



STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

MICHAEL F. EASLEY
GOVERNOR

LYNDO TIPPETT
SECRETARY

July 9, 2004

U.S. Army Corps of Engineers
Raleigh Regulatory Field Office
6508 Falls of Neuse Road
Suite 120
Raleigh, NC 27615

ATTN: Mr. Eric Alsmeyer
NCDOT Coordinator

Dear Sir:

SUBJECT: Permit Modification Request for TIP No. U-2527, Vance County, Western Outer Loop from SR 1128 (Ruin Creek Road) to SR 1101 (Old County Home Road) near Henderson, Federal Aid No. STP-0509(2), State Project No. 8.2390201, NCDOT Division 5, \$475 Debit WBS Element 34822.1.1.

Reference: USACE 404 Individual Permit, Action ID: 199708127, issued March 25, 2004
NCDWQ Major 401 Water Quality Certification, WQC 031494, issued February 13, 2004.
NCDWQ Buffer Certification, WQC 031494, issued February 13, 2004.

The U.S. Army Corps of Engineers (USACE) issued an Individual Permit for the above referenced project on March 25, 2004 (Action ID 199708127). This permit authorized 2,368 ft of stream impacts and 0.06 ac of wetland impacts. The N.C. Division of Water Quality (NCDWQ) issued a 401 Water Quality Certification and Tar-Pamlico River Buffer Certification for this project on February 19, 2004 (WQC Project No. 031494). This certification authorized 127,710 square feet of riparian buffer impacts in Zone 1 and 86,284 square feet of riparian buffer impacts in Zone 2.

USACE, 401 Water Quality Certification, and Tar-Pamlico River Buffer Certification special conditions direct the permittee to ensure that the construction design plans for this project do not deviate from the permit plans. It further directs the permittee to forward

any deviation in the construction design plans to the USACE and NCDWQ prior to any active construction in waters and wetlands.

The purpose of this letter is to request modifications to the CWA Section 404 Individual Permit issued by the USACE, the 401 Water Quality Certification issued by the NC Division of Water Quality (DWQ), and Riparian Buffer Certification issued by DWQ. Revised permit drawings are attached. A revised natural stream design plan is also attached.

NCDOT Division 5 has recently completed a pre-Let environmental review associated with this project. The pre-let review is based on the final roadway construction plan sheets, permit drawings and other information that may be present in the permit application. The review identified all permit drawing and plan sheet discrepancies as well as other associated constructability concerns that can be identified during the pre-construction phase of this project. The following information presents the findings of this comprehensive review. The following table summarizes old impact numbers and new impact numbers by site.

Stream Site	Buffer Site	Old Stream Impact (ft/ac)	New Stream Impact (ft/ac)	Old Buffer Impact (ac/ft ²)	New Buffer Impact (ac/ft ²)
1	1	174/0	174/0	0.39/17,054	0.39/17,054
2	2	272/0.06	272/0.06	0.53/23,037	0.53/23,037
3	3	266/0.11	266/0.13	0.49/21,520	0.55/23,958
4	4	262/0.07	262/0.07	0.17/7,521	0.17/7,521
5	5	394/0.03	410/0.03	0.57/24,662	0.57/24,662
6	6	223/0.11	233/0.11	0.34/14,601	0.34/14,601
7	7	777/0.18	777/0.18	0.80/35,056	0.82/35,719.2
	8			0.46/20,014	0.46/20,014
	9			1.16/50,529	1.20/52,272
Total		2368/0.56	2394/0.58	4.91/213,994	5.03/218,838.2

- Stream site 3, buffer site 3 (permit drawing 7, 24, and 25, plan sheet 7, Station 23+40)
 Issue: The plan sheet indicates the presence of rip rap along the northern streambank immediately upstream of the relocated channel at the inlet of the culvert. This rip rap is not depicted on the permit drawing.
 Issue: The plan sheet indicates the presence of a relocated channel, rip rap and a lateral base ditch immediately upstream of the inlet of the culvert. These impacts are not depicted on the permit drawing.
 Issue: The plan sheet indicates the presence of rip rap immediately downstream of the outlet of the culvert. The impact associated with this rip rap is not entirely depicted as a buffer impact on the permit drawing.
 Issue: There is a discrepancy in the depiction of the western fill slope between the permit drawing and the plan sheet.
 Status: The permit drawing has been modified to depict rip rap along the streambank, the additional buffer impacts and the correct fill slope. **This resulted in an increase**

of stream impact of 0.02 ac and an increase of riparian buffer impact of 0.03 ac (1306.8 square ft) in Zone 1 and 0.03 ac (1306.8 square feet) in Zone 2.

- Stream site 4, buffer site 5 (permit drawing 9 and 27, plan sheet 8, Station 26+00 to 26+30)

Issue: The plan sheet indicates that the cross pipe located at Station 26+58 is a 600mm structure. The permit drawing indicates that this cross pipe is a 450mm structure.

Issue: The plan sheet indicates the presence of a cross vane downstream of the outlet of the structure. The impact associated with the cross vane is not depicted as a buffer impact on the permit drawing.

Status: The permit drawing has been modified to depict the correct size of the structure and additional buffer impact. **This resulted in no change to stream or riparian buffer impacts.**

- Stream site 5, buffer site 7 (permit drawing 10 and 29, plan sheet 11, Station 36+72)

Issue: There is a discrepancy in the depiction of the southern fill slope between the permit drawing and the plan sheet.

Issue: The plan sheet depicts the installation of Class I rip rap along the streambank at the outlet of the cross pipe. The permit drawing depicts Class B rip rap at this location.

Issue: The plan sheet indicates the presence of rip rap at the outlet of the structure and lateral base ditches in the northwest and southwest quadrants. The impacts associated with the rip rap and the lateral base ditches are not entirely depicted as buffer impacts on the permit drawing.

Status: The permit drawing has been modified to depict the correct fill slope, size of rip rap and additional buffer impact. **This resulted in an increase of stream impact of 16.4 ft and an increase of riparian buffer impact of 0.02 ac (871.2 square ft) in Zone 2.**

- Stream site 6, buffer site 8 (permit drawing 11 and 30, plan sheet 12, erosion control sheet EC-13, Station 40+81)

Issue: The plan sheet depicts Structure 92 at Station 40+39 Rt and Structure 93 at Station 40+59 Rt. These structures are not depicted on the permit drawing.

Issue: The plan sheet depicts a Preformed Scour Hole (PSH) located outside of the riparian buffer at Station 40+90 Rt. This PSH is located inside of the riparian buffer on the permit drawing.

Issue: The tie in points of the temporary channel change as depicted on EC-13 are located outside of the permitted stream and buffer footprint as depicted on the permit drawing.

Issue: There are slight discrepancies in the depiction of the fill slopes in the northeast, northwest and southwest quadrants between the permit drawing and the plan sheet.

Issue: The plan sheet indicates the presence of rip rap at the inlet and outlet of the structure. The impact associated with the rip rap is not entirely depicted as buffer impacts on the permit drawing.

Status: The permit drawing has been modified to depict structures, the correct location of the PSH, revised stream impact, revised buffer impact, additional buffer impact and the correct fill slope. **This resulted in an increase of stream impact of 9.9 ft.**

- Stream site 7, buffer site 9 (permit drawing 12, 13, 31, and 32, plan sheet 14, Station 46+20)
Issue: The plan sheet depicts a lateral base ditch through the riparian buffer at Station 46+10 Rt. This lateral base ditch is not depicted on the permit drawing.
Issue: The plan sheet depicts a lateral base ditch at Station 46+30 Lt. This lateral base ditch is not depicted on the permit drawing.
Issue: The plan sheet depicts a 450mm cross pipe and an associated PSH at Station 47+40. The cross pipe and PSH are not depicted on the permit drawing.
Issue: The plan sheet depicts a small portion of the riparian buffer within the mechanized clearing limits of the project at Station 45+40 Rt. This buffer impact is not depicted on the permit drawing.
Status: The permit drawing has been modified to depict the lateral base ditches, cross pipe, additional buffer impact and PSH. **This resulted in an increase of riparian buffer impact of 0.03 ac (1306.8 square ft) in Zone 1 and 0.01 ac (435.6 square ft) in Zone 2.**

There will be an additional 26.3 ft (0.02 ac) of stream impacts, 0.06 ac (2613.6 square ft) of riparian buffer impacts in Zone 1, and 0.06 ac (2613.6 square ft) of riparian buffer impacts in Zone 2 due to these revisions. No additional mitigation is proposed for the additional stream impacts since the natural stream design is 2,592 ft and total revised stream impacts equal 2,394 ft. Mitigation is proposed for the additional riparian buffer impacts and NCDOT proposes to use the Ecosystem Enhancement Program for this mitigation. A copy of the request letter is attached.

The revised design does not compromise NCDOT's compliance with the existing permit conditions. No additional mitigation is proposed. The new impact sites have been evaluated for compliance with the avoidance/minimization criteria and are in compliance with all previous Individual Permit factors, including the following:

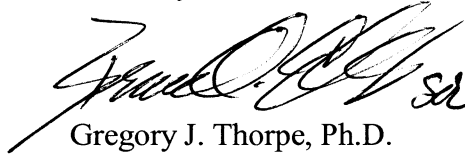
- Protected Species,
- Cultural Resources,
- Aquatic Life passage,
- FEMA compliance, and
- Utilities.

The NCDOT respectfully requests that the referenced CWA Section 404 Individual Permit, 401 Water Quality Certification, and Tar-Pamlico River Buffer Certification be modified to reflect the revisions outlined in this letter. In compliance with Section 143-215.3D(e) of the NCAC we will provide \$475 to act as payment for processing the Section 401 permit modification application previously noted in this application (see Subject line). We are providing seven copies of this application to the North Carolina

Department of Environment and Natural Resources, Division of Water Quality, for their review.

If you have any questions or need additional information, please contact Matt Haney at (919) 715-1428.

Sincerely,

A handwritten signature in black ink, appearing to read "Gregory J. Thorpe" with a stylized flourish at the end.

Gregory J. Thorpe, Ph.D.
Environmental Management Director, PDEA

Cc: Mr. David Franklin, COE, Wilmington (Cover Letter only)
Mr. John Hennessy, DWQ Raleigh (7 copies)
Mr. Travis Wilson, NCWRC
Ms. Becky Fox, EPA
Mr. Gary Jordan, USFWS
Mr. John F. Sullivan, III, FHWA
Mr. Jay Bennett, P.E., Roadway Design
Mr. Omar Sultan, Programming and TIP
Mr. Art McMillan, P.E., Design Services
Mr. David Chang, P.E., Hydraulics
Mr. Greg Perfetti, P.E., Structure Design
Mr. Mark Staley, Roadside Environmental
Mr. J.G. Nance, P.E., Division 5 Engineer
Mr. Chris Murray, Division 5 Environmental Officer
Mr. Bill Gilmore, P.E., EEP

File: U-2527

Attachments: Revised permit drawings
Revised natural stream design plan



STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

MICHAEL F. EASLEY
GOVERNOR

LYNDO TIPPETT
SECRETARY

July 7, 2004

Mr. William D. Gilmore, P.E.
EEP Transition Manager
Ecosystem Enhancement Program
1652 Mail Service Center
Raleigh, NC 27699-1652

Dear Sir:

Subject: Additional Request for Mitigation. Vance County. Western Outer Loop from SR 1128 (Ruin Creek Road) to SR 1101 (Old County Home Road) near Henderson. State Project No 8.2390201. TIP No. U-2527. NCDOT Division 5. Federal Aid Project No. STP-0509(2).

Reference: EEP request letter dated February 20, 2004.
EEP confirmation letter dated May 26, 2004.

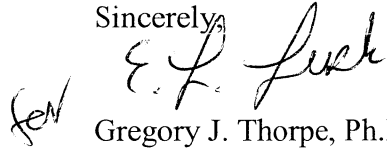
The North Carolina Department of Transportation (NCDOT) sent a letter to the North Carolina Ecosystem Enhancement Program (EEP) dated February 20, 2004 requesting that the EEP provide confirmation that you are willing to provide compensatory mitigation for the subject project. In this letter, we estimated that 214,072.7 square feet of riparian buffers will be impacted. We have since realized that there is an additional 2,613.6 square feet of riparian buffer impacts in Zone 1 and 2,613.6 square feet of riparian buffer impacts in Zone 2. Therefore, the riparian buffer impacts total 219,299.9 square feet. The riparian buffer impacts will occur adjacent to Red Bud Creek [DWQ# 28-17-2-3], a second order perennial stream, and to first and/or third order perennial streams and first order intermittent streams that are tributaries to Red Bud Creek.

We request that these impacts be included in the original request sent on February 20, 2004.

In order to satisfy regulatory assurances that mitigation will be performed, the NCDWQ requires a formal letter from EEP indicating their willingness and ability to provide the mitigation work requested by NCDOT. The NCDOT requests such a letter of confirmation be addressed to Mr. John Hennessy of NCDWQ, with copies submitted to NCDOT.

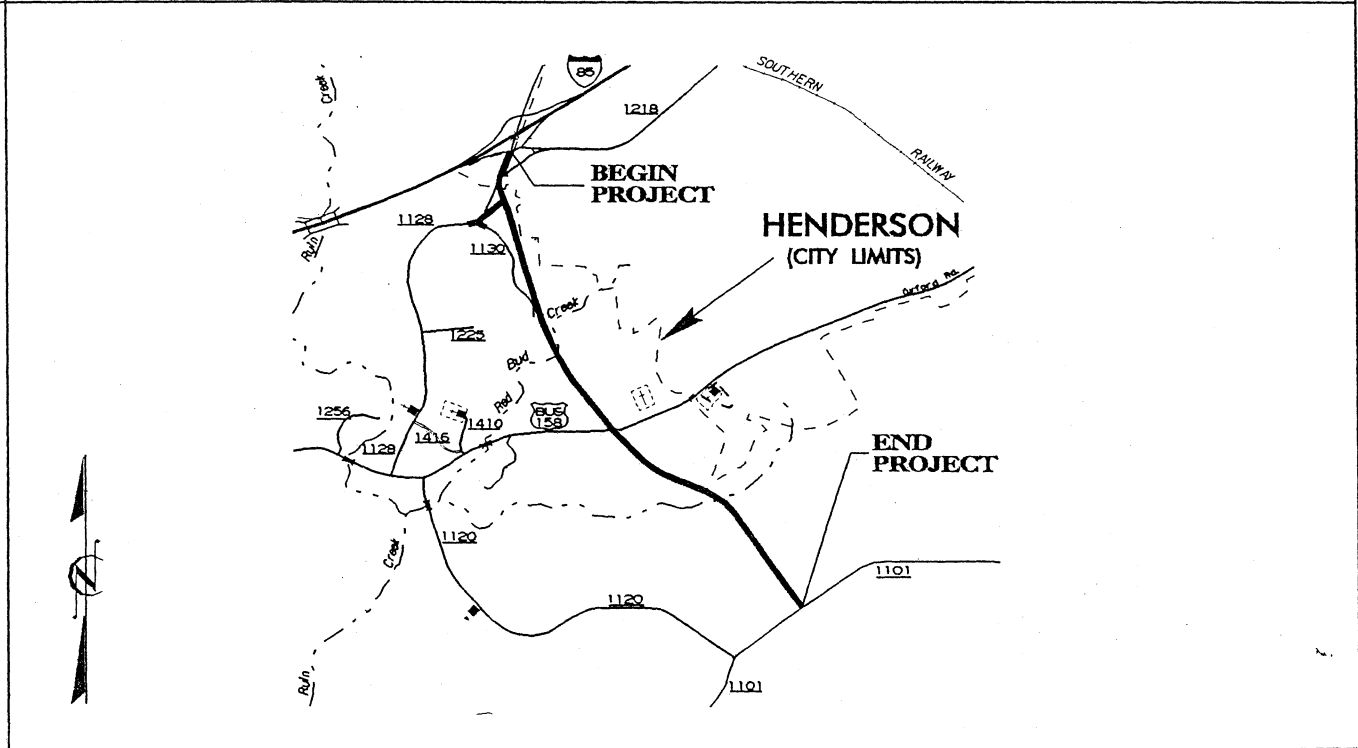
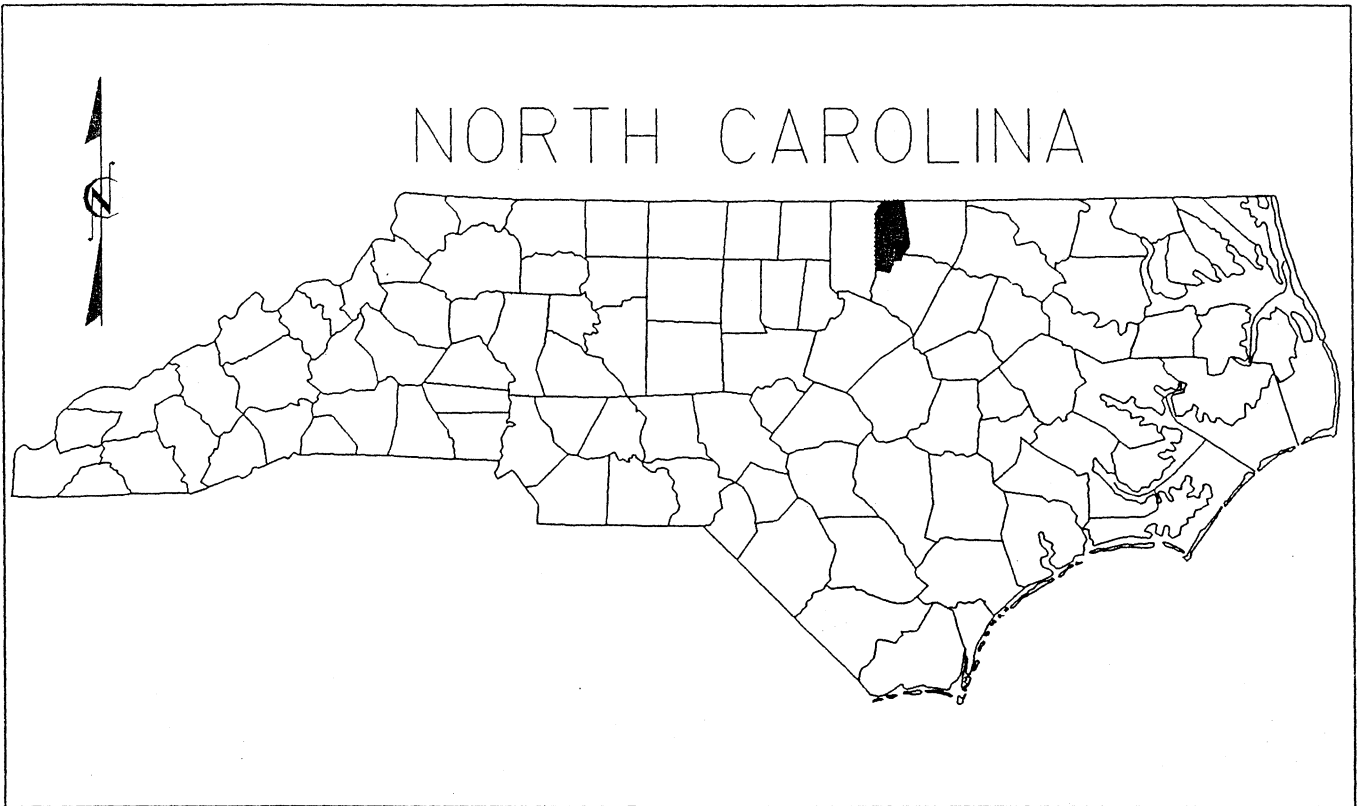
If you have any questions or need additional information please call Matt Haney at (919) 715-1428.

Sincerely,

A handwritten signature in black ink, appearing to read "G. J. Thorpe". The signature is written in a cursive style with a large initial "G".

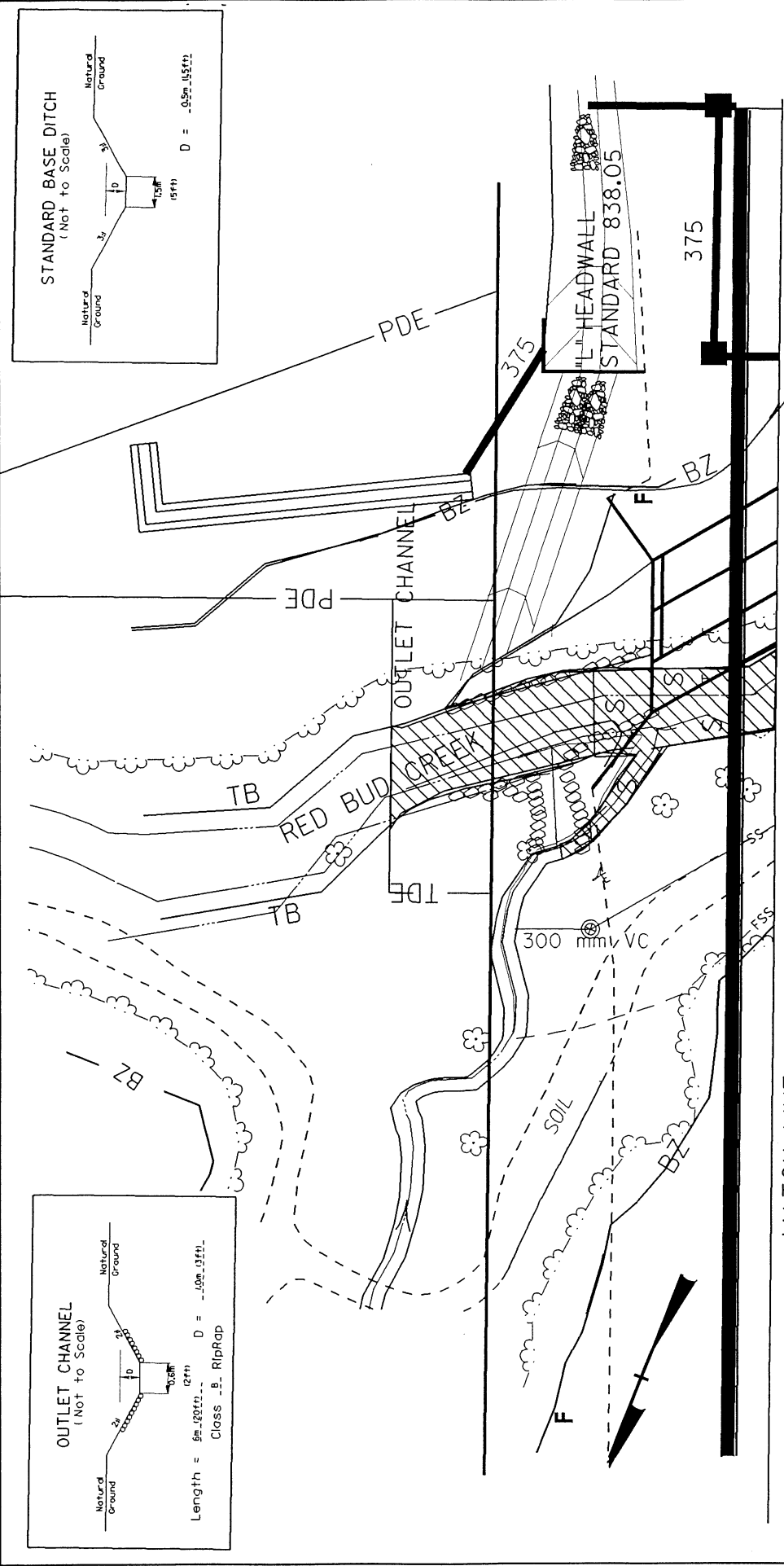
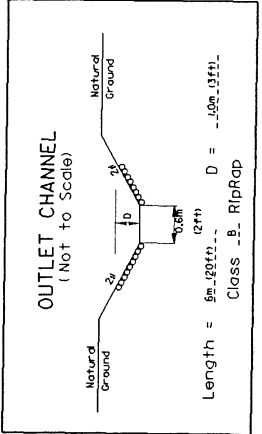
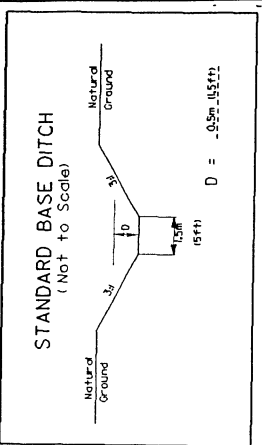
Gregory J. Thorpe, Ph.D.,
Environmental Management Director
Project Development & Environmental Analysis Branch

cc: Mr. John Hennessy, Division of Water Quality
Mr. Gary Jordan, USFWS
Mr. Travis Wilson, NCWRC
Mr. David Franklin, USACE, Wilmington
Mr. Eric Alsmeyer, USACE
Ms. Beth Harmon, EEP, Raleigh



STREAM AND
WETLANDS IMPACTS
VICINITY
MAPS

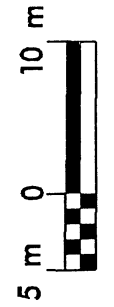
NCDOT
DIVISION OF HIGHWAYS
VANCE COUNTY
PROJECT: 8.2390201 (U-2527)
HENDERSON WESTERN
OUTER LOOP FROM
SR 1128 TO SR 1101
SHEET 1 OF 41 03/15/02



NC DOT
DIVISION OF HIGHWAYS
VANCE COUNTY
PROJECT: 8.2290201 (U-2527)
HENDERSON WESTERN
OUTER LOOP FROM
SR 1128 TO SR 1101
REV 06//04
3/16/02

MATCH LINE A

3 @ 3.6m X 2.7m RCBC
 Depth bkf = 0.5m (1.6ft)
 Width bkf = 5.4m (17.7ft)
 Area bkf = 2.3 m² (24.8sq.ft.)



SITE 3
PLAN VIEW



23+00

23+60

3 @ 3.6m X 2.7m RCBC
 Depth bkf = 0.5m (1.6ft)
 Width bkf = 5.4m (17.7ft)
 Area bkf = 2.3 m² (24.8sq.ft.)

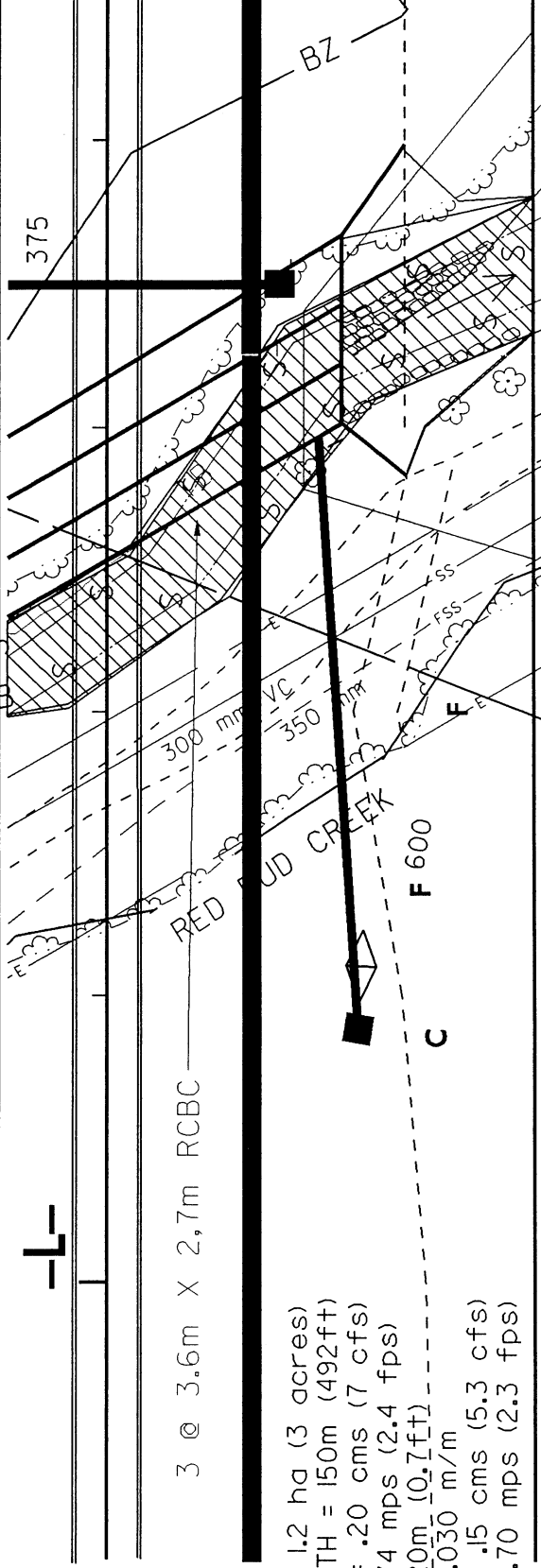
MATCH LINE A

MATCH STATION 23+90

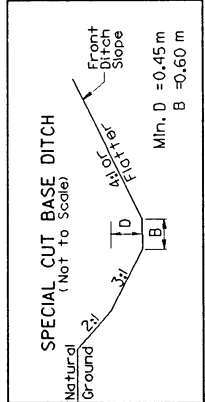


3 @ 3.6m X 2.7m RCBC

DA = 1.2 ha (3 acres)
 LENGTH = 150m (492ft)
 Q10 = .20 cms (7 cfs)
 V = .74 mps (2.4 fps)
 D = .20m (0.7ft)
 S = 0.030 m/m
 Q2 = .15 cms (5.3 cfs)
 V = .70 mps (2.3 fps)



HARVEY A. WILSON
 &
 GLORIA D. CARVER



SPECIAL CUT BASE DITCH
 (Not to Scale)

Min. D = 0.45m
 B = 0.60m

MARJORIE P. LEWIS

NCDOT

DIVISION OF HIGHWAYS
 VANCE COUNTY

PROJECT: 8.2290201 (U-2527)
 HENDERSON WESTERN

OUTER LOOP FROM

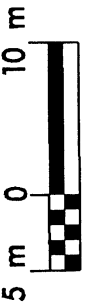
SR 1128 TO SR 1101

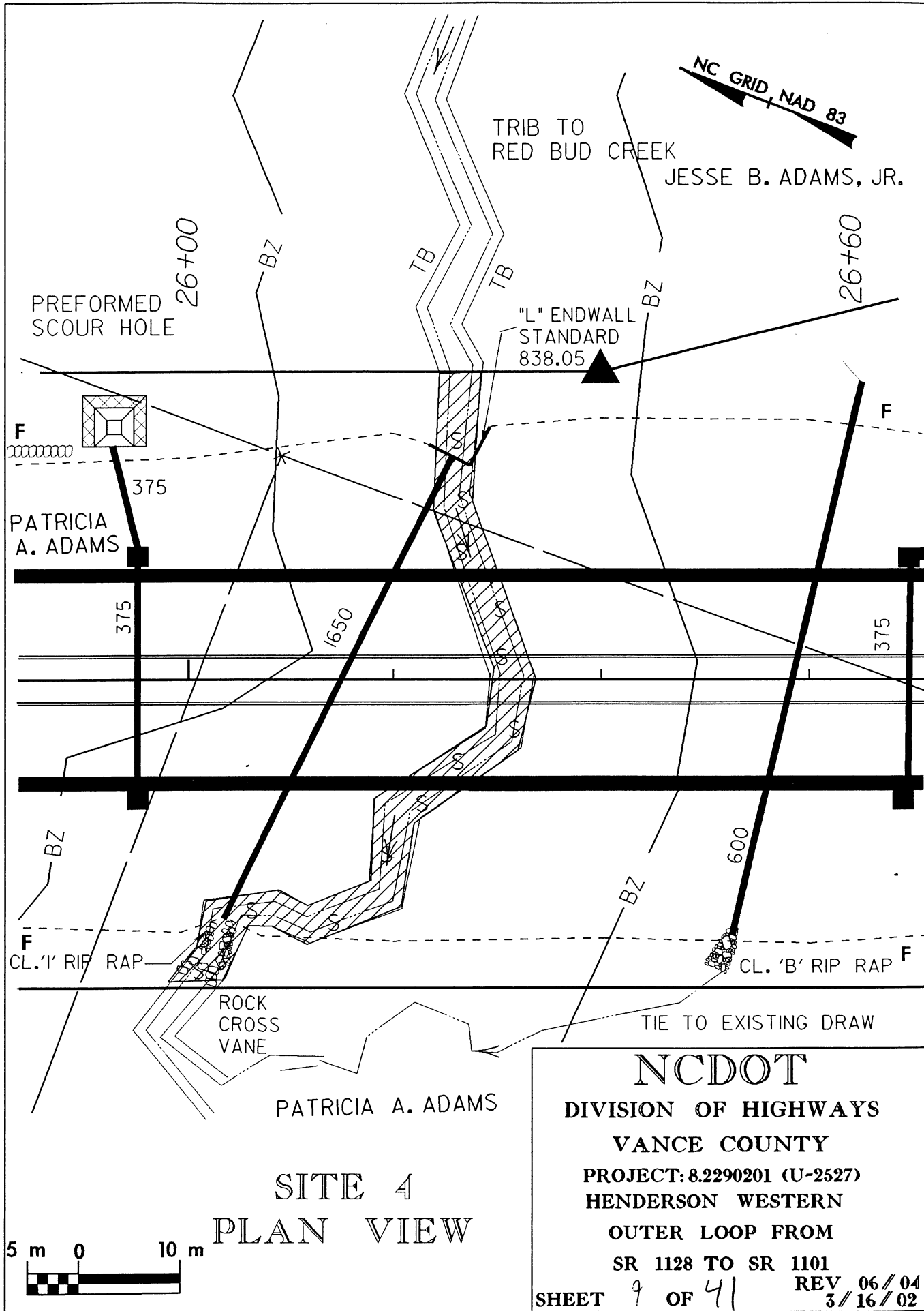
REV 06/04

3/16/02

SITE 3

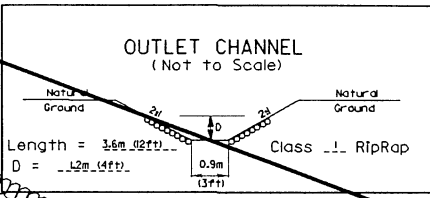
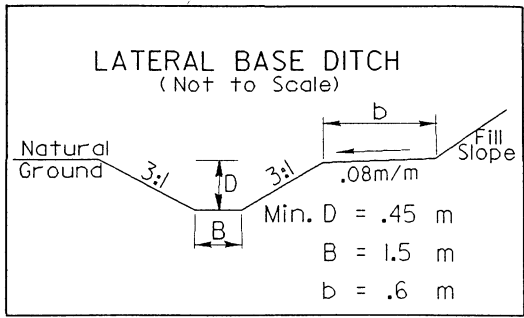
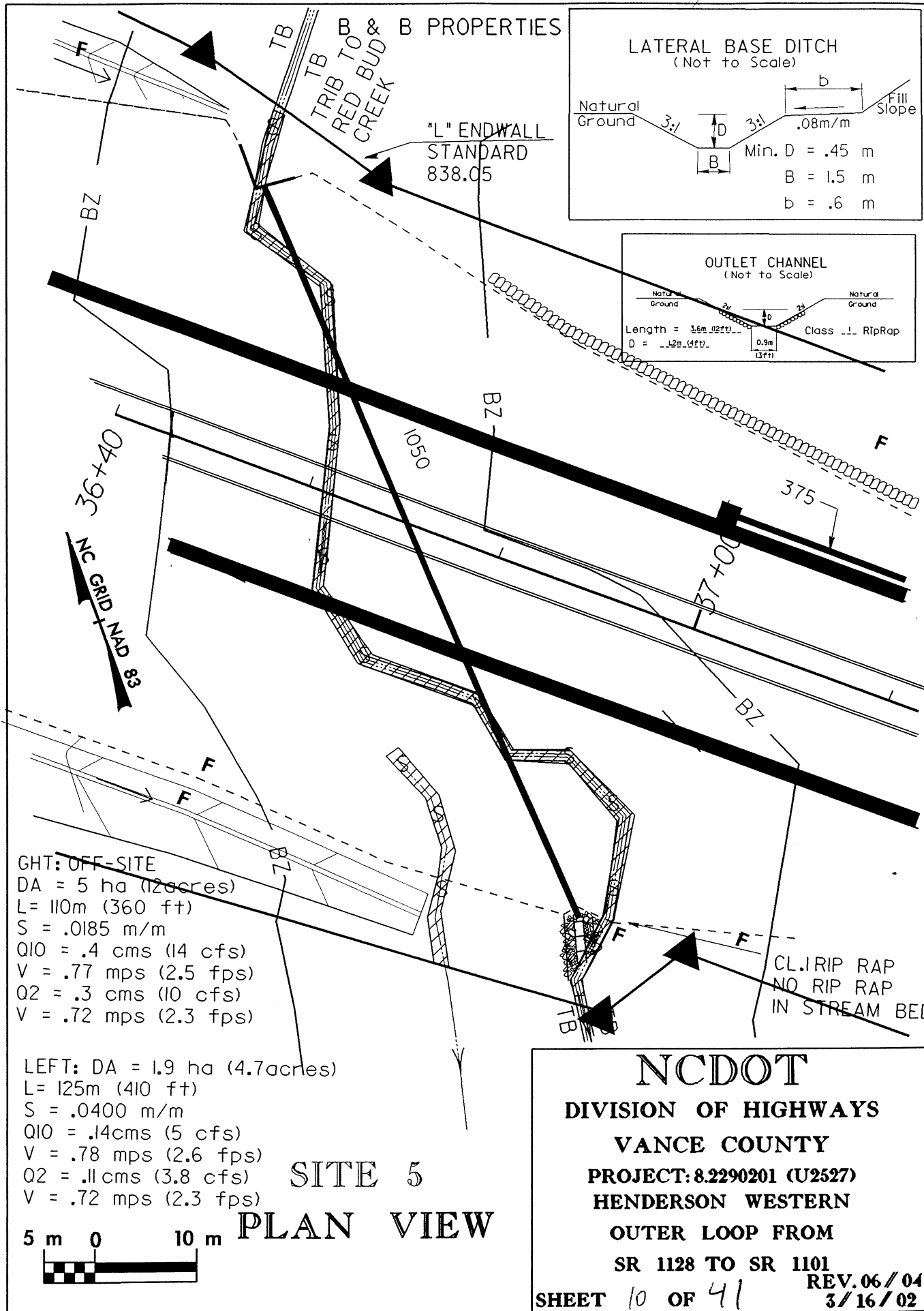
PLAN VIEW





SITE 4
PLAN VIEW

NCDOT
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 VANCE COUNTY
 PROJECT: 8.2290201 (U-2527)
 HENDERSON WESTERN
 OUTER LOOP FROM
 SR 1128 TO SR 1101
 SHEET 9 OF 41
 REV 06/04
 3/16/02



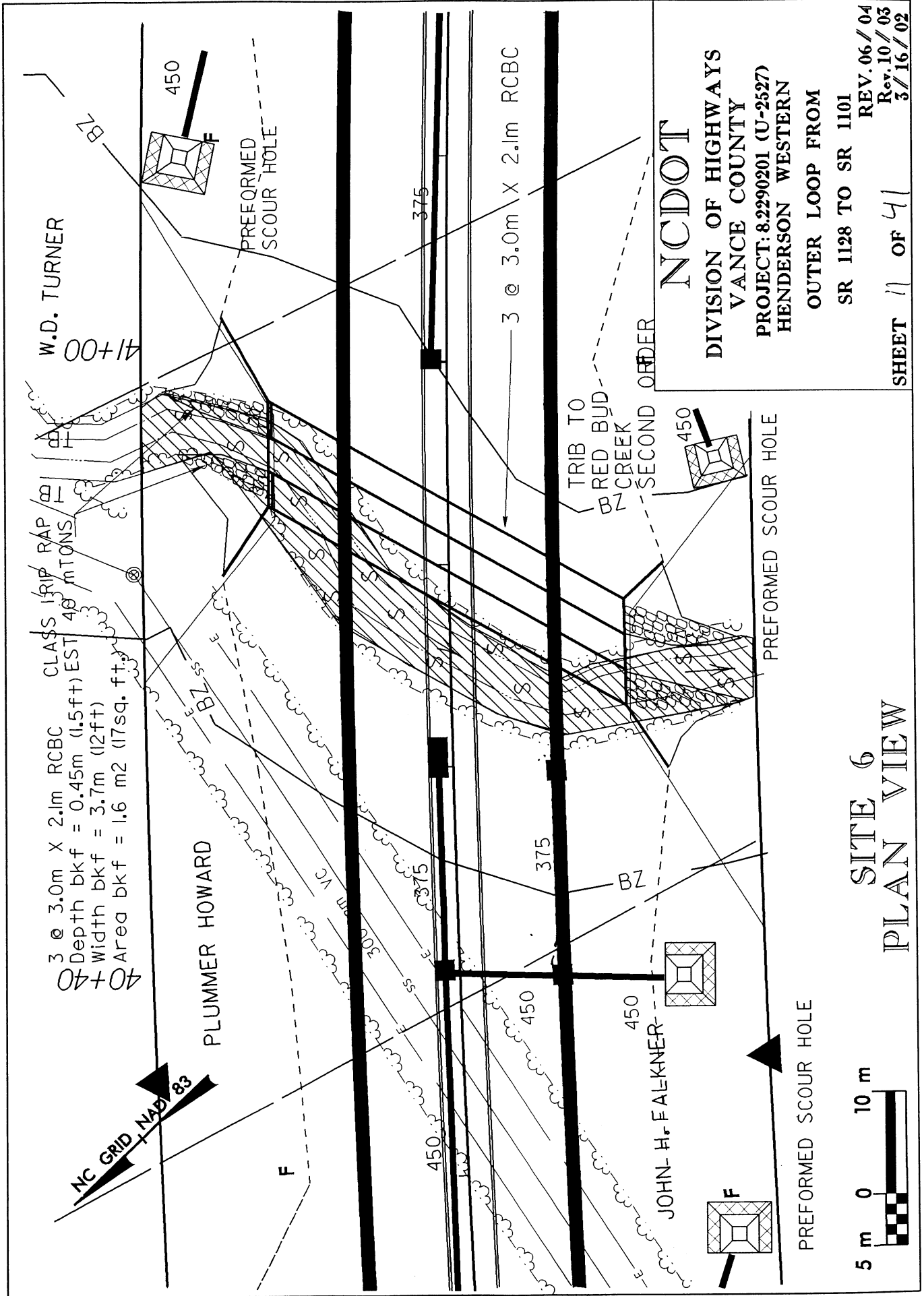
GHT: OFF-SITE
DA = 5 ha (12 acres)
L = 110m (360 ft)
S = .0185 m/m
Q10 = .4 cms (14 cfs)
V = .77 mps (2.5 fps)
Q2 = .3 cms (10 cfs)
V = .72 mps (2.3 fps)

LEFT: DA = 1.9 ha (4.7 acres)
L = 125m (410 ft)
S = .0400 m/m
Q10 = .14 cms (5 cfs)
V = .78 mps (2.6 fps)
Q2 = .11 cms (3.8 cfs)
V = .72 mps (2.3 fps)

SITE 5
PLAN VIEW



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DIVISION OF HIGHWAYS
VANCE COUNTY
PROJECT: 8.2290201 (U2527)
HENDERSON WESTERN
OUTER LOOP FROM
SR 1128 TO SR 1101
SHEET 10 OF 41
REV. 06 / 04
3 / 16 / 02

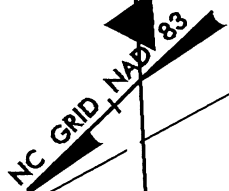


W.D. TURNER
41+00

CLASS 1 RIP RAP
EST 48 TONS
Depth bkf = 0.45m (1.5ft)
Width bkf = 3.7m (12ft)
Area bkf = 1.6 m² (17sq. ft.)

40+40

PLUMMER HOWARD



PERFORMED SCOUR HOLE

3 @ 3.0m X 2.1m RCBC

TRIB TO RED BUD CREEK
SECOND ORDER

NCDOT

DIVISION OF HIGHWAYS
VANCE COUNTY
PROJECT: 8.2290201 (U-2527)
HENDERSON WESTERN

OUTER LOOP FROM
SR 1128 TO SR 1101

REV. 06 / 04
Rev. 10 / 03
3 / 16 / 02

SHEET 11 OF 41

PERFORMED SCOUR HOLE

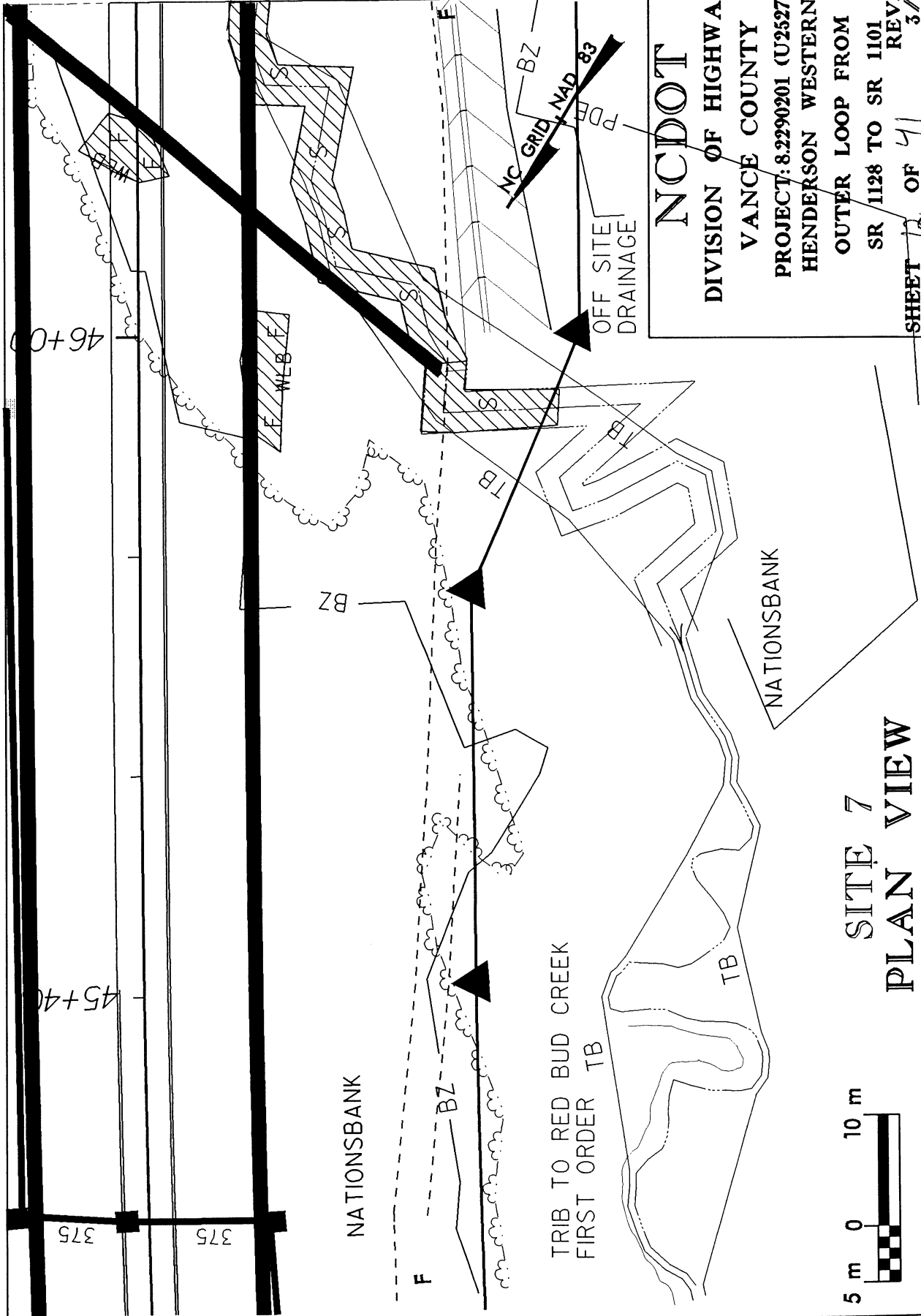
PERFORMED SCOUR HOLE



SITE 6
PLAN VIEW

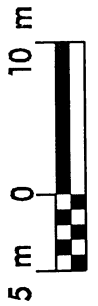
JOHN H. FALKNER

MATCH STATION 46+30



NCDOT
 DIVISION OF HIGHWAYS
 VANCE COUNTY
 PROJECT: 8.2290201 (U2527)
 HENDERSON WESTERN
 OUTER LOOP FROM
 SR 1128 TO SR 1101
 REV. 06 / 04
 3 / 16 / 02

SITE 7
PLAN VIEW



SHEET 41 OF 41

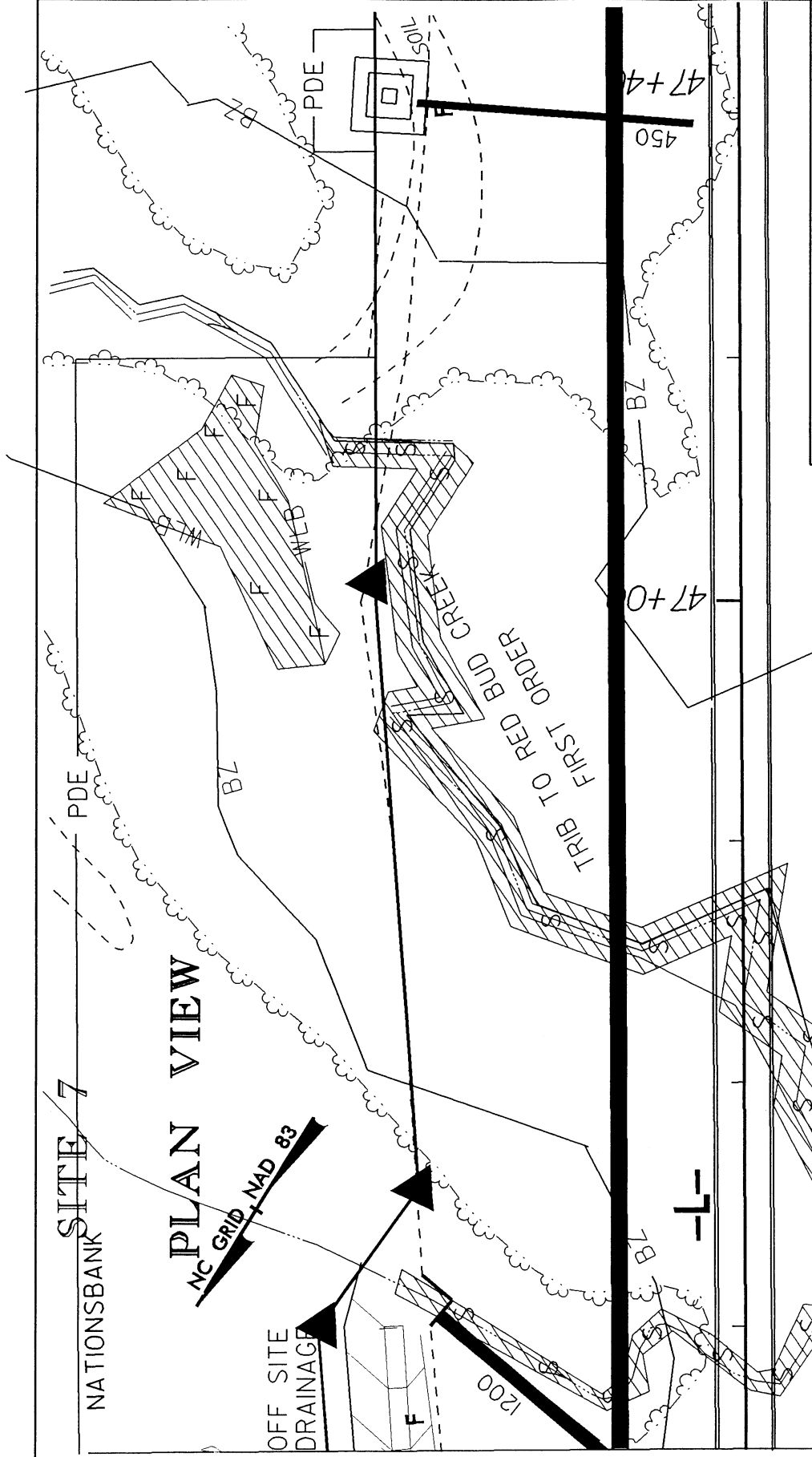
SITE 7
NATIONSBANK

PLAN VIEW

NC GRID, MAD 83

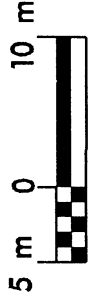
OFF SITE DRAINAGE

MATCH STATION 46+30



NC DOT
 DIVISION OF HIGHWAYS
 VANCE COUNTY
 PROJECT: 8.2290201 (U-2527)
 HENDERSON WESTERN
 OUTER LOOP FROM
 SR 1128 TO SR 1101
 REV. 06/04
 3/16/02

NATIONSBANK



OFF SITE DRAINAGE

SHEET 13 OF 41

WETLAND PERMIT IMPACT SUMMARY

Site No.	Station (From/To)	Structure Size / Type	WETLAND IMPACTS				SURFACE WATER IMPACTS						
			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)	Temp. Fill In SW (ac)	Existing Channel Impacted (ft)	Natural Stream Design (ft)		
1	18+40 -L-	600 RCP					0.00					173.8	
2	21+30 -L-	600 RCP					0.06					272.2	
3	23+40 -L-	CULVERT					0.13					265.7	
4	26+00 to 26+30 -L-	1500 RCP					0.07					262.4	
5	36+72 -L-	900 RCP					0.03					410.0	
6	40+81 -L-	CULVERT					0.11					232.9	
7	46+20 -L-	1500 RCP	0.06				0.18					777.4	
TOTALS:			0.06	0.00	0.00	0.00	0.58	0.00	0.00	0.00	0.00	2394.4	0.0

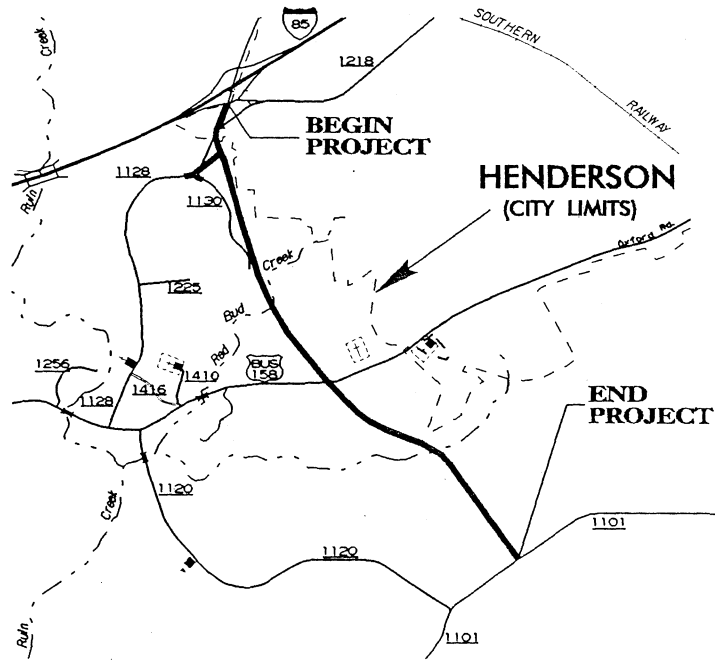
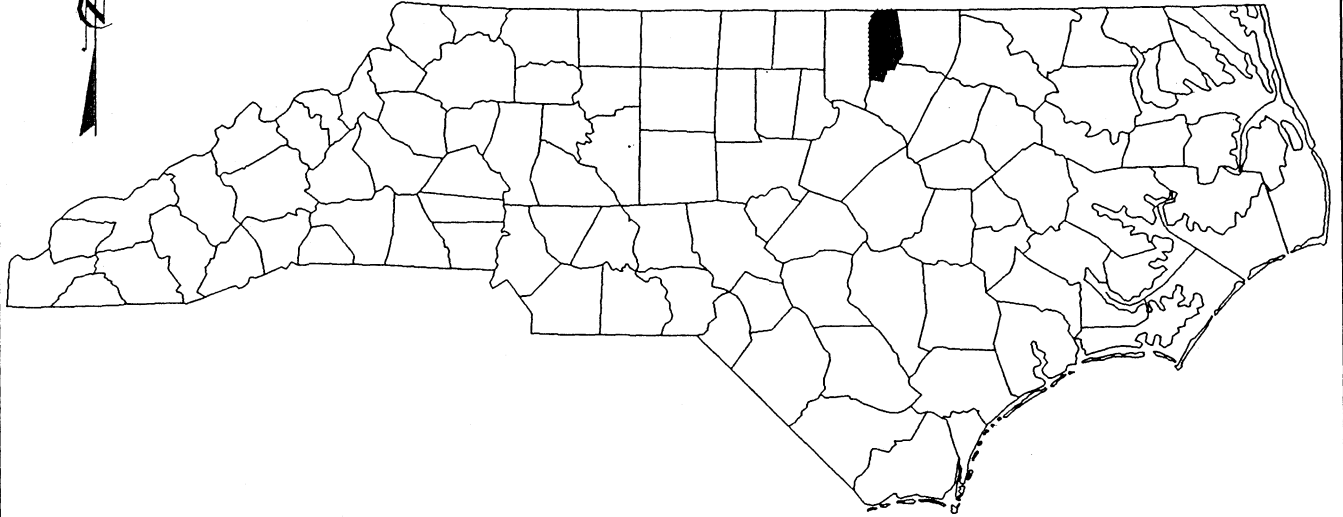
NC DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS

VANCE COUNTY
PROJECT 8.2290201 U-2527

REV.06/04
/2002 Rev.1

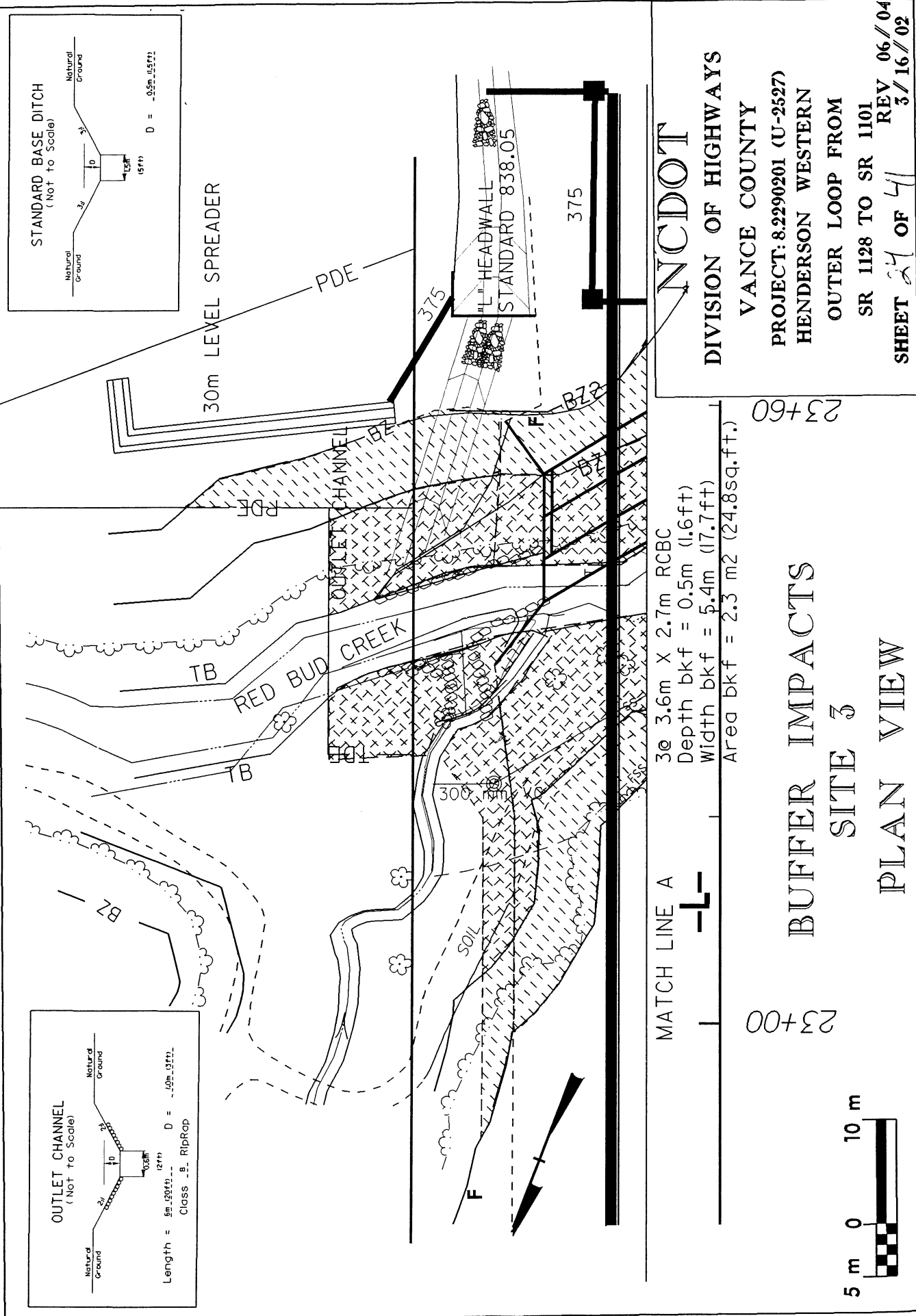
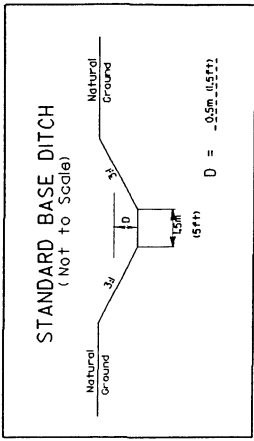
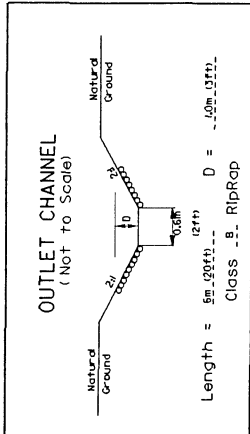
SHEET 14 of 41

NORTH CAROLINA



BUFFER IMPACTS VICINITY MAPS

NCDOT
DIVISION OF HIGHWAYS
VANCE COUNTY
PROJECT: 8.2390201 (U-2527)
HENDERSON WESTERN
OUTER LOOP FROM
SR 1128 TO SR 1101



MATCH LINE A

3 @ 3.6m X 2.7m RCBC
 Depth bkf = 0.5m (1.6ft)
 Width bkf = 5.4m (17.7ft)
 Area bkf = 2.3 m² (24.8sq.ft.)

NCDOT

DIVISION OF HIGHWAYS

VANCE COUNTY

PROJECT: 8.2290201 (U-2527)

HENDERSON WESTERN

OUTER LOOP FROM

SR 1128 TO SR 1101

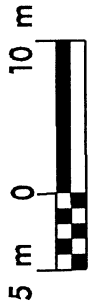
SHEET 24 OF 41

REV 06/04
 3/16/02

BUFFER IMPACTS

SITE 3

PLAN VIEW





23+00

23+60

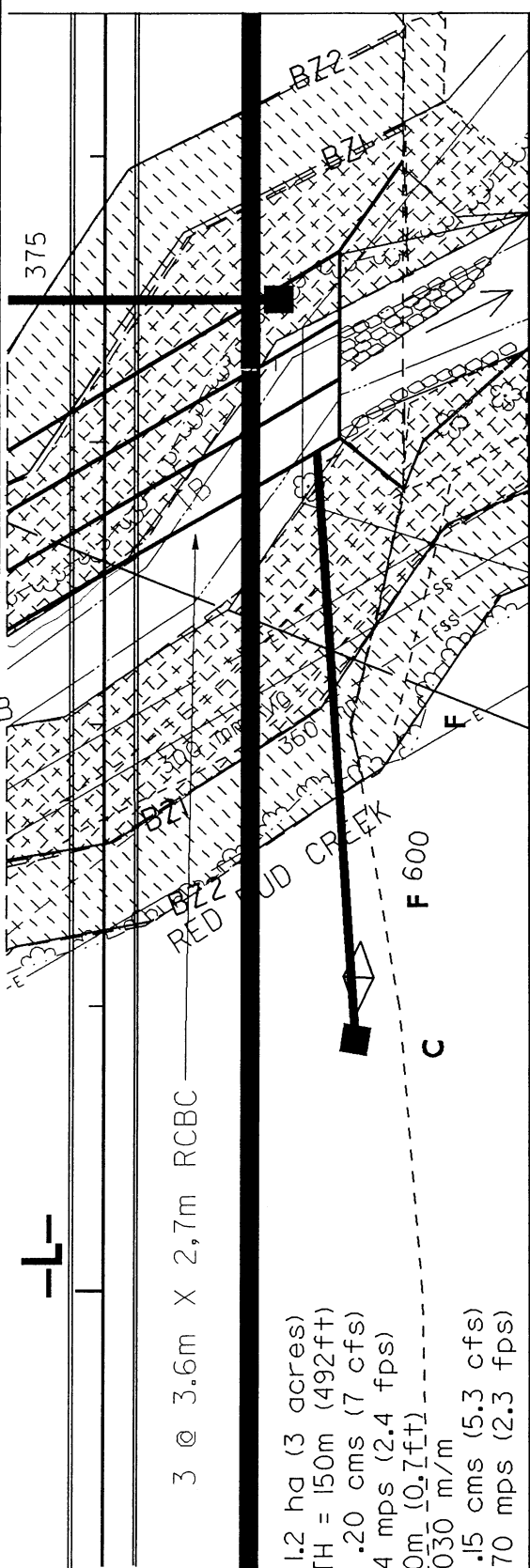
3 @ 3.6m X 2.7m RCBC
 Depth bkf = 0.5m (1.6ft)
 Width bkf = 5.4m (17.7ft)
 Area bkf = 2.3 m2 (24.8sq.ft.)

MATCH LINE A



3 @ 3.6m X 2,7m RCBC

MATCH STATION 23+90

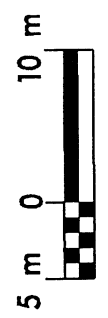
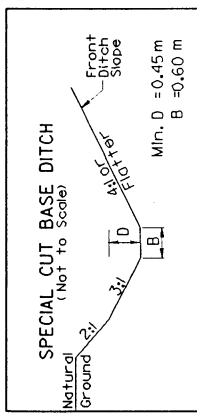


DA = 1.2 ha (3 acres)
 LENGTH = 150m (492ft)
 Q10 = .20 cms (7 cfs)
 V = .74 mps (2.4 fps)
 D = .20m (0.7ft)
 S = 0.030 m/m
 Q2 = .15 cms (5.3 cfs)
 V = .70 mps (2.3 fps)

HARVEY A. WILSON
 &
 GLORIA D. CARVER

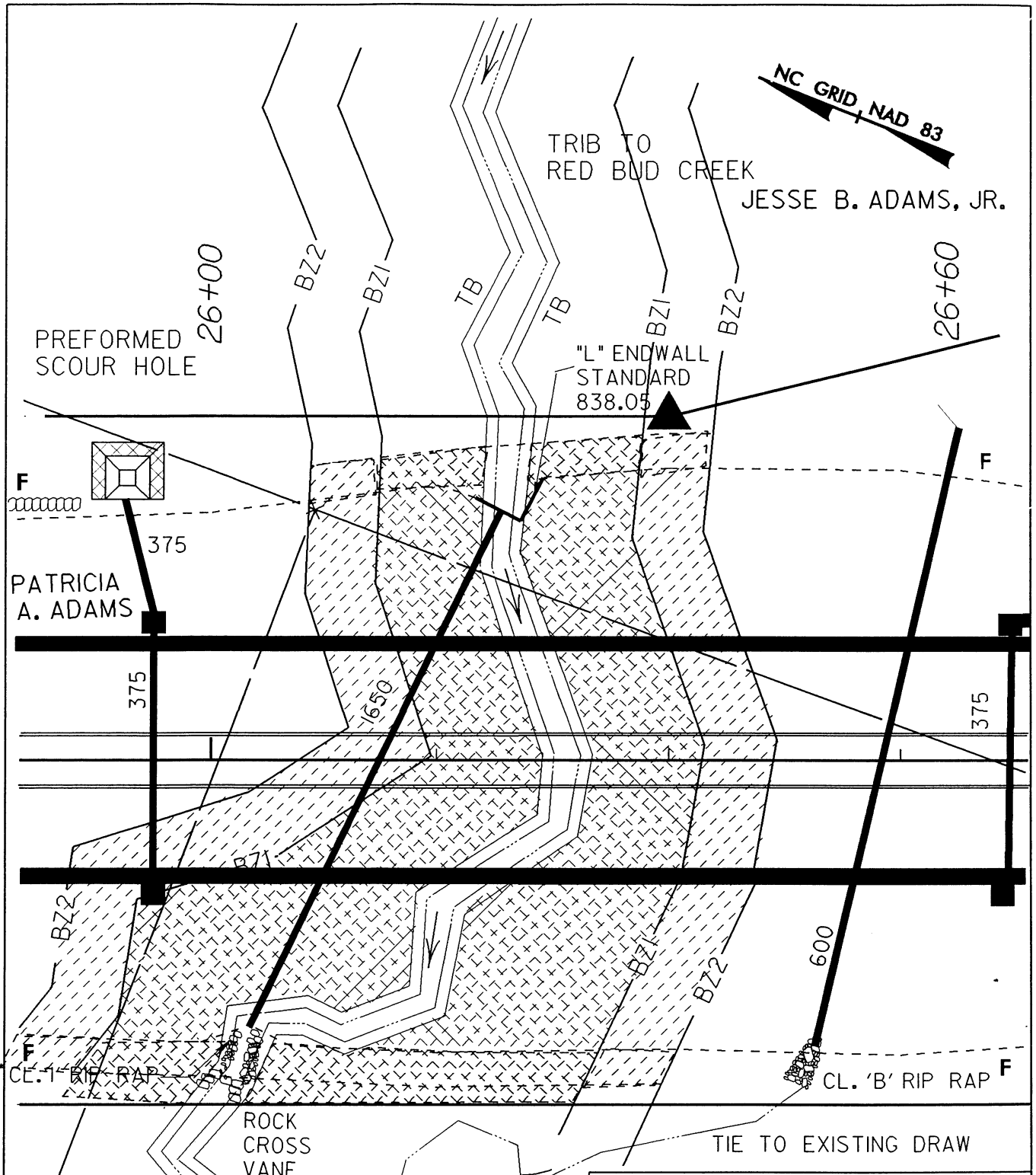
MARJORIE P. LEWIS

BUFFER IMPACTS
SITE 3
PLAN VIEW

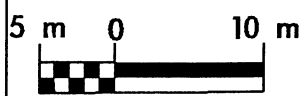


NCDOT
DIVISION OF HIGHWAYS
VANCE COUNTY
 PROJECT: 8.2290201 (U-2527)
 HENDERSON WESTERN
 OUTER LOOP FROM
 SR 1128 TO SR 1101
 REV 06/04
 3/16/02

SHEET 25 OF 41

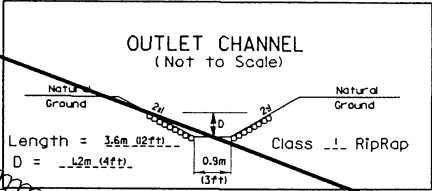
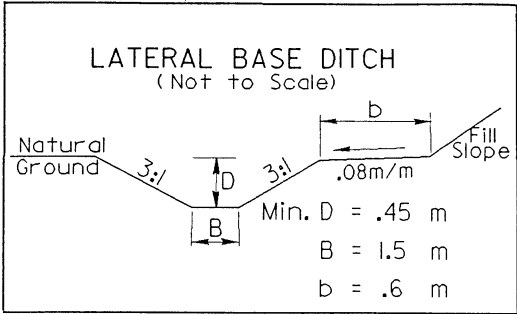
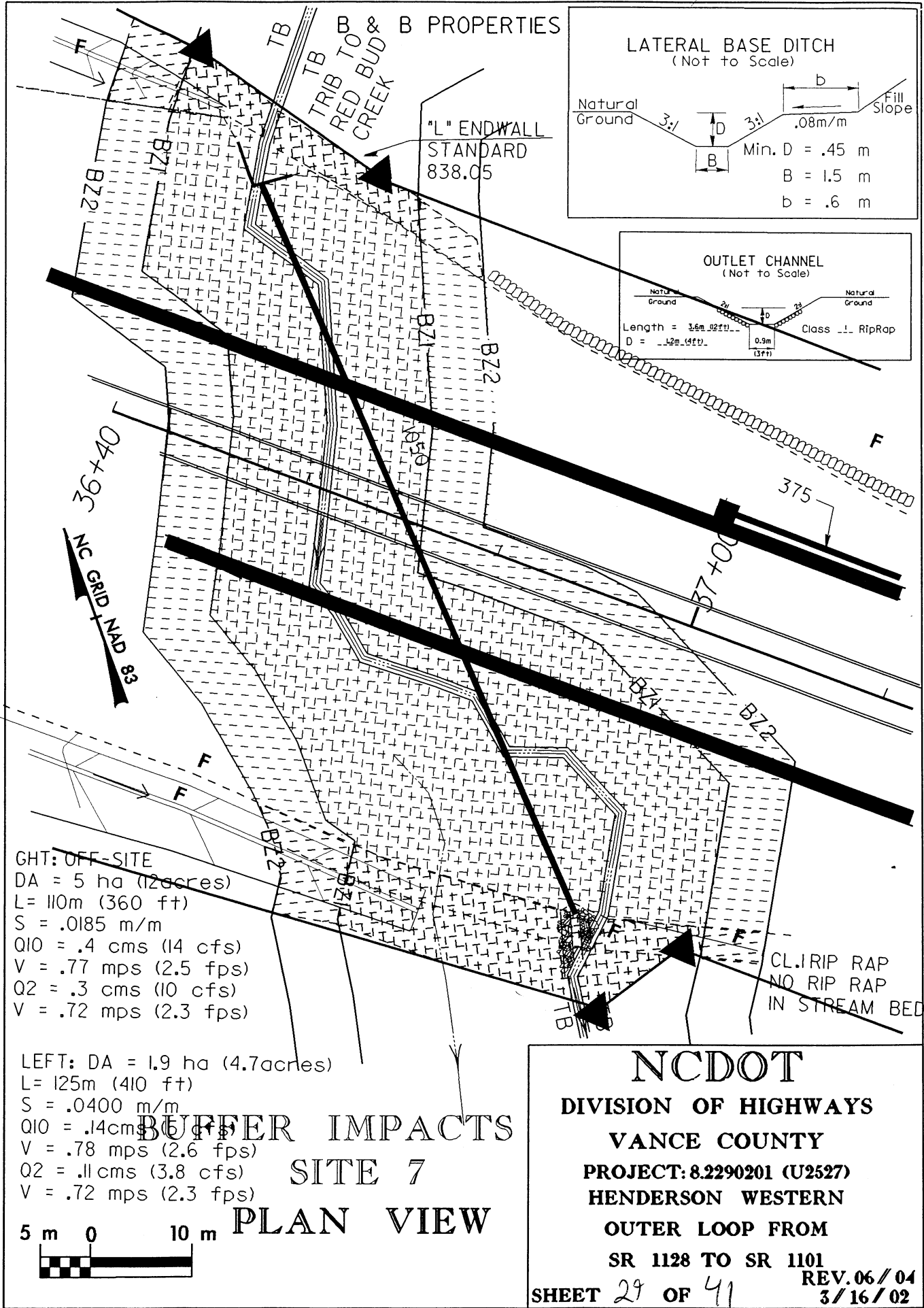


PATRICIA A. ADAMS
 BUFFER IMPACTS
 SITE 5
 PLAN VIEW



NCDOT
 DIVISION OF HIGHWAYS
 VANCE COUNTY
 PROJECT: 8.2290201 (U-2527)
 HENDERSON WESTERN
 OUTER LOOP FROM
 SR 1128 TO SR 1101
 SHEET 27 OF 41

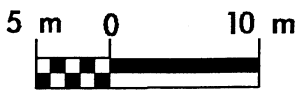
REV 06//04
 3//16//02



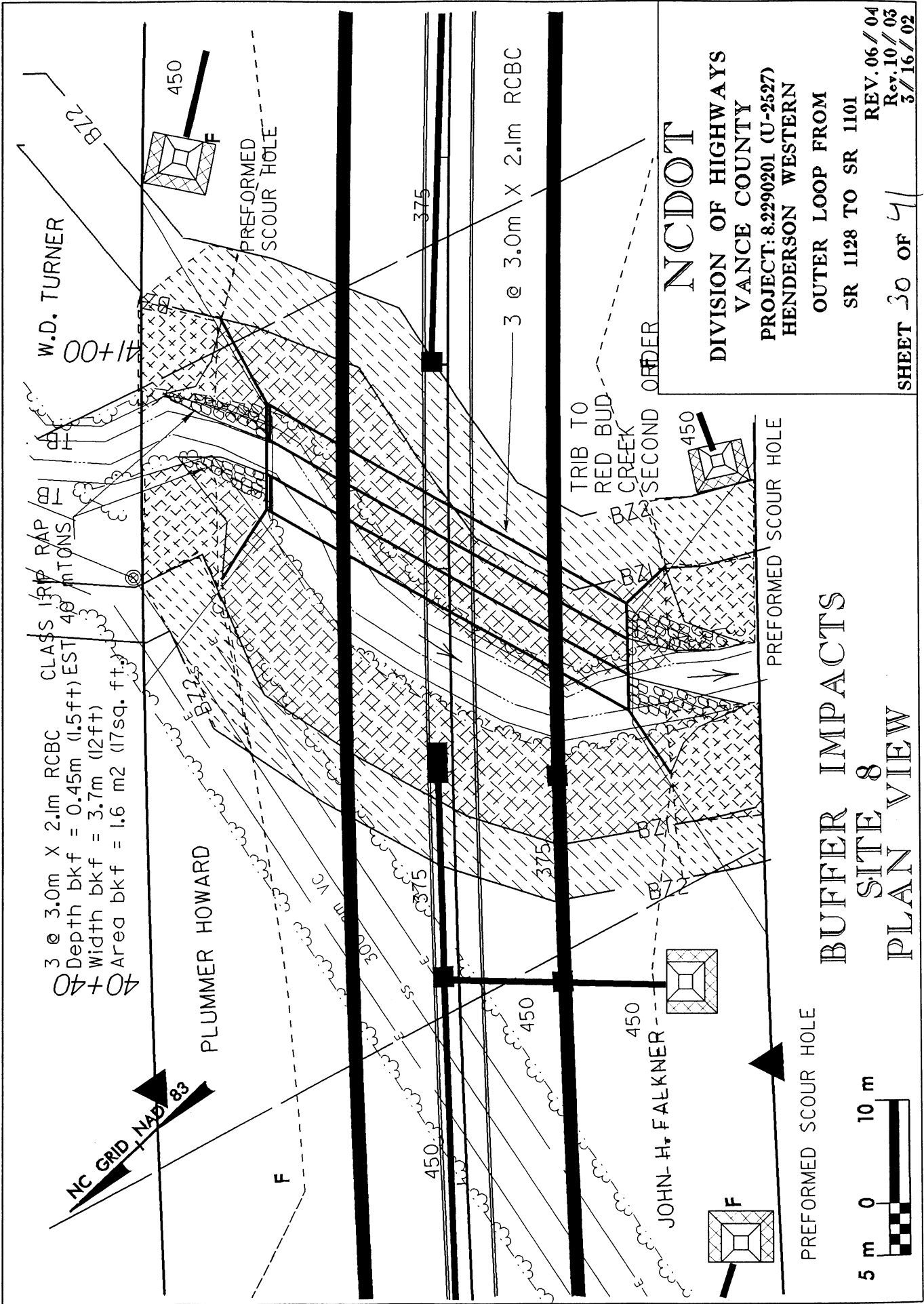
GHT: OFF-SITE
 DA = 5 ha (12 acres)
 L = 110m (360 ft)
 S = .0185 m/m
 Q10 = .4 cms (14 cfs)
 V = .77 mps (2.5 fps)
 Q2 = .3 cms (10 cfs)
 V = .72 mps (2.3 fps)

LEFT: DA = 1.9 ha (4.7 acres)
 L = 125m (410 ft)
 S = .0400 m/m
 Q10 = .14 cms (5 cfs)
 V = .78 mps (2.6 fps)
 Q2 = .11 cms (3.8 cfs)
 V = .72 mps (2.3 fps)

BUFFER IMPACTS
SITE 7
PLAN VIEW



NCDOT
DIVISION OF HIGHWAYS
VANCE COUNTY
PROJECT: 8.2290201 (U2527)
HENDERSON WESTERN
OUTER LOOP FROM
SR 1128 TO SR 1101
SHEET 29 OF 41
 REV. 06 / 04
 3 / 16 / 02



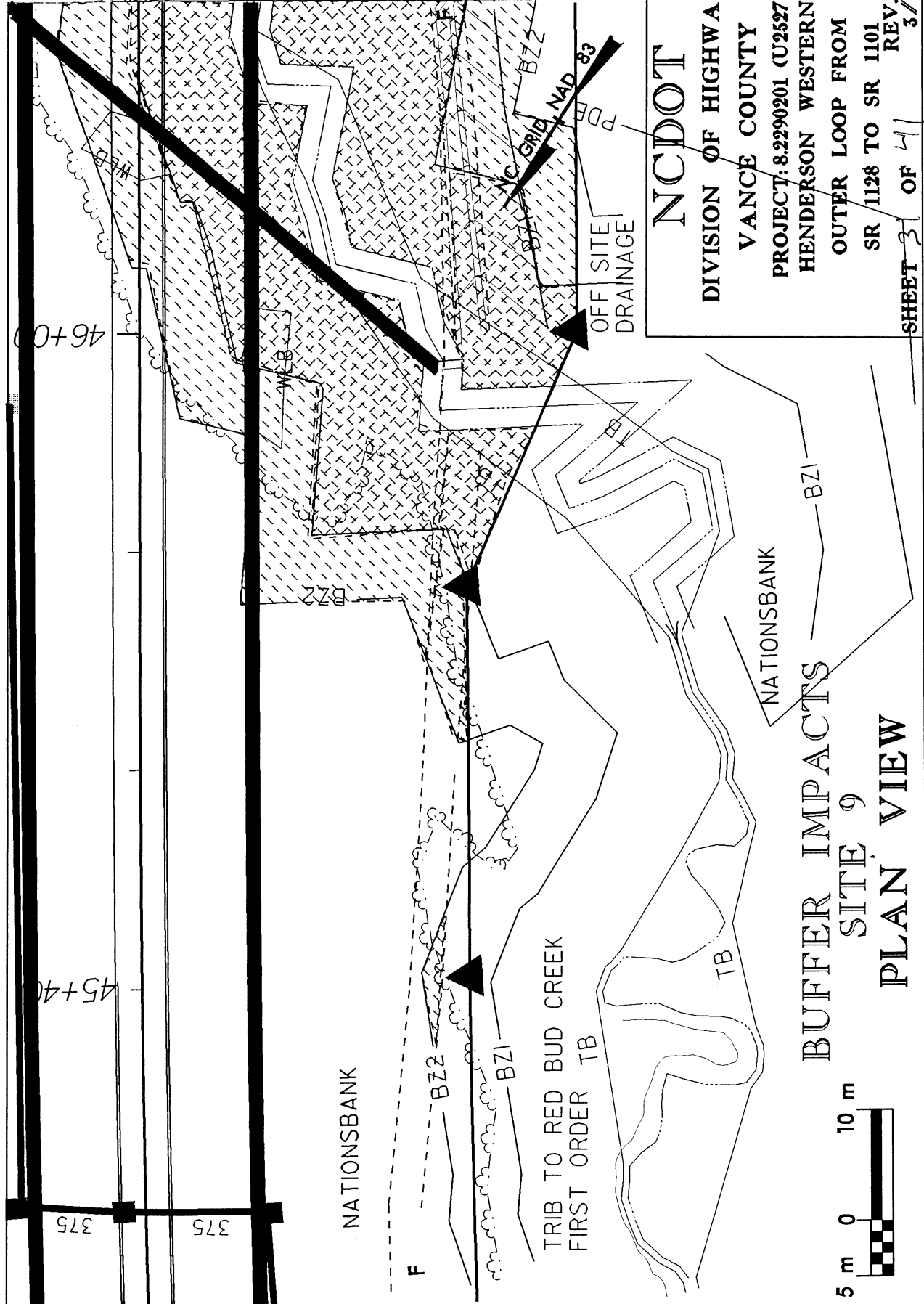
CLASS 1 RP RAP
 40+40 48 m TONS
 3 @ 3.0m X 2.1m RCBC
 Depth bkf = 0.45m (1.5ft) EST
 Width bkf = 3.7m (12ft)
 Area bkf = 1.6 m² (17sq. ft.)

NCDOT
 DIVISION OF HIGHWAYS
 VANCE COUNTY
 PROJECT: 8.2290201 (U-2527)
 HENDERSON WESTERN
 OUTER LOOP FROM
 SR 1128 TO SR 1101
 REV. 06/04
 Rev. 10/03
 3/16/02

BUFFER IMPACTS
SITE 8
PLAN VIEW

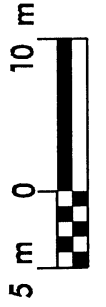
PREFORMED SCOUR HOLE
 5 m 0 10 m

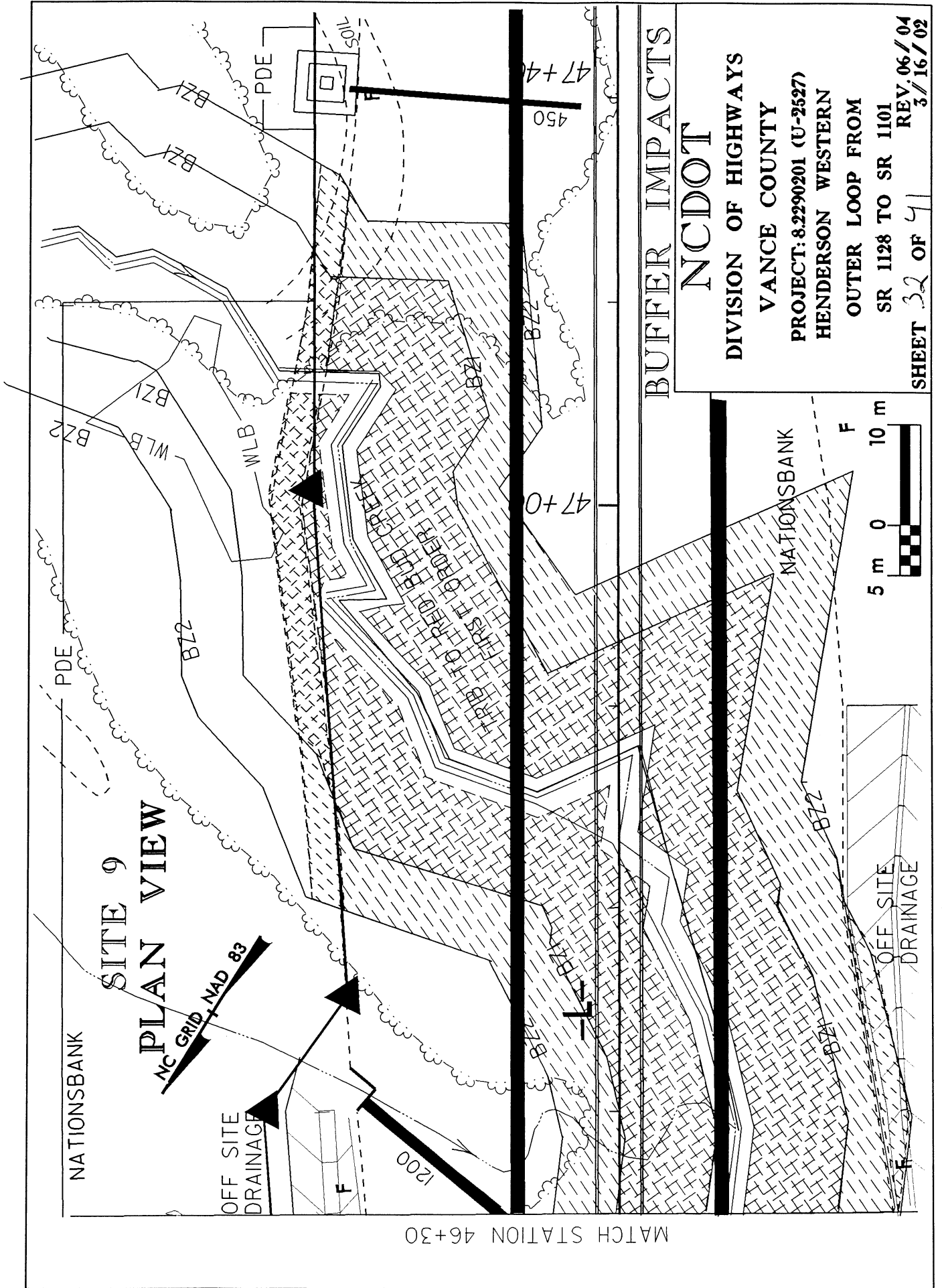
MATCH STATION 46+30



NC DOT
DIVISION OF HIGHWAYS
VANCE COUNTY
PROJECT: 8.2290201 (U2527)
HENDERSON WESTERN
OUTER LOOP FROM
SR 1128 TO SR 1101
REV. 06/04
3/16/02

BUFFER IMPACTS
SITE 9
PLAN VIEW





BUFFER IMPACTS

NC DOT

DIVISION OF HIGHWAYS
VANCE COUNTY
PROJECT: 8.2290201 (U-2527)
HENDERSON WESTERN
OUTER LOOP FROM
SR 1128 TO SR 1101
REV. 06/04
3/16/02

Stream Mitigation Plan
U-2527 Vance County
June 22, 2004

This project involves restoration of approximately 790 m. (2592ft.) of an unnamed tributary to Red Bud Creek. The proposed Western Outer Loop near Henderson is unavoidably impacting Red Bud Creek as well as its tributaries along the proposed alignment. The proposed restoration will be used to mitigate these impacts. The existing stream flows through cut over woods with uncut trees along the stream. The stream has low riffle/ pool sequence and sinuosity. The side slopes are 1:1 in some areas and eroded in pool areas. The existing stream reach is entrenched and most nearly fits the geomorphic characteristics of a G4 stream type (see Morphological Measurement Table). At the confluence of the tributary to Red Bud Creek and the proposed stream, bedrock exist and will prevent any further down cutting at the confluence. With this in mind it is proposed to restore the unnamed tributary to its original dimension, pattern, and profile to the extent practicable by installing grade control structures in a riffle pool sequence at the confluence thus exposing the tributary to its original floodplain.

The drainage area contributing to the project site is 0.16 sq.mi. The drainage area for the proposed restoration for the most part lies between the main tributary to the north, NC SR 1101 to the south, and approximately 2000 feet east of the proposed outer loop. This drainage basin is totally wooded and cut over for the most part. Currently there is no development in the basin. Development in the future would encompass approximately 10 to 15 percent of the drainage basin. The stream extends approximately 1200 feet upstream of the site.

As stated above the existing stream is entrenched. Morphological data was difficult to collect on the existing stream but was attempted and is shown on the Morphological Measurement Table. Pebble counts were conducted at two locations and the D50 size material was approximately 0.031 inches (.79 mm). The bankfull depth and width were determined for the existing stream so that a bankfull discharge could be developed for design purposes.

The reference stream for the proposed project is Silas Creek near Winston Salem in Forsyth County (see attachments for verification of reference reach material). The drainage area for Silas Creek is 3.30 sq.mi. Morphological ratios from the reference stream in conjunction with natural stream design techniques from the Applied River Morphology book by Dave Rosgen and bankfull depth from the existing stream were used to extrapolate pertinent data to the proposed stream. Silas Creek best fits the geomorphic characteristics of a B4c/1 stream type (see Morphological Measurement Table).

The proposed stream reach has a drainage area of 0.16 sq.mi. and will be 791m (2595ft.) long. The width/depth ratio was adjusted to 13.00 so that the stream could be constructed as a B4c stream type. The existing stream shall be backfilled with the most impervious

material available. Shear calculations indicate that the existing bed material will need to be supplemented to increase the d50 size material such that the calculated shear is slightly higher than the permissible shear for the bed. The riffles for the proposed stream shall consist of a mixture of 10% Class “B”, 60% Class “A” stone and 30% #57 stone (See Constructed Riffle Detail). This will insure motion of the bed load and reduce the possibility of degrading the riffles (see shear calculations).

Sediment Transport:

The following is a summary of the shear stress and stream power for the proposed stream restoration. The shear calculations come from the HYCHL program in the FHWA Integrated Drainage Design Computer System, Version 6.0 (HYDRAIN). HYCHL can analyze channels for stability through application of tractive force theory. The program compares shear exerted on the lining with the permissible shear stress of the lining. HYCHL can analyze composite linings (i.e. a bed lining and a side slope lining). Attached are the results calculated by HYCHL for the existing and proposed stream, having a natural cobble bed lining and vegetative side slope lining. The results were determined for the proposed bankfull elevation. The results indicate a stable side slope lining and an unstable bed lining for the existing bed material (d50=0.031in.). It would take a d50 = 4.0in to increase the permissible shear too slightly less than the bed shear. The increase in bed material size will insure motion of the bed load and reduce the possibility of degrading the riffles.

Stream power in lb/ft-s is given by the equation $\omega = \tau V$, where: τ is the average channel shear stress in lb/ft² given by HYCHL.

	<u>STREAM POWER</u>	<u>BED SHEAR</u>	<u>SIDE SHEAR</u>	<u>PERMISSIBLE SHEAR</u>	
				Bed	Side
Existing D50 = 0.031in	3.99	0.95	0.51	0.33	2.10
Proposed D50 = 4.0in	2.44	1.18	0.78	1.65	2.10

Commands Read From File: u2527b4e.chl

EXISTING STREAM

```

JOB U-2527 FIRST ORDER TRIBUTARY
UNI 0
** UNITS PARAMETER = 0 (ENGLISH)
   CHL 0.0162 27
   TRP 6.03 2
** LEFT SIDE SLOPE 2.0 AND RIGHT SIDE SLOPE 2.0
** THE BASE WIDTH OF THE TRAPEZOID (ft) 6.03
   N .03 .08
** LOW FLOW N VALUE= .030
** SIDE SLOPE N VALUE= .080
   LRR .031
** D50 (ft) .03
   CPS .5
   LVG B
   PSS .33 2.10
** USER SUPPLIED - LOW PERMIS. SHEAR = (lb/ft^2) .33
** USER SUPPLIED - HIGH PERMIS. SHEAR = (lb/ft^2) 2.10
END
    
```

*****END OF COMMAND FILE*****

U-2527 FIRST ORDER TRIBUTARY

INPUT REVIEW

```

DEFAULT ANGLE OF REPOSE (degrees): 33.98
DESIGN PARAMETERS:
  DESIGN DISCHARGE (ft^3/s): 27.00
  CHANNEL SHAPE: TRAPEZOIDAL
  CHANNEL SLOPE (ft/ft): .016
  LINING TRANSITION HEIGHT (ft): .50
    
```

HYDRAULIC CALCULATIONS USING NORMAL DEPTH

	DESIGN	MAXIMUM
FLOW (cfs)	27.00	.00
DEPTH (ft)	.94	.00
AREA (ft^2)	7.39	.00
WETTED PERIMETER (ft)	10.21	6.03
HYDRAULIC RADIUS (ft)	.72	.00
VELOCITY (ft/s)	3.65	.00
MANNINGS N (LOW FLOW)	.030	.030
MANNINGS N (SIDE SLOPE)	.080	.080
EFFECTIVE MANNINGS N	.042	.030
REYNOLDS NUMBER (10^5)	.01	

*** WARNING: Davg/D50 <= 2 FOR THE MAXIMUM DISCHARGE PROCEDURE.
Qmax MAY BE INCORRECT BECAUSE IT REQUIRES BATHURST

STABILITY ANALYSIS

CONDITION	LINING TYPE	PERMIS SHR (lb/ft^2)	CALC. SHR (lb/ft^2)	STAB. FACTOR	REMARKS
LOW FLOW LINING					
BOTTOM; STRAIGHT	RIPRAP	.33	.95	.35	UNSTABLE
SIDE SLOPE LINING					
SIDE; STRAIGHT	VEGETATIVE B	2.10	.51	4.15	STABLE

RATIO OF SIDE SHEAR TO BOTTOM SHEAR = .54

*** NORMAL END OF HYCHL ***

Commands Read From File: u2527b4p.chl

PROPOSED STREAM

```

JOB U-2527 FIRST ORDER TRIBUTARY
UNI 0
** UNITS PARAMETER = 0 (ENGLISH)
   CHL 0.0162 27
   TRP 6.03 2
** LEFT SIDE SLOPE 2.0 AND RIGHT SIDE SLOPE 2.0
** THE BASE WIDTH OF THE TRAPEZOID (ft) 6.03
   N .055 .08
** LOW FLOW N VALUE= .055
** SIDE SLOPE N VALUE= .080
   LRR .33
** D50 (ft) .33
   CPS .5
   LVG B
   PSS 1.65 2.10
** USER SUPPLIED - LOW PERMIS. SHEAR = (lb/ft^2) 1.65
** USER SUPPLIED - HIGH PERMIS. SHEAR = (lb/ft^2) 2.10
END
*****END OF COMMAND FILE*****
    
```

U-2527 FIRST ORDER TRIBUTARY

INPUT REVIEW

```

DEFAULT ANGLE OF REPOSE (degrees): 40.95
DESIGN PARAMETERS:
  DESIGN DISCHARGE (ft^3/s): 27.00
  CHANNEL SHAPE: TRAPEZOIDAL
  CHANNEL SLOPE (ft/ft): .016
  LINING TRANSITION HEIGHT (ft): .50
    
```

HYDRAULIC CALCULATIONS USING NORMAL DEPTH

	DESIGN	MAXIMUM
FLOW (cfs)	27.00	48.08
DEPTH (ft)	1.17	1.63
AREA (ft^2)	9.74	15.17
WETTED PERIMETER (ft)	11.24	13.33
HYDRAULIC RADIUS (ft)	.87	1.14
VELOCITY (ft/s)	2.77	3.17
MANNINGS N (LOW FLOW)	.055	.055
MANNINGS N (SIDE SLOPE)	.080	.080
EFFECTIVE MANNINGS N	.062	.065
REYNOLDS NUMBER (10^5)	.25	

STABILITY ANALYSIS

CONDITION	LINING TYPE	PERMIS SHR (lb/ft^2)	CALC. SHR (lb/ft^2)	STAB. FACTOR	REMARKS
LOW FLOW LINING BOTTOM; STRAIGHT	RIPRAP	1.65	1.18	1.40	STABLE
SIDE SLOPE LINING SIDE; STRAIGHT	VEGETATIVE B	2.10	.78	2.71	STABLE

RATIO OF SIDE SHEAR TO BOTTOM SHEAR = .66

*** NORMAL END OF HYCHL ***

<i>Variables</i>	<i>Existing Channel</i>	<i>Proposed Reach</i>	<i>USGS Station</i>	<i>Reference Reach</i>
1. Stream type	G4	B4c	NONE	B4c/1
2. Drainage area (D.A.) (ac.)	102.5 ac.	102.5 ac.		2112 ac.
3. Bankfull width (W_{bkt}) (ft.)	5.26 ft.	10.27 ft.		25.58 ft.
4. Bankfull mean depth (d_{bkt}) (ft.)	1.04 ft.	0.79 ft.		1.69 ft.
5. Width/depth ratio (W_{bkt}/d_{bkt})	5.06	13.00		15.11
6. Bankfull cross-sectional area (A_{bkt}) (ft ²)	5.47 ft ²	8.11 ft ²		43.30 ft ²
7. Bankfull mean velocity (V_{bkt}) (ft/s)	4.84 ft/s	2.77 ft/s		4.6 ft/s
8. Bankfull discharge (Q_{bkt}) (ft ³ /s)	26.50 ft ³ /s	27.00 ft ³ /s		199 ft ³ /s
9. Bankfull max depth (d_{mbkt}) (ft)	1.47 ft.	1.06 ft.		3.0 ft
10. Width of floodprone area (W_{fpa}) (ft)	2.95 ft.	20.87 ft.		36.58 ft
11. Entrenchment ratio (W_{fpa}/W_{bkt})	0.56	2.03		1.43
12. Meander length (L_m) (ft)	62.57 ft.	65.10 ft.		168.3 ft
13. Ratio of meander length to bankfull width (L_m/W_{bkt})	11.90	6.34		6.57
14. Radius of curvature (R_c) (ft)	8.04 ft.	21 ft.		41.18 ft
15. Ratio of radius of curvature to bankfull width (R_c/W_{bkt})	1.53	2.04		1.61
16. Belt width (W_{bit}) (ft)	26.02 ft.	26.51 ft.		43.7 ft
17. Meander width ratio (W_{bit}/W_{bkt})	4.95	2.58		1.71
18. Sinuosity (stream length/valley length) (K)	1.35	1.18		1.07
19. Valley Slope (VS)	.0196	.0191		0.0088
20. Average slope (CS)	.0145	.0162		0.0094
21. Pool slope	.0142	.005		0.0004
22. Ratio of pool slope to average slope	.01	.31		.04
23. Maximum pool depth (d_{pmax}) (ft)	1.80 ft.	1.80 ft.		5.0 ft
24. Ratio of pool depth to average bankfull depth (d_p/d_{bkt})	1.73	2.28		1.57
25. Pool width (W_p) (ft)	3.29 ft.	12.02 ft.		25.84 ft
26. Ratio of pool width to bankfull width	.63	1.17		1.01
27. Pool to pool spacing (ft)	23.83 ft.	36.30 ft.		62.4 ft
28. Ratio of pool to pool spacing to bankfull width	4.53	3.53		2.44
29. Ratio of lowest bank height to bankfull height (or max bankfull depth) (BH_{low}/d_{mbkt})	1.00	1.00		1.00

NATURAL CHANNEL DESIGN DATA
MORPHOLOGICAL MEASUREMENT
TABLE (ENGLISH UNITS)

* Reference reach is Silas Creek near
Winston Salem in Forsyth County, NC.

SITE 1

N.C. DEPT. OF TRANSPORTATION
DIVISION OF HIGHWAYS
VANCE COUNTY
PROJECT: 8.2390201 (U-2527)

June 16, 2004
SHEET __ OF __

Pebble Count

Project: 8.2390201

Sheet # 5 of 6

TIP No.: U-2527

Comm. No.: _____

Pebble Count

	Particle	mm	PARTICLE COUNT			Total #	Item %	% Cum.
			1	2	3			
	Silt/Clay	<.062	11	1		12	6.8	6.8
(Sand)	Very Fine	.062-.125	15	1		16	9.1	15.9
	Fine	.125-.25	14	32		46	26.1	42.0
	Medium	.25-.50	6			6	3.4	45.5
	Coarse	.50-1.0	2	10		12	6.8	52.3
	Very Coarse	1.0-2	4	1		5	2.8	55.1
(Gravel)	Very Fine	2.0-4.0	4	8		12	6.8	61.9
	Fine	4.0-5.7	3	5		8	4.5	66.5
	Fine	5.7-8.0	3	3		6	3.4	69.9
	Medium	8.0-11.3	3	9		12	6.8	76.7
	Medium	11.3-16.0	5	4		9	5.1	81.8
	Coarse	16.0-22.6	9			9	5.1	86.9
	Coarse	22.6-32.0	10			10	5.7	92.6
	Very Coarse	32-45				0	0.0	92.6
	Very Coarse	45-64	3			3	1.7	94.3
(Cobble)	Small	64-90	4			4	2.3	96.6
	Small	90-128				0	0.0	96.6
	Large	128-180	1			1	0.6	97.2
	Large	180-256				0	0.0	97.2
(Boulder)	Small	256-362				0	0.0	97.2
	Small	362-512				0	0.0	97.2
	Medium	512-1024				0	0.0	97.2
	Lg-Very Lg	1024-2048	2			2	1.1	98.3
(Bedrock)			3			3	1.7	100.0
TOTALS						176		100.0

D₁₆: 0.13 mm

Sand &< 55 %

D₃₅: 0.21 mm

Gravel 39 %

D₅₀: 0.79 mm

Cobble 3 %

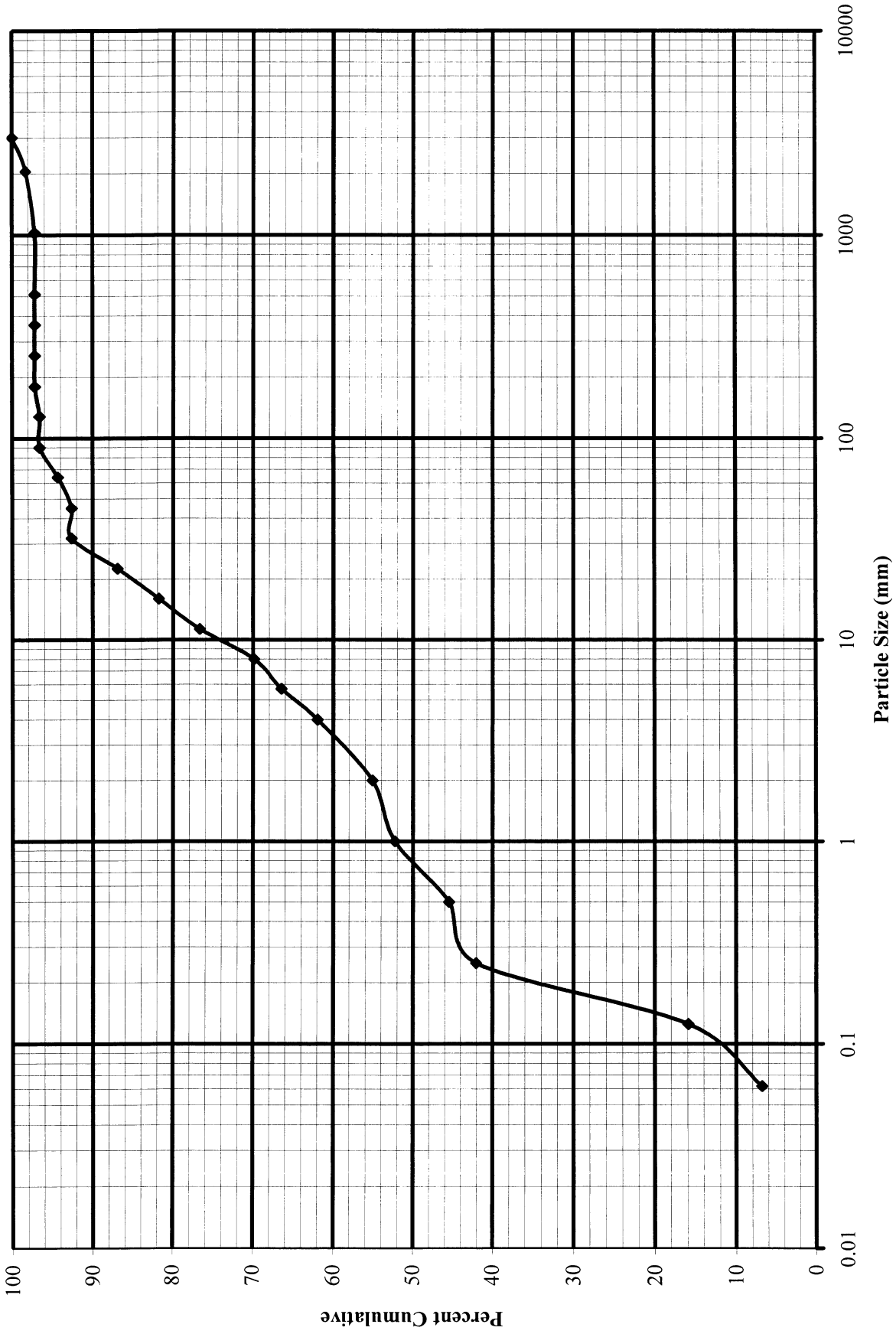
D₈₄: 18.57 mm

Boulder 1 %

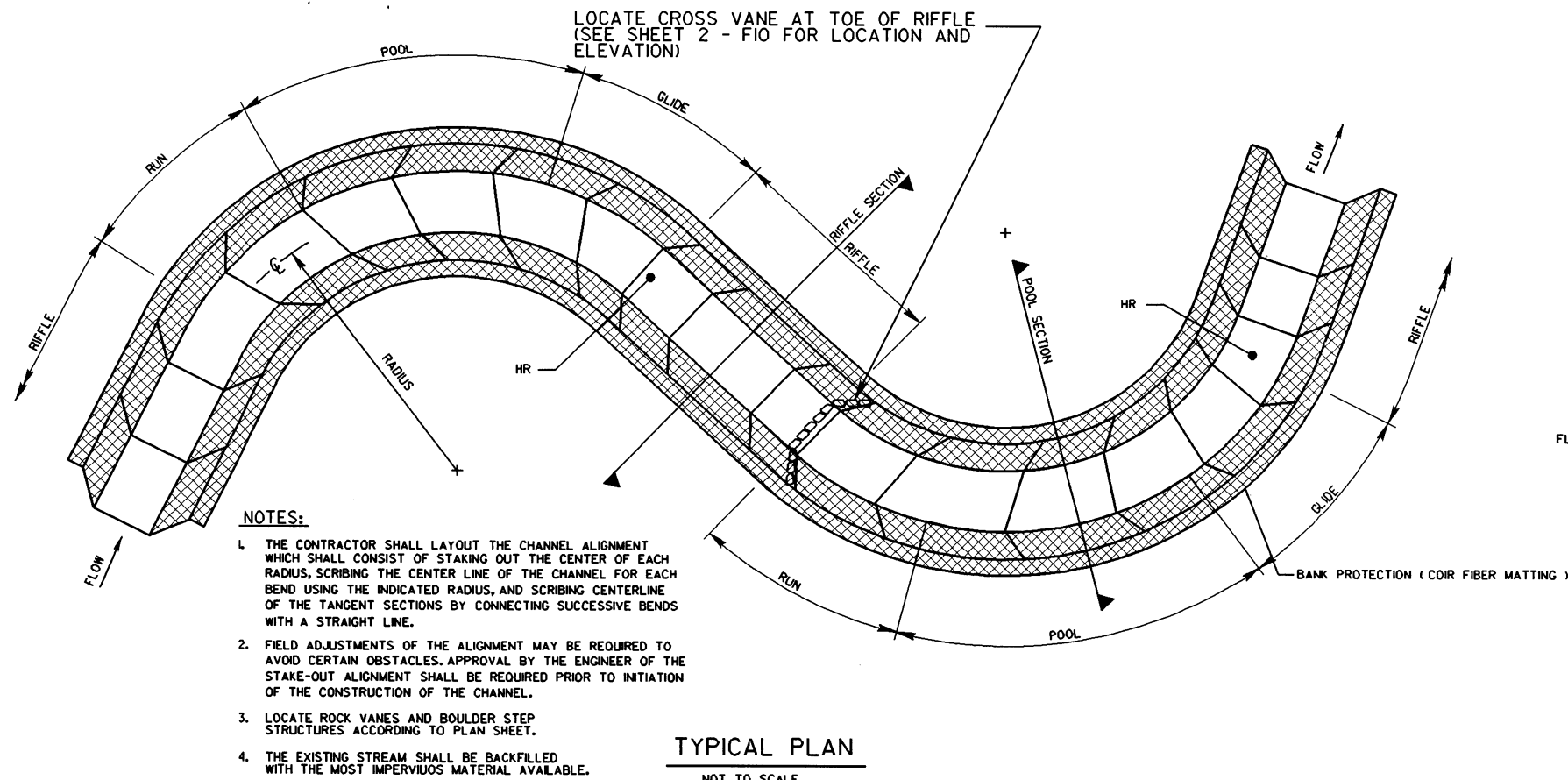
D₉₅: 71.0 mm

Bedrock 2 %

Pebble Count



PROJECT REFERENCE NO. U-2527	SHEET NO. 2-F
RW SHEET NO.	
ROADWAY DESIGN ENGINEER	HYDRAULICS ENGINEER

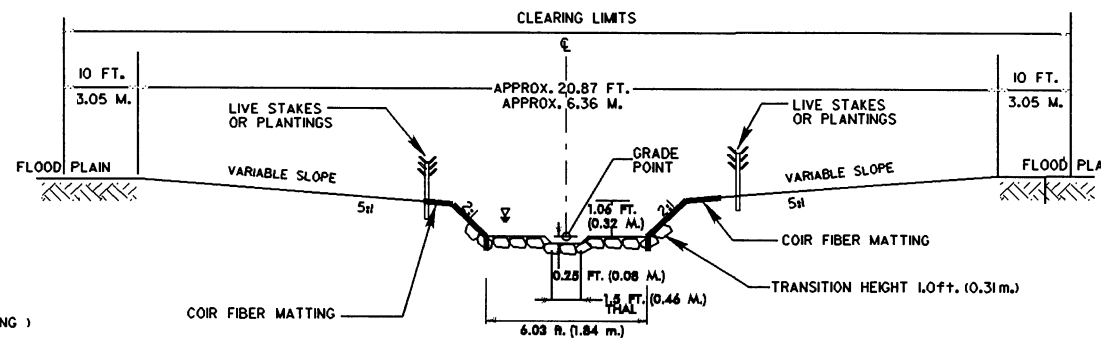


NOTES:

1. THE CONTRACTOR SHALL LAYOUT THE CHANNEL ALIGNMENT WHICH SHALL CONSIST OF STAKING OUT THE CENTER OF EACH RADIUS, SCRIBING THE CENTER LINE OF THE CHANNEL FOR EACH BEND USING THE INDICATED RADIUS, AND SCRIBING CENTERLINE OF THE TANGENT SECTIONS BY CONNECTING SUCCESSIVE BENDS WITH A STRAIGHT LINE.
2. FIELD ADJUSTMENTS OF THE ALIGNMENT MAY BE REQUIRED TO AVOID CERTAIN OBSTACLES. APPROVAL BY THE ENGINEER OF THE STAKE-OUT ALIGNMENT SHALL BE REQUIRED PRIOR TO INITIATION OF THE CONSTRUCTION OF THE CHANNEL.
3. LOCATE ROCK VANES AND BOULDER STEP STRUCTURES ACCORDING TO PLAN SHEET.
4. THE EXISTING STREAM SHALL BE BACKFILLED WITH THE MOST IMPERVIUOUS MATERIAL AVAILABLE.

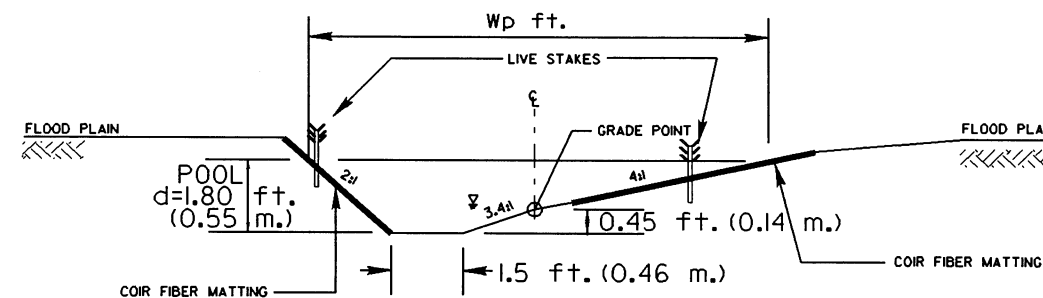
TYPICAL PLAN

NOT TO SCALE



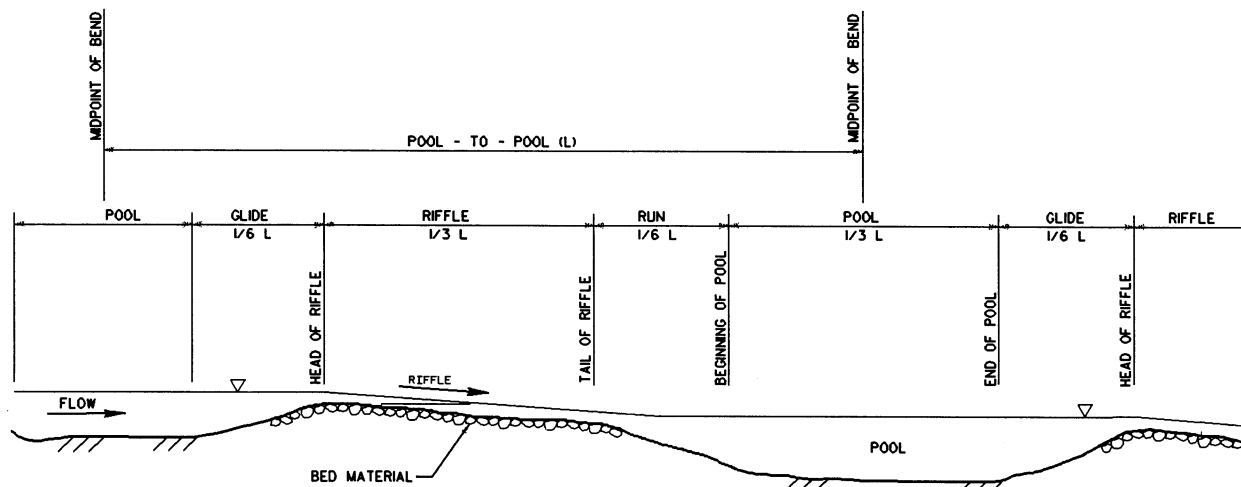
TYPICAL RIFFLE SECTION

NOT TO SCALE



TYPICAL POOL SECTION

NOT TO SCALE



NOTES:

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

TYPICAL PROFILE

NOT TO SCALE

MORPHOLOGICAL MEASUREMENT TABLE (ENGLISH TABLE)

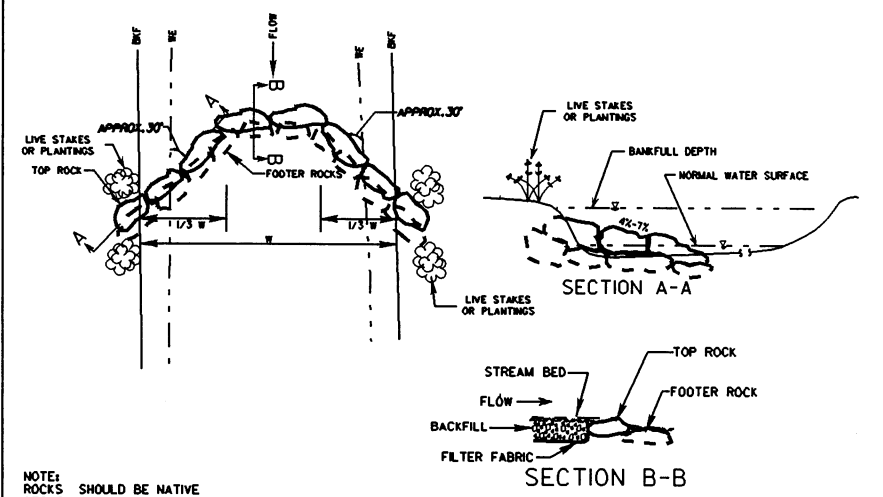
VARIABLES	EXISTING CHANNEL	PROPOSED REACH 1	PROPOSED REACH 2	REFERENCE REACH 3
1) STREAM TYPE	G4	B4c	NONE	B4c/1
2) DRAINAGE AREA	0.16sq.m	0.16sq.m		3.30sq.m
3) BANKFULL WIDTH	5.26ft	10.27ft		25.58ft
4) BANKFULL MEAN DEPTH	1.04ft	0.79ft		1.69ft
5) WIDTH/DEPTH RATIO	5.06	13.00		15.14
6) BANKFULL CROSS-SECTIONAL AREA	5.47sq.ft	8.18sq.ft		43.30sq.ft
7) BANKFULL MEAN VELOCITY	4.84fps	2.77fps		4.6fps
8) BANKFULL DISCHARGE Q _b	26.50cfs	27cfs		199cfs
9) BANKFULL MAX DEPTH	1.47ft	1.06ft		3.0ft
10) WIDTH OF FLOODPRONE AREA	2.95ft	20.87ft		36.58ft
11) ENTRENCHMENT RATIO	0.56	2.03		1.43
12) MEANDER LENGTH	62.57ft	65.10ft		168.3ft
13) RATIO OF MEANDER LENGTH TO BANKFULL WIDTH	11.90	6.34		6.57
14) RADIUS OF CURVATURE	8.04ft	21ft		41.8ft
15) RATIO OF RADIUS OF CURVATURE TO BANKFULL WIDTH	1.53	2.04		1.61
16) MEAN WIDTH	26.02ft	26.51ft		43.7ft
17) MEANDER WIDTH RATIO	4.95	2.58		1.71
18) MEANDER WIDTH RATIO TO VALLEY LENGTH	1.35	1.18		1.07
19) VALLEY SLOPE	0.0196	0.0191		0.0088
20) AVERAGE SLOPE	0.0145	0.0162		0.0094
21) POOL SLOPE	0.0142	0.005		0.0004
22) RATIO OF POOL SLOPE TO AVERAGE SLOPE	.01	0.31		0.04
23) MAXIMUM POOL DEPTH	1.80ft	1.80ft		5.0ft
24) RATIO OF POOL DEPTH TO AVERAGE BANKFULL DEPTH	1.73	2.28		1.57
25) POOL WIDTH	3.29ft	12.02ft		25.84ft
26) RATIO OF POOL WIDTH TO BANKFULL WIDTH	.63	1.17		1.01
27) POOL TO POOL SPACING	23.83ft	36.30ft		62.4ft
28) RATIO OF POOL TO POOL SPACING TO BANKFULL WIDTH	4.53	3.53		2.44
29) RATIO OF LOWEST BANK HEIGHT TO BANKFULL HEIGHT (at max bankfull depth)	1.8	1.0		1.00

MORPHOLOGICAL MEASUREMENT TABLE (METRIC TABLE)

VARIABLES	EXISTING CHANNEL	PROPOSED REACH 1	PROPOSED REACH 2	REFERENCE REACH 3
1) STREAM TYPE	G4	B4c	NONE	B4c/1
2) DRAINAGE AREA	0.16sq.m	0.16sq.m		3.30sq.m
3) BANKFULL WIDTH	1.60 m	3.13 m		7.80 m
4) BANKFULL MEAN DEPTH	0.32 m	0.24 m		0.52 m
5) WIDTH/DEPTH RATIO	5.06	13.00		15.14
6) BANKFULL CROSS-SECTIONAL AREA	0.51sq.m	0.75sq.m		4.03sq.m
7) BANKFULL MEAN VELOCITY	1.48 mps	0.84 mps		1.40 mps
8) BANKFULL DISCHARGE Q _b	0.75cms	0.76cms		5.63cms
9) BANKFULL MAX DEPTH	0.45 m	0.32 m		0.91 m
10) WIDTH OF FLOODPRONE AREA	0.90 m	6.36 m		11.5 m
11) ENTRENCHMENT RATIO	0.56	2.03		1.43
12) MEANDER LENGTH	19.07 m	19.84 m		51.30 m
13) RATIO OF MEANDER LENGTH TO BANKFULL WIDTH	11.90	6.34		6.57
14) RADIUS OF CURVATURE	2.45 m	6.40 m		12.55 m
15) RATIO OF RADIUS OF CURVATURE TO BANKFULL WIDTH	1.53	2.04		1.61
16) MEAN WIDTH	7.93 m	8.08 m		13.32 m
17) MEANDER WIDTH RATIO	4.95	2.58		1.71
18) MEANDER WIDTH RATIO TO VALLEY LENGTH	1.35	1.18		1.07
19) VALLEY SLOPE	0.0196	0.0191		0.0088
20) AVERAGE SLOPE	0.0145	0.0162		0.0094
21) POOL SLOPE	0.0142	0.005		0.0004
22) RATIO OF POOL SLOPE TO AVERAGE SLOPE	.01	0.31		0.04
23) MAXIMUM POOL DEPTH	0.55 m	0.55 m		1.52 m
24) RATIO OF POOL DEPTH TO AVERAGE BANKFULL DEPTH	1.73	2.28		1.57
25) POOL WIDTH	1.00 m	3.66 m		7.88 m
26) RATIO OF POOL WIDTH TO BANKFULL WIDTH	.63	1.17		1.01
27) POOL TO POOL SPACING	7.26 m	11.06 m		19.02 m
28) RATIO OF POOL TO POOL SPACING TO BANKFULL WIDTH	4.53	3.53		2.44
29) RATIO OF LOWEST BANK HEIGHT TO BANKFULL HEIGHT (at max bankfull depth)	1.8	1.0		1.00

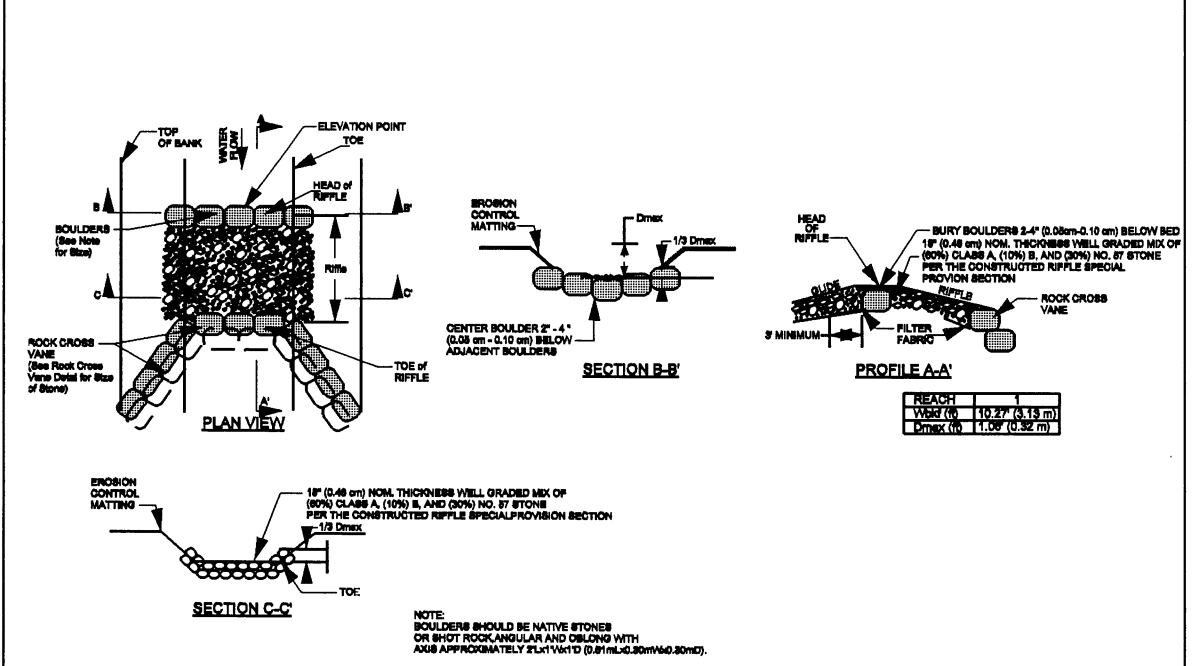
ROCK CROSS VANE

(NOT TO SCALE)



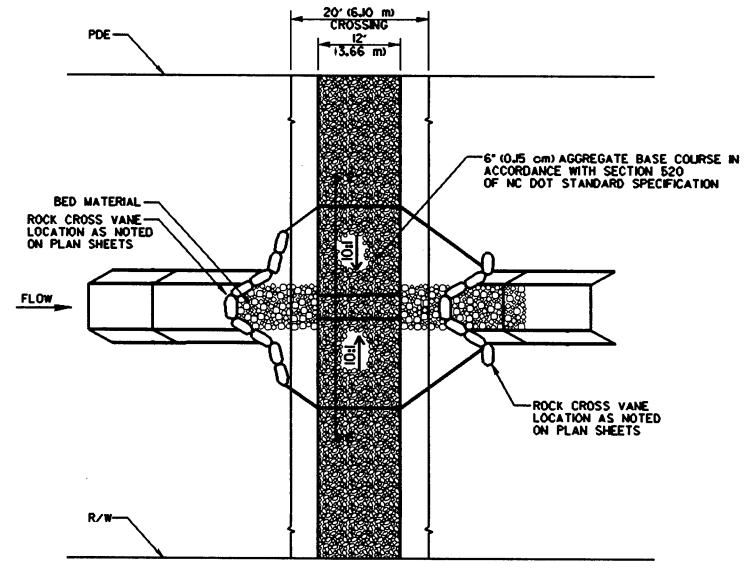
NOTE:
ROCKS SHOULD BE NATIVE
STONE OR SHOT ROCK, ANGULAR AND OBLONG WITH
AXIS APPROXIMATELY 3'Lx2"WxD (0.9mLx0.6mWx0.30mD).

CONSTRUCTED RIFFLE

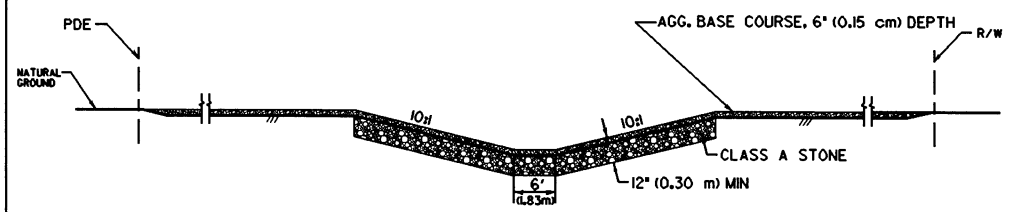


NOTE:
BOULDERS SHOULD BE NATIVE STONES
OR SHOT ROCK, ANGULAR AND OBLONG WITH
AXIS APPROXIMATELY 3'Lx1"WxD (0.9mLx0.30mWx0.30mD).

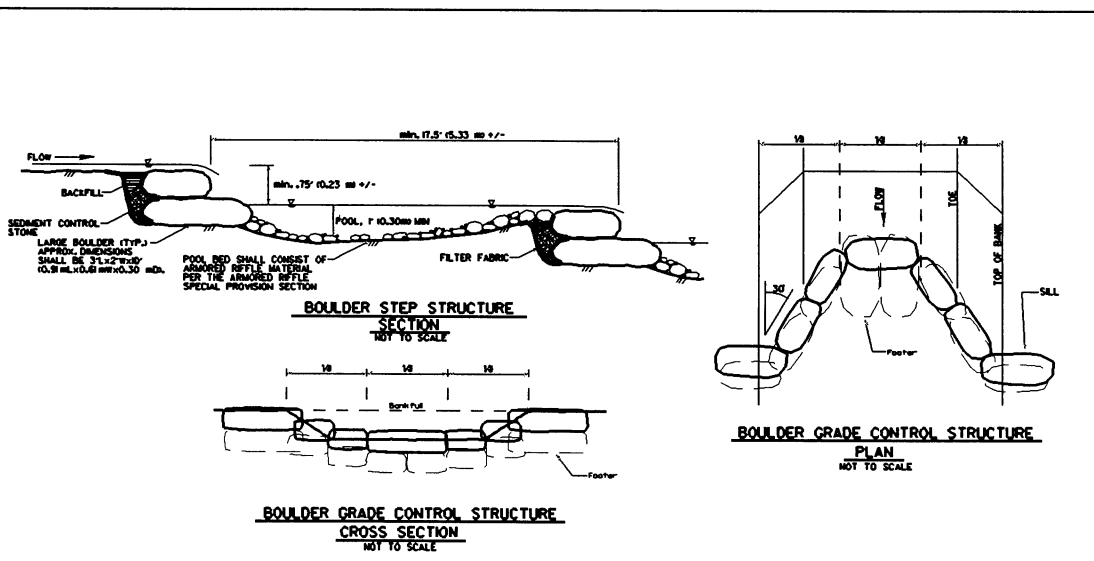
CONSTRUCTED RIFFLE



STREAM CROSSING - TYPE II
PLAN VIEW
NOT TO SCALE



STREAM CROSSING - TYPE II
SECTION E-E
NOT TO SCALE



BOULDER STEP STRUCTURE
SECTION
NOT TO SCALE

BOULDER GRADE CONTROL STRUCTURE
CROSS SECTION
NOT TO SCALE

BOULDER GRADE CONTROL STRUCTURE
PLAN
NOT TO SCALE

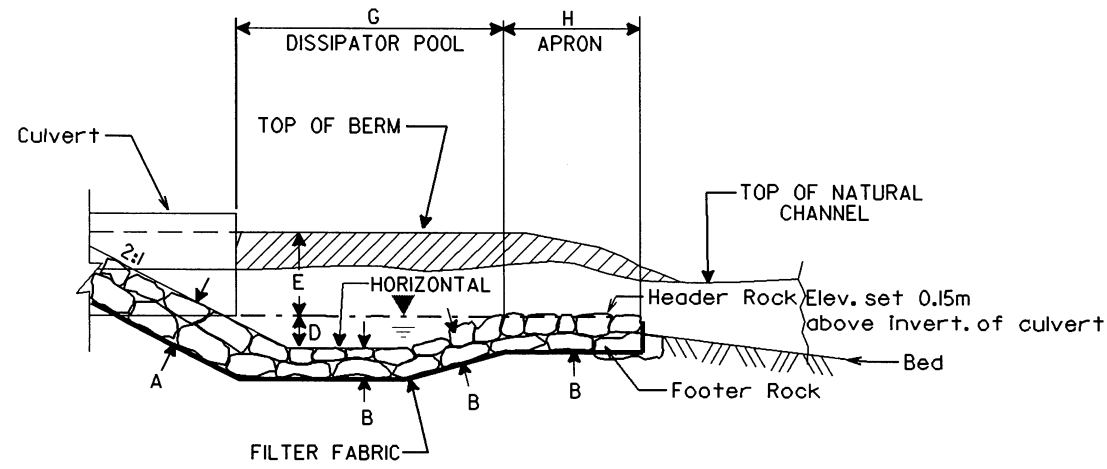
DISSIPATOR BASIN

ROCK CROSS VANE

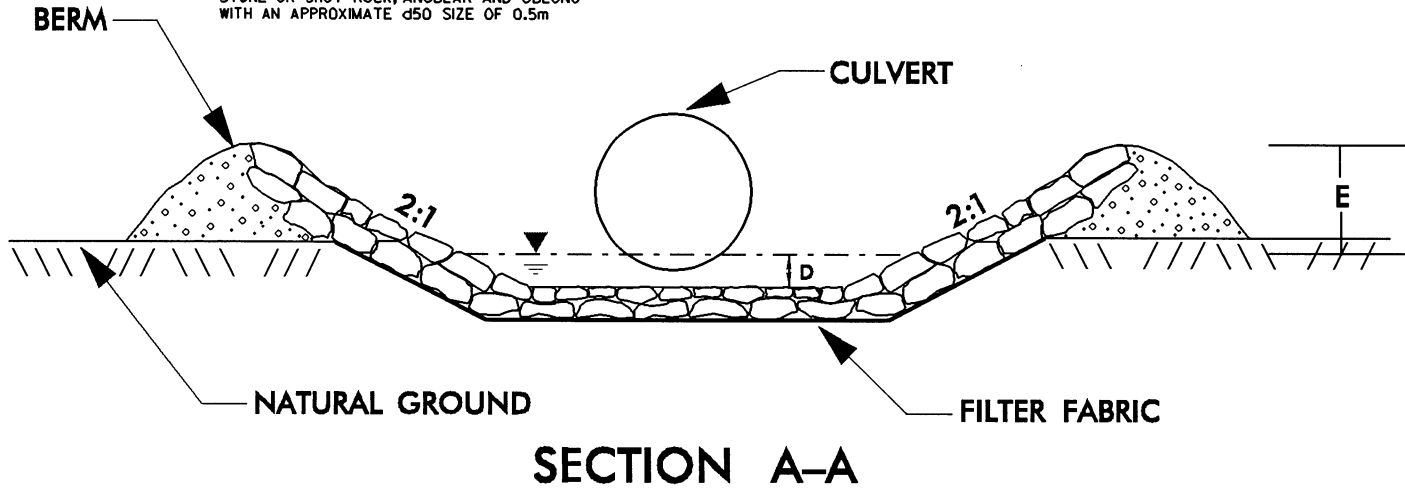
METRIC

PROJECT REFERENCE NO. U-2527	SHEET NO. 2-F2
HIGHWAY DESIGN ENGINEER	HYDRAULICS ENGINEER

SECTION C-C



NOTE: DISSIPATOR ROCKS SHOULD BE NATIVE STONE OR SHOT ROCK, ANGULAR AND OBLONG WITH AN APPROXIMATE d50 SIZE OF 0.5m

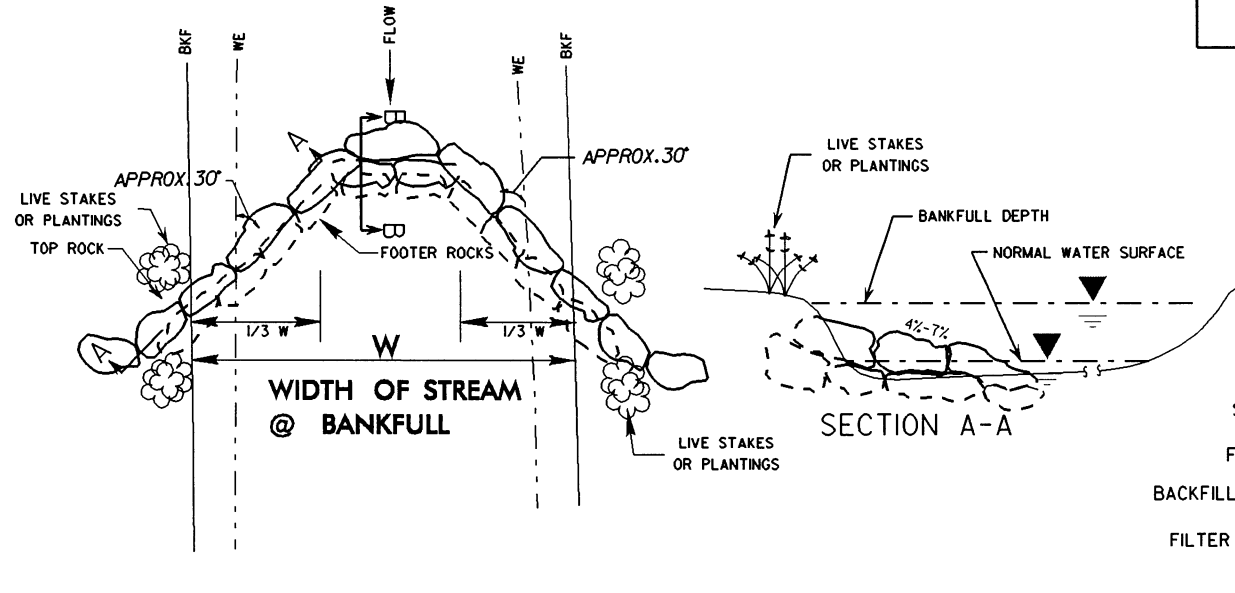


DIM.	RIP RAP BASIN #							
	1	2	3	4	5	6	7	8
A	1.0							
B	1.0							
C	—							
D	1.0							
E	1.0							
F	—							
G	5.08							
H	1.52							

BASIN #	LOCATION (AT OUTLET)
1	45+96.576 RT. (1200mm)
2	
3	
4	
5	
6	
7	
8	

ALL DIMENSIONS APPROXIMATE IN m

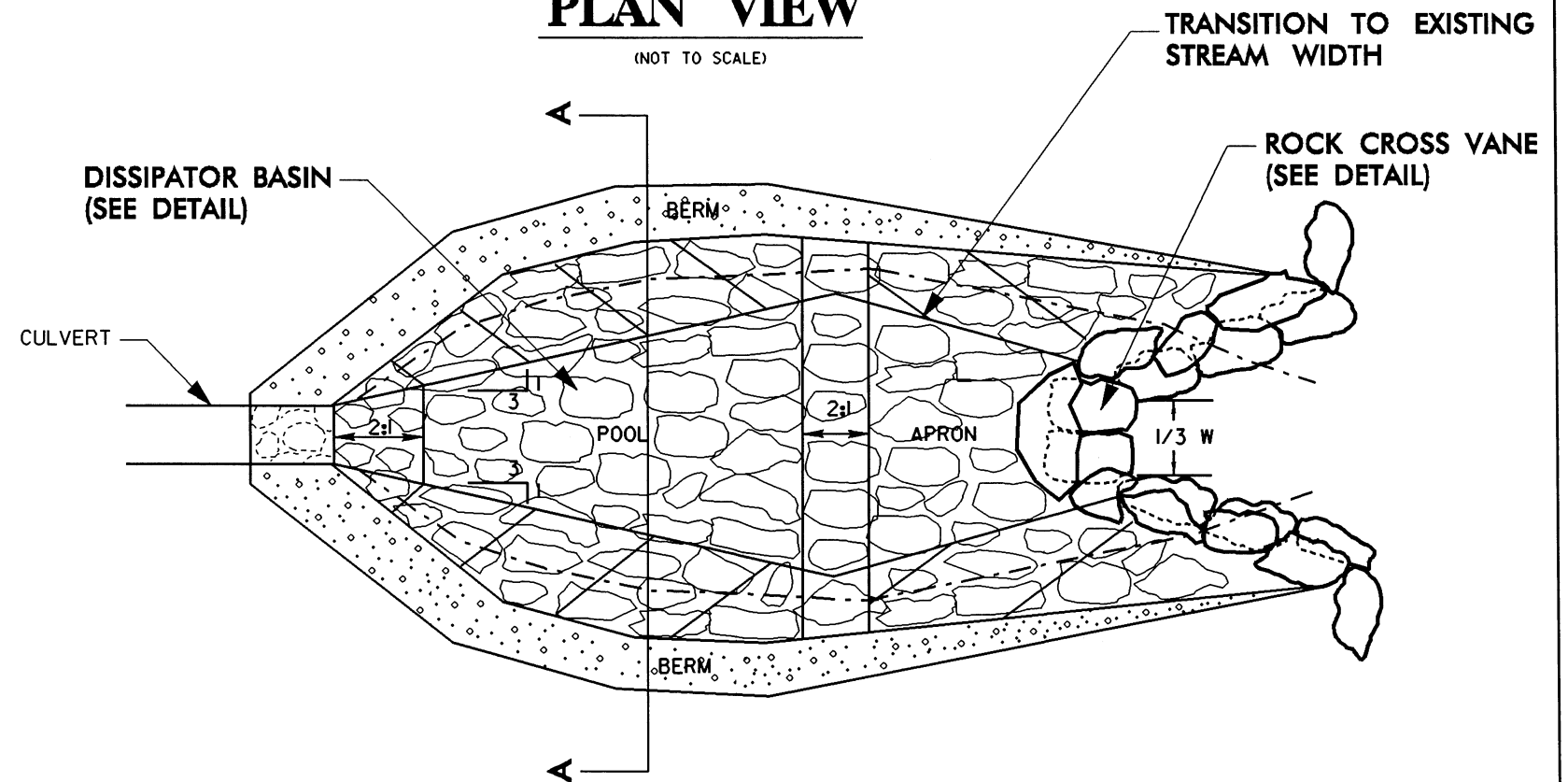
(NOT TO SCALE)



NOTE: CROSS VANE ROCKS SHOULD BE NATIVE STONE OR SHOT ROCK, ANGULAR AND OBLONG WITH LONG AXIS APPROXIMATELY 3'Lx2'Wx1'D IN LENGTH

PLAN VIEW


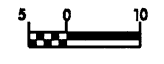
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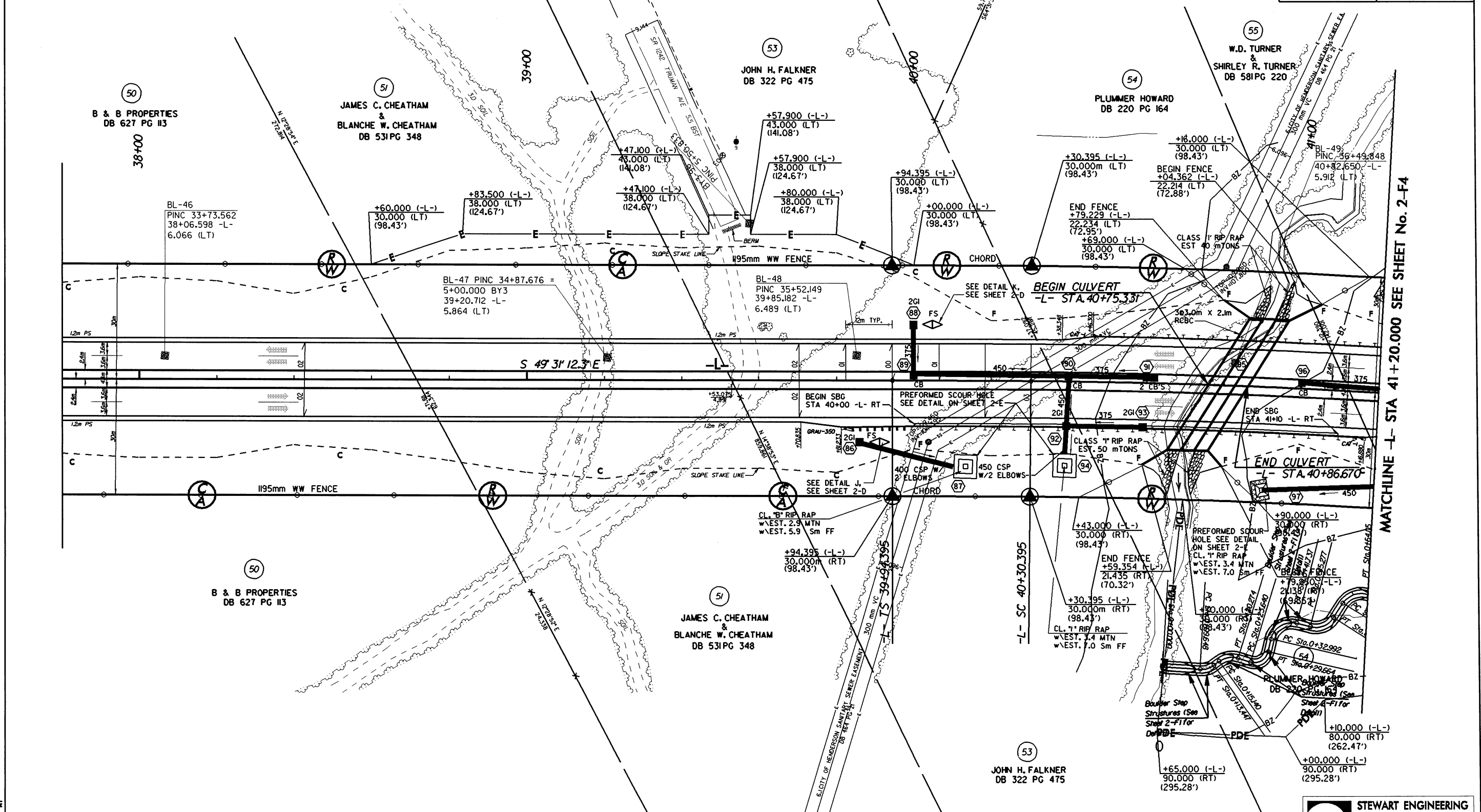


DETAIL OF NATURAL ROCK ENERGY DISSIPATOR BASIN (NOT TO SCALE)

STATE OF NORTH CAROLINA
DIVISION OF HIGHWAYS
RALEIGH, N.C.

REVISIONS

	PROJECT REFERENCE NO.	SHEET NO.
	U-2527	2-F3
	R/W SHEET NO.	
	ROADWAY DESIGN ENGINEER	HYDRAULICS ENGINEER
CONST. REV.		
R/W REV.		




SEE SHEETS 2-F6 THROUGH 2-F8 FOR STREAM ALIGNMENT

SEE SHEETS 2-F9 AND 2-F10 FOR STREAM PROFILE

SEE SHEETS 22 & 23 FOR -L- PROFILE



SEE SHEETS C-5 THRU C-9 FOR CULVERT

MATCHLINE -L- STA 41+20.000 SEE SHEET No. 2-F4

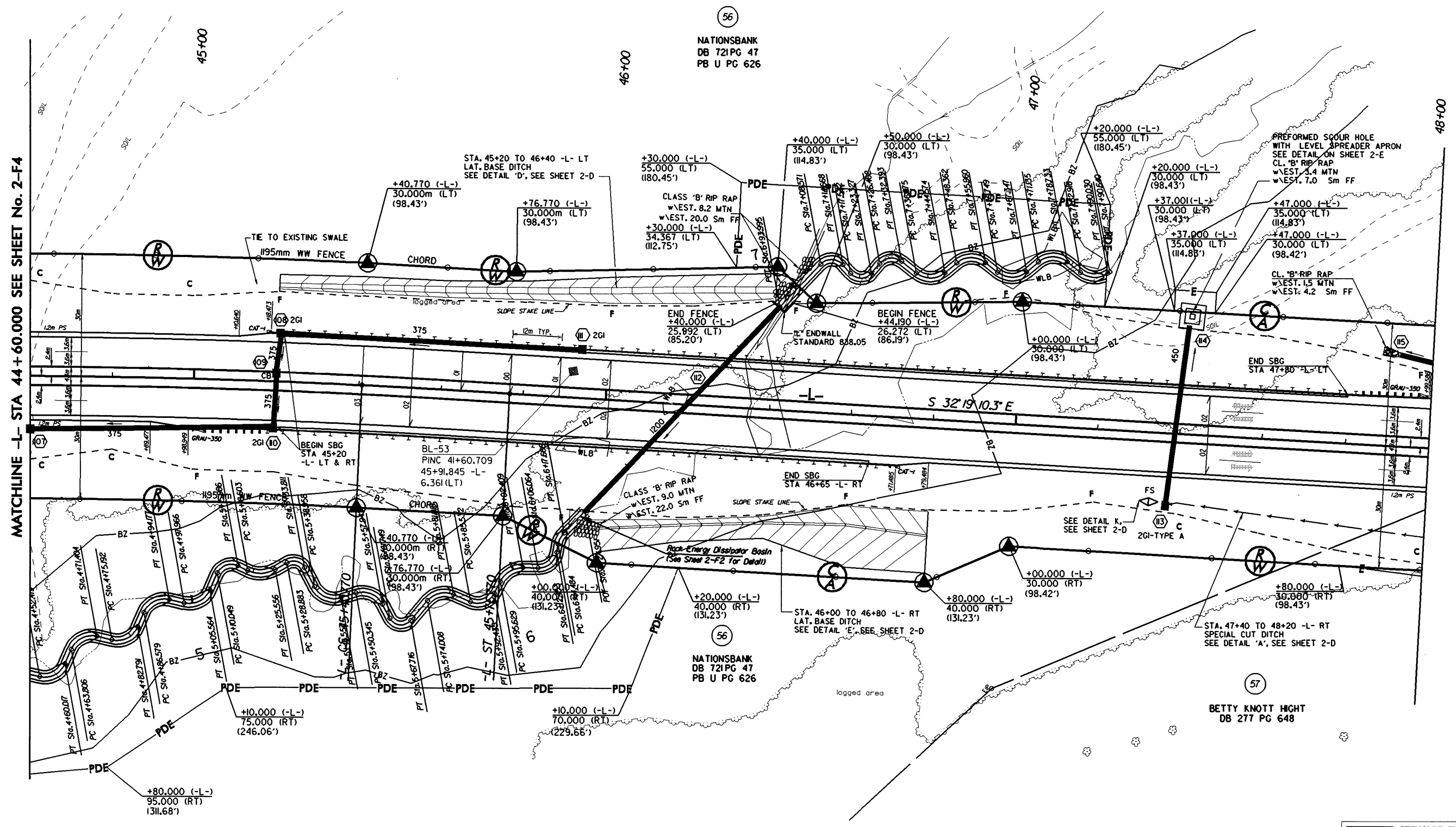


STEWART ENGINEERING
 STRUCTURAL
 TRANSPORTATION
 CIVIL
 P.O. BOX 22054 RESEARCH TRIANGLE PARK, NC 27709
 TEL. 919.280.8750 FAX 919.280.8752

REVISIONS	

	PROJECT REFERENCE NO.	SHEET NO.
	U-2527	2-F5
	R/W SHEET NO.	
	ROADWAY DESIGN ENGINEER	HYDRAULICS ENGINEER
CONST. REV.		
R/W REV.		

NC GRID NAD 83




MATCHLINE -L- STA 44+60.000 SEE SHEET No. 2-F4

SEE SHEETS 2-F6 THROUGH 2-F8 FOR STREAM ALIGNMENT

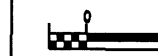
SEE SHEETS 2-F9 AND 2-F10 FOR STREAM PROFILE

SEE SHEETS 23 & 24 FOR -L- PROFILE

	STEWART ENGINEERING
	STRUCTURAL TRANSPORTATION CIVIL
P.O. BOX 12054 RESEARCH TRIANGLE PARK, NC 27709	
TEL 919.380.8750 FAX 919.380.8782	



PROJECT REFERENCE NO.	SHEET NO.
U-2527	2-F7
R/W SHEET NO.	
ROADWAY DESIGN ENGINEER	HYDRAULICS ENGINEER





CONST.REV.

R/W REV.

PROPOSED STREAM CENTER LINE TRAVERSE

Curve Data	Curve Data	Curve Data	Curve Data	Curve Data	Curve Data		
<p>Curve FNLSTM-27 P.I. Station = 2498.10 N 283.032.4159 E 660.412.4680 Delta = 79° 30' 52.53" (LT) Degree = 1044° 23' 59.71" Tangent = 4.5509 Length = 7.5981 Radius = 5.4860 External = 1.6419 Long Chord = 7.0052 Mid. Ord. = 1.2637 P.C. Station = 2433.53 N 283.036.8764 E 660.413.4338 P.T. Station = 2461.15 N 283.035.7154 E 660.418.7952 C.C. = Back = S 12° 13' 03.14" N Ahead = S 67° 17' 49.40" E Chord Bear = S 27° 32' 23.13" E Course from PT FNLSTM-27 to PC FNLSTM-28 S 67° 17' 49.40" E D1st 4.2016</p>	<p>Curve FNLSTM-34 P.I. Station = 3478.51 N 282.985.9713 E 660.467.0825 Delta = 79° 21' 15.68" (RT) Degree = 1044° 23' 59.71" Tangent = 4.5509 Length = 7.5981 Radius = 5.4860 External = 1.6419 Long Chord = 7.0052 Mid. Ord. = 1.2637 P.C. Station = 3413.36 N 282.986.3264 E 660.462.5455 P.T. Station = 3481.56 N 282.981.4468 E 660.467.5717 C.C. = Back = S 85° 31' 29.48" E Ahead = S 6° 10' 13.80" E Chord Bear = S 45° 50' 51.64" E Course from PT FNLSTM-34 to PC FNLSTM-35 S 6° 10' 13.80" E D1st 3.7883</p>	<p>Curve FNLSTM-41 P.I. Station = 4456.97 N 282.937.8374 E 660.515.7638 Delta = 79° 21' 26.87" (LT) Degree = 1044° 23' 59.71" Tangent = 4.5511 Length = 7.5984 Radius = 5.4860 External = 1.6420 Long Chord = 7.0054 Mid. Ord. = 1.2638 P.C. Station = 4402.42 N 282.942.0321 E 660.514.0183 P.T. Station = 4462.52 N 282.938.7919 E 660.520.2324 C.C. = Back = S 22° 49' 33.69" E Ahead = N 77° 48' 59.44" E Chord Bear = S 62° 30' 17.12" E Course from PT FNLSTM-41 to PC FNLSTM-42 N 77° 48' 59.44" E D1st 3.7883</p>	<p>Curve FNLSTM-48 P.I. Station = 532.07 N 282.907.9152 E 660.574.6467 Delta = 92° 38' 09.43" (RT) Degree = 1879° 46' 58.05" Tangent = 3.1916 Length = 4.9200 Radius = 3.0480 External = 1.3652 Long Chord = 4.4085 Mid. Ord. = 0.9429 P.C. Station = 542.88 N 282.908.2122 E 660.571.7306 P.T. Station = 543.81 N 282.905.0618 E 660.573.2170 C.C. = Back = S 66° 01' 19.64" E Ahead = S 26° 36' 49.79" W Chord Bear = S 19° 42' 14.93" E Course from PT FNLSTM-48 to PC FNLSTM-49 S 26° 36' 49.79" W D1st 5.1478</p>	<p>Curve FNLSTM-28 P.I. Station = 3409.49 N 283.027.4352 E 660.424.3731 Delta = 61° 07' 35.98" (RT) Degree = 817° 20' 36.61" Tangent = 4.1396 Length = 7.4787 Radius = 7.0100 External = 1.1311 Long Chord = 7.1290 Mid. Ord. = 0.9739 P.C. Station = 3405.35 N 283.029.0329 E 660.420.5542 P.T. Station = 3412.83 N 283.023.3195 E 660.424.8181 C.C. = Back = S 67° 17' 49.40" E Ahead = S 6° 10' 13.22" E Chord Bear = S 36° 44' 01.41" E Course from PT FNLSTM-28 to PC FNLSTM-29 S 6° 10' 13.22" E D1st 4.1936</p>	<p>Curve FNLSTM-35 P.I. Station = 3489.80 N 282.973.1559 E 660.468.4681 Delta = 79° 21' 15.25" (LT) Degree = 1044° 23' 59.71" Tangent = 4.5509 Length = 7.5981 Radius = 5.4860 External = 1.6419 Long Chord = 7.0052 Mid. Ord. = 1.2637 P.C. Station = 3425.35 N 282.977.6804 E 660.467.9789 P.T. Station = 3492.94 N 282.972.8008 E 660.473.0051 C.C. = Back = S 6° 10' 13.80" E Ahead = S 85° 31' 29.05" E Chord Bear = S 45° 50' 51.43" E Course from PT FNLSTM-35 to PC FNLSTM-36 S 85° 31' 29.05" E D1st 3.7885</p>	<p>Curve FNLSTM-42 P.I. Station = 4468.36 N 282.940.5579 E 660.528.3840 Delta = 79° 21' 23.97" (RT) Degree = 1044° 23' 59.71" Tangent = 4.5511 Length = 7.5983 Radius = 5.4860 External = 1.6420 Long Chord = 7.0054 Mid. Ord. = 1.2637 P.C. Station = 4423.81 N 282.939.5974 E 660.523.9354 P.T. Station = 4471.40 N 282.936.3632 E 660.530.1495 C.C. = Back = N 77° 48' 59.44" E Ahead = S 22° 49' 36.59" E Chord Bear = S 62° 30' 18.58" E Course from PT FNLSTM-42 to PC FNLSTM-43 S 22° 49' 36.59" E D1st 3.7884</p>	<p>Curve FNLSTM-49 P.I. Station = 5443.51 N 282.896.3906 E 660.568.8722 Delta = 79° 21' 18.83" (LT) Degree = 1044° 23' 59.71" Tangent = 4.5511 Length = 7.5982 Radius = 5.4860 External = 1.6419 Long Chord = 7.0053 Mid. Ord. = 1.2637 P.C. Station = 5438.96 N 282.900.4594 E 660.570.9109 P.T. Station = 5446.56 N 282.898.0018 E 660.572.4944 C.C. = Back = S 26° 36' 49.79" W Ahead = S 52° 44' 30.15" E Chord Bear = S 13° 03' 50.18" E Course from PT FNLSTM-49 to PC FNLSTM-50 S 52° 44' 30.15" E D1st 3.7883</p>
<p>Curve FNLSTM-29 P.I. Station = 3421.58 N 283.014.6197 E 660.425.7587 Delta = 79° 21' 15.63" (LT) Degree = 1044° 23' 59.71" Tangent = 4.5509 Length = 7.5981 Radius = 5.4860 External = 1.6419 Long Chord = 7.0052 Mid. Ord. = 1.2637 P.C. Station = 3417.03 N 283.019.1442 E 660.425.2695 P.T. Station = 3424.63 N 283.014.2646 E 660.430.2957 C.C. = Back = S 6° 10' 13.22" E Ahead = S 85° 31' 29.05" E Chord Bear = S 45° 50' 51.24" E Course from PT FNLSTM-29 to PC FNLSTM-30 S 85° 31' 29.05" E D1st 3.7885</p>	<p>Curve FNLSTM-36 P.I. Station = 4401.28 N 282.972.1501 E 660.481.3191 Delta = 79° 21' 15.84" (RT) Degree = 1044° 23' 59.71" Tangent = 4.5509 Length = 7.5981 Radius = 5.4860 External = 1.6419 Long Chord = 7.0052 Mid. Ord. = 1.2637 P.C. Station = 4385.35 N 282.972.5052 E 660.476.7820 P.T. Station = 4404.33 N 282.967.6256 E 660.473.4331 C.C. = Back = S 85° 31' 29.05" E Ahead = S 6° 10' 13.22" E Chord Bear = S 45° 50' 51.13" E Course from PT FNLSTM-36 to PC FNLSTM-37 S 6° 10' 13.22" E D1st 3.7884</p>	<p>Curve FNLSTM-43 P.I. Station = 4479.74 N 282.928.6769 E 660.533.3848 Delta = 79° 21' 23.97" (LT) Degree = 1044° 23' 59.71" Tangent = 4.5511 Length = 7.5983 Radius = 5.4860 External = 1.6420 Long Chord = 7.0054 Mid. Ord. = 1.2637 P.C. Station = 4475.19 N 282.932.8716 E 660.531.6192 P.T. Station = 4482.79 N 282.929.6374 E 660.537.8333 C.C. = Back = S 22° 49' 36.59" E Ahead = N 77° 48' 59.44" E Chord Bear = S 62° 30' 18.58" E Course from PT FNLSTM-43 to PC FNLSTM-44 N 77° 48' 59.44" E D1st 3.7883</p>	<p>Curve FNLSTM-50 P.I. Station = 5454.90 N 282.888.5867 E 660.579.1317 Delta = 79° 21' 18.83" (RT) Degree = 1044° 23' 59.71" Tangent = 4.5509 Length = 7.5982 Radius = 5.4860 External = 1.6419 Long Chord = 7.0053 Mid. Ord. = 1.2637 P.C. Station = 5450.34 N 282.891.3419 E 660.575.5096 P.T. Station = 5457.94 N 282.884.5180 E 660.577.0930 C.C. = Back = S 26° 36' 49.79" W Ahead = S 52° 44' 30.15" E Chord Bear = S 13° 03' 50.18" E Course from PT FNLSTM-50 to PC FNLSTM-51 S 26° 36' 49.79" W D1st 3.8063</p>	<p>Curve FNLSTM-30 P.I. Station = 3432.96 N 283.013.6139 E 660.438.6037 Delta = 79° 21' 15.84" (RT) Degree = 1044° 23' 59.71" Tangent = 4.5509 Length = 7.5981 Radius = 5.4860 External = 1.6419 Long Chord = 7.0052 Mid. Ord. = 1.2637 P.C. Station = 3428.41 N 283.013.9690 E 660.434.0726 P.T. Station = 3436.01 N 283.009.0894 E 660.439.0988 C.C. = Back = S 85° 31' 29.05" E Ahead = S 6° 10' 13.22" E Chord Bear = S 45° 50' 51.13" E Course from PT FNLSTM-30 to PC FNLSTM-31 S 6° 10' 13.22" E D1st 3.7884</p>	<p>Curve FNLSTM-37 P.I. Station = 4412.87 N 282.959.3346 E 660.482.7045 Delta = 79° 21' 16.37" (LT) Degree = 1044° 23' 59.71" Tangent = 4.5509 Length = 7.5981 Radius = 5.4860 External = 1.6419 Long Chord = 7.0052 Mid. Ord. = 1.2637 P.C. Station = 4408.12 N 282.963.8591 E 660.482.2154 P.T. Station = 4415.72 N 282.958.9795 E 660.487.2416 C.C. = Back = S 6° 10' 13.22" E Ahead = S 85° 31' 29.05" E Chord Bear = S 45° 50' 51.40" E Course from PT FNLSTM-37 to PC FNLSTM-38 S 85° 31' 29.05" E D1st 4.3192</p>	<p>Curve FNLSTM-44 P.I. Station = 4491.13 N 282.931.3974 E 660.545.9849 Delta = 79° 21' 23.97" (RT) Degree = 1044° 23' 59.71" Tangent = 4.5511 Length = 7.5983 Radius = 5.4860 External = 1.6420 Long Chord = 7.0054 Mid. Ord. = 1.2637 P.C. Station = 4486.58 N 282.930.4369 E 660.541.5363 P.T. Station = 4494.18 N 282.927.2027 E 660.547.7504 C.C. = Back = N 77° 48' 59.44" E Ahead = S 22° 49' 36.59" E Chord Bear = S 62° 30' 18.58" E Course from PT FNLSTM-44 to PC FNLSTM-45 S 22° 49' 36.59" E D1st 3.7884</p>	<p>Curve FNLSTM-51 P.I. Station = 5466.28 N 282.877.0622 E 660.573.3573 Delta = 112° 03' 57.33" (LT) Degree = 1879° 46' 58.05" Tangent = 4.5330 Length = 5.9670 Radius = 3.0480 External = 2.4144 Long Chord = 5.0587 Mid. Ord. = 1.3472 P.C. Station = 5461.75 N 282.881.1149 E 660.575.3879 P.T. Station = 5469.35 N 282.876.7107 E 660.577.8766 C.C. = Back = S 26° 36' 49.79" W Ahead = S 85° 31' 29.05" E Chord Bear = S 28° 28' 09.99" E Course from PT FNLSTM-51 to PC FNLSTM-52 S 85° 31' 29.05" E D1st 6.2916</p>
<p>Curve FNLSTM-31 P.I. Station = 3444.35 N 283.000.7984 E 660.439.9951 Delta = 79° 21' 15.84" (LT) Degree = 1044° 23' 59.71" Tangent = 4.5509 Length = 7.5981 Radius = 5.4860 External = 1.6419 Long Chord = 7.0052 Mid. Ord. = 1.2637 P.C. Station = 3439.80 N 283.005.3229 E 660.439.5060 P.T. Station = 3447.40 N 283.000.4433 E 660.444.5322 C.C. = Back = S 6° 10' 13.22" E Ahead = S 85° 31' 29.05" E Chord Bear = S 45° 50' 51.13" E Course from PT FNLSTM-31 to PC FNLSTM-32 S 85° 31' 29.05" E D1st 3.7884</p>	<p>Curve FNLSTM-38 P.I. Station = 4424.06 N 282.958.3288 E 660.495.5556 Delta = 72° 28' 40.94" (RT) Degree = 1044° 23' 59.71" Tangent = 4.0203 Length = 6.9390 Radius = 5.4860 External = 1.3156 Long Chord = 6.4866 Mid. Ord. = 1.0610 P.C. Station = 4420.04 N 282.958.6425 E 660.491.5476 P.T. Station = 4426.98 N 282.954.4124 E 660.496.4837 C.C. = Back = S 85° 31' 29.05" E Ahead = S 13° 03' 15.99" E Chord Bear = S 49° 17' 22.73" E Course from PT FNLSTM-38 to PC FNLSTM-39 S 13° 03' 15.99" E D1st 3.1082</p>	<p>Curve FNLSTM-45 P.I. Station = 5402.52 N 282.919.5164 E 660.550.9857 Delta = 79° 21' 24.11" (LT) Degree = 1044° 23' 59.71" Tangent = 4.5511 Length = 7.5983 Radius = 5.4860 External = 1.6420 Long Chord = 7.0054 Mid. Ord. = 1.2637 P.C. Station = 4997.77 N 282.923.7111 E 660.549.2201 P.T. Station = 5405.56 N 282.920.4769 E 660.555.4342 C.C. = Back = S 22° 49' 36.59" E Ahead = N 77° 48' 59.30" E Chord Bear = S 62° 30' 18.65" E Course from PT FNLSTM-45 to PC FNLSTM-46 N 77° 48' 59.30" E D1st 4.4853</p>	<p>Curve FNLSTM-52 P.I. Station = 5478.08 N 282.875.9068 E 660.588.2118 Delta = 73° 12' 27.57" (RT) Degree = 1044° 23' 59.71" Tangent = 4.0748 Length = 7.0095 Radius = 5.4860 External = 1.3478 Long Chord = 6.5424 Mid. Ord. = 1.0582 P.C. Station = 5474.01 N 282.876.2228 E 660.584.1493 P.T. Station = 5481.02 N 282.871.9262 E 660.589.0830 C.C. = Back = S 85° 31' 29.05" E Ahead = S 12° 20' 41.08" E Chord Bear = S 48° 56' 54.87" E Course from PT FNLSTM-52 to PC FNLSTM-53 S 12° 20' 41.08" E D1st 4.5142</p>	<p>Curve FNLSTM-32 P.I. Station = 3455.74 N 282.999.7926 E 660.452.8460 Delta = 79° 21' 15.25" (RT) Degree = 1044° 23' 59.71" Tangent = 4.5509 Length = 7.5981 Radius = 5.4860 External = 1.6419 Long Chord = 7.0052 Mid. Ord. = 1.2637 P.C. Station = 3451.19 N 283.000.1477 E 660.448.3090 P.T. Station = 3458.79 N 282.995.2681 E 660.453.3522 C.C. = Back = S 85° 31' 29.05" E Ahead = S 6° 10' 13.80" E Chord Bear = S 45° 50' 51.43" E Course from PT FNLSTM-32 to PC FNLSTM-33 S 6° 10' 13.80" E D1st 3.7884</p>	<p>Curve FNLSTM-39 P.I. Station = 4434.59 N 282.946.9980 E 660.498.1829 Delta = 89° 07' 40.94" (LT) Degree = 1253° 11' 18.70" Tangent = 4.5029 Length = 7.1121 Radius = 4.5720 External = 1.8451 Long Chord = 6.4166 Mid. Ord. = 5.3064 P.C. Station = 4430.08 N 282.951.3845 E 660.497.1658 P.T. Station = 4437.20 N 282.947.9482 E 660.502.5844 C.C. = Back = S 13° 03' 15.99" E Ahead = N 77° 48' 59.30" E Chord Bear = S 57° 37' 06.45" E Course from PT FNLSTM-39 to PC FNLSTM-40 N 77° 48' 59.30" E D1st 3.8366</p>	<p>Curve FNLSTM-46 P.I. Station = 5413.90 N 282.922.2369 E 660.563.5857 Delta = 92° 59' 20.52" (RT) Degree = 1566° 18' 51.72" Tangent = 3.8669 Length = 5.9368 Radius = 3.0480 External = 1.6558 Long Chord = 5.3064 Mid. Ord. = 1.1937 P.C. Station = 5410.03 N 282.921.4235 E 660.559.8185 P.T. Station = 5417.77 N 282.918.4324 E 660.564.2015 C.C. = Back = N 77° 48' 59.30" E Ahead = S 9° 11' 40.18" E Chord Bear = S 55° 41' 20.44" E Course from PT FNLSTM-46 to PC FNLSTM-47 S 9° 11' 40.18" E D1st 2.6169</p>	<p>Curve FNLSTM-53 P.I. Station = 5489.83 N 282.863.3145 E 660.590.9677 Delta = 86° 30' 23.05" (LT) Degree = 1253° 11' 18.70" Tangent = 6.9029 Length = 4.5720 Radius = 7.0100 External = 6.2657 Long Chord = 1.2421 Mid. Ord. = 5.9853 P.C. Station = 5485.53 N 282.867.5164 E 660.590.0481 P.T. Station = 5492.55 N 282.863.8763 E 660.595.2179 C.C. = Back = S 12° 20' 41.08" E Ahead = N 81° 08' 55.87" E Chord Bear = S 55° 35' 52.60" E Course from PT FNLSTM-53 to PC FNLSTM-54 N 81° 08' 55.87" E D1st 3.1949</p>

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	PROJECT REFERENCE NO.	SHEET NO.
	U-2527	2-F8
	R/W SHEET NO.	
	ROADWAY DESIGN ENGINEER	HYDRAULICS ENGINEER
CONST. REV.		
R/W REV.		

PROPOSED STREAM CENTER LINE TRAVERSE

Curve Data

Curve FNLSTM-54
P.I. Station = 5+99.42 N 282,865.0508 E 660,602.1182
Delta = 63° 43' 17.27" (RT)
Degree = 93° 53' 29.03"
Tangent = 3.7886
Length = 6.7797
Radius = 6.0960
External = 1.0814
Long Chord = 6.4356
Mid. Ord. = 0.9185
P.C. Station = 5+35.63 N 282,864.4679 E 660,598.3747
P.T. Station = 6+02.41 N 282,861.9523 E 660,604.2983
C.C. = 5+69.02 N 282,858.4445 E 660,599.3127
Back = N 81° 08' 55.87" E
Ahead = S 35° 07' 46.86" E
Chord Bear = S 66° 59' 25.49" E

Course from PT FNLSTM-54 to PC FNLSTM-55 S 35° 07' 46.86" E Dist 3.6551

Curve Data

Curve FNLSTM-55
P.I. Station = 6+09.90 N 282,855.8220 E 660,608.6115
Delta = 80° 03' 37.20" (LT)
Degree = 125° 31' 18.10"
Tangent = 3.8405
Length = 6.3885
Radius = 4.5120
External = 1.3990
Long Chord = 5.8813
Mid. Ord. = 1.0712
P.C. Station = 6+06.06 N 282,858.9630 E 660,606.4016
P.T. Station = 6+12.45 N 282,857.4566 E 660,612.0867
C.C. = 6+09.25 N 282,857.9538 E 660,610.1408
Back = S 35° 07' 46.86" E
Ahead = N 64° 48' 35.95" E
Chord Bear = S 75° 09' 35.45" E

Course from PT FNLSTM-55 to PC FNLSTM-56 N 64° 48' 35.95" E Dist 2.0314

Curve Data

Curve FNLSTM-56
P.I. Station = 6+16.12 N 282,859.0180 E 660,615.4063
Delta = 33° 13' 49.30" (RT)
Degree = 104° 23' 59.71"
Tangent = 1.6370
Length = 3.1818
Radius = 5.4860
External = 0.2390
Long Chord = 3.1374
Mid. Ord. = 0.2291
P.C. Station = 6+14.48 N 282,858.3212 E 660,613.9249
P.T. Station = 6+17.67 N 282,858.7890 E 660,617.0272
C.C. = 6+16.07 N 282,853.3569 E 660,616.2599
Back = N 64° 48' 35.95" E
Ahead = S 81° 57' 34.75" E
Chord Bear = N 81° 25' 30.60" E

Course from PT FNLSTM-56 to 50005 S 81° 57' 34.75" E Dist 7.2853

Point 50005 N 282,857.7700 E 660,624.2409 Sta 6+24.95

Course from 50005 to 50006 S 82° 14' 40.64" E Dist 69.0442

Point 50006 N 282,848.4529 E 660,692.6536 Sta 6+94.00

Course from 50006 to PC FNLSTM-57 S 82° 14' 40.14" E Dist 14.5754

Curve Data

Curve FNLSTM-57
P.I. Station = 7+12.60 N 282,845.9426 E 660,711.0855
Delta = 95° 29' 37.31" (RT)
Degree = 156° 18' 51.72"
Tangent = 4.0267
Length = 6.0867
Radius = 3.6580
External = 1.7822
Long Chord = 5.4152
Mid. Ord. = 1.1983
P.C. Station = 7+08.57 N 282,846.4860 E 660,707.0957
P.T. Station = 7+14.67 N 282,842.0231 E 660,710.1627
C.C. = 7+11.58 N 282,842.8615 E 660,706.6020
Back = S 82° 14' 40.14" E
Ahead = S 13° 14' 57.21" W
Chord Bear = S 34° 29' 51.46" E

Course from PT FNLSTM-57 to PC FNLSTM-58 S 13° 14' 57.21" W Dist 2.8639

Curve Data

Curve FNLSTM-58
P.I. Station = 7+21.46 N 282,835.4113 E 660,708.6059
Delta = 99° 02' 27.31" (LT)
Degree = 170° 47' 29.46"
Tangent = 3.9287
Length = 5.7960
Radius = 3.3530
External = 1.8120
Long Chord = 5.1008
Mid. Ord. = 1.1763
P.C. Station = 7+17.53 N 282,839.2394 E 660,709.5063
P.T. Station = 7+23.33 N 282,835.1230 E 660,712.5240
C.C. = 7+20.43 N 282,838.4670 E 660,712.7701
Back = S 13° 14' 57.21" W
Ahead = S 65° 47' 30.10" E
Chord Bear = S 36° 16' 16.44" E

Course from PT FNLSTM-58 to PC FNLSTM-59 S 85° 47' 30.10" E Dist 3.1343

Curve Data

Curve FNLSTM-59
P.I. Station = 7+30.22 N 282,834.6173 E 660,719.3967
Delta = 89° 11' 49.71" (RT)
Degree = 150° 3' 49"
Tangent = 3.7570
Length = 5.9313
Radius = 3.8100
External = 1.5408
Long Chord = 5.3503
Mid. Ord. = 1.0971
P.C. Station = 7+26.46 N 282,834.8930 E 660,715.6498
P.T. Station = 7+32.39 N 282,830.8670 E 660,719.1735
C.C. = 7+29.42 N 282,831.0933 E 660,715.3702
Back = S 85° 47' 30.10" E
Ahead = S 3° 24' 19.61" W
Chord Bear = S 41° 11' 35.24" E

Course from PT FNLSTM-59 to PC FNLSTM-60 S 3° 24' 19.61" W Dist 4.5823

Curve Data

Curve FNLSTM-60
P.I. Station = 7+41.63 N 282,821.7498 E 660,718.6310
Delta = 79° 21' 18.96" (LT)
Degree = 104° 23' 59.71"
Tangent = 4.5509
Length = 7.5982
Radius = 5.4860
External = 1.6419
Long Chord = 7.0053
Mid. Ord. = 1.2637
P.C. Station = 7+36.98 N 282,826.2928 E 660,718.9013
P.T. Station = 7+44.57 N 282,820.6450 E 660,723.0458
C.C. = 7+41.78 N 282,825.9669 E 660,724.3776
Back = S 3° 24' 19.61" W
Ahead = S 75° 56' 59.34" E
Chord Bear = S 36° 16' 19.86" E

Course from PT FNLSTM-60 to PC FNLSTM-61 S 75° 56' 59.34" E Dist 3.7884

Curve Data

Curve FNLSTM-61
P.I. Station = 7+52.91 N 282,818.6205 E 660,731.1956
Delta = 79° 21' 17.04" (RT)
Degree = 104° 23' 59.71"
Tangent = 4.5509
Length = 7.5981
Radius = 5.4860
External = 1.6419
Long Chord = 7.0052
Mid. Ord. = 1.2637
P.C. Station = 7+48.36 N 282,819.7253 E 660,726.7208
P.T. Station = 7+55.96 N 282,814.0776 E 660,730.8553
C.C. = 7+52.16 N 282,814.4034 E 660,725.3890
Back = S 75° 56' 59.34" E
Ahead = S 3° 24' 17.70" W
Chord Bear = S 36° 16' 20.82" E

Course from PT FNLSTM-61 to PC FNLSTM-62 S 3° 24' 17.70" W Dist 3.7885

Curve Data

Curve FNLSTM-62
P.I. Station = 7+64.30 N 282,805.7529 E 660,730.3700
Delta = 79° 21' 18.36" (LT)
Degree = 104° 23' 59.71"
Tangent = 4.5509
Length = 7.5982
Radius = 5.4860
External = 1.6419
Long Chord = 7.0053
Mid. Ord. = 1.2637
P.C. Station = 7+59.75 N 282,810.2958 E 660,730.6403
P.T. Station = 7+67.35 N 282,804.6481 E 660,734.7848
C.C. = 7+64.55 N 282,809.3700 E 660,736.1166
Back = S 3° 24' 17.70" W
Ahead = S 75° 27' 00.66" E
Chord Bear = S 36° 16' 21.48" E

Course from PT FNLSTM-62 to PC FNLSTM-63 S 75° 27' 00.66" E Dist 3.7884

Curve Data

Curve FNLSTM-63
P.I. Station = 7+75.69 N 282,802.6236 E 660,742.8748
Delta = 79° 21' 21.81" (RT)
Degree = 104° 23' 59.71"
Tangent = 4.5510
Length = 7.5982
Radius = 5.4860
External = 1.6420
Long Chord = 7.0053
Mid. Ord. = 1.2637
P.C. Station = 7+71.14 N 282,803.7284 E 660,738.4599
P.T. Station = 7+78.73 N 282,798.0806 E 660,742.6044
C.C. = 7+74.93 N 282,798.4065 E 660,737.1281
Back = S 75° 27' 00.66" E
Ahead = S 3° 24' 21.15" W
Chord Bear = S 36° 16' 19.76" E

Course from PT FNLSTM-63 to PC FNLSTM-64 S 3° 24' 21.15" W Dist 4.1828

Curve Data

Curve FNLSTM-64
P.I. Station = 7+87.07 N 282,789.7563 E 660,742.1090
Delta = 74° 17' 45.52" (LT)
Degree = 104° 23' 59.71"
Tangent = 4.1563
Length = 7.1137
Radius = 5.4860
External = 1.3966
Long Chord = 6.6257
Mid. Ord. = 1.1132
P.C. Station = 7+82.92 N 282,793.9052 E 660,742.3559
P.T. Station = 7+90.08 N 282,788.3956 E 660,746.0362
C.C. = 7+86.50 N 282,793.5793 E 660,747.8322
Back = S 3° 24' 21.15" W
Ahead = S 70° 53' 24.38" E
Chord Bear = S 33° 44' 31.82" E

Course from PT FNLSTM-64 to 50007 S 70° 53' 24.38" E Dist 0.6097

Point 50007 N 282,788.1960 E 660,746.6123 Sta 7+90.64

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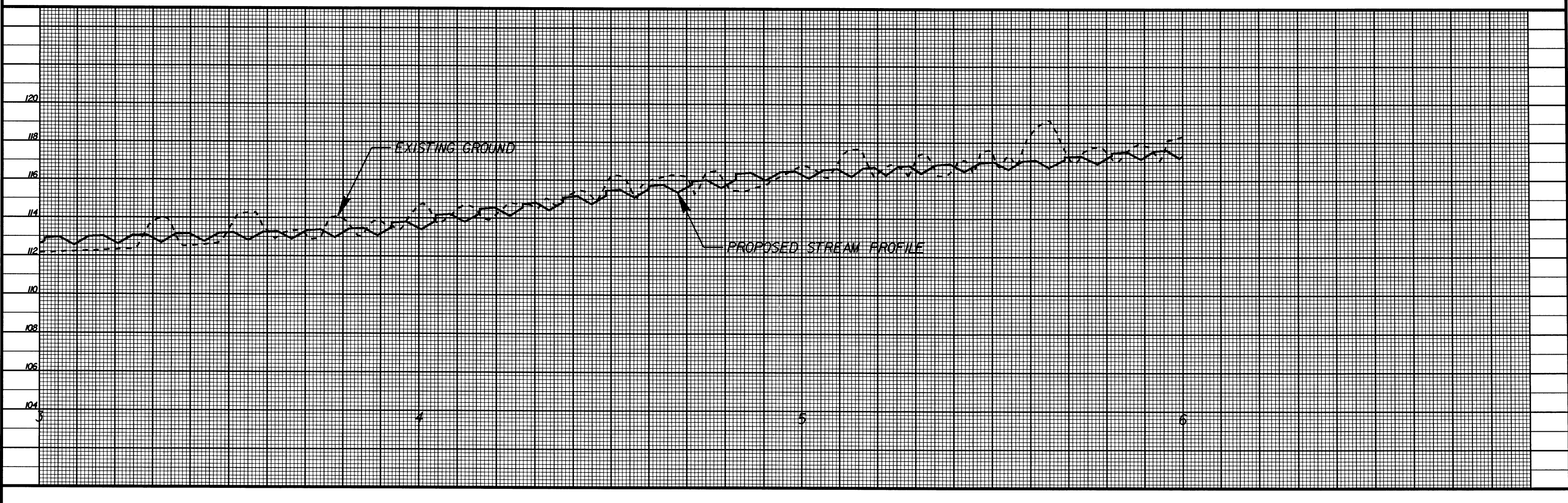
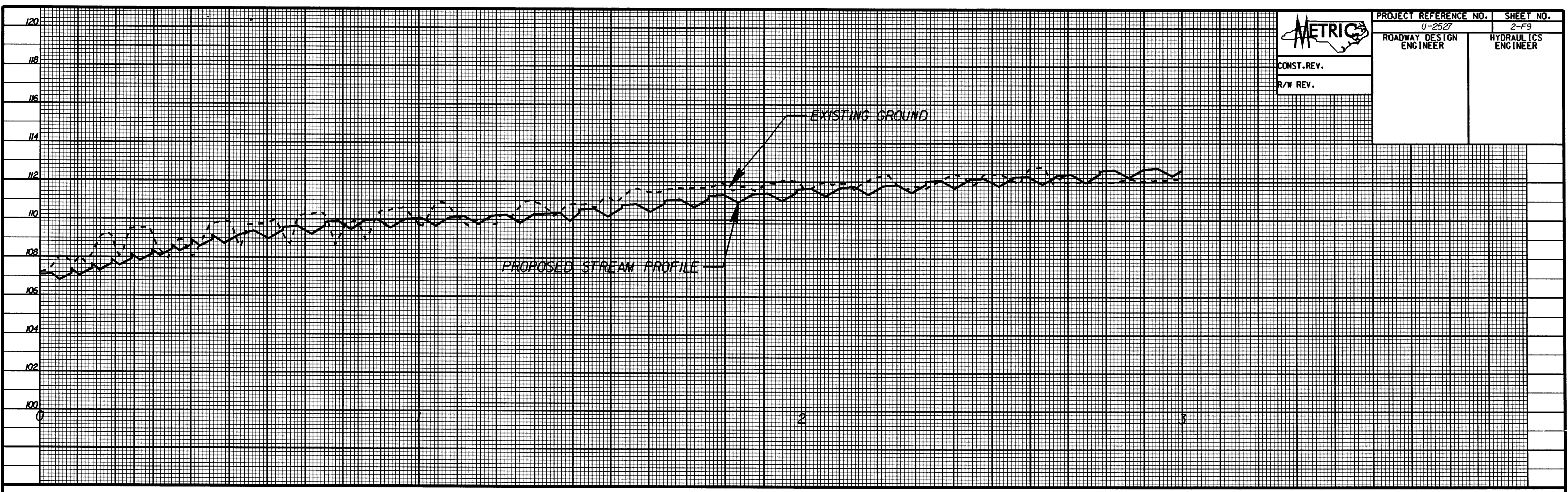
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PROJECT REFERENCE NO. U-2527 SHEET NO. 2-F9

ROADWAY DESIGN ENGINEER HYDRAULICS ENGINEER

CONST. REV.
R/W REV.



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