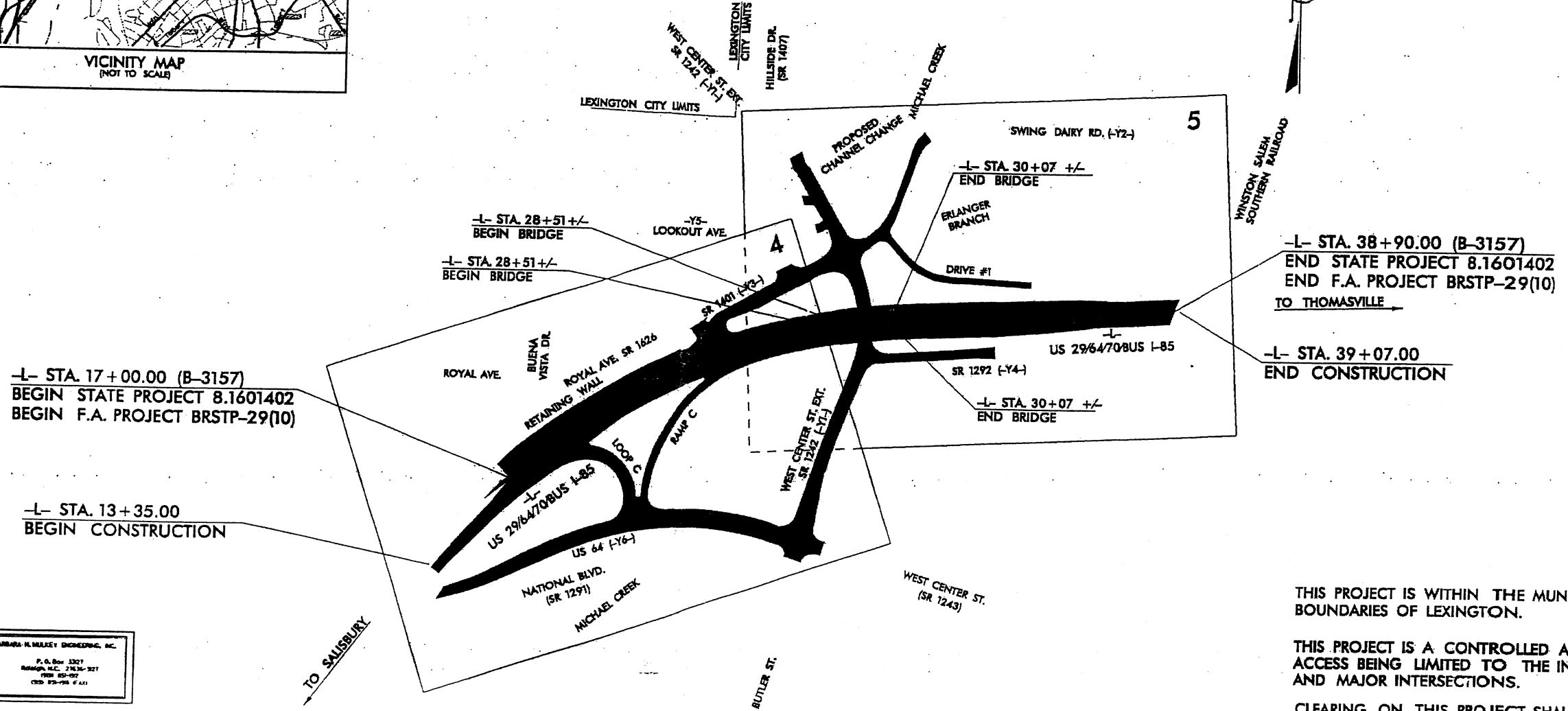


# STATE OF NORTH CAROLINA DIVISION OF HIGHWAYS DAVIDSON COUNTY

LOCATION: BRIDGE NOS. 74 AND 76 OVER SR 1242 AND MICHAEL CREEK  
AND APPROACHES ON US 29/6470 & I-85 BUSINESS  
TYPE OF WORK: GRADING, PAVING, DRAINAGE, GUARDRAIL, CULVERTS, STRUCTURES, AND SIGNING

STATE	STATE PROJECT REFERENCE NO.	SHEET NO.	TOTAL SHEETS
N.C.	8.1601402	1	
STATE PROJ. NO.	F.A. PROJ. NO.	DESCRIPTION	
8.1601401	BRSTP-29(10)	P.E.	
8.1601402	BRSTP-29(10)	RW, UTIL.	

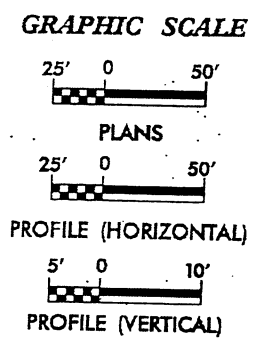
stream impact drawing  
sheet 27 of 31



THIS PROJECT IS WITHIN THE MUNICIPAL BOUNDARIES OF LEXINGTON.

THIS PROJECT IS A CONTROLLED ACCESS PROJECT WITH ACCESS BEING LIMITED TO THE INTERCHANGE AND MAJOR INTERSECTIONS.

CLEARING ON THIS PROJECT SHALL BE PERFORMED TO THE LIMITS ESTABLISHED BY METHOD III.



DESIGN DATA

ADT 2002 =	26,400
ADT 2023 =	42,160
DHV =	10%
D =	60%
T =	9% *
V =	60 mph

\* (Duals = 5% + TTST = 4%)

PROJECT LENGTH

LENGTH ROADWAY F.A. PROJECT BRSTP-29(10)	= 0.385 MILE
LENGTH STRUCTURES F.A. PROJECT BRSTP-29(10)	= 0.030 MILE
TOTAL LENGTH STATE PROJECT 8.1601402	= 0.415 MILE

Prepared in the Office of:  
**Barbara H. Mulkey Engineering, Inc.**  
FOR THE NORTH CAROLINA DEPARTMENT OF TRANSPORTATION  
2002 STANDARD SPECIFICATIONS

RIGHT OF WAY DATE:  
SEPTEMBER 20, 2002

LETTING DATE:  
JULY 15, 2003

NCDOT CONTACT: **CATHY S. HOUSER, P.E.**  
DESIGN SERVICES - PROJECT ENGINEER

HYDRAULICS ENGINEER

ROADWAY DESIGN

PRELIMINARY PLANS  
DO NOT USE FOR CONSTRUCTION

DIVISION OF HIGHWAYS  
STATE OF NORTH CAROLINA

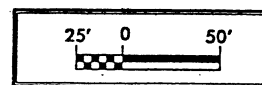
STATE HIGHWAY ENGINEER - DESIGN

DEPARTMENT OF TRANSPORTATION  
FEDERAL HIGHWAY ADMINISTRATION

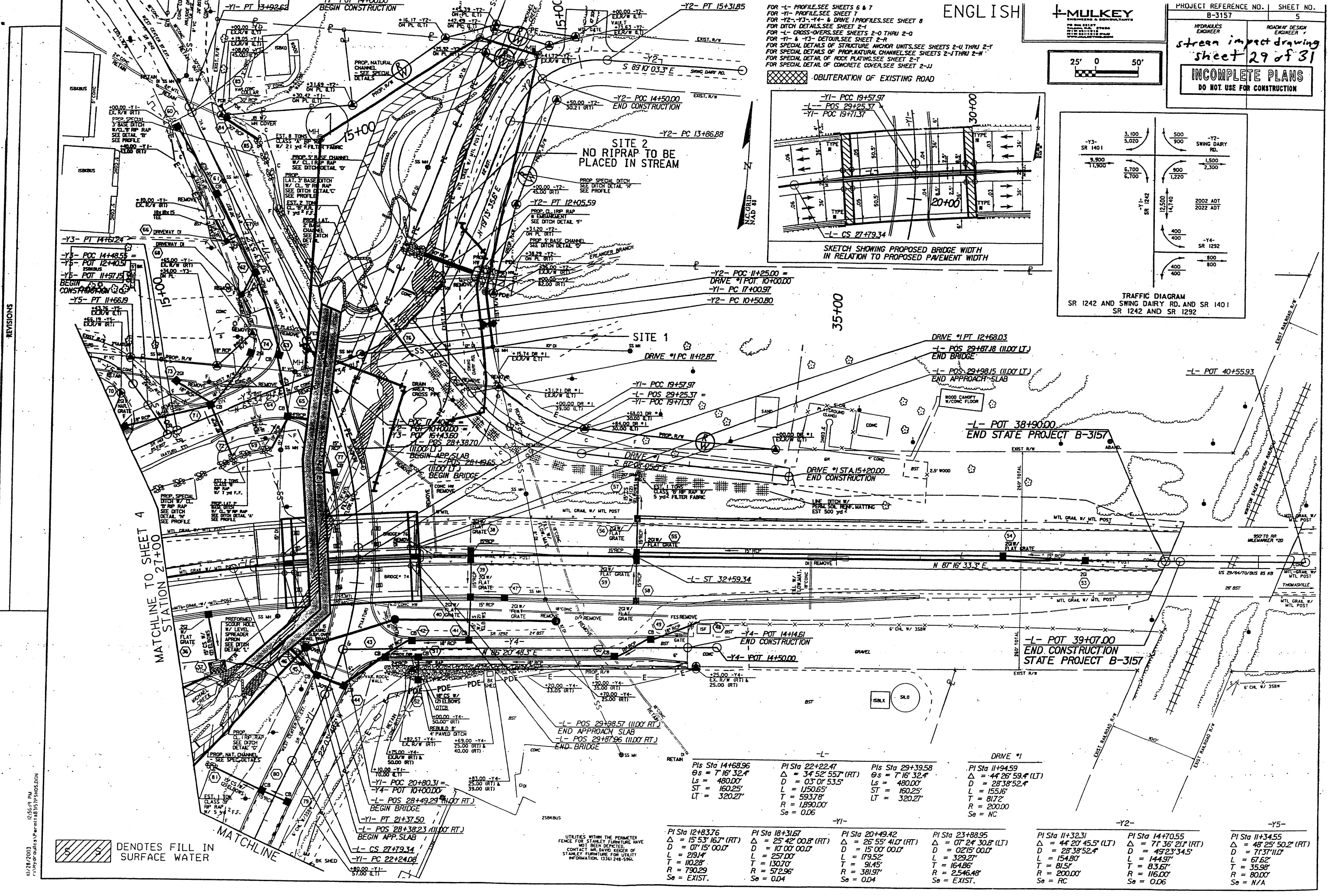
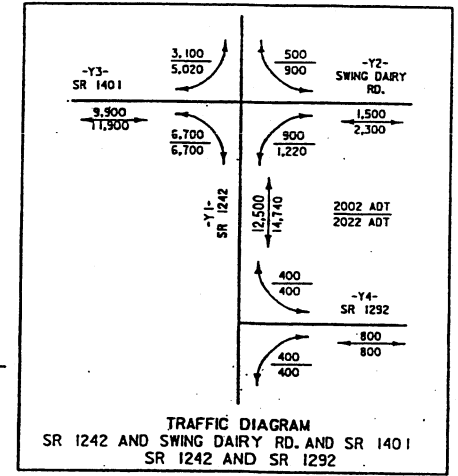
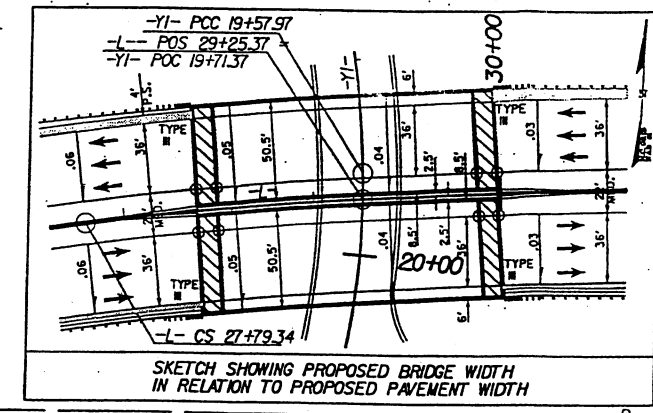
APPROVED FOR  
DIVISION ADMINISTRATOR







FOR -L- PROFILE, SEE SHEETS 6 & 7  
FOR -Y1- PROFILE, SEE SHEET 7  
FOR -Y2-, -Y3-, -Y4- & DRIVE 1 PROFILES, SEE SHEET 8  
FOR DITCH DETAILS, SEE SHEET 2-I  
FOR -L- CROSS-OVERS, SEE SHEETS 2-O THRU 2-Q  
FOR -Y1- & -Y3- DETOURS, SEE SHEET 2-R  
FOR SPECIAL DETAILS OF STRUCTURE ANCHOR UNITS, SEE SHEETS 2-U THRU 2-Y  
FOR SPECIAL DETAILS OF PROP. NATURAL CHANNEL, SEE SHEETS 2-J THRU 2-N  
FOR SPECIAL DETAIL OF ROCK PLATING, SEE SHEET 2-T  
FOR SPECIAL DETAIL OF CONCRETE COVER, SEE SHEET 2-JJ



SITE 2  
NO RIPRAP TO BE PLACED IN STREAM

SITE 1

MATCHLINE TO SHEET 4  
STATION 27+00

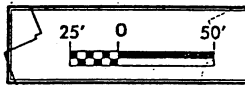
MATCHLINE

5 DENOTES FILL IN SURFACE WATER

UTILITIES WITHIN THE PERMETER FENCE FOR STANLEY FURNITURE HAVE NOT BEEN DEPICTED. CONTACT MR. DAVID REGER OF STANLEY FURNITURE FOR UTILITY INFORMATION. (336) 248-5961

Table of curve data for Drive 1, Drive 2, Drive 3, Drive 4, Drive 5, Drive 6, Drive 7, Drive 8, Drive 9, Drive 10, Drive 11, Drive 12, Drive 13, Drive 14, Drive 15, Drive 16, Drive 17, Drive 18, Drive 19, Drive 20, Drive 21, Drive 22, Drive 23, Drive 24, Drive 25, Drive 26, Drive 27, Drive 28, Drive 29, Drive 30, Drive 31, Drive 32, Drive 33, Drive 34, Drive 35, Drive 36, Drive 37, Drive 38, Drive 39, Drive 40, Drive 41, Drive 42, Drive 43, Drive 44, Drive 45, Drive 46, Drive 47, Drive 48, Drive 49, Drive 50, Drive 51, Drive 52, Drive 53, Drive 54, Drive 55, Drive 56, Drive 57, Drive 58, Drive 59, Drive 60, Drive 61, Drive 62, Drive 63, Drive 64, Drive 65, Drive 66, Drive 67, Drive 68, Drive 69, Drive 70, Drive 71, Drive 72, Drive 73, Drive 74, Drive 75, Drive 76, Drive 77, Drive 78, Drive 79, Drive 80, Drive 81, Drive 82, Drive 83, Drive 84, Drive 85, Drive 86, Drive 87, Drive 88, Drive 89, Drive 90, Drive 91, Drive 92, Drive 93, Drive 94, Drive 95, Drive 96, Drive 97, Drive 98, Drive 99, Drive 100.

stream impact drawing  
Sheet 30 of 31  
INCOMPLETE PLANS  
DO NOT USE FOR CONSTRUCTION



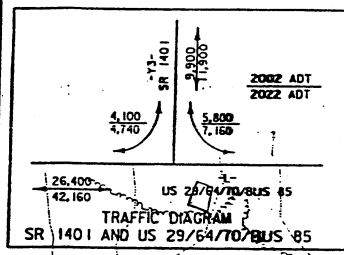
ENGLISH

Denotes fill in surface water

Pls Sta 14+68.96 θs = 7°16'32.4" Ls = 480.00' ST = 160.25' LT = 320.27'	Pls Sta 22+22.47 Δ = 34°52'55.7" (RT) D = 030°53.5" L = 150.65' T = 593.78' R = 1890.00' S <sub>e</sub> = 0.06	Pls Sta 29+39.58 θs = 7°16'32.4" Ls = 480.00' ST = 160.25' LT = 320.27'	Pls Sta 11+92.38 Δ = 25°58'44.3" (RT) D = 81°5'04.0" L = 317.4' T = 1615' R = 70.00' S <sub>e</sub> = NC	Pls Sta 14+267.6 Δ = 02°45'35.6" (RT) D = 04°00'00" L = 68.98' T = 34.50' R = 1432.33' S <sub>e</sub> = NC	Pls Sta 24+55.50 Δ = 10°23'06.6" (LT) D = 2°15'00" L = 48.56' T = 231.42' R = 2546.48' S <sub>e</sub> = EXIST.	Pls Sta 27+66.75 Δ = 8°05'50.0" (RT) D = 5°00'00" L = 161.94' T = 811' R = 1145.92' R = EXIST.
---	--	---	--	--	--	--

RAMP C

Pls Sta 1+00.24 θs = 12°02'40.3" Ls = 168.00' ST = 68.34' LT = 100.24' Δ1 = 3°05'19.4" Δ2 = 11°15'00.0" R1 = 1855.00' R2 = 509.30'	Pls Sta 4+80.12 Δ = 63°00'13.5" (RT) D = 11°15'00" L = 560.03' T = 312.12' R = 509.30' S <sub>e</sub> = 0.06
--	--



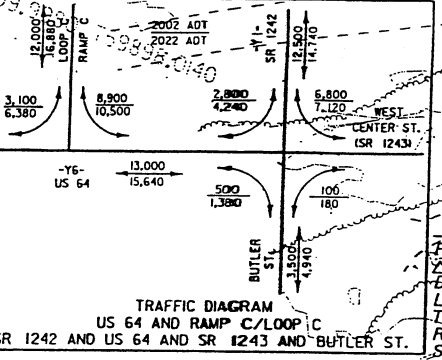
LOOP C

Pls Sta 0+93.89 θs = 38°11'49.9" Ls = 1440' ST = 52.95' LT = 93.89' Δ1 = 3°05'19.4" Δ2 = 38°11'49.9" R1 = 1855.00' R2 = 150.00'	Pls Sta 3+17.06 Δ = 98°09'52.6" (RT) D = 38°11'49.9" L = 256.99' T = 173.06' R = 150.00' S <sub>e</sub> = 0.06
---	--

-L- POC 17+00.00  
BEGIN STATE PROJECT B-3157

-L- POS 13+35.00  
BEGIN CONSTRUCTION

Y6- POC 12+44.81  
BEGIN CONSTRUCTION



Pls Sta 11+71.6 Δ = 20°19'25.3" (LT) D = 6°00'00" L = 338.73' T = 171.6' R = 954.93' S <sub>e</sub> = EXIST.	Pls Sta 13+98.78 θs = 05°24'00.0" Ls = 180.00' ST = 60.05' LT = 120.06'	Pls Sta 16+38.78 θs = 05°24'00.0" Ls = 180.00' ST = 60.05' LT = 120.06'	Pls Sta 20+13.39 Δ = 26°28'30.0" (RT) D = 6°00'00" L = 607.92' T = 314.65' R = 954.93' S <sub>e</sub> = 0.04
--	---	---	--

OBLITERATION OF EXISTING ROAD

FOR -L- PROFILE SEE SHEETS 6 & 7  
FOR -Y1- PROFILE SEE SHEET 8  
FOR -Y3- PROFILE SEE SHEET 9  
FOR -Y6- LOOP C & RAMP C PROFILES SEE SHEET 9  
FOR DITCH DETAILS SEE SHEET 2-1  
FOR -L- CROSS-OVERS & RAMP C DETOUR SEE SHEETS 2-0 THRU 2-0  
FOR SPECIAL DETAILS OF STRUCTURE ANCHOR UNITS SEE SHEETS 2-4 THRU 2-4  
FOR SPECIAL DETAILS OF PROP. NATURAL CHANNELS SEE SHEETS 2-1 THRU 2-1  
FOR SPECIAL DETAIL OF ROCK PLATING SEE SHEET 2-5  
FOR SPECIAL DETAIL OF SPECIAL HEADWALL SEE SHEET 2-11

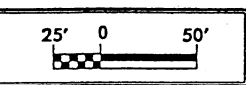
MATCHLINE TO SHEET 5  
STATION 27+00

MATCHLINE

END CONSTRUCTION

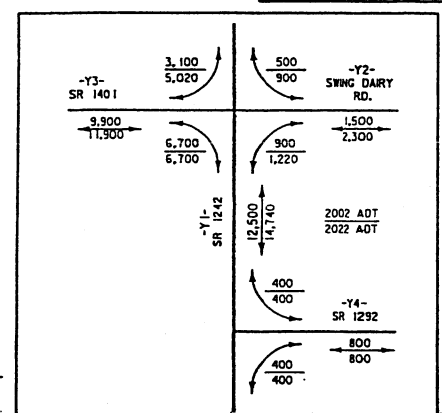
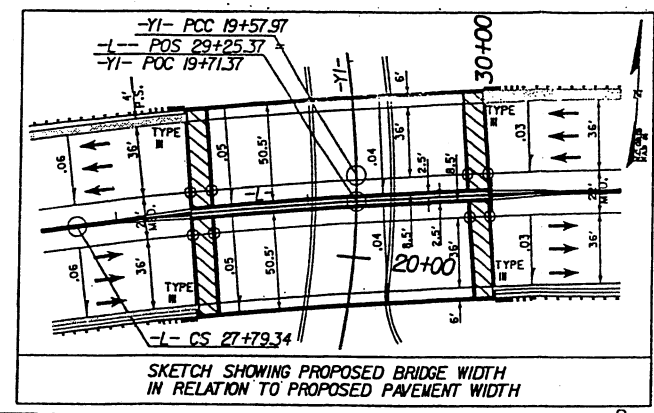
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FOR -L- PROFILE, SEE SHEETS 6 & 7  
FOR -Y1- PROFILE, SEE SHEET 7  
FOR -Y2-, -Y3-, -Y4- & DRIVE I PROFILES, SEE SHEET 8  
FOR DITCH DETAILS, SEE SHEET 2-1  
FOR -L- CROSS-OVERS, SEE SHEETS 2-0 THRU 2-0  
FOR -Y1- & -Y3- DETOURS, SEE SHEET 2-R  
FOR SPECIAL DETAILS OF STRUCTURE ANCHOR UNITS, SEE SHEETS 2-U THRU 2-Y  
FOR SPECIAL DETAILS OF PROP. NATURAL CHANNEL, SEE SHEETS 2-J THRU 2-N  
FOR SPECIAL DETAIL OF ROCK PLATING, SEE SHEET 2-T  
FOR SPECIAL DETAIL OF CONCRETE COVER, SEE SHEET 2-W

OBLETORATION OF EXISTING ROAD



TRAFFIC DIAGRAM  
SR 1242 AND SWING DAIRY RD. AND SR 1401  
SR 1242 AND SR 1292

SITE 2  
NO RIPRAP TO BE PLACED IN STREAM

SITE 1

MATCHLINE TO SHEET 4  
STATION 27+00

MATCHLINE  
STATION 27+00

DENOTES FILL IN SURFACE WATER

UTILITIES WITHIN THE PERIMETER FENCE FOR STANLEY FURNITURE HAVE NOT BEEN DEPICTED. CONTACT MR. DAVID KEGAN OF STANLEY FURNITURE FOR UTILITY INFORMATION. (336) 248-5964.

Table of curve data for Drive #1 and Drive #2, including stationing, PI, POC, and curve parameters.

REVISIONS

12:56:15 PM  
C:\pwork\mulkey\pwork\3157\3157.DWG