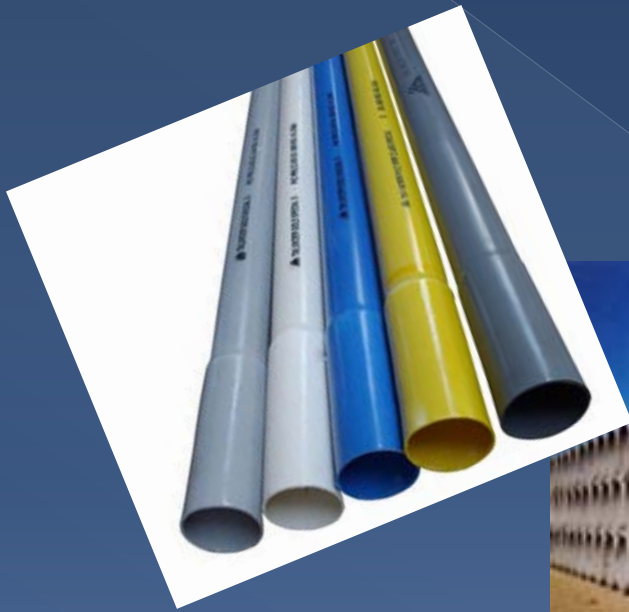


# Selection of Pipe Materials and Incorporation Into Plan Set



# To Be Covered

- ◉ Alternative Pipe Policy
- ◉ Pipe Materials
- ◉ Situation to Use Specific Pipe
- ◉ Wall Thickness
- ◉ Money Matters
- ◉ Clear Zones
- ◉ End Sections
- ◉ Incorporating Pipes Into Plans

# Alternative Pipe Policy

- Policy Statement:

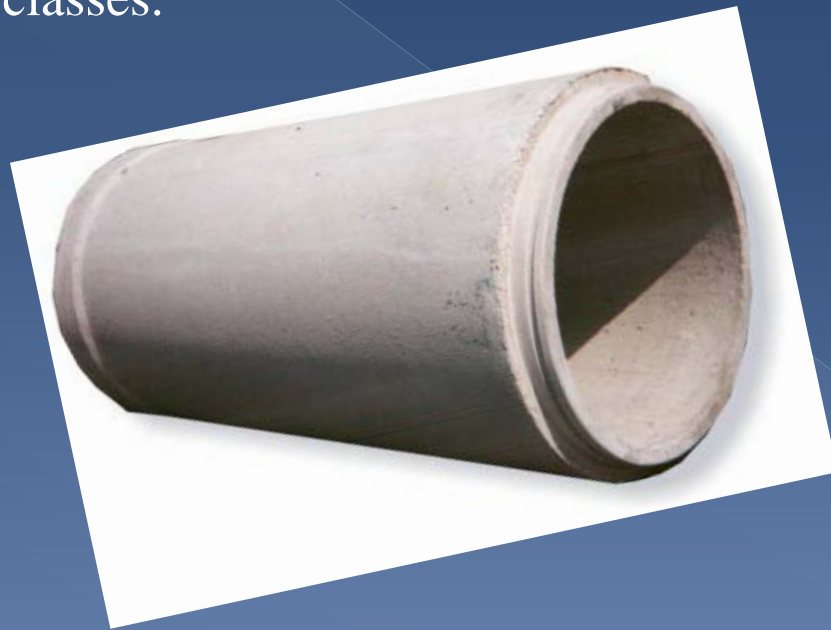
*The North Dakota Department of Transportation will allow all available pipe products (materials) that are judged to be of satisfactory quality and equally acceptable on the basis of engineering, economic analysis, and NDDOT experience.*

# Pipe Materials

## ◎ Concrete Pipe

### > Classes

- Cement and aggregate contents determine the differences between the classes.



Pipe Class

Pipe Size	Class I	Class II	Class III	Class IV	Class IV Alternate	Class V	Class V Alternate
(inches)	Round Reinforced Concrete Pipe Backfill Heights (feet)						
12			1-16	16-24		24-35	
15			1-16	16-24		24-35	
18			1-16	16-24		24-35	
21			1-16	16-24		24-35	
24			1-16	16-24		24-35	
27		3-11	1-3, 11-16	16-24		24-35	
30		3-11	1-3, 11-16	16-24		24-35	
33		3-11	1-3, 11-16	16-24		24-35	
36		3-11	1-3, 11-16	16-24		24-35	
42		3-11	1-3, 11-16	16-24		24-35	
48		3-11	1-3, 11-16	16-24		24-35	24-35
54		3-11	1-3, 11-16	16-24		24-35	24-35
60	6-9	3-11	1-3, 11-16	16-24	16-24	24-35	24-35
66	6-9	3-11	1-3, 11-16	16-24	16-24	24-35	24-35
72	6-9	3-11	1-3, 11-16	16-24	16-24	24-35	24-35
78	6-9	3-11	1-3, 11-16	16-24	16-24		24-35
84	6-9	3-11	1-3, 11-16	16-24	16-24		24-35
90	6-9	3-11	1-3, 11-16		16-24		24-35
96	6-9	3-11	1-3, 11-16		16-24		24-35
102	6-9	3-11	1-3, 11-16		16-24		24-35
108	6-9	3-11	1-3, 11-16		16-24		24-35



Most Commonly Used

# Pipe Materials

## ◉ Metal Pipe

- › Corrugated Steel
  - Aluminum or Zinc coated
- › Polymeric Coated Steel
  - Over Zinc or Aluminum Coated Steel
- › Structural Steel Plate
- › Aluminum Alloy Pipe

# Pipe Materials

- ◎ Why is Aluminum or Zinc Used?
  - > Corrosion Resistant
  - > Become more resistant after initial oxide forms
  - > Self-renewing film

# Pipe Materials

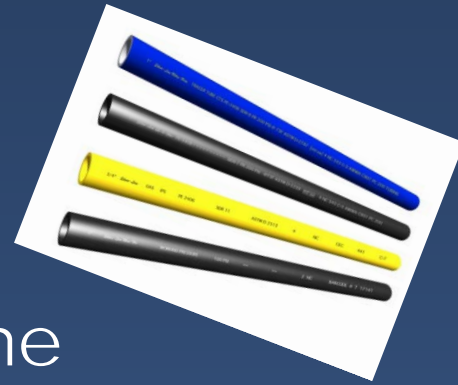
## ◎ Plastic Pipe

### > High-Density Polyethylene

- Softer, bendable plastic
- Best suited for
  - Lower pressure
  - Tight Bending Radius

### > Polyvinyl Chloride

- Stronger, Stiffer





# What Pipe to Use?

- Mainline Drainage
  - > Metal
  - > Concrete
- Approach Drainage
  - > Metal
  - > Concrete
  - > Plastic
- Pipe Extensions
  - > Mainline-Match Existing Material
  - > Approach-Unlike Material Acceptable
- Storm Drains
  - > Metal
  - > Concrete
  - > Plastic

\*\*Plastic Pipe cannot be used under paved roadways.  
--Plastic hasn't proven itself yet, was a decision by management

## ○ Abrasion

- > Level 1- No Bedload
- > Level 2-Sand, Gravel, Debris at Velocities of 0-5ft/s
- > Level 3-Sand, Gravel, Debris at Velocities of 5-10ft/s
- > Level 4-Sand, Gravel, Debris at Velocities of 10-15ft/s
- > Level 5- Sand, Gravel, Debris at Velocities of >15ft/s

Approach Drainage	Level 1	Level 2	Level 3	Level 4	Level 5
<b>Concrete Pipe (Section 830.01)</b>	Y	Y	Y	Y	Y
<b>Metal Pipe (Section 830.02)</b>					
Zinc Coated Corrugated Steel	Y	Y			
Aluminum Coated Corrugated Steel	Y	Y	Y		
Polymeric Coated Steel	Y	Y	Y	Y	
Structural Steel Plate Pipe (Zinc Coated)		Y	Y		
Aluminum Alloy Pipe	Y	Y	Y		
<b>Plastic Pipe (Section 830.03)</b>					
High-Density Polyethylene (HDPE)	Y	Y	Y	Y	Y

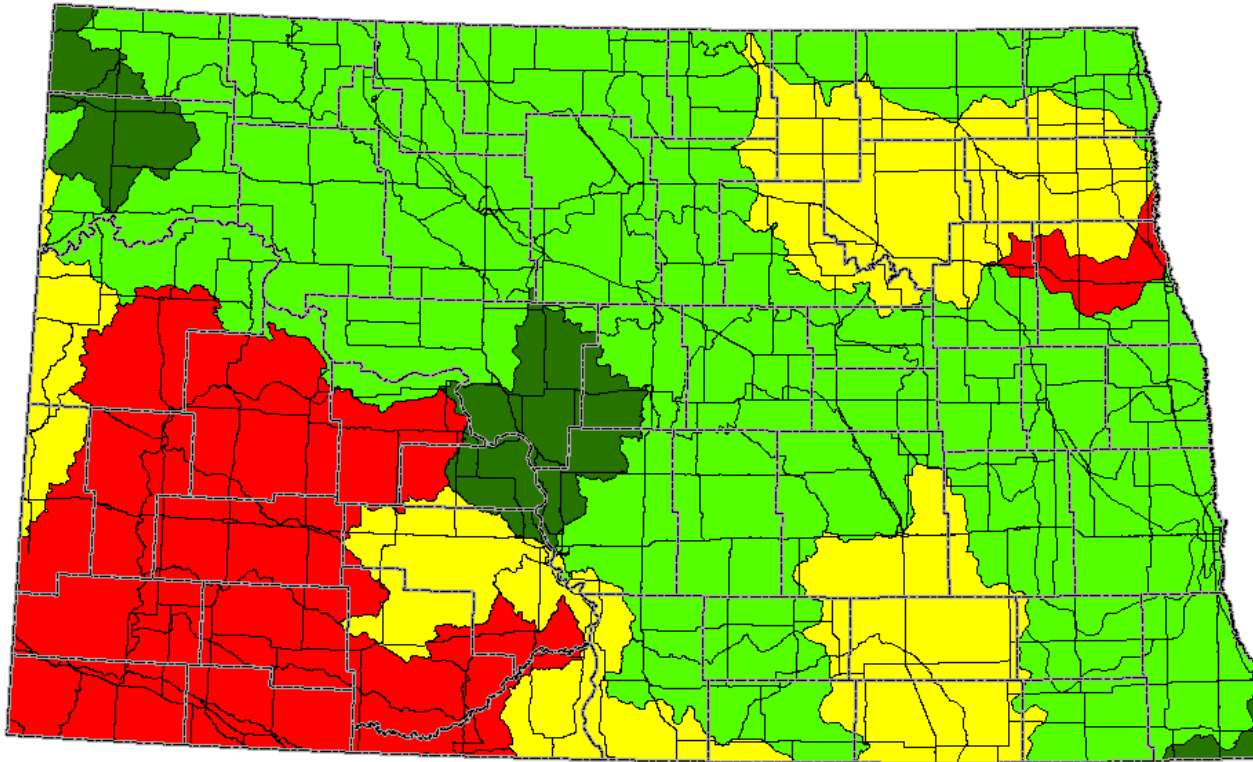
# Corrosion

## ⦿ Resistivity

- High resistivity=Low Corrosion
- Resistivity is reduced as water content and concentration of ionic compounds is increased

## ⦿ How it happens

- Electrical current removes metallic ions from one part of the metal and relocates them to another portion of the metal.
- Can also happen in concrete, but much less common



- Zone 1** ( $> 1250$  ohms\*cm)
- Zone 2** ( $750 - 1250$  ohms\*cm)
- Zone 3** ( $400 - 750$  ohms\*cm)
- Zone 4** ( $< 400$  ohms\*cm)

## Corrosion

- > [http://www.dot.nd.gov/manuals/design/designmanual/chapter5/DM-5-05\\_tag.pdf](http://www.dot.nd.gov/manuals/design/designmanual/chapter5/DM-5-05_tag.pdf)
  - Page 12

## Corrosion Zone

Mainline Drainage

Zone 1

Zone 2

Zone 3

Zone 4

•Concrete Pipe (Section 830.01)

Y

Y

Y

Y

•Metal Pipe (Section 830.02)

Gauge

Zinc Coated Corrugated Steel

16 ga.

14 ga.

12 ga.

10 ga. Y

8 ga. Y Y

Aluminum Coated Corrugated Steel

16 ga.

14 ga.

12 ga. Y

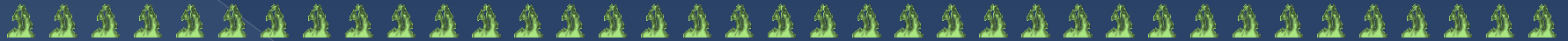
10 ga. Y Y

8 ga. Y Y Y

# Flammability

# Factors

## > Burning is Expected in the Area

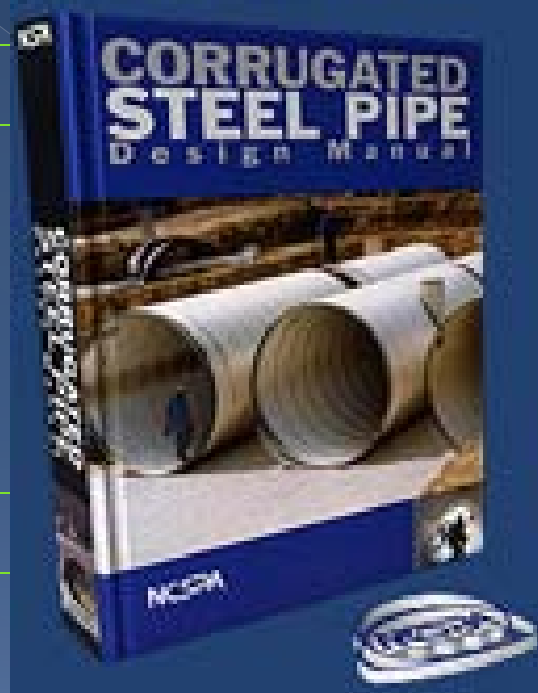


	Mainline Drainage	Approach Drainage	Storm Drain Trunk Line And Lateral Drainage
<b>Concrete Pipe (Section 830.01)</b>	Y	Y	Y
<b>Metal Pipe (Section 830.02)</b>			
Zinc Coated Corrugated Steel	Y	Y	Y
Aluminum Coated Corrugated Steel	Y	Y	Y
Polymeric Coated Steel	N(1)	N(1)	N(1)
Structural Steel Plate Pipe	Y	Y	Y
Aluminum Alloy Pipe	Y	Y	Y
<b>Plastic Pipe (Section 830.03)</b>			
Polyvinyl Chloride (PVC)	N/A(2)	N/A(3)	N(1)
High-Density Polyethylene (HDPE)	N/A(2)	N(1)	N(1)

(1) - N; plastic coated metal or plastic pipe may not be used in flammable applications without the addition of non-flammable segments and/or end treatment as determined by the Designer. (2) - N/A; pipe not allowed for Mainline Drainage applications (3) - N/A; pipe not allowed for Approach Drainage applications

# Wall Thickness

## Conversion of Gage to Thickness in Inches



Gage No.

16

14

12

10

Uncoated Thickness  
(in.)

0.0598

0.0747

0.1046

0.1345

Galvanized Thickness  
(in.)

0.064

0.079

0.109

0.138

Gage No.

3

1

5/16"

3/8"

Uncoated Thickness  
(in.)

0.1644

0.1838

0.2145

0.2451

0.2758

0.3125

0.375

Galvanized Thickness  
(in.)`

0.168

# Money Matters

- ◎ Pay Items
  - > Pipe
  - > Reinforcement Fabric
  - > Surfacing Removal





# Money Matters

- ◎ Included In Pipe Pay Item
  - > Pipe
  - > Trench Excavation
  - > Disposal of unsuitable excavated material and placement of suitable material on inslope
  - > Aggregate Base Course
  - > Approved Backfill

# Additional Facts

- ◎ Pipe Conduit measured in linear feet from one edge to the other.
  - > From opening to opening measured along the top
- ◎ Backfill Standard Drawings
  - > 4 Feet or Less
  - > Over 4 Feet

TRANSVERSE CENTERLINE PIPE BACKFILL FOR PIPES  
4 FEET OR LESS BELOW THE PROPOSED BASE

Included in Pipe Pay Item

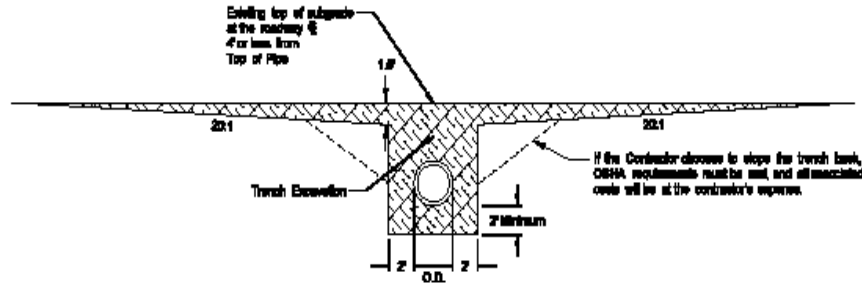
- 1) Pipe
- 2) Trench excavation
- 3) Deposit of suitable excavated material and placement of suitable excavated material on bridge.
- 4) Aggregate Base Course C13 or C15
- 5) Approved Backfill

Pay Items

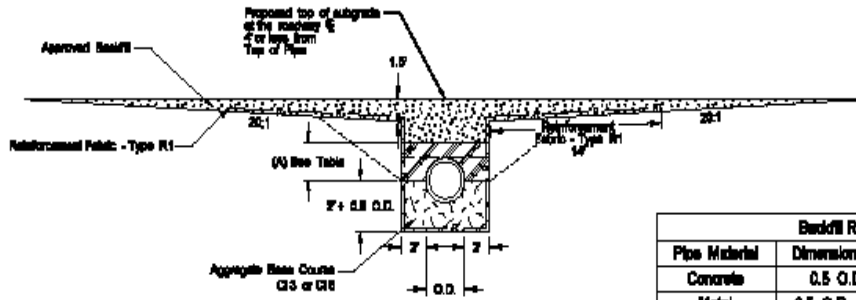
- 1) Pipe
- 2) Reinforcement Fabric - Type R1
- 3) Surfacing Removal

NOTES:

1. This drawing corresponds to nonstoppered machine and paved intersection roadway pipes only (including ramps). It does not include pipes in approaches.
2. Approved Backfill shall meet the requirements of AASHTO M 146 for A-1, A-2, and A-3 soils.
3. Compaction requirements for all materials associated with the trench installation shall meet 90% of AASHTO T-163. Maximum thickness of any one lift shall not exceed 6 inches.

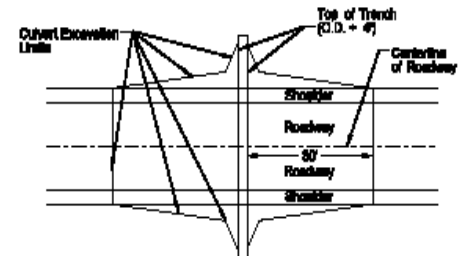


Removal Detail

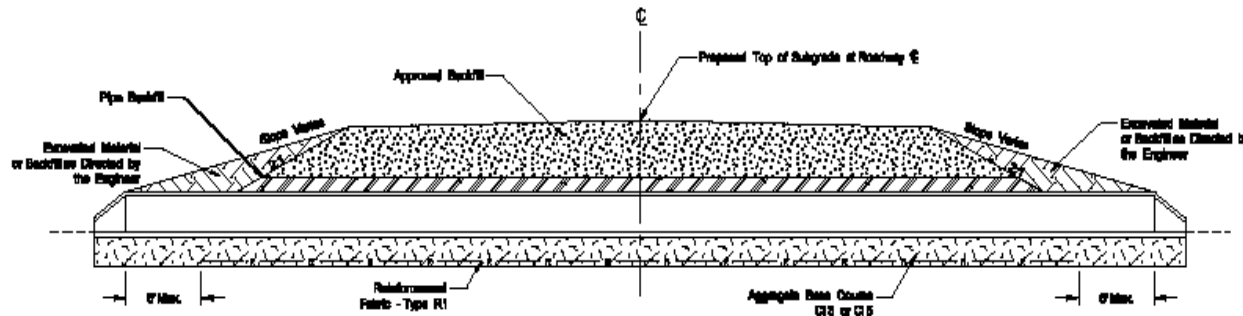


Backfill Detail

Backfill Requirements		
Pipe Material	Dimension (A)	Backfill
Concrete	0.5 O.D.	Approved Backfill (Note 2)
Metal	0.5 O.D. + 1'	C15 or C16



Plan View of Culvert (Not to Scale)



Cross Section View - Proposed Section

MDCR ENGINEERING	
DEPARTMENT OF TRANSPORTATION	
DESIGN	
REVISIONS	
DATE	DESCRIPTION

This document was originally issued and sealed by Terence R. Udland, Registration Number PE-2874, on 12/03/2008 and the original document is stored at the North Dakota Department of Transportation.

# Keep in Mind

- ◎ Hydraulics Study
  - > Needed for most pipes
  - > NDDOT Bridge Division
- ◎ Clear Zones

# Clear Zones

- ◉ Area, starting at the edge of traveled way
- ◉ Allows a driver to stop safely or for the driver to regain control of the vehicle
- ◉ Information can be found in the *Roadside Design Guide*
  - > *American Association of State Highway and Transportation Officials (AASHTO)*

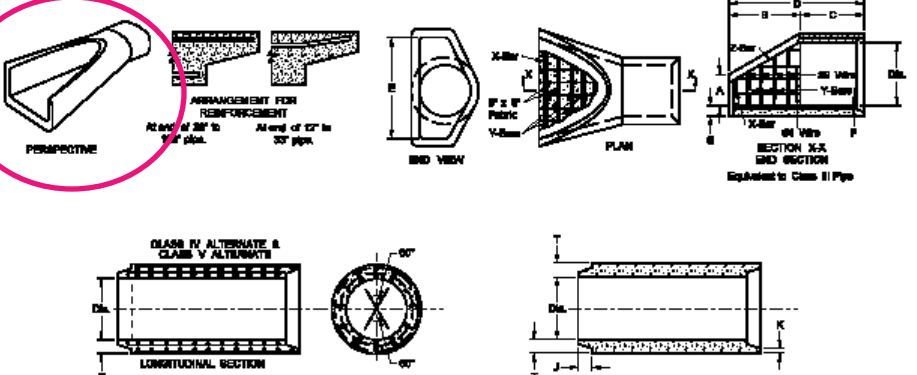
# End Sections

- Standard Drawings (714)
  - > Concrete
    - Round
    - Arch
    - Elliptical
    - Traversable
  - > Steel
    - Round
    - Arch
    - Traversable
  - > Aluminum
    - Round
    - Arch

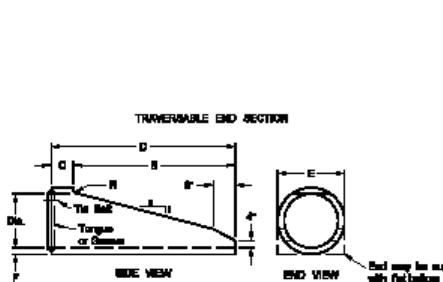
# Flared End Section

D-714-01

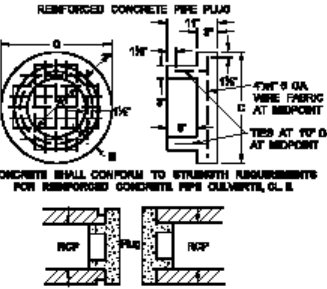
## REINFORCED CONCRETE PIPE CULVERT AND END SECTIONS



END SECTION										
TERMINAL DIMENSIONS						REINFORCING STEEL				
DLA	A	B	C	D	E	F	G	X	Y	Z
12	8'-0"	2'-0"	4'-0"	8'-0"	2'-0"	3'	3'	5-1/2" x 7	5-1/2" x 8	5-1/2" x 7
14	10'-0"	2'-0"	4'-0"	10'-0"	2'-0"	3'	3'	3-5/8" x 8-1/2	5-1/2" x 10	5-1/2" x 7
16	12'-0"	2'-0"	4'-0"	12'-0"	2'-0"	3'	3'	3-1/2" x 7	5-1/2" x 12	5-1/2" x 7
18	14'-0"	2'-0"	4'-0"	14'-0"	2'-0"	3'	3'	3-1/2" x 8-1/2	5-1/2" x 14	5-1/2" x 7
20	16'-0"	2'-0"	4'-0"	16'-0"	2'-0"	3'	3'	3-1/2" x 8-1/2	5-1/2" x 16	5-1/2" x 7
24	20'-0"	2'-0"	4'-0"	20'-0"	2'-0"	3'	3'	3-1/2" x 8-1/2	5-1/2" x 20	5-1/2" x 7
27	24'-0"	2'-0"	4'-0"	24'-0"	2'-0"	3'	3'	3-1/2" x 8-1/2	5-1/2" x 24	5-1/2" x 7
30	28'-0"	2'-0"	4'-0"	28'-0"	2'-0"	3'	3'	3-1/2" x 8-1/2	5-1/2" x 28	5-1/2" x 7
36	36'-0"	2'-0"	4'-0"	36'-0"	2'-0"	3'	3'	3-1/2" x 8-1/2	5-1/2" x 36	5-1/2" x 7



CONCRETE PIPE PILES			
Dimensions in inches			
DLA	A	B	D
12	8	32	18
14	10	36	21
16	12	40	24
18	14	44	27
20	16	48	30
24	20	56	36
27	24	64	42
30	28	72	48
36	36	84	60
42	42	96	72
48	48	108	84
54	54	120	96



CLASS IV ALTERNATE B															CLASS V ALTERNATE																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
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TRANSFERABLE END SECTION									
DLA	A	B	C	D	E	F	G	H	I
12"	4"	4"	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"
14"	4"	4"	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"
16"	4"	4"	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"
18"	4"	4"	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"
20"	4"	4"	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"

- NOTES (Transferable End Section):
- Manufactured in accordance with applicable portions of ASTM C768/ASTM M170.
  - Reinforcement per class II RCSP with double reinforcement in the upper 120° of the full barrel portion.

- NOTES:
- All reinforcement shall be electrically welded steel drawn steel wire fabric.
  - Cover reinforcement shall be to accordance with ASTM M170.
  - All straight, bent-up, and elliptical reinforcement shall be straightened and securely fastened in ends to maintain reinforcement in end shape and correct position within the form.
  - Layer length of slope 12° to 60° (incl.) = not less than 4 feet; 60° to 90° (incl.) = not less than 8 feet.
  - Joints shall be made with labor quality or with labor approved by the engineer whenever pipe size specified for storm drain or sanitary sewer.
  - Welded steel wire fabric may be substituted for the reinforcing steel bars but must match the area of steel provided by the bars and the top of the fabric must be in accordance with ASTM specifications.
  - All reinforcing steel shall meet ASTM M170 requirements.

A, Ax, Ay = Minimum circumferential reinforcement required in square inches per foot of pipe.  
 A = Minimum radial reinforcement required in square inches per square foot of pipe.  
 N = Minimum number of rows of radial reinforcement at top and bottom of pipe.  
 S = Maximum circumferential spacing of rows of radial reinforcement.

**SOUTH CAROLINA**  
 DEPARTMENT OF TRANSPORTATION  
 16-110

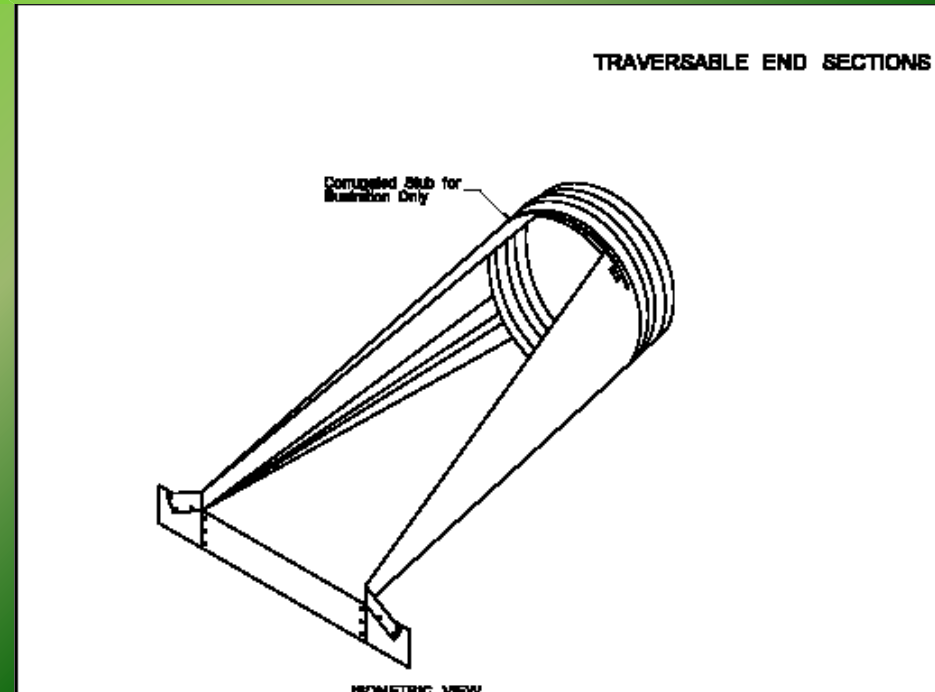
This document was originally issued and issued by Terrence A. Udani, Registration Number PC-2574, on 12/19/2008 and the original document is stored at the North Carolina Department of Transportation

**REVISIONS**

DATE	DESCRIPTION
11-12-10	Final design
11-12-10	Final design
11-12-10	Final design
11-12-10	Final design

# Traversable End Section

- Steeper slopes
- Culvert does not extend past clear zone
- 36in







# Pipe List

- ◎ Common Column Headings
  - > Begin Station/Location and Offset
  - > End Station/Location and Offset
  - > Length/Pipe Conduit Pay Size
  - > Diameter
  - > Allowable Material
  - > Min Thickness
  - > Existing Conditions
  - > End Sections
  - > Backfill
  - > Geotextile Fabric

# Geotextile Fabric

## ◎ Types

### > Woven

- Strong, does not stretch
- Made by weaving synthetic fabrics together

### > Unwoven

- Often used as in drainage as a conduit

## ◎ Processes

> Needle punching: barbed needles are pushed through one or more fiber mats which entangles the fibers.

> Heat Bonding: Fibers with different melting points are used

> Resin Bonding: Fibers are coated with resin to bond the fibers together

# Geotextile Fabric

- ◎ Uses
  - > Filtration
  - > Drainage
  - > Sediment Control
  - > Separation
  - > Erosion Control
  - > Moisture Barriers
  - > Reinforcements

# Pipe List

Begin Station / Location	Begin Offset	End Station / Location	End Offset	Length	Pipe Conduit Pay Size	Pipe Conduit Approach Pay Size	Pipe Conduit Storm Drain Pay Size	Allowable Material	Required Diameter	Minimum Thickness	R1 Fabric (Pay Item)	(A) End Sections		Applicable Backfill Detail		
												Begin	End			
												EA	EA			
				LF			In		In	In	SY					
3A		3		40			18	Reinforced Concrete Pipe - Class III (barrel length = 86 LF)	18					D-714-27		
								Zinc Coated Steel (2-2/3" x 1/2" Ribs)	18	0.168						
								Aluminum Coated Steel (Type 2)	18	0.138						
								Polymeric Coated Steel (over zinc or aluminum coated steel)	18	0.064						
1296+30	44' Lt	1296+30	46' Rt	90	24			Reinforced Concrete Pipe - Class III (barrel length = 86 LF)	24		298	Y	Y	D-714-26		
								Zinc Coated Steel (2-2/3" x 1/2" Ribs)	30	0.168						
								Zinc Coated Steel (3/4" x 3/4" @ 7-1/2" Ribs)	24	0.168						
								Aluminum Coated Steel (Type 2)	30	0.138						
								Aluminum Alloy	30	0.060						
								Polymeric Coated Steel (over zinc or aluminum coated steel)	24	0.064						
1304+25	48' Lt	1304+25	48' Rt	97	30			Reinforced Concrete Pipe - Class III (barrel length = 94 LF)	30		340	Y (Traversable)	Y (Traversable)	D-714-25		
								Zinc Coated Steel (2-2/3" x 1/2" Ribs)	30	0.064						
								Aluminum Coated Steel (Type 2)	30	0.064						
								Polymeric Coated Steel (over zinc or aluminum coated steel)	30	0.064						
1345+60	67' Rt	1346+04	67' Rt	44			18	Reinforced Concrete Pipe - Class III (barrell length = 36 LF)	18			Y	Y	N/A		
								Zinc Coated Steel (2-2/3" x 1/2" Ribs)	18	0.064						
								Aluminum Coated Steel (Type 2)	18	0.064						
								High Density Polyethylene (HDPE)	18							
								Polymeric Coated Steel (over zinc or aluminum coated steel)	18	0.064						

(A) Not paid for separately, to be included in the price bid for Pipe Conduit.

# Plans

## ◎ Excel to MicroStation

- › Copy/Paste-Won't update table if it is changed in excel
- › Edit>Insert Object>From File>Select Excel File to Insert
- › Paste Link-Axiom tool (office importer), keeps link and updates table



# Resources

- ◉ [www.ct.gov](http://www.ct.gov)
- ◉ corrosion-doctors.org
- ◉ [www.dot.nd.gov](http://www.dot.nd.gov)
- ◉ *American Association of State Highway and Transportation Officials (AASHTO)*
- ◉ Corrugated Steel Pipe Design Manual
  - › Published by National Corrugated Steel Pipe Association 2008
- ◉ [www.geotextilefabric.net](http://www.geotextilefabric.net)