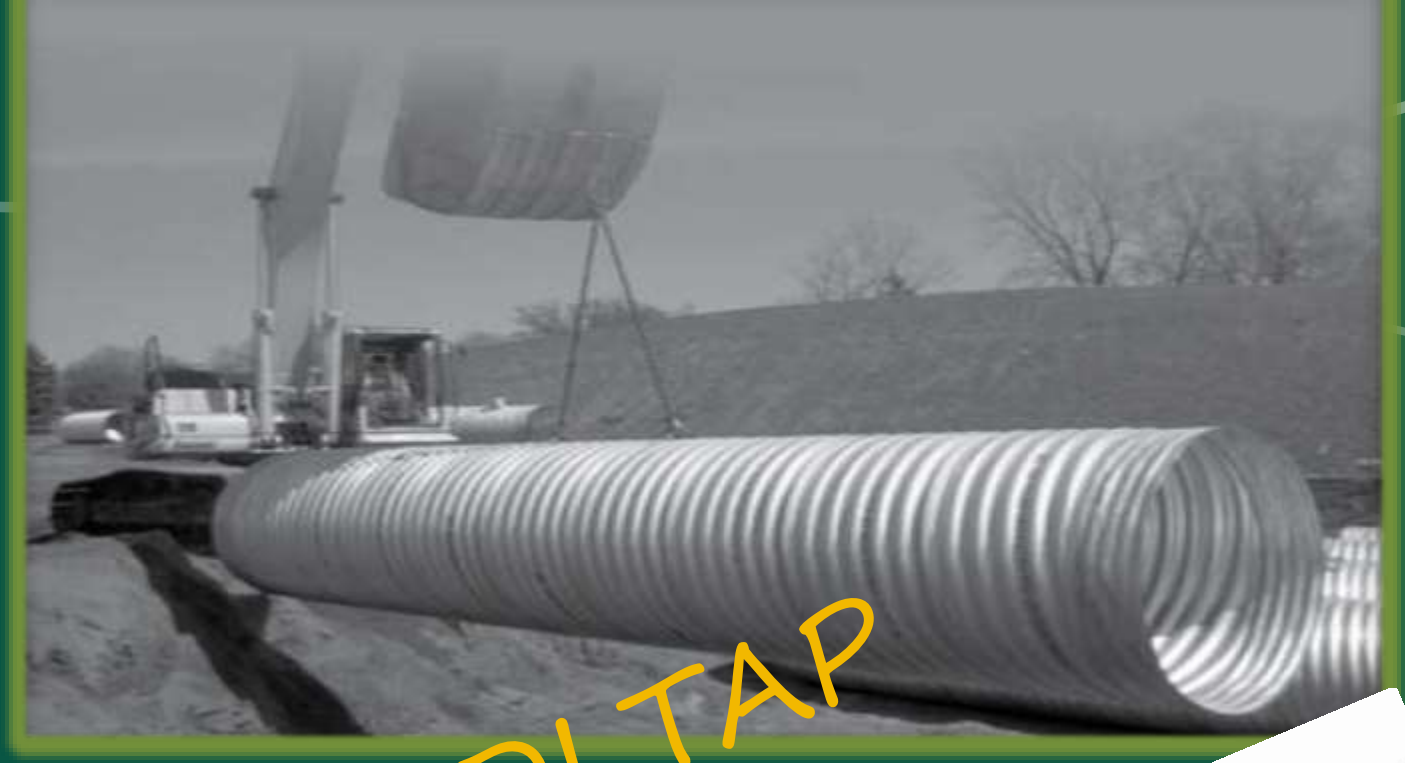
Technology Transfer

Local Roads Corrugated Metal Pipe (CMP) Workshop



NDLTAP & TrueNorth Steel

Presenter Info - Jeff Walters, True North Steel
& Dale Heglund, NDLTAP

September 13, 2017 – Barnes County, 8 AM – 3 PM MT

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Culverts

Convey water from one side of the road to the other.

9-25-17 Notes for 2018 Class, dch

<u>Couple items we should add to next class – items you may want to start gathering.</u>

12” long piece of 12” CMP, poly coated and spiral rib. We should have the pieces to show – really would drive home the info that we show in the presentation.

Tips to install bands and flared ends – review cordless impacts, extensions,….

Review bands – types, lengths, etc….

Video on flared end hydraulics. Does NCSPA have anything? Would be nice to help them ‘see’ the value of using end sections.

Add culvert length calculator. Does NCSPA have an app? Run through it in class.

I’ll bring a white board – we should jot down some key learning points.

Books – hand out at class.

CMP installation sheet – hand out at class.

Stream Stat – run through a sample on line and in class.

Other?????

Culvert Types

I can buy 55 gal. drums and weld them end-to-end for less than $100 each. I know the galvinized culverts will last longer than the drums - even in the Ozarks - but have any of you had experience with the drums and how long did they last in rocks and clay? A "newbie" who has read Cattle Today for four years and this is the first question. Thanks in advance!

I built a culvert (round here we call them whistles) once from a bunch of old hot water heater tanks.
Cut the ends out and welded them together.
Went in in 1975 and are still holding today. Don't know if the tanks today are made of as heavy a gauge metal. And it did take a bunch for a 20 foot whistle (but they were free :-)

Culvert Types

NS
INSTITUTE

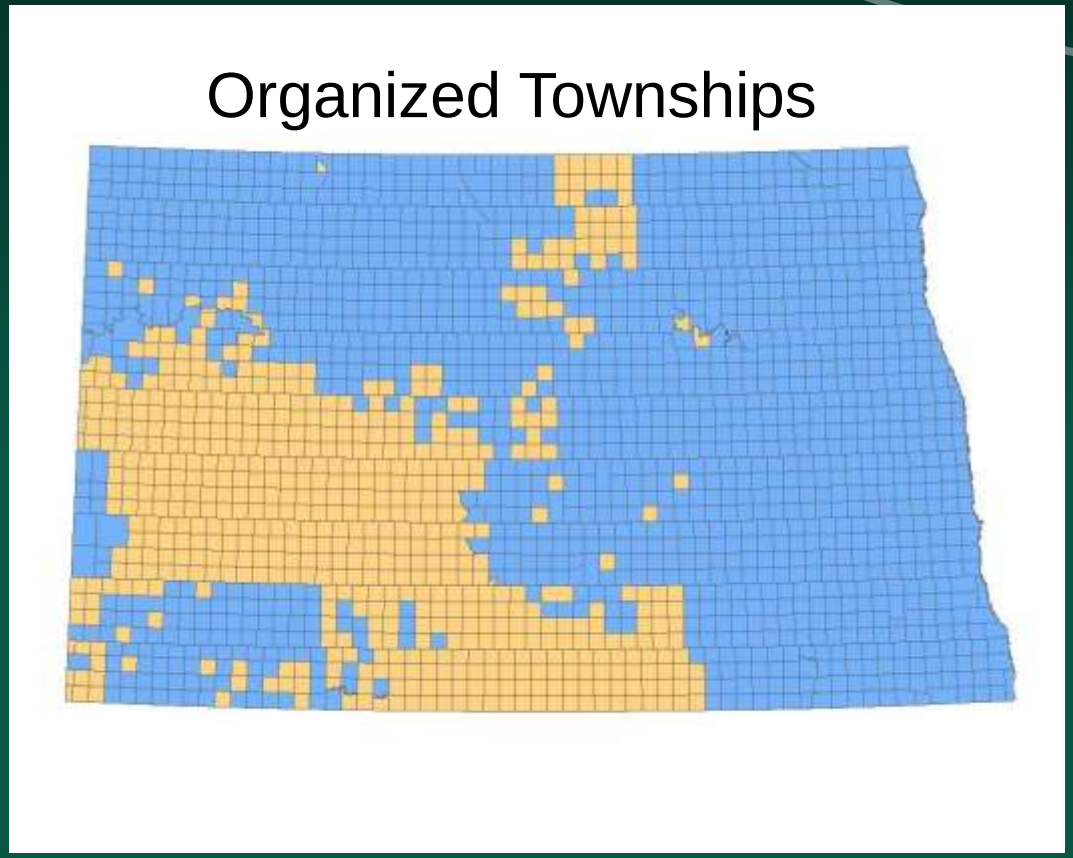
Culvert Types

Culvert - Key Points

- [x] Pipe Design Info
- [x] Pipe Basics
- [x] Pipe Lengths/Grades
- [x] Pipe Performance
- [x] Pipe Installation – Field Hands On
- [x] Pipe Sliplining – Field Hands On

Local Practices

- Pipe type
- Minimum Pipe Size – ice, debris, mud
- Engineering study
- Permits
- Townships




T1
T 63305
OVERSIZE LOAD

Stream Rules

North Dakota's Laws

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Stream Crossings Statutes & Rules

Office of the
North Dakota State Engineer
900 East Boulevard
Bismarck, North Dakota 58505

North Dakota Department of Transportation
608 East Boulevard
Bismarck, North Dakota 58505

January 1, 2015

North Dakota Stream Crossing Standards

89-14-01-03. Design flood frequency. The following table provides the minimum design standard recurrence interval of the event for which each type of stream crossing must be designed. Nothing contained in this chapter is intended to restrict an entity from providing greater capacity.

Type of Crossing	State Highway System						County	
	Urban System		Rural System				Rural System	
	Regional	Urban Roads	Principal Arterial		Minor Arterial	Major Collector	Major Collector	Off System[4]
			Interstate	Other				
Bridges & Reinforced Concrete Boxes	25 year[2]	25 year[2]	50 year[2]	50 year[2]	50 year[2]	25 year[2]	25 year[2, 3]	15 year[2, 3]
Roadway Culverts	25 year[2]	25 year[2]	50 year[2]	25 year[2]	25 year[2]	25 year[2]	25 year[2, 3]	15 year[2, 3, 5]
Storm Drains	10 year[1]	5 year[1]	10 year[2]	10 year[2]	10 year[2]	10 year[2]		
Underpass Storm Drains	25 year[1]	25 year[1]	50 year[2]	25 year[2]	25 year[2]	25 year[2]		

[1] Discharges must be computed using the rational method or other recognized hydrologic methods.

[2] Discharges must be computed using United States geological survey report 92-4020 or other recognized hydrologic methods.

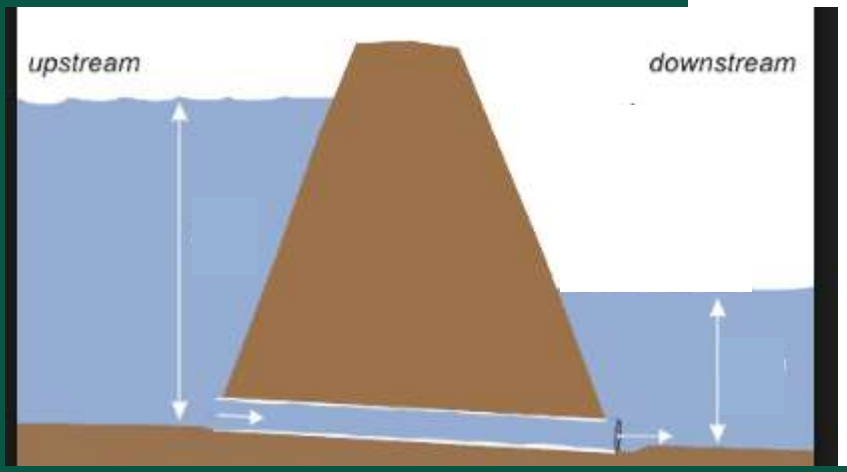
[3] If an overflow section is provided, the pipes and the overflow section, in combination, must pass the appropriate design event within the headwater limitations provided in this chapter.

[4] Off system roads include all township roads.

[5] For township roads, the recurrence interval is 10 years.

89-14-01-04. Floodplain consideration - Upstream development. All stream crossings must comply with applicable floodplain regulations and regulatory floodway requirements. If a stream crossing is being replaced and buildings or structures are located upstream from the crossing, the stream crossing must not be reconstructed in a manner that increases the likelihood of impacts to those upstream buildings or structures, even if the capacity of the crossing being replaced was greater than the capacity otherwise required by this chapter. Any stream crossing constructed as part of a newly constructed roadway must be constructed to pass a one hundred-year event without the resulting increase in headwater impacting any existing buildings or structures. Structures, for the purposes of this section, include grain bins, silos, feedlots, and corrals. Structures do not include pasture fencing.

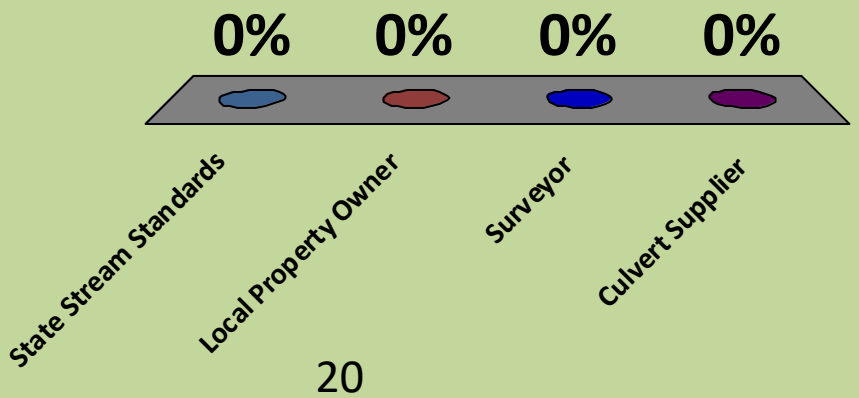
89-14-01-05. Allowable headwater. The allowable maximum headwater when passing the design discharge must be measured from the bottom of the channel. For arch pipes, the maximum allowable headwater must be based on the rise of the pipe, and the pipe size category must be the equivalent round pipe size. For multiple pipe installations, the pipe diameter used to calculate the allowable headwater must be the diameter of the largest pipe. Tailwater resulting from downstream conditions, either natural or manmade, must be accounted for in the determination of the crossing's capacity and the resulting headwater. Additional guidance is provided in the North Dakota department of transportation design manual. If a crossing results in less than one-half foot [15.24 centimeters] of headloss when passing the appropriate design discharge, this section does not apply.



Streambed Slope (feet/mile)	Pipe Size	Allowable Headwater
< 5	24" - 54"	pipe diameter + 2 feet
	> 60"	1.5 pipe diameters
5 to 10	24" - 36"	pipe diameter + 2 feet
	42" - 54"	1.5 pipe diameters
	> 60"	2 pipe diameters
> 10	> 24"	2 pipe diameters

Pipe size is determined by

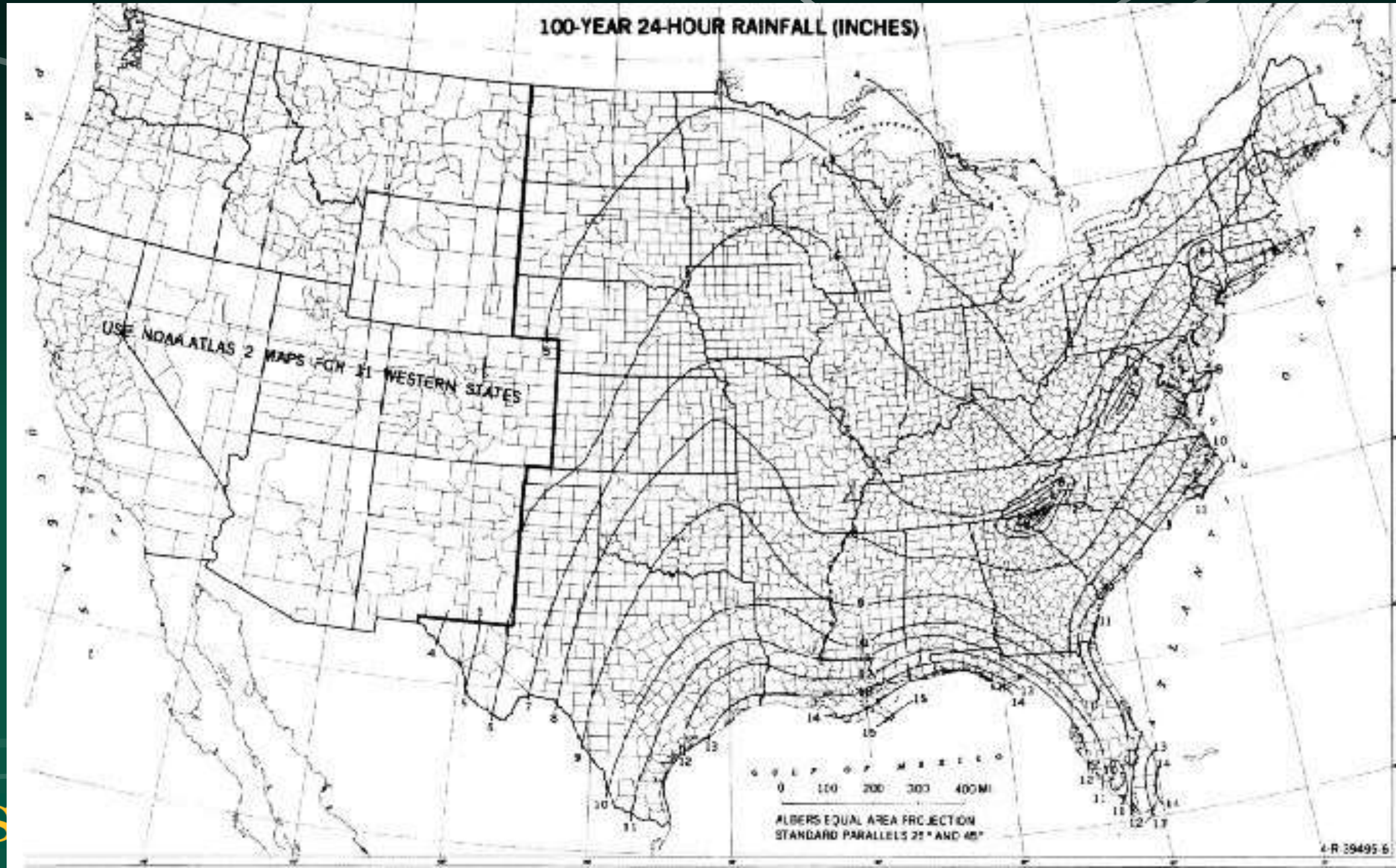
1. State Stream Standards ✓
2. Local Property Owner
3. Surveyor
4. Culvert Supplier

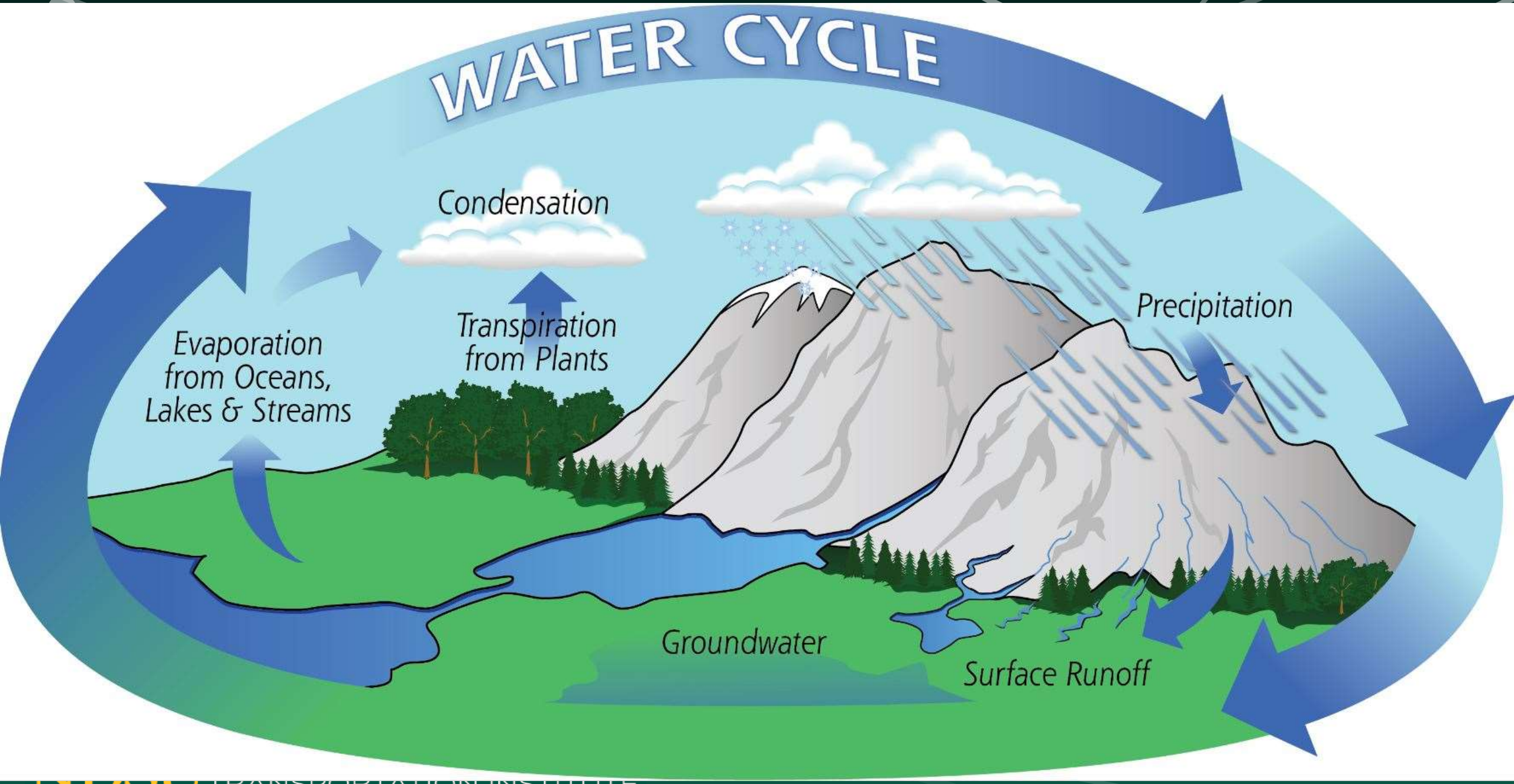


Gambling – the odds are always in your favor

100 – Year Storm

A 100-year storm refers to rainfall totals that have a one percent probability of occurring at that location in that year. Encountering a "100-year storm" on one day does not decrease the chance of a second 100-year storm occurring in that same year or any year to follow. In other words, there is a 1 in 100 or 1% chance that a storm will reach this intensity in any given year.


100-YEAR 24-HOUR RAINFALL (INCHES)
USE NOAA ATLAS 2 MAPS FOR 11 WESTERN STATES
GULF OF MEXICO
0 100 200 300 400 MI
ALBERS EQUAL AREA PROJECTION
STANDARD PARALLELS 29.5° AND 45.5°
4-R 39495-6


WATER CYCLE
Condensation
Transpiration
from Plants
Evaporation
from Oceans,
Lakes & Streams
Precipitation
Groundwater
Surface Runoff

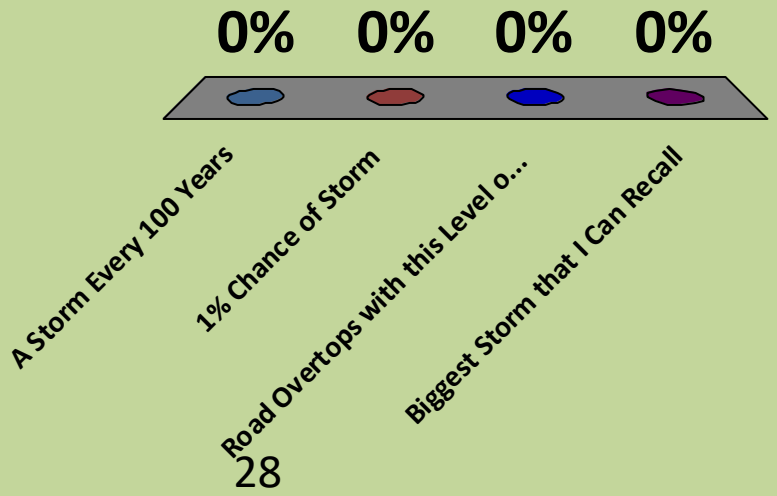

Is this a “DESIGN EVENT”?

Mama always said:
Life was like a box of chocolates.
You never know what you're gonna get."

- Forrest Gump

A 100-year storm event means

1. A Storm Every 100 Years
2. ✓ 1% Chance of Storm
3. Road Overtops with this Level of Storm
4. Biggest Storm that I Can Recall



Culvert Calculations

Rational Method – Q= CIA

Q= predicted runoff from a specific storm event (cubic feet per second)

C= runoff coefficient (percent of rainfall that becomes runoff)

I = uniform rate of rainfall intensity (inches/hour)

A = drainage area (in acres from quad map)

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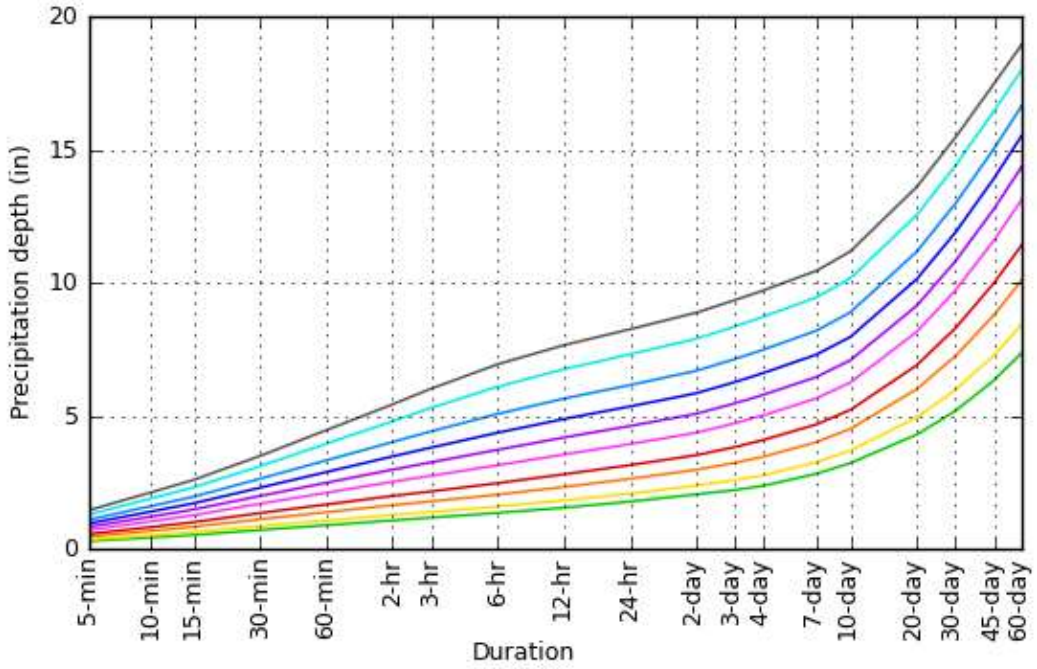
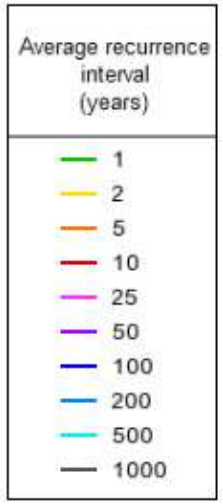
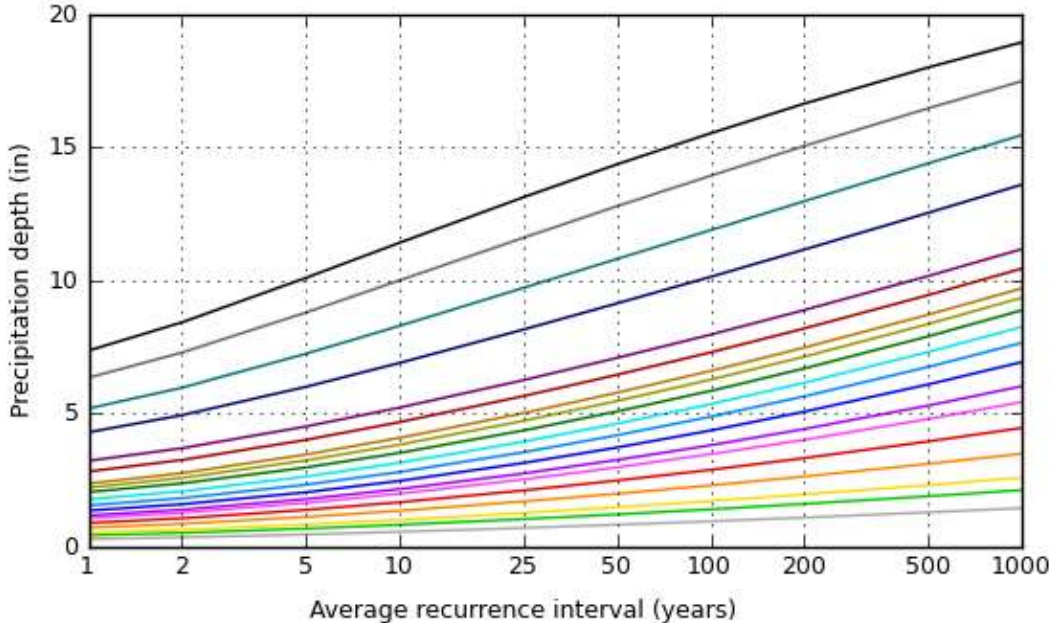
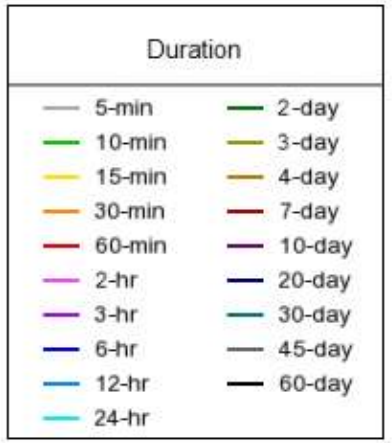
PDS-based depth-duration-frequency (DDF) curves
Latitude: 46.9367°, Longitude: -100.0582°









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NDDOT Design Standards

SECTION III-04 _____ **Earthwork**
Page 8 **Revised 1/26/16**

III-04.11 Replacement of Approach and Centerline Culverts

A "stream crossing structure" is defined as a pipe, culvert, box culvert, and structural plate pipe. All new stream crossing structures must be sized to meet the requirements of Article 89-14 "Public Highway Stream Crossings" (Stream Crossings Standards) as defined in North Dakota State Administrative Code. The requirements of Article 89-14 also apply for projects that:

"...regrade, add a lane adjacent to the existing alignment, or do full depth road surface replacement on an existing highway location."

III-04.11.01 New/Reconstruction Culvert Replacement

All existing culverts need to be hydraulically analyzed for compliance with stream crossing standards.

III-04.11.02 Major Rehabilitation Culvert Replacement

Culverts shall be extended or made traversable as recommended within the Major Rehabilitation Safety Review. Use the applicable Clear Zone for *DESIGN GUIDELINES* Major Rehabilitation.

Existing culverts will not be hydraulically analyzed on these projects. *(Only approved culvert replacements and particular pipe liners as outlined in Section III-04.11 will be hydraulically analyzed)*

Sliplining

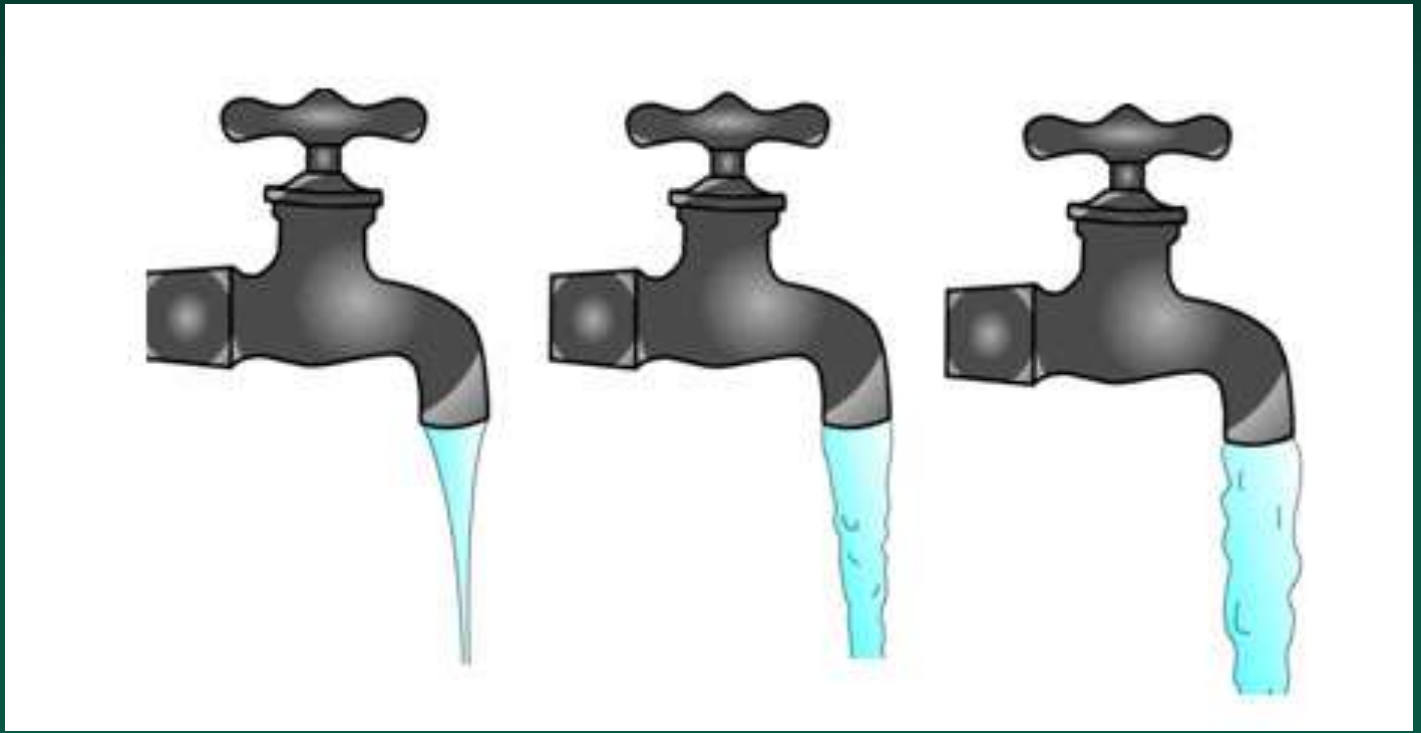
If approval is granted to address a stream crossing structure in a project that is not in the New/Reconstruction Strategy, all rehabilitation options must be identified and evaluated to determine the most cost effective strategy. All rehabilitation options must be exhausted before a replacement strategy can be considered. If it determined that lining a stream crossing structure is the appropriate rehabilitation strategy, a hydraulic analysis is only required if:

1. The stream crossing structure's diameter is 48 inches or less and the thickness of the lining is greater than one half inch.

2. The stream crossing structure's diameter is greater than 48 inches and the thickness of the lining is greater than one inch.

If rehabilitation is not a feasible strategy and replacement of the failed stream crossing structure is required, a hydraulic analysis will be required to determine the structure(s) size, and to assure that the Stream Crossing Standards are being met.

Flow Rate of Water



Flow Rate of Water – Velocity Checks

Bridge - 5 feet per second

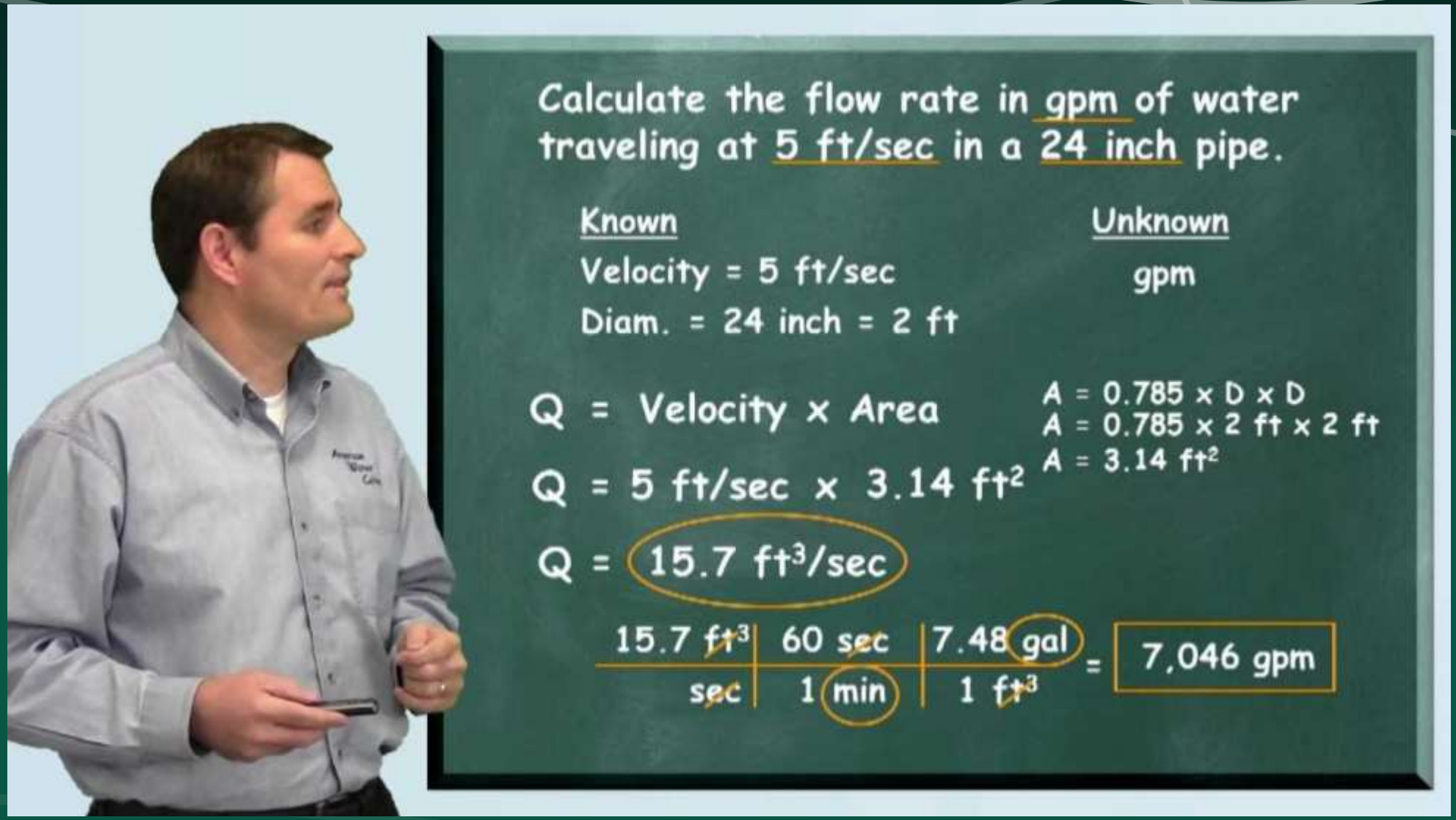
Culvert – 10 feet per second

(USFS uses 7 fps in the Badlands)

Walk = 3 mph = 4.5 feet per second

Jog = 5 mph = 7 feet per second

Run = 10 mph = 15 feet per second


Calculate the flow rate in gpm of water traveling at 5 ft/sec in a 24 inch pipe.
Known
Velocity = 5 ft/sec
Diam. = 24 inch = 2 ft
Unknown
gpm
Q = Velocity x Area
Q = 5 ft/sec x 3.14 ft²
Q = 15.7 ft³/sec
A = 0.785 x D x D
A = 0.785 x 2 ft x 2 ft
A = 3.14 ft²
15.7 ft³ / sec | 60 sec / 1 min | 7.48 gal / 1 ft³ = 7,046 gpm

Estimates for Pipe Capacity

(Comparison values only – culvert capacities should be calculated)

Pipe Size(In)	Pipe Area(Sq Ft)	Pipe Capacity (CFS) (Rough est w/ 5% slope)
12	.8	1.7
18	1.8	4.9
24	3.1	10
30	4.9	19
36	7.1	31
48	12.6	68
60	19.6	120

Data courtesy of MNLTAP

Culvert Sizing – rule of thumb or experience

Don’t assume culvert that you are replacing is adequately sized

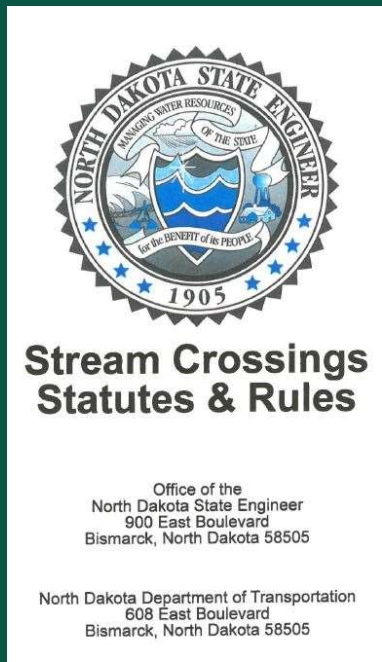
Examine history – snow melt, heavy rains, roadway overtopping, and other

Look at culverts upstream and downstream

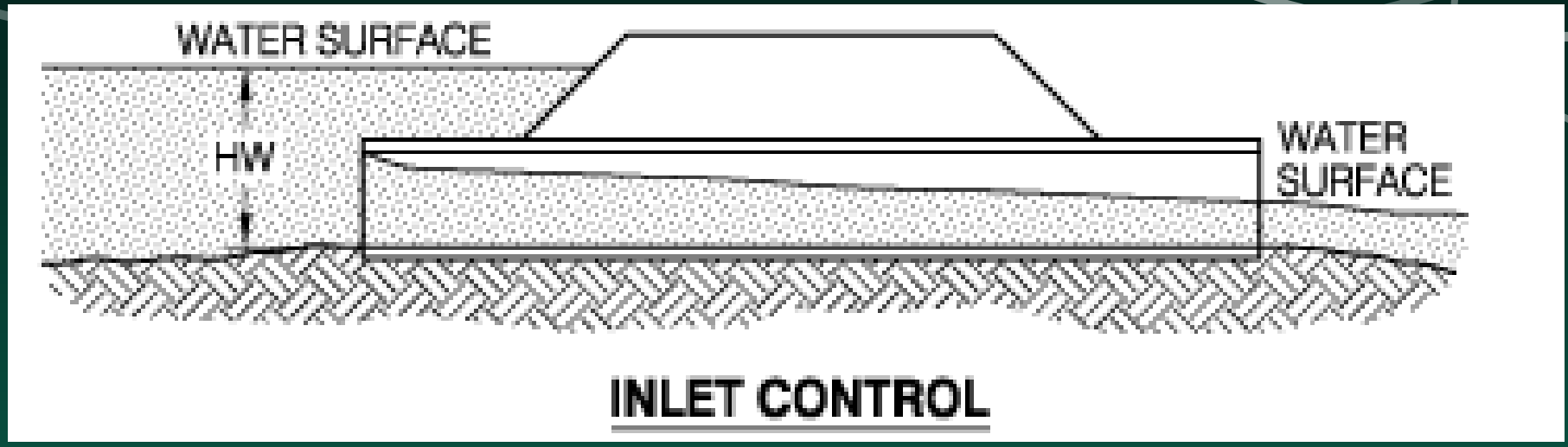
Look for recent land use changes

Look for outlet erosion

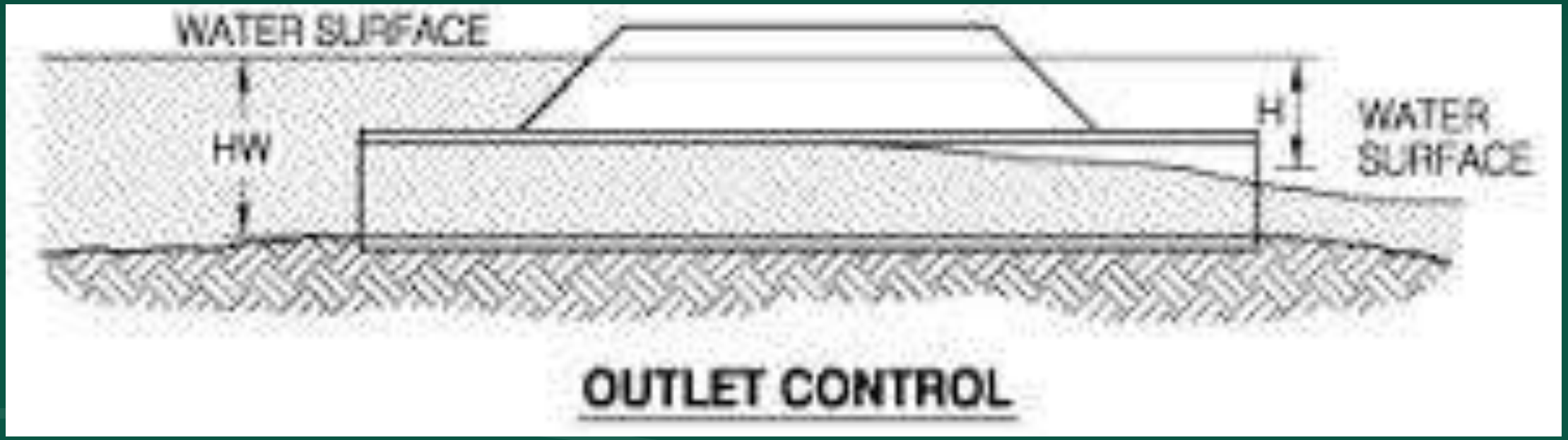
If in doubt - ask for assistance and a culvert design



Environmental Responsibilities



INLET CONTROL



OUTLET CONTROL

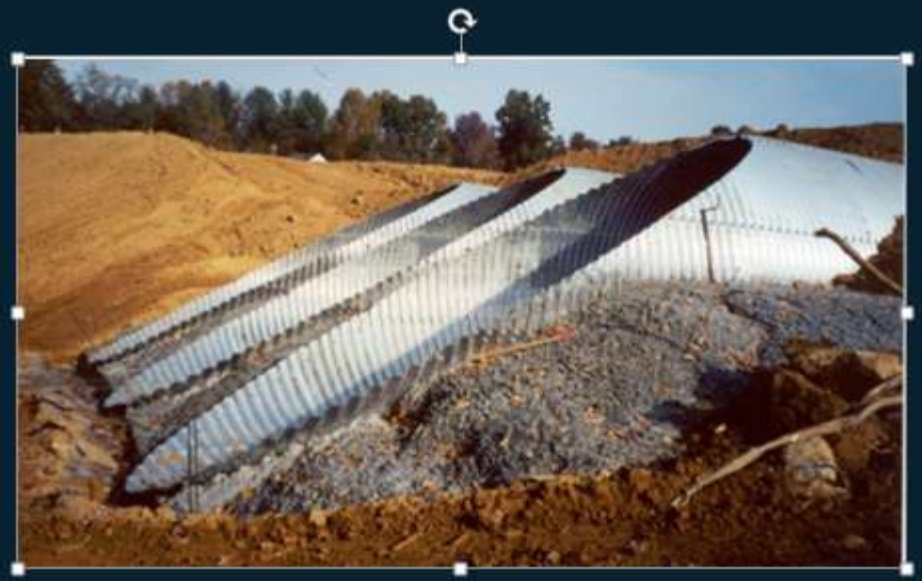
End Sections

NCSPA

STEEL: PROVEN 100-YEARS STRONG

End Treatment

- Proper end treatment is a key to long term performance



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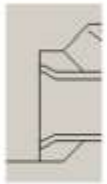
Culvert Entrance Conditions:

Return to Main Window

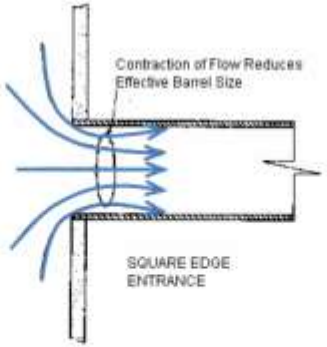
Projecting Groove Edge (Applies only to **Concrete** Culverts with the socket end projecting from the fill)

Projecting Square Edge (Applies to **Concrete** Culverts for non-socket end of the pipe projecting from the fill)

Projecting Thin Edge (Applies to Corrugated Metal Pipe (**CMP**), Smooth **HDPE** or **Corrugated PE** culverts projecting from the fill)

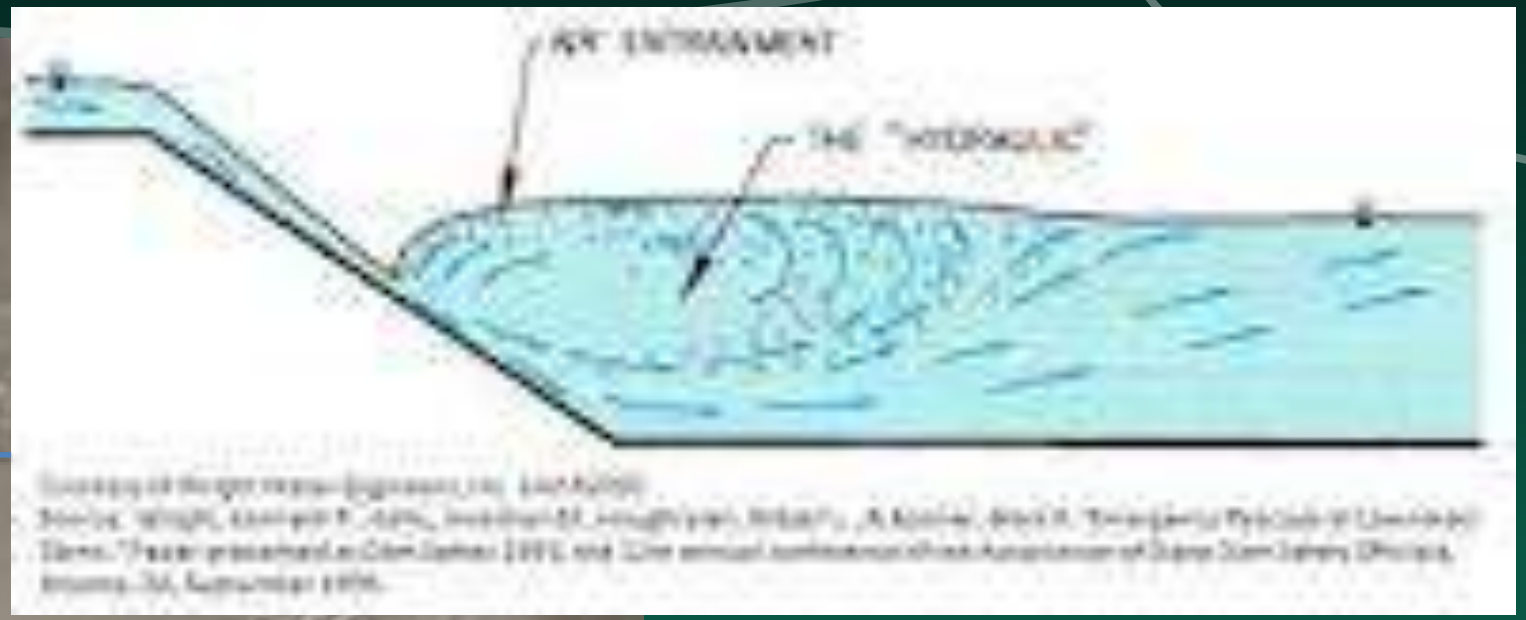


Headwall – Groove Edge (applies to **Concrete pipe** with the socket end in combination with a concrete headwall)

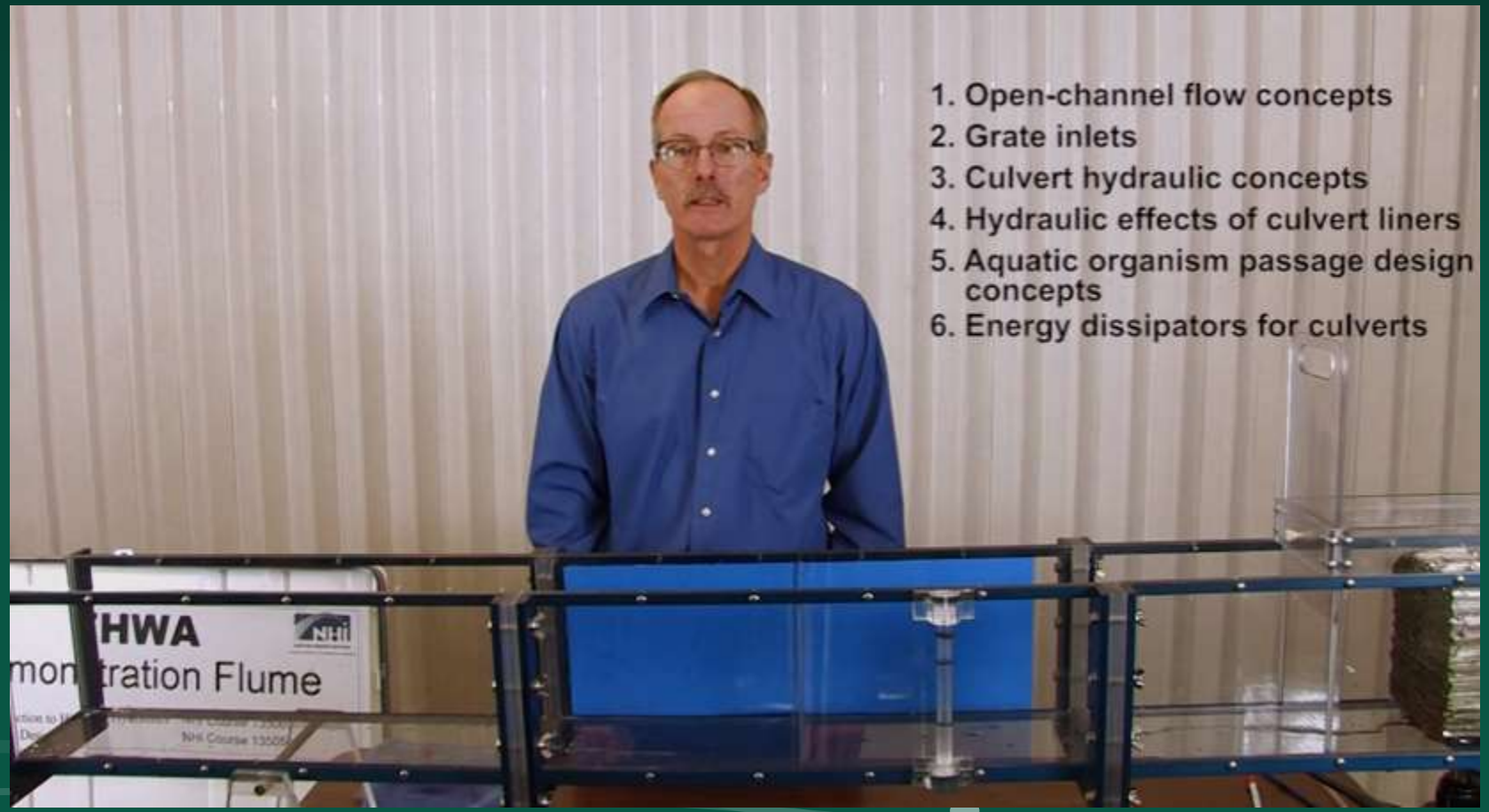


Headwall – Square Edge (applies to **Concrete, CMP, PVC plastic, Smooth HDPE,** or **Corrugated PE** culverts with a concrete headwall and a square edge entrance)

Miter/Square/2:1 Slope (applies to **CMP, PVC plastic, Smooth HDPE** or **Corrugated PE** culverts that are mitered to conform to the slope)


AIR ENTRAINMENT
THE "HYDRAULIC"

https://www.youtube.com/watch?v=vnXmGyb_hKQ

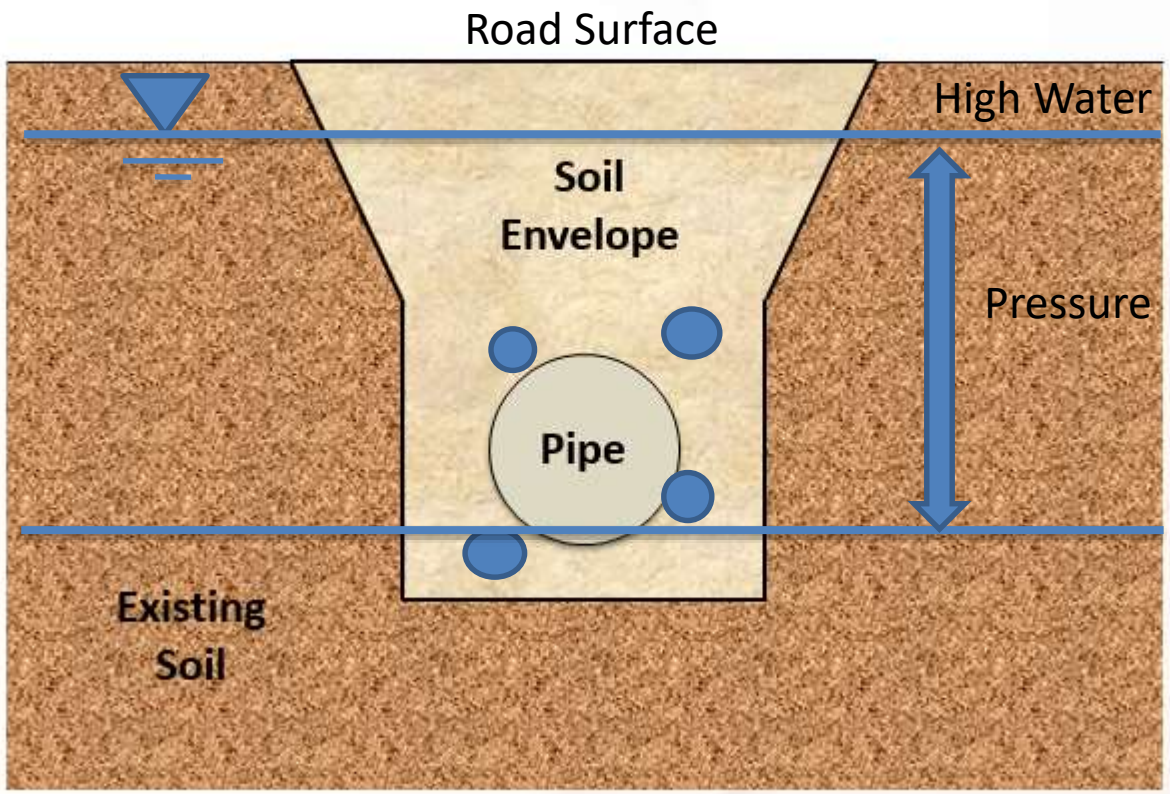


How Much Does Water Weigh?

8.3 pounds per gallon

62.4 pounds per cubic foot

Water Pressure – What is Piping?



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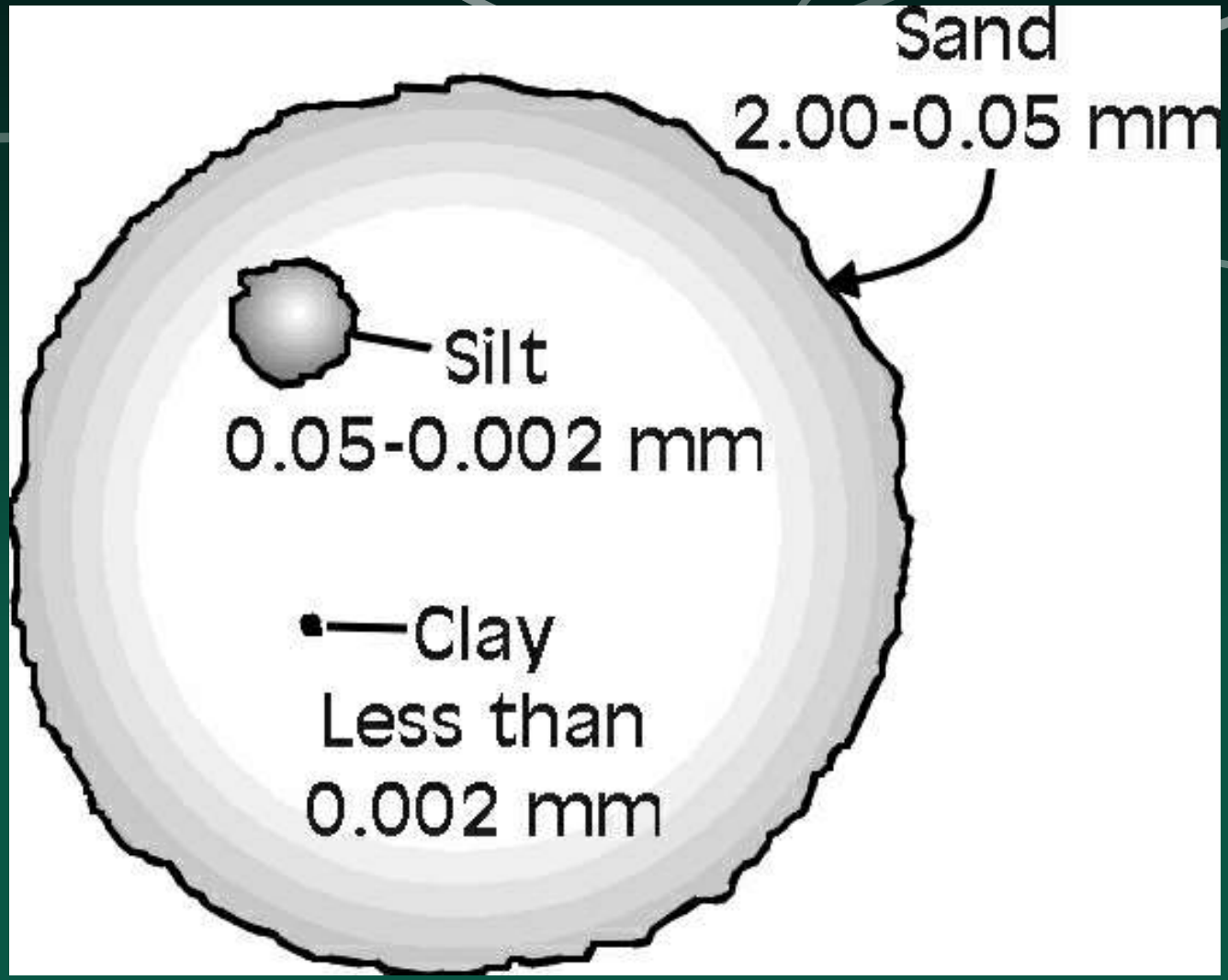
Soil Types

Pipe collars

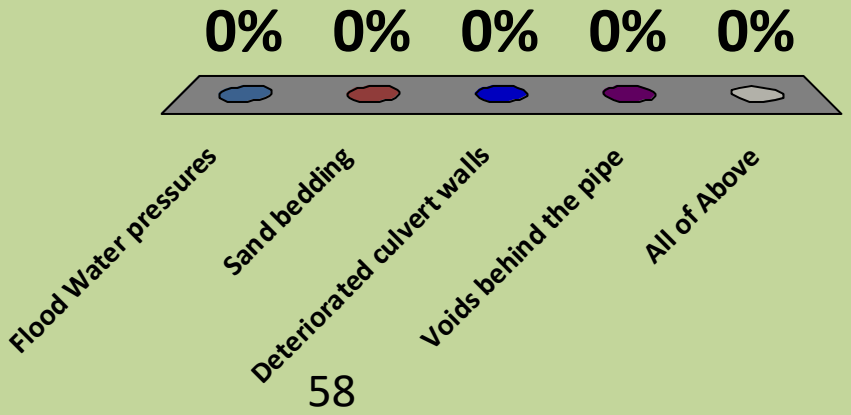
Headwalls




04/07/2009

Culverts wash out because of

1. Flood Water pressures
2. Sand bedding
3. Deteriorated culvert walls
4. Voids behind the pipe
5. ✓ All of Above



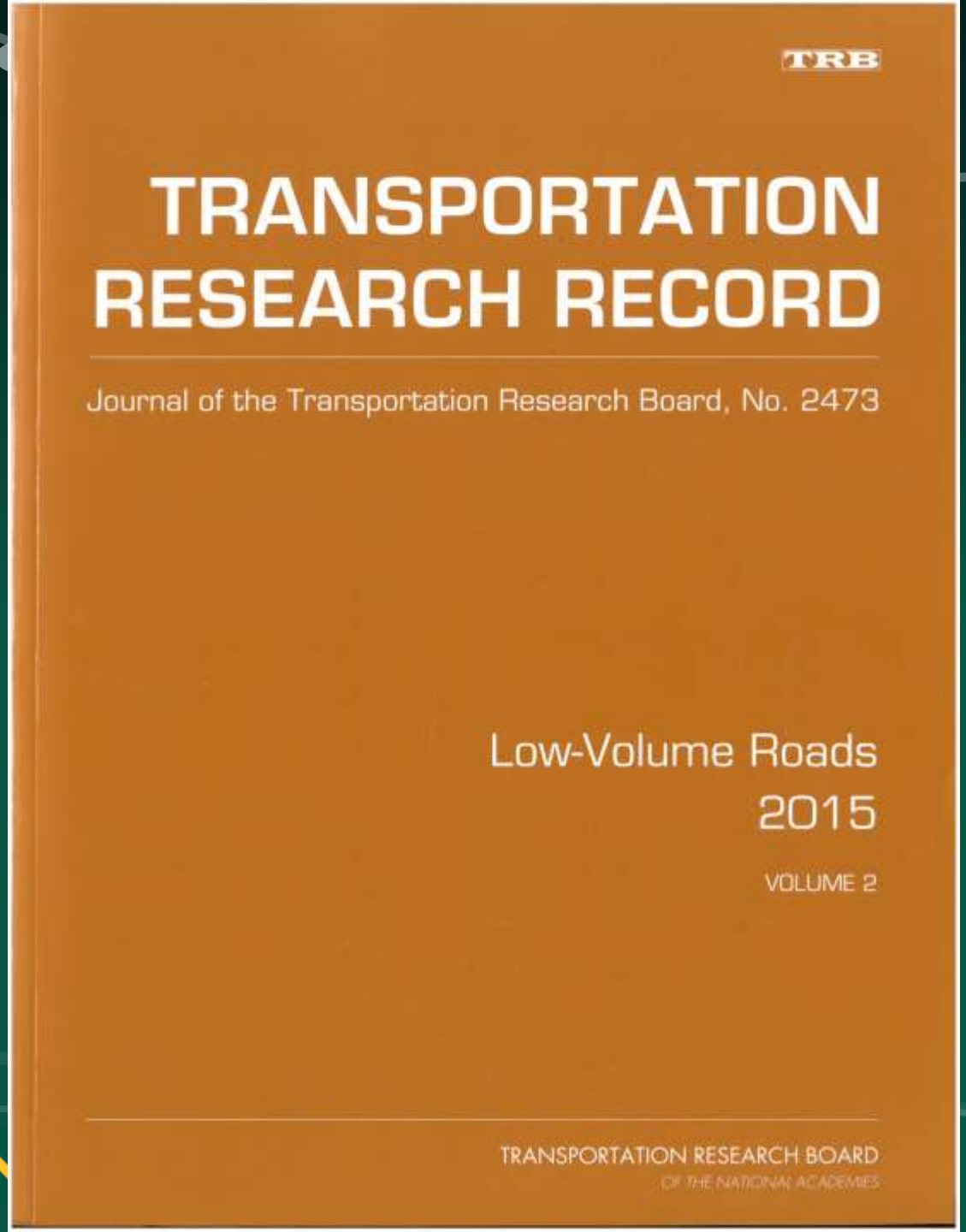


FIGURE 3 Filter bib placed around culvert pipe to prevent seepage and piping.

Geotextile Filter Bib Seepage Collar

A unique application of a geosynthetic involves placing a filter cloth around the circumference of a corrugated metal culvert pipe to prevent piping along the length of the pipe. This concept, developed on the Plumas National Forest, was used as an inexpensive anti-

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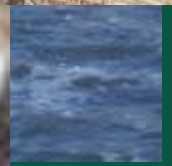

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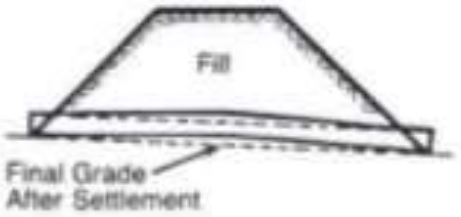
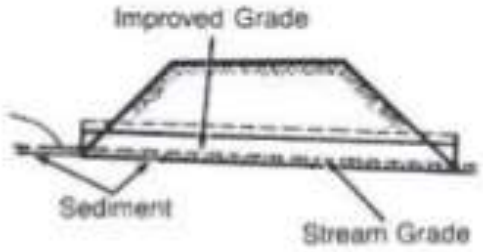
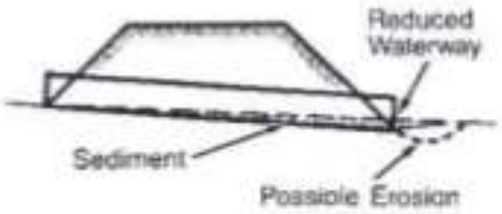
CULVERT ALIGNMENT



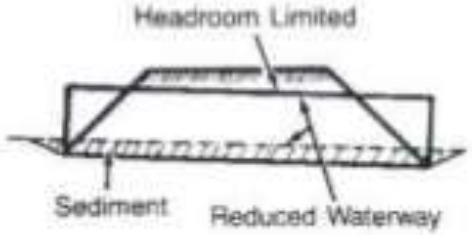
(a) "Camber" under high fills



(b) Anticipating Sedimentation



(c) Changes from channel grade may cause sedimentation or erosion



(d) Culvert placed below proper grade; waterway is reduced

- Ideal grade ***should***:
- Minimize length
- Account for settlement
- Account for sediment
- Ideal grade should ***not***:
- Produce sediment
- Induce excessive velocity
- Cause scour

- Culverts buried below natural streambed can lose anticipated waterway depth

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FURY
SOKKIA

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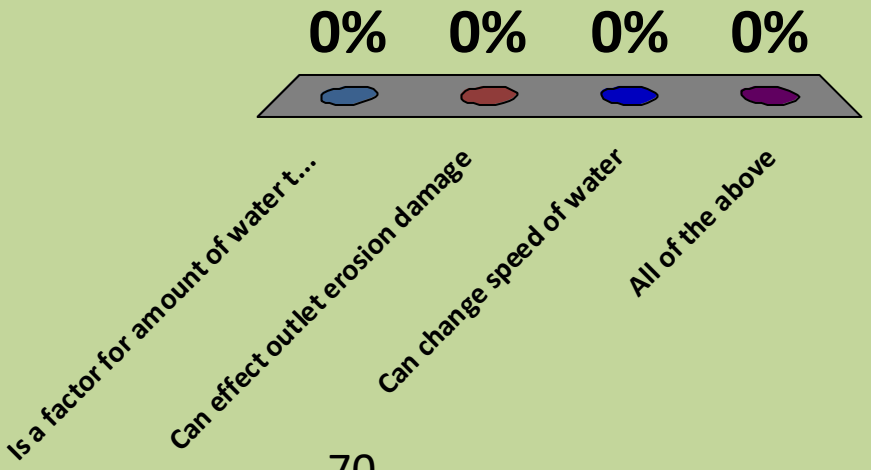
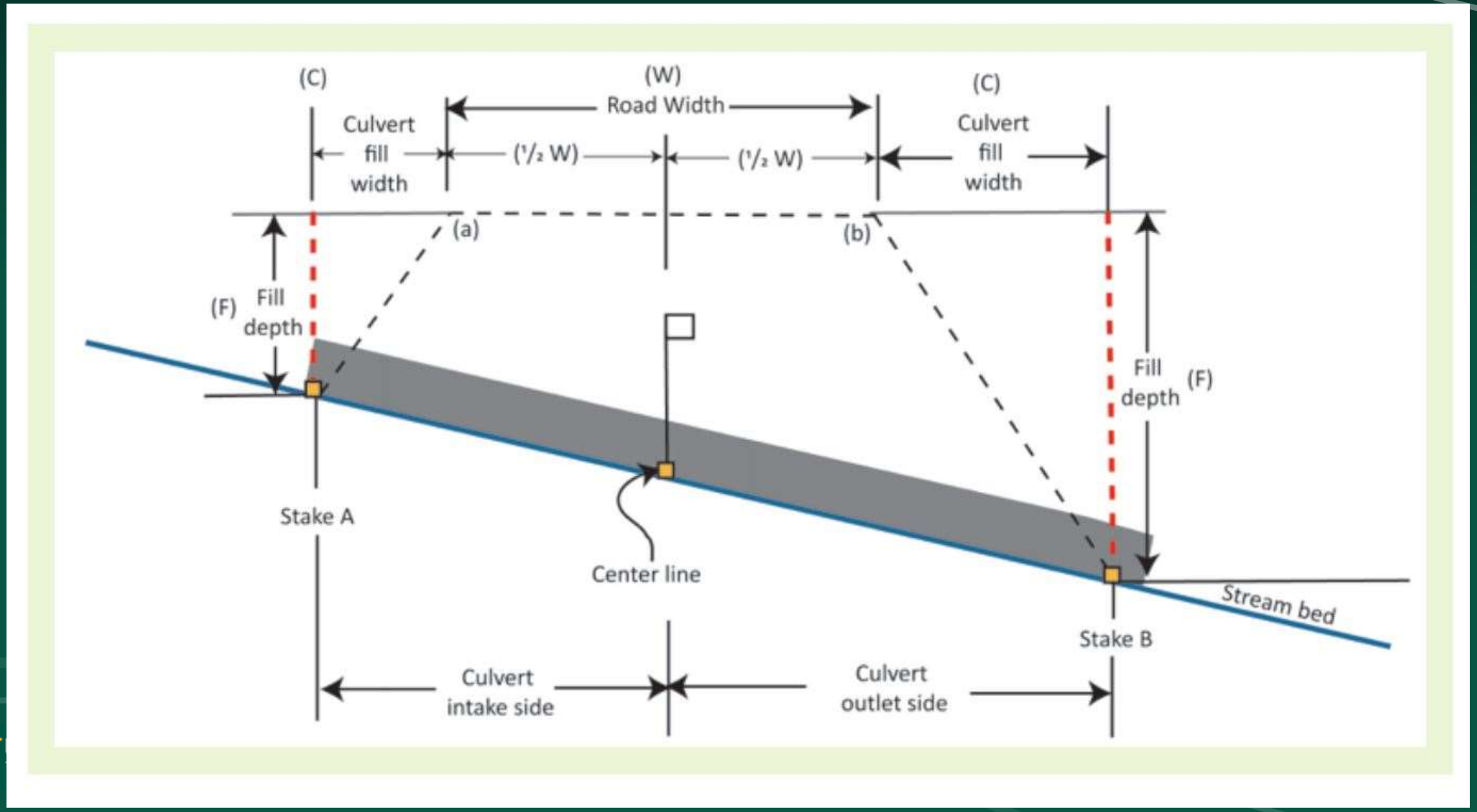
Pipe grade is important because

1. Is a factor for amount of water that passes through
2. Can effect outlet erosion damage
3. Can change speed of water
4. All of the above ✓



Culvert Length



Culvert Length = (3 x 5) + 24 + (3 x 4) = 51 ft

Maintenance

NDSU UPP TRA

2017 YOU SHOW US CONTEST

CULVERT BLASTER

COUNTY:

DESIGNERS:

ADDRESS:

CONTACT:

E-MAIL:

TELEPHONE:

PROBLEM STATEMENT:
Culverts plugged by beaver activity, silt, rock and/or other debris do not allow water to flow properly. Backed up and ponding water causes the road to “soften.” It is difficult to clean immersed culverts.

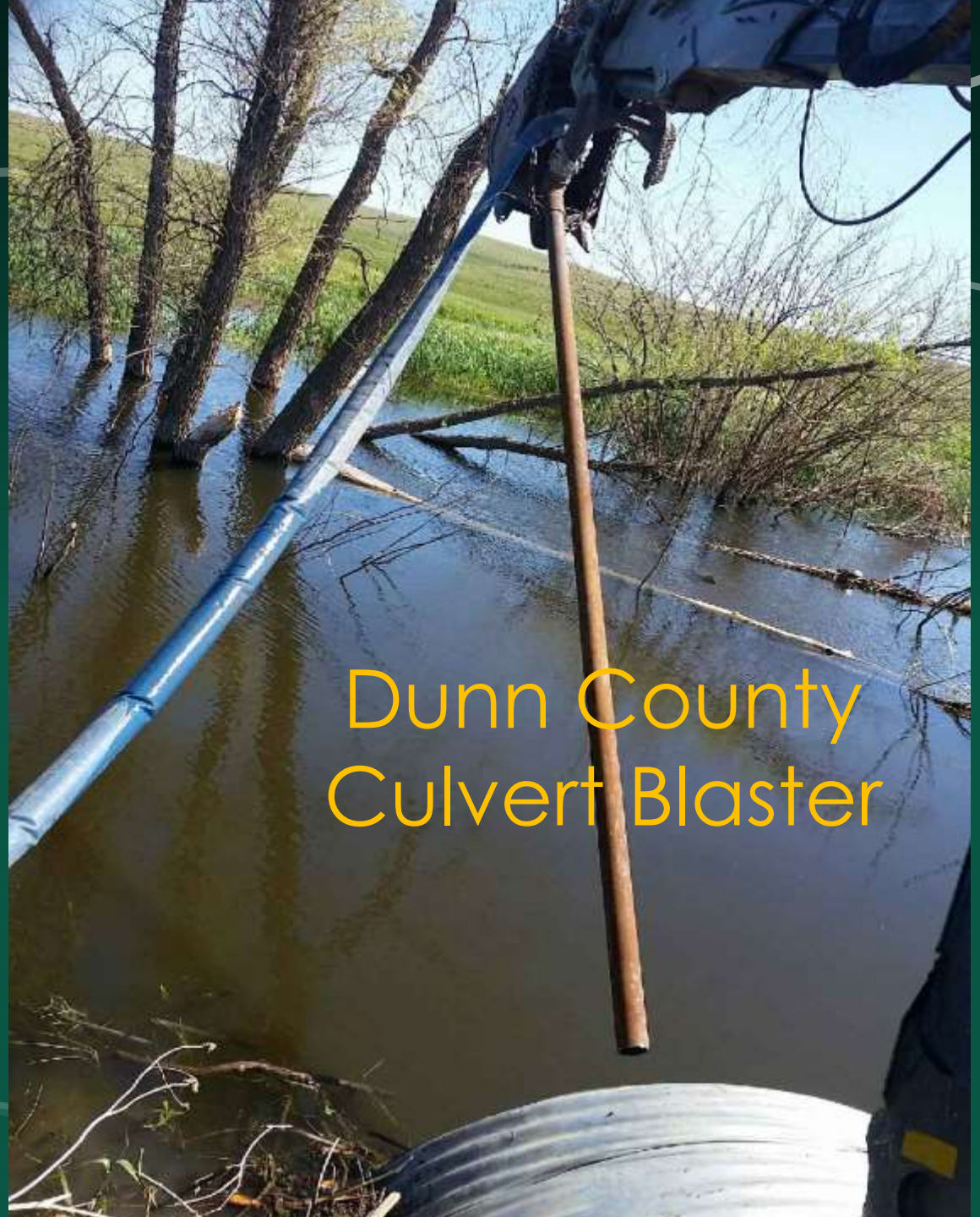
SOLUTION:
We created an innovative system that eliminates the necessity of going into water that is backed up behind a culvert. Details of our system are as follows:

- We used a 2-7/8 inch pipe that is retrofitted with flat iron brackets that attach to the bucket of a backhoe.
- The brackets attach to the bucket with bolts.
- Chain hooks are welded to the backhoe bucket.
- Chain is welded to the pipe and used to support the pipe when attached to the chain hooks on the bucket.
- A water line is attached to a water pump and to the pipe.
- The pipe is probed in and around the blockage inside the culvert.

The pump pushes water under pressure through the pipe and into the culvert. The water pressure dislodges the debris and forces it out the other end of the culvert.

LABOR, EQUIPMENT, AND MATERIAL USED:
The following equipment was used: Welder, cutting torch, grinder, drill

The following materials were used:
Water pump – 4 inch 700 gpm (gallons per minute)
Backhoe with 18 inch wide bucket
2 7/8” steel drill pipe - 14 feet long



Plugged

Plugged Culvert

NDSU

Culvert Maintenance

Know what culverts you have and what condition they are in
Inspection cycle and procedures
Identify problems and find out the cause
Evaluate problems to determine appropriate action
Make repairs
Update inventory
Identify modifications you want to see used in future installations

Inspections & Inventories

GRIT

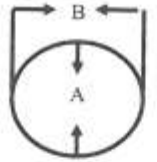
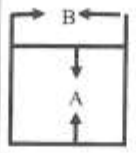
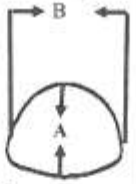
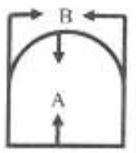
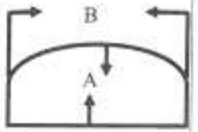
NDSU UPPER GREAT PLAINS TRANSPORTATION INSTITUTE

NDIRF

CULVERT INSPECTION/INVENTORY LOG-ENTITY: _____

1. CULVERT #	2. RANGE:	3. SECTION:	4. GPS:LAT: LONG:	5. # OF CULVERTS:
6. ROAD:			7. LOCATION:	
8. TWNSHP ROAD: YES NO	9. PRIVATE APPROACH: YES NO		10. YEAR INSTALLED:	
11. BUS ROUTE: YES NO	12. MAIL ROUTE: YES NO		13. MILK ROUTE: YES NO	
14. ROAD WIDTH @ CULVERT:	15. ALINGMENT TO ROAD: ANGLED PERPENDICULAR			
16. LENGTH OF CLUVERT:	17. HEIGHT TO ROAD:			
18. WINGWALLS: YES NO	19. HEADWALLS: YES NO		20. RIP RAP: YES NO	
21. CULVERT EXTENDS PAST DITCH SLOPE: YES NO STRAIGHT BEVELED			22. MARKED: YES NO	

23. CULVERT MATERIAL: CONCRETE: REINFORCED NON-REINFRCD CORRUGATED: STEEL ALUMINUM

24.CULVERT SHAPES	ELLIPTICAL	BOX:	PIPE ARCH	METAL BOX	ARCH
CIRCULAR A:_____	A:_____	A:_____	A:_____	A:_____	A:_____
					
	B:_____	B:_____	B:_____	B:_____	B:_____

25. CULVERT FEATURES: RATE THE CONDITION OF EACH FEATURE 1, 2, 3, 4 4 = CRITICAL

FEATURE	RATE	DATE	INITIALS	RATE	DATE	INITIALS	RATE	DATE	INITIALS
HEADWALLS									
WINGWALLS									
ABRASION									
PITTING									
CONNECTIONS									
CULVERT BODY									
SETTLEMENT									
DEBRIS									
JOINTS									
CRACKS									
EROSION									
ROADWAY SAG									

DESCRIBE ALL CONDITIONS "3 OR 4", MAINTENANCE AND REPAIR ON REAR


CULVERT 36"X24"


FLARE 24"

NDSU

Prior to ALL Culvert Installations

811®

Know what's **below.**
Call before you dig.

Installation of Corrugated Steel Pipe

Pipe Experts – True North Steel

TrueNorthSteel

Jeff Walters
Territory Manager – Eastern North Dakota/Western Minnesota
701-371-9980
JeffWalters@TrueNorthSteel.com

How Long will CSP Last???

Our group is asked this question all the time.

- Our Territory Managers usually don't last as long as the pipe!
- It depends on what the native soil is!
- It depends on what the backfill material is!
- It depends on how well it is installed!

How Long will CSP Last???

CSP Material Selection is **NOT** a

"One Size Fits All" Proposition

What is the project design life?

- 25 Years
- 50 Years
- 75 Years
- 100 Years

Service Life Predictions

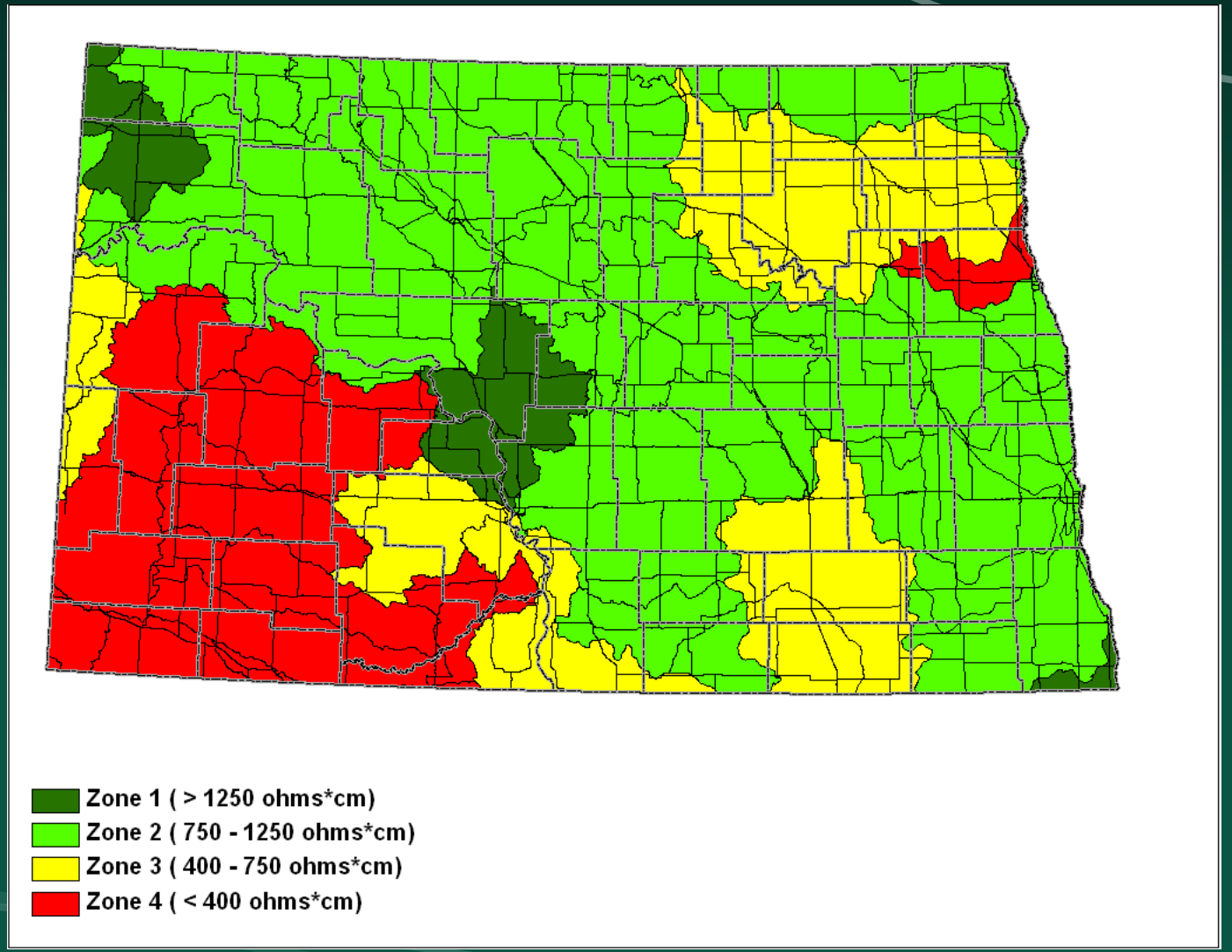
The NDDOT has an established corrosion map for the state. The 4 zones shown in the chart indicate the estimated soil resistivity in the state. Resistivity is measured in ohm*cm

ZONE 1 - DARK GREEN > (1250 ohms*cm)

ZONE 2 - LIGHT GREEN (750 – 1250 ohms*cm)

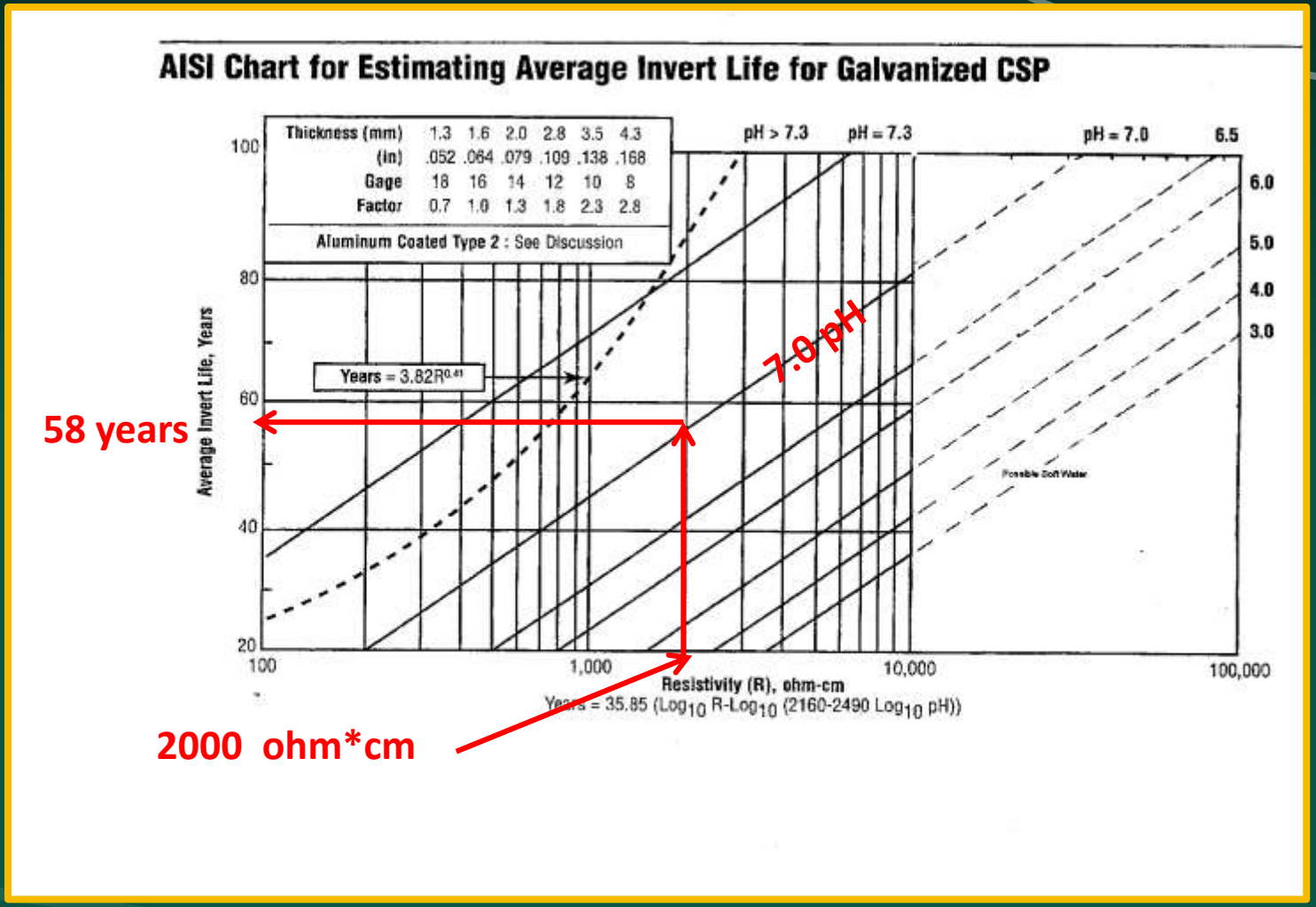
ZONE 3 - YELLOW (400 – 750 ohms*cm)

ZONE 4 – RED (< 400 ohms*cm)



Service Life Predictions

- The American Iron and Steel Institute assisted our industry in developing this chart for Estimating average invert life for 16 gauge galvanized CSP.
- Resistivity and pH of the native soil and water is required to plot data point on the chart.
- Soil resistivity is plotted on the horizontal axis. **2000 ohm*cm**
- Move up the graph until the soil pH is reached. **7.0**
- Average invert life. **58 years**



Service Life

- Free draining clean sands are the most favorable for galvanized CSP. 2000 ohm*cm or higher.
- When the soil resistivity is 2000 ohm*cm or lower considerations should be made to extend the EMSL (estimated material service life) of the by switching coating materials
- Aluminized Type II - 75 years
- Polymer Coated - 100 years

Table 9.2

Corrosiveness of Soils

Soil Type	Description	Aeration	Drainage	Color	Water Table
20,000 ohms*cm I. Non Corrosive	1. Clean Sands 2. Well graded gravel	Excellent	Excellent	Uniform	Very low
II. Lightly Corrosive 2000 ohms*cm	1. Sandy loams 2. Light textured silt loams 3. Porous loams or clay loams thoroughly oxidized to great depths.	Good	Good	Uniform color	Very low
III. Moderately Corrosive	1. Sandy loams 2. Silt loams 3. Clay loams	Fair	Fair	Slight mottling	Low
IV. Badly Corrosive	1. Clay loams 2. Clay	Poor	Poor	Heavy texture Moderate mottling	2 to 3 ft below surface
V. Unusually Corrosive 200 ohms*cm	1. Muck 2. Peat 3. Tidal Marsh 4. Clays and organic soils	Very poor	Very poor	Blue, gray, green	At surface; or extreme impermeability

NOTE: Soil types III, IV and V are poor quality and are not recommended for use as backfill.

Estimated CSP Service Life (NCSPA)

Pipe Coatings Available

- Galvanized CSP
  - 50 years
- Aluminized Type II CSP
  - 75 years
- Polymer Coated CSP
  - 100 years

Table 9.1

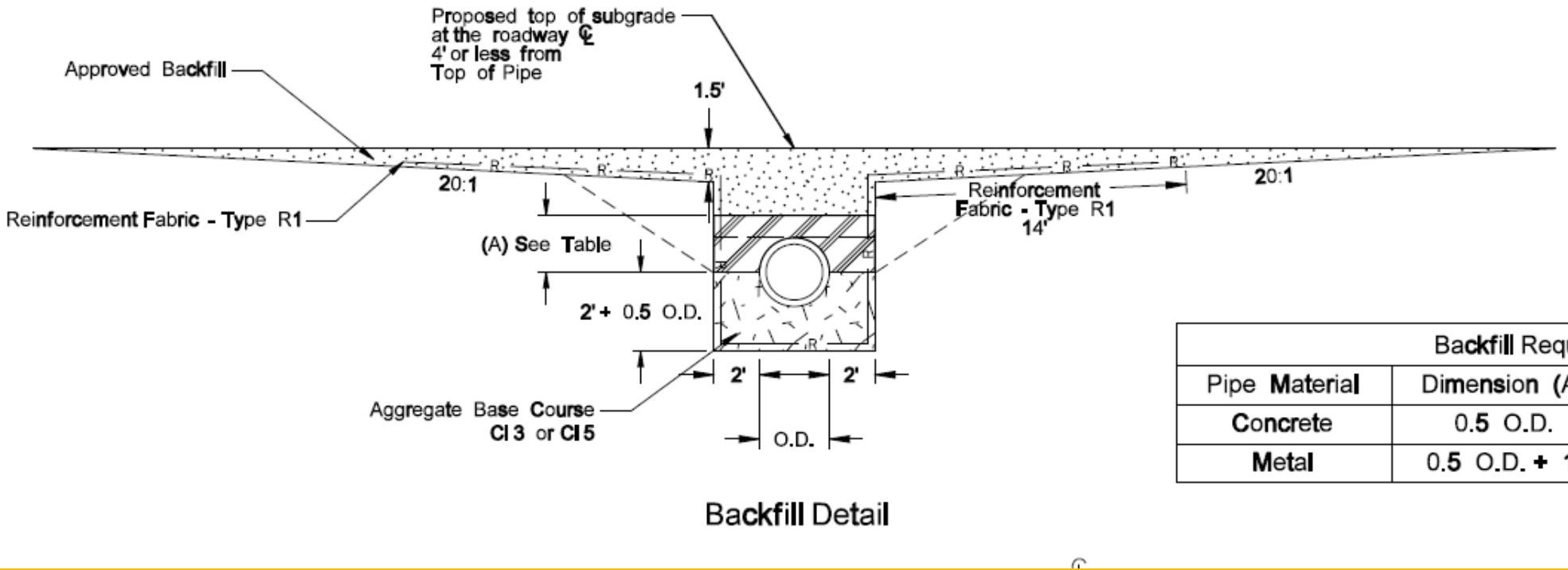
Estimated Csp Service Life

CSP Material	Estimated Pipe Service Life	Site Environmental Conditions	Maximum FHWA Abrasion Level
GALVANIZED CSP (Minimum 16 ga)	AVERAGE 50 YEARS	$6.0 \leq pH \leq 10.0$ $2000 \leq r \leq 8000$ (ohm-cm) Water Hardness ($< 62.5 ppm CaCo_3$)	LEVEL #2
ALUMINIZED TYPE II CSP (Minimum 16 ga)	MINIMUM 75 YEARS	$5.0 \leq pH \leq 9.0$ $r > 1500$ ohm-cm	LEVEL #2
POLYMER COATED CSP (Minimum 16 ga)	MINIMUM 100 YEARS	$5.0 \leq pH \leq 9.0$ $r > 1500$ ohm-cm	LEVEL #3
	MINIMUM 75 YEARS	$4.0 \leq pH \leq 9.0$ $r \geq 750$ ohm-cm	
	MINIMUM 50 YEARS	$3.0 \leq pH \leq 12.0$ $r \geq 250$ ohm-cm	

NOTE: Refer to Table 9.3 For Definition of FHWA Abrasion Levels

Installation of Corrugated Steel Pipe

D-714-26



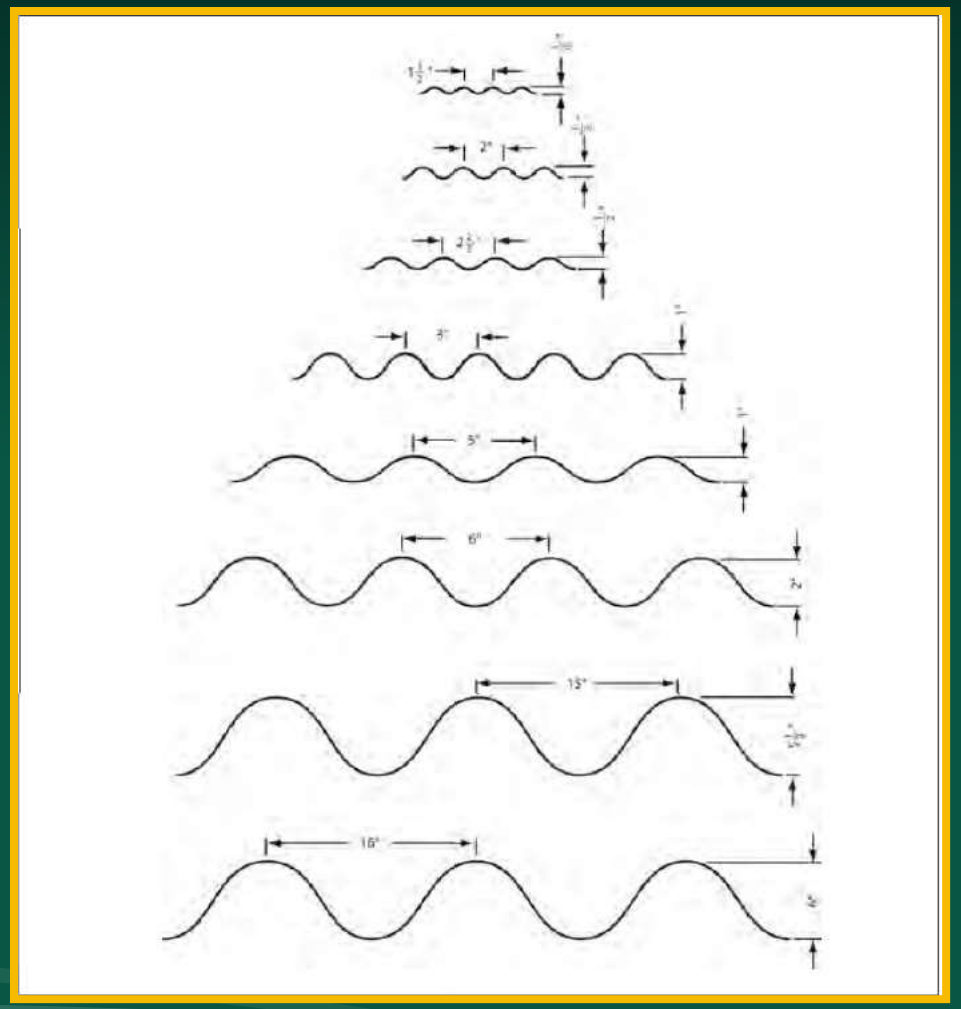
Backfill Detail

Backfill Requirements		
Pipe Material	Dimension (A)	Backfill
Concrete	0.5 O.D.	Approved Backfill (Note 2)
Metal	0.5 O.D. + 1'	Cl 3 or Cl 5

- Current NDDOT Standard plate drawing for conduit under roadway 4’ below the proposed base.

Corrugated Steel Pipe Profiles

- There are many combinations of corrugation and gauge.
- 11/2” x ½”
- 2” x ½”
- 22/3” x ½”
- 3”x1”
- 5”x1”
- 6”x2”
- 15” x 51/2”
- 16” x 6”
- Spiral Rib

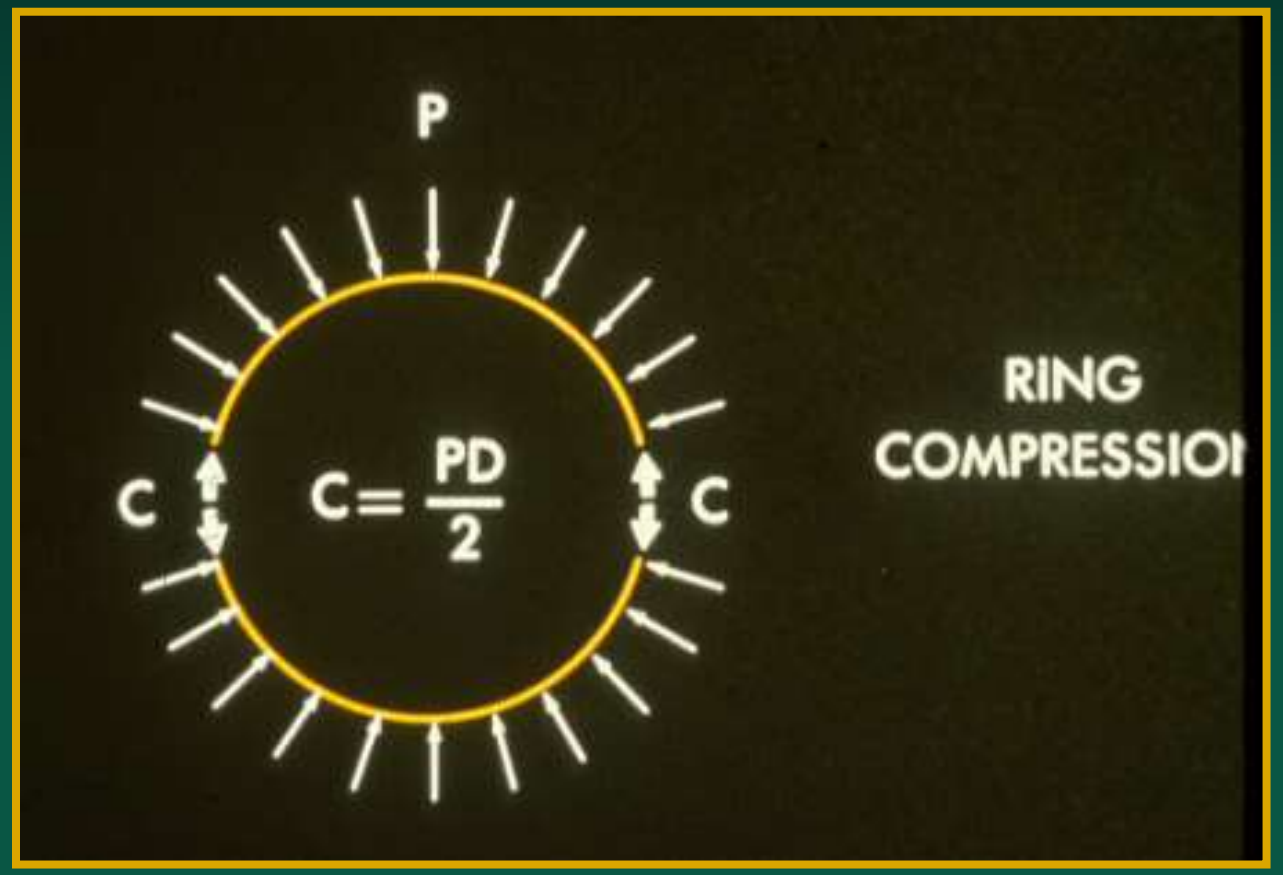


Industry recommended gauges

- 16 gauge
- 14 gauge
- 12 gauge
- 10 gauge
- 8 gauge

Installation of Corrugated Steel Pipe

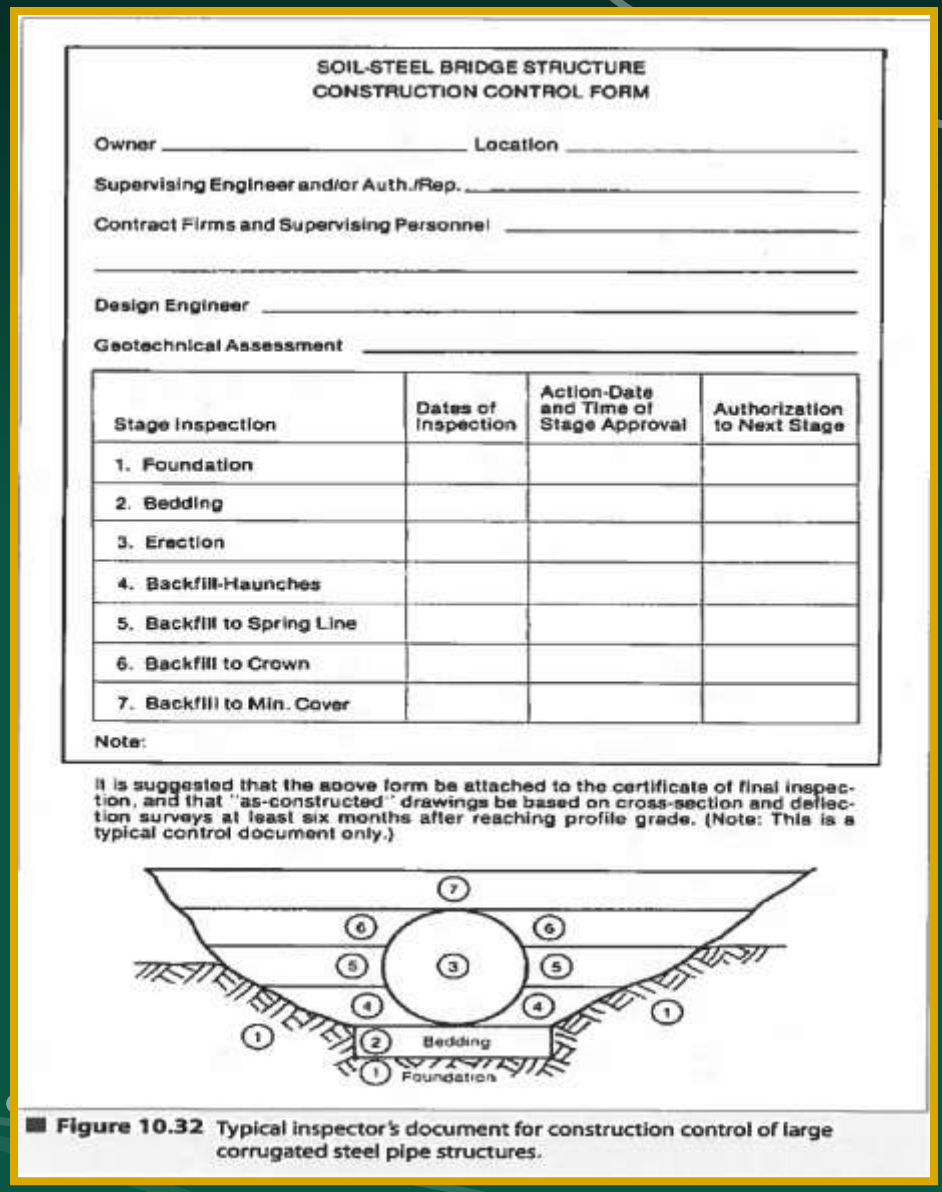
- Ring Compression is the principal stress in a confined thin circular ring subjected to external pressure.
- Proper fill and fill placement is essential to achieve ring compression
- You have to pack them!!!!!!



Installation of Corrugated Steel Pipe

- Typical stage inspection forms similar to this for small CSP culverts (6” to 60” diameter) are available.

- It is important to verify these.
  - Foundation
  - Bedding
  - Pipe Construction
  - Backfill – Haunches
  - Backfill – Spring line
  - Backfill – Crown
  - Backfill – Minimum cover



SOIL-STEEL BRIDGE STRUCTURE
CONSTRUCTION CONTROL FORM

Owner _____ Location _____

Supervising Engineer and/or Auth./Rep. _____

Contract Firms and Supervising Personnel _____

_____

Design Engineer _____

Geotechnical Assessment _____

Stage Inspection	Dates of Inspection	Action-Date and Time of Stage Approval	Authorization to Next Stage
1. Foundation			
2. Bedding			
3. Erection			
4. Backfill-Haunches			
5. Backfill to Spring Line			
6. Backfill to Crown			
7. Backfill to Min. Cover			

Note:

It is suggested that the above form be attached to the certificate of final inspection, and that "as-constructed" drawings be based on cross-section and deflection surveys at least six months after reaching profile grade. (Note: This is a typical control document only.)

Figure 10.32 Typical inspector's document for construction control of large corrugated steel pipe structures.

Installation of Corrugated Steel Pipe

Proper preparation of the foundation material is critical in all building projects. These soils often times need to be scarified and compacted prior to any fill and culvert placement.

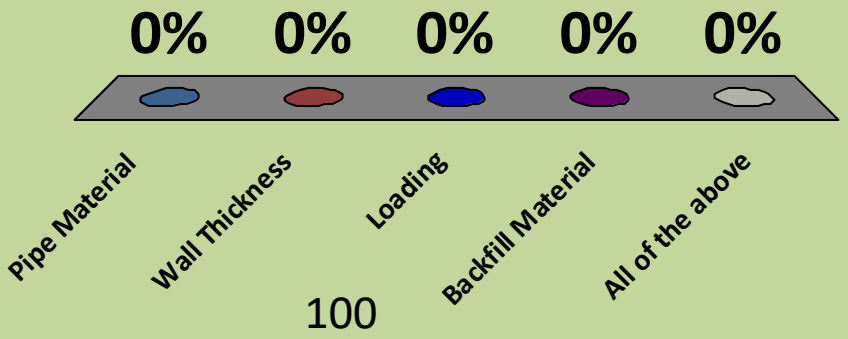
A good practice is to test these soils to ensure they meet or exceed project specifications.

Installation of Corrugated Steel Pipe

- **Trench should be constructed according to appropriate pipe detail.**
- **Separation fabric often specified and recommended where marginal subgrades are present.**
- **Bedding materials should be placed in a loose fashion and not compacted to conform to the corrugation.**

Pipe strength is a function of

1. Pipe Material
2. Wall Thickness
3. Loading
4. Backfill Material
5. ✓ All of the above



Installation of Corrugated Steel Pipe

- One of the many benefits of corrugated steel pipe is its long length. Up to 44’ with 16 gauge steel and 60’ with 12 gauge steel.
- Straps or lifting hooks are always recommended to ensure that damage to the coating is minimized.
- If coating damage is noted approved touch up coating is available.

Installation of Corrugated Steel Pipe

- **Vibratory compaction in 6 lift thicknesses is recommended**
- **Well compacted fill around the pipe helps to support the pipe load**
- **Well compacted material reduces settlement and deflection in the pipe**

Installation of Corrugated Steel Pipe

- **Fill directly over the pipe should be free of any rocks that may cause point loading on the pipe**
- **Minimum fill height is 12” for AASHTO H-25 loading for 24” diameter CSP**
- **Additional moisture may need to be added to lubricate soil particles.**

Installation of Corrugated Steel Pipe

- **Live loads for construction traffic shall be in accordance with the manufacturer's recommendation.**

- **During construction phases it is necessary to cross over the pipe with heavy equipment. Excess fill material may be needed to carry the construction loads.**

Installation of Corrugated Steel Pipe

- Point loading tends one of the biggest concerns during installation.
- Table 10.1 of the NCSPA design manual lists safe minimum cover depths for various heavy off road construction equipment

Table 10.1

Guidelines for minimum cover for heavy off-road construction equipment.

Span	Min. Cover (ft) for Axle Loads (kips)			
(in)	18-50	50-75	75-110	110-150
12-42	2.0	2.5	3.0	3.0
48-72	3.0	3.0	3.5	4.0
78-120	3.0	3.5	4.0	4.0
126-144	3.5	4.0	4.5	4.5

1) Min. crossing width of twice the span is recommended.
2) Additional cover may be needed depending on local conditions.

Installation of Corrugated Steel Pipe

- A key component to a successful installation is keeping the backfill protected.
- A compacted clay collar near both ends of the pipe is critical to seal off water migration past the out side of the pipe.
- Also flared end sections, anti seep collars, head and wing walls with fabric and rip rap do the job and minimize water from wicking along the outside of the pipe.

Rehabilitation Opportunities

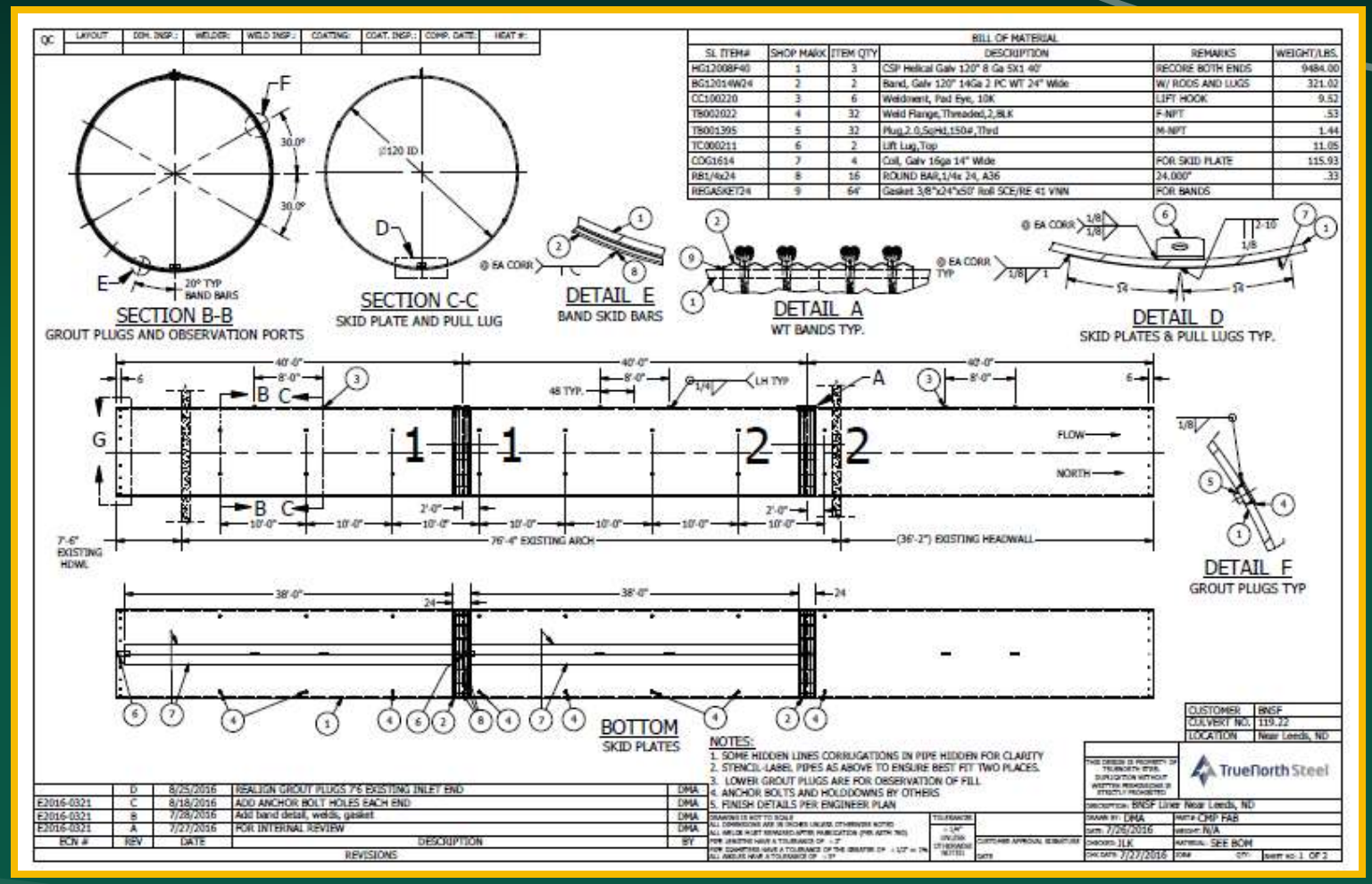
When does it make sense to rehabilitate / line?

- Deep fill sections!
- To avoid closure of crossing!
- Condition on host pipe!

Rehabilitation Opportunities

Project Details

- Rail Road Embankment
- 23 feet of fill
- Existing opening 14’ arch
- Liner is 10’ diameter
- 5” x 1” corrugation
- 8 gauge galvanized CSP
- Annual space will be grouted in 3 stages.



Rehabilitation Opportunities

Type of distress noted:

- This pipe is old but the un tied joints have separated allowing backfill material to wash into the pipe.
- Internal expanding bands were placed to seal the joint separation.

Rehabilitation Opportunities

A structural assessment should include identifying

- Shape of the host pipe
- Joint Separation
- Crimping of the pipe wall
- Invert lifting
- Excessive alignment changes

Rehabilitation Opportunities

This existing CSP crossing was lined with CSP. The County desired to rehabilitate with a liner so they would not have to close the road.

The existing culvert was a 30” diameter annular CSP. (Rivited)

Rehabilitation Opportunities

68’ of 24” diameter spiral rib pipe was placed inside a 30” diameter annular pipe.

Two (2) section of CSP each being 34’ in length were slide into the 30” diameter pipe.

Rehabilitation Opportunities

A small tractor backhoe slide the liner pipe into the host pipe easily as the existing pipe was fairly straight in alignment.

Gasketed connecting bands are used to keep the grout from entering the pipe during that process.

Rehabilitation Opportunities

Often time it is necessary to use a silo type rod and lug fastener in these applications as the typical band angle creates clearance problems.

Excess bolt thread can be trimmed off prior to advancing the liner completely into the host pipe.

Rehabilitation Opportunities

This County did not even remove to existing Flared End Section.

After the liner pipe was place they removed the sod areas and added a clay collar around the old pipe and direct buried several feet that extended from the host pipe.

Separation fabric and Rip Rap aggregate was again placed to minimize soil erosion.

Rehabilitation Opportunities

Another liner option to consider is Snap Tite.

This is a solid walled HDPE material that is slid into the host pipe in a similar fashion.

Two pipe snap together as they are slid into position.

Rehabilitation Opportunities

For these rehabilitation options it in necessary to fill the annual space between the liner and the host pipe to effectively transfer the load to the liner pipe.

Selection of the grout type depends on the physical dimensions and condition of the host pipe.

Installation of Corrugated Steel Pipe

NATIONAL CORRUGATED STEEL PIPE ASSOCIATION

NCSPA INSTALLATION MANUAL for

- Corrugated Steel Pipe
- Structural Plate

CORRUGATED STEEL PIPE Design Manual

NCSPA

NDSU UP TR

Field Demonstration – CMP Installation


BARNES COUNTY
HIGHWAY DEPT.
RAM 1500
HEMI

NDSU UPPER GREAT PLAINS TRANSPORTATION INST

USGS Stream Stats

https://streamstatsags.cr.usgs.gov/streamstats/

https://streamstatsags.cr.usgs.gov/streamstats/

USGS STREAM STATS

Open website USGS : Streamstats 4.0

Select state – North Dakota

Hit North Dakota on the world map, use the + box in upper left corner to Zoom to level 15 or more for program to work.

Hit North Dakota in green box. Step 2 should come up, then hit Delineate, a blue teardrop with lat - long on it should come up locate with your mouse the drainage you want studied; to delineate the basin, wait it will come up in a yellow color showing the drainage area (basin). You can download the basin to GeoJSON, shapefile or ESRI file, just high lite and go; if not using this hit continue in the next green box;

Hit peakflow characteristics to get the cubic feet per second flow for the various flood years, 2, 5, 10, 25, 50, 100, 500; also fill in the basin characteristics or just hit the box for all characteristics to be filled in.

Then hit continue again, wait for the report, the basin area should be first then the characteristics, then the Peak-flow sheet, just scroll down to see the whole report.

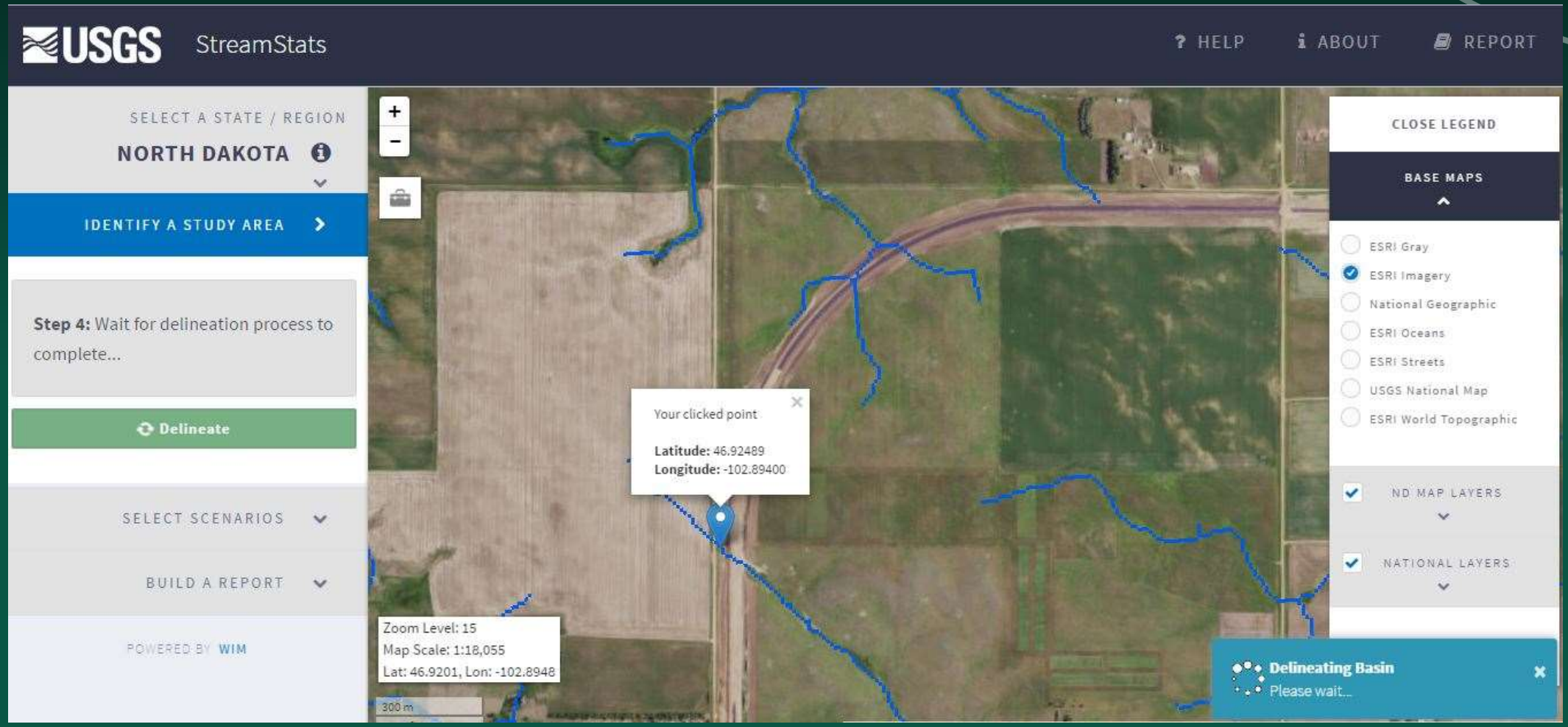
Press the print button to print.

Press the North Dakota green block and then start over for your next Basin study..

This gives one the cubic feet per second of flow for the various drainages, then one has to estimate the velocity you would like for the area, I always used between 8 and 12 feet per second; usually below 10 due to the erosion prone soils we deal with in western North Dakota. Then it is a simple division to get the end area of the drainage structure.

For the end area conversions to pipe size, most pipe companies have a list of pipes, round, squash, box, etc to compare end areas with to suit your culvert location as to fill height, grade, etc.

Curtis W. Glasoe NDSU-LTAP..


USGS StreamStats
HELP
ABOUT
REPORT
SELECT A STATE / REGION
NORTH DAKOTA
IDENTIFY A STUDY AREA
Step 4: Wait for delineation process to complete...
Delineate
SELECT SCENARIOS
BUILD A REPORT
POWERED BY WIM
Your clicked point
Latitude: 46.92489
Longitude: -102.89400
Zoom Level: 15
Map Scale: 1:18,055
Lat: 46.9201, Lon: -102.8948
300 m
CLOSE LEGEND
BASE MAPS
ESRI Gray
ESRI Imagery
National Geographic
ESRI Oceans
ESRI Streets
USGS National Map
ESRI World Topographic
ND MAP LAYERS
NATIONAL LAYERS
Delineating Basin
Please wait...

USGS StreamStats

? HELP

SELECT A STATE / REGION

NORTH DAKOTA

IDENTIFY A STUDY AREA

BASIN DELINEATED

Step 5: Your delineation is complete. You can now clear, edit, or download your basin, or choose a state or regional study specific function (if available). Click **continue** when you are ready.

Clear Basin

Edit Basin

Download Basin

StreamStats Report

Region ID: ND
Workspace ID: ND2017C
Clicked Point (Latitude, Longitude): 46.9248
Time: 2017-05-

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	0.12	square miles
COMPRAT	A measure of basin shape related to basin perimeter and drainage area	1.56	dimensionless
RUGGED	Ruggedness number computed as stream density times basin relief	0	feet per mi
AG_OF_DA	Agricultural Land in Percentage of Drainage Area (Idaho Logistic Regression Equations SIR 2006-5035	91.7	percent
ELEV	Mean Basin Elevation	2650	feet
PRECIP	Mean Annual Precipitation	16.6	inches
SOILPERM	Average Soil Permeability	3.32	inches per hour

Peak-Flow Statistics Parameters [100 Percent (0.12 square miles) Peak Region B 2015 5096]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.12	square miles	0.11	8343
RUGGED	Ruggedness_Number	0	feet per mi	68	7820
COMPRAT	Compactness Ratio	1.56	dimensionless	1.4	3.48

Peak-Flow Statistics Disclaimers [100 Percent (0.12 square miles) Peak Region B 2015 5096]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Peak-Flow Statistics Flow Report [100 Percent (0.12 square miles) Peak Region B 2015 5096]

Statistic	Value	Unit

NDSU UPPER GREAT PLAINS TRANSPORTATION INSTITUT

Installation Demonstration

- Typical stage inspection forms similar to this for small CSP culverts (6” to 60” diameter) are available.

- It is important to verify these.
  - Foundation
  - Bedding
  - Pipe Construction
  - Backfill – Haunches
  - Backfill – Spring line
  - Backfill – Crown
  - Backfill – Minimum cover

SOIL-STEEL BRIDGE STRUCTURE
CONSTRUCTION CONTROL FORM

Owner _____ Location _____

Supervising Engineer and/or Auth./Rep. _____

Contract Firms and Supervising Personnel _____

_____

Design Engineer _____

Geotechnical Assessment _____

Stage Inspection	Dates of Inspection	Action-Date and Time of Stage Approval	Authorization to Next Stage
1. Foundation			
2. Bedding			
3. Erection			
4. Backfill-Haunches			
5. Backfill to Spring Line			
6. Backfill to Crown			
7. Backfill to Min. Cover			

Note:

It is suggested that the above form be attached to the certificate of final inspection, and that "as-constructed" drawings be based on cross-section and deflection surveys at least six months after reaching profile grade. (Note: This is a typical control document only.)

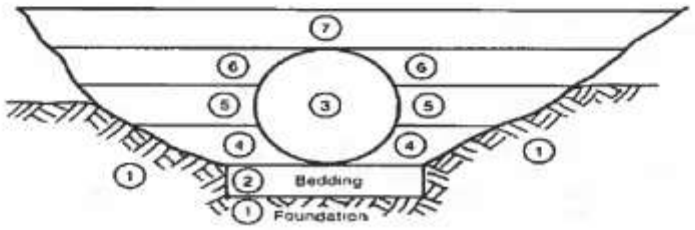


Figure 10.32 Typical inspector's document for construction control of large corrugated steel pipe structures.

Design Considerations

- Pipe size
- Soil loading
- Overtopping roadway
- Outlet scour
- Soil pH
- Pipe bedding and structure

Culvert Sizing – rule of thumb or experience

Don’t assume culvert that you are replacing is adequately sized

Examine history – snow melt, heavy rains, roadway overtopping, and other

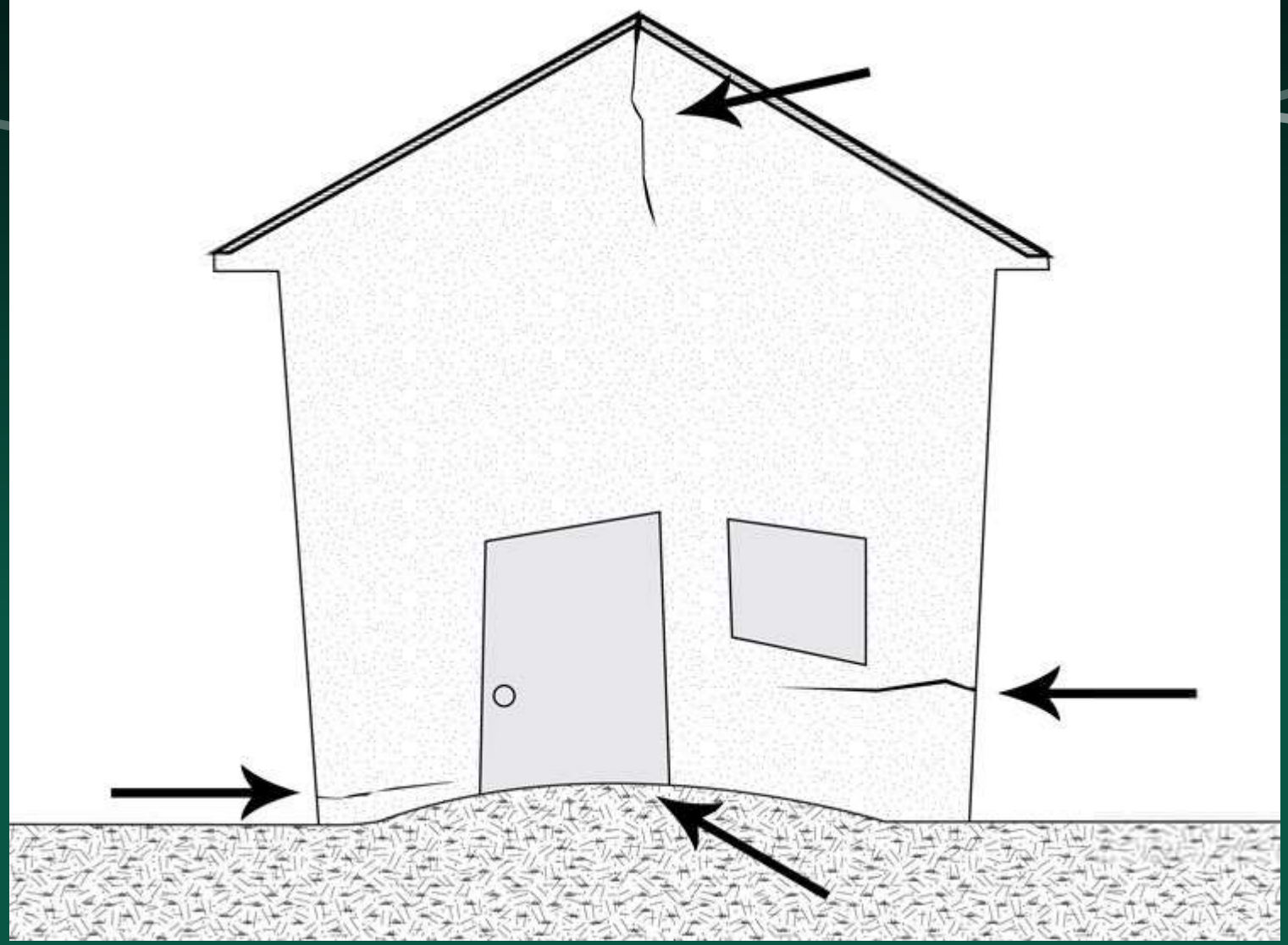
Look at culverts upstream and downstream

Look for recent land use changes

Look for outlet erosion

If in doubt - ask for assistance and a culvert design


CAT



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Mountrail County
CAT
322


710J
DEERE


CORPORATE HQ
ISCO
SnapTite®
1-800-CULVERT
JOB # 3035467-1
ISCO PLANT LOU STAR KING MART
MFG DATE 7-22-15
NOMINAL O.D. 22"
PIPE DR 32.5
CUSTOMER stock
PRODUCT # 22" x 32.5 x 24'u x MF
AASHTO M 326
TAG #
HDPE Resin Material description: ASTM D 3350-02, Cell Classification 345464C
Pipe Type: Solid Wall HDPE ASTM F 714

Bullet nose

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Installation of Corrugated Steel Pipe

Jeff Walters
Territory Manager – Eastern North Dakota/Western Minnesota
701-371-9980
JeffWalters@TrueNorthSteel.com

Dale C. Heglund, PE/PLS
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