DESIGN GUIDE

SnapTite®

WWW.CULVERT-REHAB.COM | 800-CULVERT

VERSION 4.0 2013

Chapter 2

Snap-Tite® High-Density Polyethylene (HDPE) Pipe

Introduction

Snap-Tite® HDPE Pipe, sold and distributed by ISCO Industries, Inc., offers a complete package of sales and support to rehabilitate failing culverts throughout the US. Please call 1-800-CULVERT or visit www.culvert-rehab.com for all your culvert lining needs.

Some of the characteristics of Snap-Tite® Solid-wall HDPE Pipe are:

- Economical
- Corrosion Resistant
- Hydraulically Smooth
- Long Design Life
- Tappable
- Chemically Resistant
- Easily Installed
- Small to Large Diameters
- Non-Toxic
- Lightweight
- Reliable
- Flexible
- Mechanically Joined
- Strong and Ductile
- Weather Resistant
- Impact Resistant
- Freeze Resistant
- Durable
- Abrasion Resistant
- Inert
- Listed and Approved

Important Standards for High Density Polyethylene (HDPE) Pipe

Standards important for Snap-Tite® HDPE pipe relate to the resin the pipe is made from and the standards related to manufacturing sizes and tolerances.

ASTM Standards:
ASTM D3350 Standard Specification for Polyethylene Plastics Pipe and Fittings Materials. This standard defines the physical properties of the resin.

ASTM F714 Standard Specification for Polyethylene (PE) Pipe (SDR-PR) Based on Outside Diameter. This standard is used for most large diameter HDPE pipe (6" to 63") Applications.

ASTM D2321 Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications.

ASTM F585 Standard Practice for Insertion of Flexible Polyethylene Pipe into Existing Sewers

ASTM D3212 Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals

Industry Standard for Culvert Relining:
AASHTO M326 Polyethylene (PE) Liner Pipe, 300-to1600-mm Diameter, Based on Controlled Outside Diameter

Specifications for HDPE Pipe

Polyethylene piping systems are defined or specified using two important criteria: the ASTM D3350 cell classification and the ASTM F412 thermoplastic piping material designation code. The ASTM D3350 consists of a series of six digits followed by one letter. The six digits equate to the specified level of performance required in six separate physical properties defined within the standard. The final letter specifies the color or UV-resistance requirement. Taken together the D3350 cell classification establishes a minimum range of technical performance for the PE compound used to produce the pipe.

The F412 thermoplastic piping material designation code further defines the performance requirement of the pipe produced from a particular PE compound. This code consists of an abbreviation for the basic material as defined within the ASTM standards. The standardized abbreviation for polyethylene is the term “PE”. This basic polymer designation is then followed by a series of four digits. The first two digits relate directly to specific physical properties for the compound as defined within ASTM D3350. The last two digits are the long-term hydrostatic stress rating as recommended by the Hydrostatic Stress Board of the Plastic Pipe Institute in hundreds of psi. The long-term hydrostatic stress rating is the hydrostatic design basis (HDB) multiplied by the appropriate design factor (DF).

So the thermoplastic piping material designation code follows the form below.

PEXYZZ, the format of the thermoplastic material designation code for PE pipe

Where:
PE indicates polyethylene

X is the characteristic density range for the compound used to make the pipe as defined within ASTM D3350

Y is the characteristic slow crack growth resistance range for the compound used to make the pipe as defined within ASTM D3350

ZZ is the long-term hydrostatic stress at 23^{O} F, expressed in hundreds of psi

Historically, the market for PE pipe was dominated by essentially two primary thermoplastic material designation codes. These were PE2406 and PE3408. In 2005, changes were made to ASTM D3350 to allow for the identification and integration of much higher levels of technical performance in PE piping materials within the North American standards system. This resulted in a temporary proliferation of PE thermoplastic piping material designation codes. Today, we still have a fairly broad selection of material designation codes for PE piping systems throughout the marketplace. However, for all practical purposes, the market for PE pipe is characterized by the three common thermoplastics materials designation codes.

PE2708 – This piping product is produced from a medium density compound as defined in the current version of D3350 and is widely used in natural gas distribution and some specialty applications

PE3608 - This piping product is the legacy product resulting from the old PE3408 thermoplastic piping material designation code that was so widely specified and used prior to 2005. It is not uncommon today to see these piping products dual labeled PE3408/PE3608.

PE4710 - This piping product designation represents the culmination of years of technical research on polymer performance in PE piping and offers the designer or end-user exceptional levels of pipe system performance. For example, the PE4710 piping products support a higher long-term hydrostatic stress rating making the pressure rating for a given wall thickness of pipe 25% higher than a comparable PE3608 piping product. By the same token, these piping products exhibit a significantly higher resistance to slow crack growth. Given the exceedingly high technical performance of the PE4710 piping products, it is no surprise that they meet or exceed all of the technical requirements of the PE3408 or PE3608 piping products. For this reason it is not uncommon to see these piping products dual labeled as PE3408/PE4710 or even triple labeled as PE3408/PE3608/PE4710.

Table 2-1 provides a summary of the different ASTM D3350 cell classifications for each of these materials based on these three primary thermoplastic piping material designation codes.

Table 2-1
Typical Cell Classification
by Current Thermoplastic Piping Material Designation Code

Physical Property	ASTM Test Method	Units	PE2708		PE3608		PE4710	
			Cell Number	Typical Value	Cell Number	Typical Value	Cell Number	Typical Value
Density	D 1505	GR/CM^3	2	>0.925-0.940	3	>0.940-0.947	4	>0.947-0.955
Melt Index	D 1238	GR/10 MIN	3	<0.4-0.15	4	<0.15	4	<0.15
Flexural Modulus	D 790	PSI	3	40,000 -<80,000	5	110,000 - <180,000	5	110,000 - <180,000
Tensile Strength	D 638	PSI	3	2600 - <3000	4	3000 - <3500	4	3000 – < 3500
Resistance to Slow Crack Growth	D 1479	HOURS	7	500 Minimum	6	100 Minimum	7	500 Minimum
Hydrostatic Design Basis, HDB	D 2387	PSI	3	1250	4	1600	4	1600
UV Stabilizer	D 1603	%	E	Colored with UV Stabilizer	C	2% Min Carbon Black	C	2% Min Carbon Black

Notes:

1. *The density provided is base resin density (without the influence of carbon black). Typical PE4710 HDPE pipe has a density of 0.956 to 0.964 with carbon black.*
2. *To be designated a PE4710, the pipe resin must meet certain supplementary requirements established by the Hydrostatic Stress Board (HSB) of the Plastics Pipe Institute (PPI).*

Table 2-2 below provides a simplification of Table 2-1 and illustrates the relative ease with which PE piping products may be specified. Using this approach allows the designer or specifier to accurately designate the appropriate PE piping product through the use of a single thermoplastic piping material designation code and a relatively simple text string that establishes the physical property requirements for seven key performance properties.

Table 2-2
Representative Minimum Cell Classification
by Thermoplastic Piping Material Designation Code

Thermoplastic Piping Material Designation Code	Minimum Cell Classification Per ASTM D3350
PE2708	233373E
PE3608	345464C
PE4710	445474C

It should be noted that other PE thermoplastics piping material designation codes do exist and may be encountered in the different markets. However, the three primary PE thermoplastic piping material designations codes of Tables 2-1 and 2-2 represent the principle PE piping products in the market today. For the culvert lining market, HDPE resins with a PE3608 or PE4710 are commonly used for solid-wall piping systems.

The selected thermoplastic piping material designation code and minimum cell classification is then combined with the appropriate production and installation standards to effectively specify a tough, durable PE piping system. A model specification is available in Chapter 13 and available at culvert-rehab.com or by contacting your local Snap-Tite® representative.

Chapter 3
Hydraulics

Table 3-1
Comparative Flow Rates for Corrugated Metal Pipe (CMP) lined with Snap-Tite®
Based on Manning's equation n=.00914 for Snap-Tite®, n=.024 for CMP, s=.001 ft/ft

CMP			Snap-Tite®				% of Flow Relined
Culvert Size ID (in)	Flow (gpm)	Flow (cfs)	Outside Dia. (in)	DR 32.5 Av. ID (in)	Flow (gpm)	Flow (cfs)	
12	274	0.6	10.75	10.05	448	1.0	164%
15	497	1.1	12.75	11.92	706	1.6	142%
18	808	1.8	14	13.09	906	2.0	112%
18	808	1.8	16	14.96	1294	2.9	160%
21	1218	2.7	16	14.96	1294	2.9	106%
21	1218	2.7	18	16.83	1771	3.9	145%
24	1739	3.9	18	16.83	1771	3.9	102%
24	1739	3.9	20	18.70	2346	5.2	135%
24	1739	3.9	22	20.56	3025	6.7	174%
27	2381	5.3	22	20.56	3025	6.7	127%
27	2381	5.3	24	22.43	3815	8.5	160%
30	3153	7.0	24	22.43	3815	8.5	121%
30	3153	7.0	28	26.17	5755	12.8	182%
36	5128	11.4	28	26.17	5755	12.8	112%
36	5128	11.4	30	28.04	6917	15.4	135%
36	5128	11.4	32	29.91	8216	18.3	160%
42	7735	17.2	34	31.78	9658	21.5	125%
42	7735	17.2	36	33.65	11248	25.1	145%
48	11043	24.6	36	33.65	11248	25.1	102%
48	11043	24.6	42	39.26	16967	37.8	154%
54	15118	33.7	42	39.26	16967	37.8	112%
54	15118	33.7	48	44.87	24224	54.0	160%
60	20023	44.6	48	44.87	24224	54.0	121%
60	20023	44.6	54	50.48	33163	73.9	166%
66	25817	57.5	54	50.48	33163	73.9	128%
72	32559	72.5	63	58.89	50024	111.5	154%
84	49114	109.4	63	58.89	50024	111.5	102%

Table 3-2
Comparative Flow Rates for Concrete Pipe lined with Snap-Tite®
Based on Manning's equation n=.00914 for Snap-Tite®, n=.015 for Concrete, s=.001 ft/ft

Concrete			Snap-Tite®				% of Flow Relined
Culvert Size ID (in)	Flow (gpm)	Flow (cfs)	Outside Dia. (in)	DR 32.5 Av. ID (in)	Flow (gpm)	Flow (cfs)	
12	438	1.0	10.75	10.05	448	1.0	102%
15	795	1.8	12.75	11.92	706	1.6	89%
18	1292	2.9	14	13.09	906	2.0	70%
18	1292	2.9	16	14.96	1294	2.9	100%
21	1949	4.3	16	14.96	1294	2.9	66%
21	1949	4.3	18	16.83	1771	3.9	91%
24	2783	6.2	18	16.83	1771	3.9	64%
24	2783	6.2	20	18.70	2346	5.2	84%
24	2783	6.2	22	20.56	3025	6.7	109%
27	3810	8.5	22	20.56	3025	6.7	79%
27	3810	8.5	24	22.43	3815	8.5	100%
30	5045	11.2	24	22.43	3815	8.5	76%
30	5045	11.2	28	26.17	5755	12.8	114%
36	8204	18.3	28	26.17	5755	12.8	70%
36	8204	18.3	30	28.04	6917	15.4	84%
36	8204	18.3	32	29.91	8216	18.3	100%
42	12376	27.6	32	29.91	8216	18.3	66%
42	12376	27.6	34	31.78	9658	21.5	78%
42	12376	27.6	36	33.65	11248	25.1	91%
48	17669	39.4	42	39.26	16967	37.8	96%
54	24190	53.9	42	39.26	16967	37.8	70%
54	24190	53.9	48	44.87	24224	54.0	100%
60	32037	71.4	48	44.87	24224	54.0	76%
60	32037	71.4	54	50.48	33163	73.9	104%
66	41307	92.0	54	50.48	33163	73.9	80%
66	41307	92.0	63	58.89	50024	111.5	121%
72	52095	116.1	63	58.89	50024	111.5	96%
84	78582	175.1	63	58.89	50024	111.5	64%

Chapter 5
Ease of Installation

People

Highway departments can use their own crews to install Snap-Tite®- no special training is necessary. Using minimal equipment, a team of four can easily rehabilitate a culvert. Purchase the Snap-Tite® Culvert Lining Systems today, keep it in your yard until you have some down time and install it that day. What would be lost payroll time becomes a money-saving project.

Product

Snap-Tite® Culvert liner is a tough, flexible liner made from solid-wall HDPE pipe. The ends are machined to make a mechanical connection which provides tensile and compression strength.

Equipment

Snap-Tite® is so easy to install that most jobs can be completed with a backhoe, shovels, two come-a-longs, and chains. If a culvert requires cleaning, a water truck or jet cleaner may be needed.

Chains and come-a-longs are part of the equipment needed to install Snap-Tite® Culvert Liner. Standard chain come-a-longs are available with load ratings of 1,000 to 5,000 lbs. of force. Verify the amount of force that the come-a-longs are capable of applying before using them. For safety reasons, the chains normally are able to handle twice the load applied by each come-a-long.

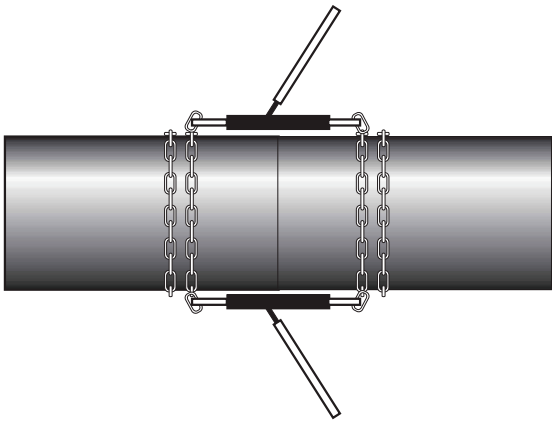
Chains are sold based on working load. The working load is the normal rating for typical lifting applications. The strength at failure is usually four times the working load. When a chain is wrapped around a Snap-Tite® liner and tightened with a chain binder, it is under tensile loading.

After a come-a-long is attached to a chain link, the link is subject to cross loading. A cross load occurs because the chain must wrap around the pipe to transfer the forces. As the cross load is increased, the angle of the chain around the liner changes. See drawing 1.

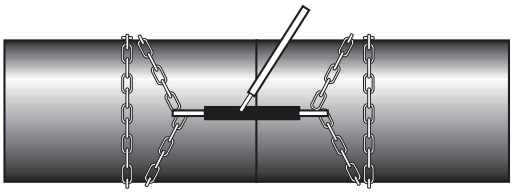
Chain manufacturers reduce the working load by 25% for cross loading. A chain with a standard rating of 6,000 lbs. is only rated for 4,500 lbs. in this application. If you have determined that you need 6,000 lbs. working load on the chain for a Snap-Tite® Installation, then an 8,000 lbs. working load rated chain is needed.

Full load is applied when the male and female joints come together straight on and part of the flat surface on both sides “catches.” The best joining procedure is to watch the joining process and make corrections based on observations. When pipe movement requires more force than expected, look for a reason. If the joints do “catch,” rotation of the two liner sections or alignment with a pry bar may solve the problem.

Drawing 1: Chain Wrap Position



Position of chain before load – Top View



Chain under load – Side View

If the male end is at a slight angle to the female and partially inserted, lower force is required to make the joints mate. Apply force from one come-a-long until liner bends slightly. Apply force slowly, this allows the female joint to expand. Be cautious when tightening a chain or cable!

Joining forces changes with temperature, type of lubrication, male-female joint alignment, presence of debris, slope and time. Forces are estimated for slow application of force with flat slope and lubricated joint. A slow application of force allows materials to stretch. Fast joining requires more force and energy because material does not immediately increase in size. More force will be required below 73 degrees Fahrenheit. Forces are estimated only!

Table 5-1
Estimated Force to Join Snap-Tite® Liner

Liner Size OD (Inches)	Weight per foot (lbs.)	Weight of 24 feet (lbs.)	Estimated Joining Force (lbs.)	Total Force (lbs.)	Min. Load Rating for Each Come-along
10.75	4.75	114	500	614	1,000 lb.
12.75	6.67	160	1,000	1,160	1,000 lb.
14	8.05	193	1,000	1,193	1,000 lb.
16	10.50	252	1,000	1,252	1,000 lb.
18	13.30	319	1,000	1,319	1,000 lb.
20	20.34	488	1,000	1,419	1,000 lb.
22	19.86	477	1,000	1,477	1,000 lb.
24	23.62	566	1,500	2,066	2,000 lb.
28	32.19	773	1,500	2,273	2,000 lb.
30	36.93	886	1,500	2,386	2,000 lb.
32	42.04	1,009	2,000	3,009	3,000 lb.
36	53.20	1,255	2,000	3,255	3,000 lb.
39.37	63.69	1,529	3,000	4,529	3,000 lb.
42	72.37	1,737	3,000	4,737	3,000 lb.
48	94.96	2,279	3,000	5,279	3,000 lb.
54	119.7	2,873	3,000	5,873	3,000 lb.
63	162.98	3,912	4,000	7,912	4,000 lb.

Chapter 13
Specifications

Material Requirement

These specifications cover the purchase of high density polyethylene (HDPE) pipe liners for lining existing culvert pipes. Pipe liners furnished to this specification shall meet or exceed all requirements.

Bidders are cautioned to read the specifications carefully, as there may be special requirements not commonly offered by the pipe liner manufacturer.

Pipe liner shall meet the following requirements and conform to the reference specifications:

The liner pipe shall be made of high density polyethylene resins in accordance with the requirements of ASTM D3350. The Cell Classification will be a minimum 345464C and shall have the Plastic Pipe Institute designation of PE3608.

Pipe liner shall be a Dimension Ratio (DR) of 32.5. The installed pipe shall have a smooth, non-corrugated interior and exterior surface.

The liner shall be capable of being joined into a continuous length by an interlocking method. The joints shall not create an increase in the outside diameter of the liner pipe to eliminate any coupling difficulties. The joints must be water-tight with gaskets that are capable of handling pressures up to 25 feet of head per ASTM D3212. Each HDPE shall have a male and a female end. The supplier shall furnish a manufacturer's certification stating that the material in the pipe meets the requirements of ASTM D3350 with a minimum cell classification of PE345464 C with the physical properties indicated above.

The supplier shall certify the dimensions meet the requirements of ASTM F714.

Before inserting the liner pipe, the existing pipe must be cleaned if needed. All debris or other materials must be removed from the host pipe.

After the liner is in place, the area between the original pipe and the liner shall be completely filled with low density flowable fill or cellular grout.

SAMPLE SPECIFICATION

Sample Specifications for Snap-Tite® Culvert Liners

This Specification is available at www.culvert-rehab.com in a downloadable word format form for this format and CSI format. A grout specification is also available at www.culvert-rehab.com in a downloadable CSI word format.

1. **Description** — This Item shall govern for furnishing, installing, grouting and providing all labor, material and equipment necessary to rehabilitate existing culvert pipe by sliplining an existing culvert pipe with high density polyethylene (HDPE) pipe. The pipes shall be sizes, types, designs and dimensions shown on the plans and shall include all connections, joints and other appurtenances as required to complete the work.
   The sliplining process will require the contractor to completely grout the annular void between the host and insert pipe. The grouting process shall be considered subsidiary to this item.

2. **Materials** — Unless otherwise specified on the plans or herein, culvert pipe renewal shall conform to the following:
   Snap-Tite® Culvert Liner as provided by ISCO Industries or approved equal.

   A. **Liner Material – High Density Polyethylene (HDPE) Pipe**

      1. High density polyethylene pipe and fittings shall meet the requirements in the AASHTO M326-08 Specification.
      2. Raw Materials. The pipes and the fittings shall be manufactured from PE resin compounds, which have a minimum cell class 345464C as defined and described in ASTM D3350.
      3. HDPE Resin Specifications.

Property	Specifications	Unit	Nominal Value
Material Designation	**PPI/ASTM**		**PE3408/PE3608**
Cell Classification	ASTM D3350		345464C
1. Density (3)	ASTM D1505	Gm/cm^3	0.955
2. Melt Index (4)	ASTM D1238	gm/10 min.	0.11
3. Flexural Modulus (5)	ASTM D790	psi	135,000
4. Tensile Strength (4)	ASTM D638	psi	3,200
5. Slow Crack Growth			
a. ESCR	ASTM D1693	hours in 100% igepal	>5,000
b. PENT (6)	ASTM F1473	hours	>100
6. HDB @ 73 deg. F (4)	ASTM D2837	psi	1,600
7. UV Stabilizer (C)	ASTM D1603	%C	2.5%

   B. **Designation of Type**

      1. The HDPE pipes used for liners in gravity flow culverts shall be solid-wall construction with mechanical end connectors, male and female, consisting of 2 machined-groove landing points, to prevent the pipe from pulling apart during installation.
      2. Individual liner section lengths shall be a minimum of 6 ft. but shall not exceed 50 ft. unless pre-approved.

C. Pipe joints shall comply with ASTM D3212 Standard Specification for joint tightness.

1. Extrusion welded joints shall not be allowed to join the liner pipe together to keep grout from leaking out during the grouting stage.
2. Neoprene Cement shall not be allowed to create a seal at the joint to prevent grout from leaking out during the grouting stage.

D. Hydraulic flow characteristics for the liner pipe shall provide a Manning's coefficient of n = 0.00914. Pipe Manufacturer shall submit 3rd party test data verifying the Manning's coefficient has been achieved.

E. Liner Pipe material must be pre-approved by the governing state agency's materials testing department before bid and have a minimum of 1,000' of said liner installed in said state.

F. Oval Pipe

1. The liner shall be furnished in an oval shape to match the existing CMP elliptical pipe, with horizontal and vertical wood struts inserted through the liner by the manufacturer before delivery to the jobsite, as to keep the liner in an oval shape before grouting into place. After the liner has been grouted fully in place, the struts shall be removed. The Contractor is responsible for ascertaining actual measurements prior to ordering the liner.

G. Other pipe liners that do not meet this specification must be submitted for approval prior to bid date.

H. Liner Pipe must be manufactured in the United States under the 'Buy American Products' program

I. Grouting Material – Contractor shall utilize material specifications for solidification of the annular void between host and the inserted liner with low-density flowable fill or cellular grout. The cellular grout with a density between 40 and 80 lbs. per cubic foot may be used. Reduced-density flowable fill grout with a density between 100 and 120 lbs. per cubic foot may be used.

J. End Treatment – The upstream/inlet end of the new liner pipe shall be fitted with a flow enhancement device to reduce inlet control effects. The device shall be HDPE material, same as the liner pipe, and have a connector included for connection to the liner pipe. The opening at the end of the device shall be larger than the ID of the host pipe. 3rd Party Test data shall be provided to show improvement of flow by at least 30% at 2 feet of headwater depth or an entrance loss coefficient (K) of approximately 0.2 for outlet control conditions. The device shall be the Hydro-Bell or approved equal.

3. Cleaning — The existing culvert pipe shall be cleaned by whatever means necessary to remove all obstructions which may be encountered that would prevent insertion of the pipe liner into the host pipe as approved by the engineer. This work will not be paid for directly, but shall be considered subsidiary to this item.

4. Construction

A. Installation

a. Contractor must be pre-approved by the pipe manufacturer and a letter of this pre-approval must be submitted from the manufacturer to the contractor at the time of bid.
b. Contractor personnel shall have a minimum of 5,000' of slipline material installation experience and submit three previous slipline project references similar in size and scope of bid in writing.

c. Manufacturer's Rep must be on site at critical stages of the liner installation and grouting application.

B. Liner Pipe – Liner pipe shall be inserted and installed in accordance with manufacturer's recommendations. Grade of liner pipe shall be maintained parallel to grade of host pipe.

C. Grouting

a. Upon completion or partial completion of the sliplining process, grouting will be required to be placed in the annular void between the insertion pipe and the host pipe. Cellular grout with a density between 40 and 80 lbs. per cubic foot may be used. Reduced-density flowable fill grout with a density between 80 and 120 lbs. per cubic foot may be used. Project engineer shall state density of grout to be used on drawings or in specifications.
b. A detailed plan on holding the liner pipe on the invert of the host pipe shall be submitted to the engineer for approval.
c. The annular void shall be completely grout filled without deflecting the insertion pipe greater than 1.5 percent.
d. The contractor shall provide end seals at the open points of each run of pipe to be grouted.
e. Penetration of the host pipe shall be permitted for host pipe constructed with Corrugated Metal Pipe (CMP) to facilitate grouting of the annular void. Multiple fill pipes will be required.
f. The annular void shall be grouted solid by injecting grout from one end of the pipe run and allowing it to flow toward the other end. Venting of the annular void shall be performed to assure uniform filling of the void space during the grouting process.
g. An open-ended, high-point tap or equivalent vent must be provided and monitored at the bulkhead opposite to the point of grouting.
h. Pressure on the annular void shall not exceed 2 PSI to avoid damage to the liner pipe. Regardless of the pressure, the contractor shall be solely responsible for any damage or distortion to the insertion pipe due to the grouting process.
i. The grout shall be made using the preformed foam process using foam-generating equipment calibrated daily by the foam manufacturer to produce a precise and predictable volume of foam. The foam concentrate shall be certified by the customer to have specific liquid/foam expansion ratio at a constant dilution ratio with water.
j. The specific job mix shall be submitted to the customer by either the foam concentrate supplier or the certified /licensed contractor for approval prior to use on this project. The mix shall have a minimum 28 day compressive strength of 300 psi.
k. Grout mixed off-site shall be delivered to the jobsite in a truck mixer filled to half its capacity. The foam concentrate shall then be added to the cement mix in the truck and mixed to a uniform consistency and pumped into the annular space.
l. Contractor must have a written erosion control plan with a method for waste grout recovery submitted to county with attached bid proposal.
m. Customer will verify that post-construction conditions are acceptable after installation and ensure that proper seeding and general cleanup has been completed.

D. Pipe Stockpiling and Handling – Pipe and fittings shall be stockpiled in a safe manner at each contractor staging area or pit location. The stockpiling shall be arranged to cause a minimum of interference to pedestrian and stored outside the safety clear zone of vehicular traffic. When handling sliplining pipe, the contractor shall take all precautions necessary to avoid damaging the pipe. For pipe with cuts greater than 10% of the wall thickness, repair or replacement will be at the entire expense of the contractor.

5. **Clean-up and Restoration** — Upon acceptance of the installation work and testing, the contractor shall clean-up and restore the project area affected by operations as approved by the engineer.

6. **Measurement** — This item shall be measured by the foot. Such measurement shall be made along the flowline of the liner pipe, complete in place.

   For multiple culverts to be lined, the measurement length shall be the sum of the lengths of each barrel, measured as prescribed above.

   The accepted quantities of pipe liner will be paid for at the contract unit price per linear foot for the size of the existing pipe in which the liner is installed, complete in place.

7. **Payment** — The work performed and the materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for as the unit bid for “Sliplining Culvert Pipe” of the type, design (if required), and size specified. This price shall be full compensation for cleaning existing pipe; for furnishing, hauling, installing liner pipe and placing grout; for all connections; and for all labor, tools equipment, materials, clean-up and incidentals.