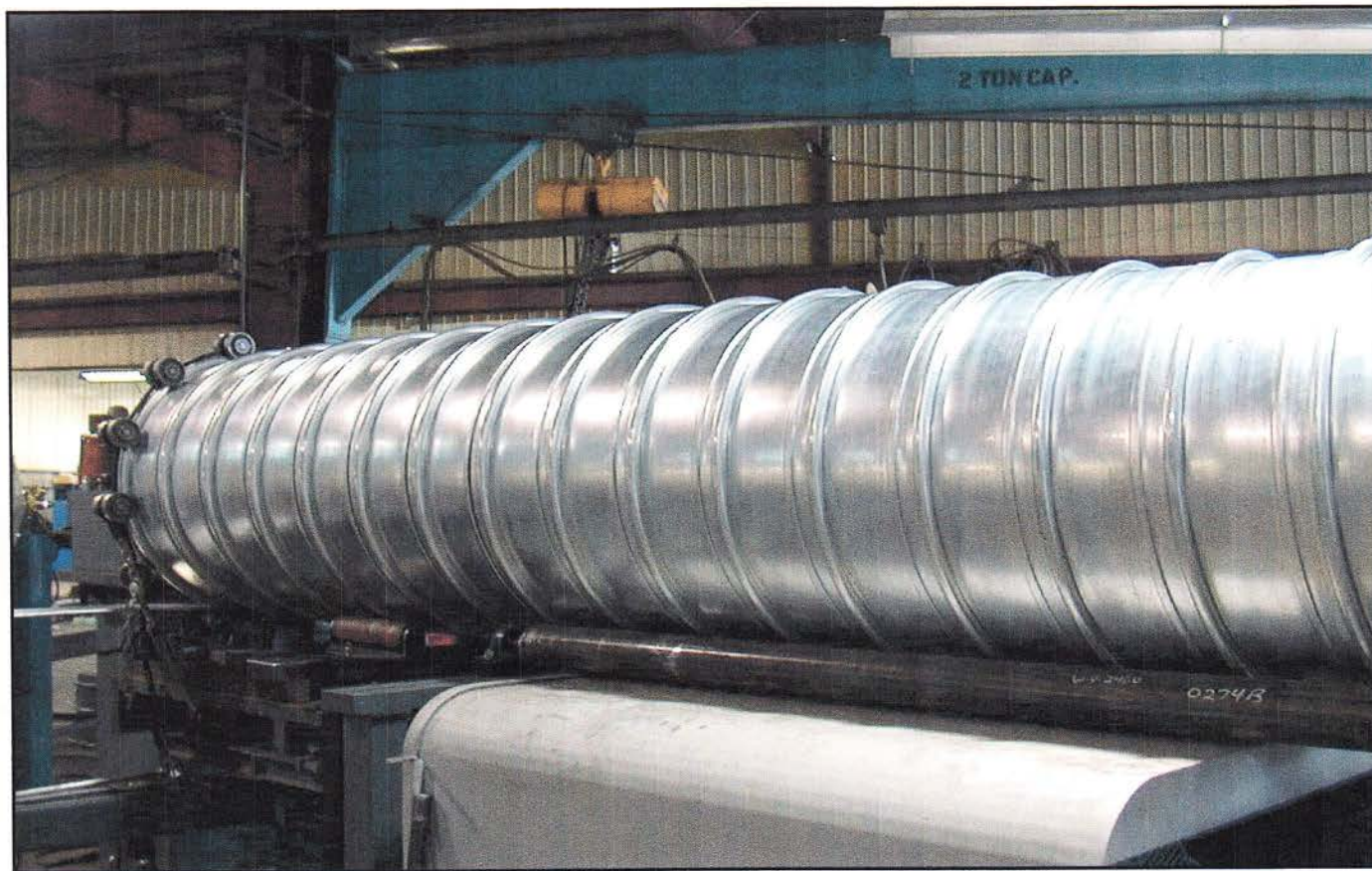


Cherokee Culvert Company

MACON, GEORGIA

HYDRA-COR

Meeting The Demands of Today's Complex Drainage Issues



- *Superior Hydraulics "n" = .012*
- *Unprecedented Structural Integrity*
- *Diameter Range From 15" to 120"*
- *Wall Thickness Available From 18 Gauge to 8 Gauge*
- *Various Production Materials to Meet Demanding Site Conditions*
- *Complete Assortment of Fabricated Structures*
- *Approved By The Georgia Department of Transportation*

In a continuing effort to address the ever changing demands of storm drain designers, Cherokee Culvert Company is pleased to introduce a pipe material which we feel will satisfy even the most stringent of industry requirements. **Hydra-Cor** is the result of over two years of research to determine how the properties necessary for a storm sewer to function both efficiently and cost-effectively could be achieved in a single piping material. Incorporating durability, versatility, structural soundness, hydraulic efficiency, and affordability into a conduit had yet to be accomplished. However, new **Hydra-Cor** raises the bar on culvert pipe expectations by offering all of these advantages and more.

COMPLETE PERFORMANCE

We have made a concerted effort to satisfy all of the criteria necessary for a successful performance of a culvert material. While competing materials promote their corrosion resistance and hydraulic benefits, they fail to satisfy the issue of structural integrity necessary to allow the system to function as intended. Excessive distortions of these materials not only alter the hydraulics for which it was designed, but can lead to the structural failure of the pipe. **Hydra-Cor** is specifically designed to maximize structural integrity and is available in a variety of production materials to easily exceed service life design requirements.

NEW DIMENSIONS IN CORRUGATED PIPE DESIGN

Hydra-Cor is not to be confused with spiral rib pipe products. It is a single, "horseshoe" shaped corrugated pipe which has been designed to maximize rigidity to help prevent excessive distortions in the line due to inadequate backfill procedures or superimposed loadings. Sectional properties, derived by Dr. Reynold K. Watkins at Utah State University, include inertia moments twice that of spiral rib pipe. Dr. Watkins had also formulated the sectional properties of spiral rib pipe in 1983, and his expertise was important in order to make a direct comparison between materials. The inertia moment of the section is a critical component in deriving the flexural stiffness of a given pipe material. Adequate flexural stiffness warrants that the material can stand up to the normal abuses associated with handling, installation, and backfill without special bracing or other excessive care by the installer. Theoretically, spiral rib pipe is required to be two culvert gages heavier to equal the flexural stiffness of **Hydra-Cor**.

Flexural Stiffness Comparison Hydra-Cor (16 gage) vs. Spiral Rib (12 Gage)

Pipe Material: Steel	Flexibility Factor (FF)
Hydra-Cor - 36" diameter 16 gage (.064")	.0061
Spiral Rib - 36" diameter 12 gage (.109")	.0060

Formulas utilize the sectional properties of spiral rib pipe profile .75"x.75"x7.5" as outlined in AISI. **Hydra-Cor** sectional properties refer to the .90"x1.0"x9.0" profile.

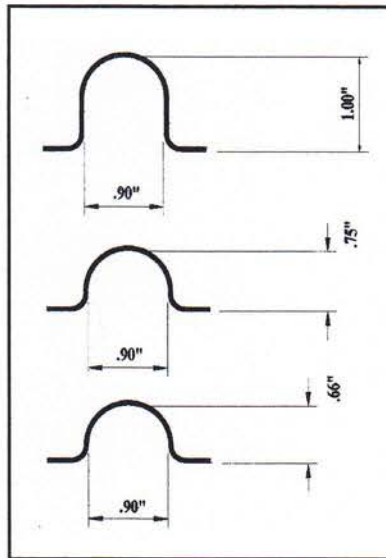
This superior structural integrity aids in proper pipe alignment and shape and ensures that the storm line function hydraulically as designed. No special backfilling procedures are required for **Hydra-Cor** as with other overly flexible conduits. Installers will find that only normal installation procedures, such as those associated with the corrugated metal pipe industry, are more than sufficient for a successful project.

The sectional properties of **Hydra-Cor** were derived under contract between Cherokee Culvert Company, Inc., and Dr. Reynold K. Watkins. His results are the property of Cherokee Culvert Company and may not be released to any third party without written permission from an authorized agent of said company.

A FULL RANGE OF WALL THICKNESSES

Because of its unique configuration and manufacturing process, *Hydra-Cor* is able to be produced in all culvert gages offered in the metal pipe industry. Piping materials such as high density polyethylene have very little control when it comes to strengthening their product. Even metal pipe products such as spiral rib pipe, due to harsh manufacturing processes, are restricted as to the wall thickness that can be utilized. This means that many diameters of spiral rib require special backfill conditions to gain structural integrity. Field observations in which the success of the installation is dependent on excessive contractor care shows that this is not a realistic approach. *Hydra-Cor* can be specified in a wall thickness ranging from 18 gage (.052") to 8 gage (.168"). This allows the designer to build in the strength he feels necessary for each application.

Hydra-Cor is offered in three profiles to address various structural requirements. While the 1" deep profile is utilized for most applications, other depths, as illustrated, may be used for situations such as small diameter, sliplining, and factory arched pipe.



Availabilities:
24" - 120" Steel
24" - 120" Aluminum

Availabilities:
18" - 102" Steel
18" - 72" Aluminum

Availabilities:
15" - 66" Steel
15" - 36" Aluminum



SUBSTANTIALLY IMPROVED HYDRAULIC EFFICIENCY "n" = .012

Corrugated metal pipe has been used successfully for over one hundred years. One of its few shortcomings has been its hydraulic capacity versus a smooth interior culvert material. This difference in roughness coefficients requires larger diameters of corrugated metal pipe to perform the same hydraulic function as smaller diameters of rigid pipes. *Hydra-Cor* has been designed to provide a hydraulically smooth interior and therefore can be included in hydraulic designs based on rigid pipe coefficients. The structural supporting members of *Hydra-Cor* project to the outside of the pipe wall causing minimal disruption of flow through the pipe. Full scale hydraulic testing was performed on 240' of 30" diameter *Hydra-Cor* at the Water Research Laboratory at Utah State University in June of 2002. The pipe was manufactured from *Durazinc* (4 oz./ft.²), representing, because in increased zinc coating, the roughest steel surface of our various production materials. Test results indicated a Manning's "n" of .011 at ten separate flow velocities. As a matter of good design, we recommend the use of a Manning's "n" of .012. This represents a roughness coefficient improvement of over 50% versus some diameters of corrugated metal pipe. A summary of this test can be provided upon request.

GALVANIZED OR ALUMINIZED STEEL HYDRA-COR

Pipe Dia.	Maximum Cover						Minimum Cover					
	18 Gage (.052") {1}	16 Gage (.064")	14 Gage (.079")	12 Gage (.109")	10 Gage (.138")	8 Gage (.168")	HS-20 Veh. / Const. Veh.					
							18	16	14	12	10	8
15"	24	42	48				1.0/2.0	1.0/2.0	1.0/2.0			
18"	33	52	64	87			1.0/2.0	1.0/2.0	1.0/2.0	1.0/2.0		
21"	24	38	46	63			1.0/2.0	1.0/2.0	1.0/2.0	1.0/2.0		
24"	26	49	60	82			1.1/2.0	1.0/2.0	1.0/2.0	1.0/2.0		
27"	21	38	46	63			1.1/2.2	1.0/2.0	1.0/2.0	1.0/2.0		
30"	18	31	38	52	65		1.2/2.4	1.1/2.0	1.0/2.0	1.0/2.0	1.0/2.0	
36"	14	23	28	38	48		1.4/2.8	1.3/2.4	1.2/2.3	1.0/2.0	1.0/2.0	
42"		20	24	32	40			1.5/3.0	1.3/3.0	1.1/3.0	1.0/3.0	
48"		18	22	30	38	46		1.7/3.2	1.5/3.0	1.2/3.0	1.1/3.0	1.0/3.0
54"		16	19	26	32	39		1.9/3.6	1.7/3.4	1.4/3.0	1.3/3.0	1.1/3.0
60"		15	18	25	31	37		2.1/4.3	1.9/3.8	1.5/3.0	1.3/3.0	1.2/3.0
66"		15	18	24	30	36		2.6/4.9	2.1/4.2	1.7/3.3	1.5/3.0	1.3/3.0
72"			17	23	29	35			2.3/4.5	1.8/3.6	1.6/3.0	1.4/3.0
78"			15	20	25	30			2.5/4.8	2.0/3.9	1.7/3.3	1.6/3.1
84"				18	23	28				2.2/4.3	1.9/3.5	1.8/3.3
90"				17	21	25				2.4/4.7	2.1/4.1	2.0/3.9
96"				15	19	23				2.6/5.1	2.3/4.5	2.2/4.3
102"					18	22					2.5/4.9	2.4/4.7
108"					17	20					2.8/5.3	2.7/5.1
114"					16	19					3.1/5.5	3.0/5.2
120"					15	18					3.3/5.7	3.3/5.5

{1} - Polymer precoated galvanized steel is recommended for this gage

Construction Notes:

Maximum cover design has been calculated on an 85% compaction density to allow for variables with installation techniques. Where greater densities are sure to be achieved, maximum cover limits will be increased. As a matter of good design, specified compaction density should be a minimum of 90% per AASHTO T99.

Minimum cover requirements assume compaction of cover material to the same specified density as the soil envelope around the pipe. This minimum cover should be maintained during the construction phase. Where rutting is possible, due to wet or sandy conditions, additional cover should be utilized.

Construction vehicle loading is based on an axle load of 120,000 pounds. Vehicles with smaller axle load may have minimum cover adjusted accordingly

HS-20 Vehicles have a maximum axle load of 32,000 pounds.

Unless specified, *Hydra-Cor* can be supplied in the following profiles. All material will meet or exceed the flexural stiffness requirements as set forth in ASTM A796.

- .66" x .90" x 9.68"
- .75" x .90" x 9.50"
- 1.0" x .90" x 9.00"

ALCLAD ALUMINUM HYDRA - COR

Alclad 3004-H34

Pipe Dia.	Maximum Cover					Minimum Cover				
	16 Gage	14 Gage	12 Gage	10 Gage	8 Gage	HS-20 Veh. / Const. Veh.				
	(.060")	(.075")	(.105")	(.135")	(.164")	16	14	12	10	8
15"	23	28				1.0/2.0	1.0/2.0			
18"	27	33	46			1.0/2.0	1.0/2.0	1.0/2.0		
21"	22	27	37			1.0/2.0	1.0/2.0	1.0/2.0		
24"	25	31	43			1.1/2.0	1.0/2.0	1.0/2.0		
27"	22	27	37			1.1/2.0	1.2/2.0	1.0/2.0		
30"	20	25	35	44		1.1/2.0	1.0/2.0	1.0/2.0	1.0/2.0	
36"	17	21	29	37		1.3/2.4	1.2/2.3	1.0/2.0	1.0/2.0	
42"	15	18	25	32		1.5/3.0	1.3/3.0	1.1/3.0	1.0/3.0	
48"	14	17	23	29	35	1.7/3.2	1.5/3.0	1.2/3.0	1.1/3.0	1.0/3.0
54"		15	21	26	31		1.7/3.4	1.4/3.0	1.3/3.0	1.1/3.0
60"		17	19	24	29			1.5/3.0	1.3/3.0	1.2/3.0
66"		15	17	22	26			1.7/3.3	1.5/3.0	1.3/3.0
72"			15	19	23			1.8/3.6	1.6/3.0	1.4/3.0
78"				17	20				1.7/3.3	1.6/3.1
84"				15	18				1.9/3.5	1.8/3.3
90"					18					2.0/3.9
96"					17					2.2/4.3
102"					17					2.4/4.7
108"					16					2.7/5.1
114"					15					3.0/5.2
120"					15					3.3/5.5

Construction Notes:

Maximum cover design has been calculated on an 85% compaction density to allow for variables with installation techniques. Where greater densities are sure to be achieved, maximum cover limits will be increased. As a matter of good design, specified compaction density should be a minimum of 90% per AASHTO T99.

Minimum cover requirements assume compaction of cover material to the same specified density as the soil envelope around the pipe. This minimum cover should be maintained during the construction phase. Where rutting is possible, due to wet or sandy conditions, additional cover should be utilized.

Construction vehicle loading is based on an axle load of 120,000 pounds. Vehicles with smaller axle load may have minimum cover adjusted accordingly

HS-20 Vehicles have a maximum axle load of 32,000 pounds.

Unless specified, *Hydra-Cor* can will be supplied in one of the following profiles. All material will meet or exceed the flexural stiffness requirements as set forth in ASTM B790.

- .66" x .90" x 9.68"
- .75" x .90" x 9.50"
- 1.0" x .90" x 9.00"

A VALUE ENGINEERED DESIGN

Hydra-Cor, though different in design, maintains all of the advantages of corrugated metal pipe. Its light weight, combined with long lengths and structural soundness, aids in faster, more efficient installations. Because the outside diameter of **Hydra-Cor** is smaller than concrete or plastic pipe, there is a reduction in excavation required for the material. Also, smaller receiving structures can be utilized in some cases, further adding to the overall installation savings.

For the optimum efficiency in a storm sewer system, Cherokee Culvert Company offers a fully prefabricated metal pipe system. Constructing the designed curb inlets, junction boxes, manholes, elbows, wyes, tees, and laterals out of corrugated metal pipe reduces friction losses associated with the use of precast or built in place structures. Materials are fabricated at our plant per the designer's requirements and shipped to the jobsite ready for installation. Our system requires no time consuming procedures such as placing heavy precast structures, grouting the pipes into the orifices, and allowing proper curing time before backfill. Fittings simply band into place using standard culvert connecting bands and are ready for immediate backfill. We work closely with the site contractor, providing the layout of the system to assure that the installation goes as quickly and as efficiently as possible.

Details of these structures can be supplied upon request. See why these systems have become popular among contractors and owners due to the time and money saved.

DESIGNED FOR PERMANENCE

Hydra-Cor is offered in a variety of metals and coatings to address virtually any type of installation in Georgia. For most storm sewer installations, Aluminized Steel Type 2 should provide a design life in excess of 75 years. For more aggressive conditions, solid aluminum alloy provides a service life equal to, or greater than, concrete pipe. Where abrasion is a concern, **Hydra-Cor** can be supplied with a polymer coating on the pipe interior and exterior laminated over a 2 oz./ft.² galvanized coating to provide an abrasion and/or corrosion barrier. Each material will provide a satisfactory service life under the following environmental parameters.

Sheet Material	pH Range	Resistivity	Abrasion Level
Aluminized Steel (AASHTO M-274)	5 - 9	>1500 ohm/cm	Moderate For Storm Sewer System
Aluminum Alloy (AASHTO M-197)	4 - 9	> 500 ohm/cm	Moderate 5 - 15 ft./sec.
Polymer Precoat (AASHTO M-245)	3 - 12	> 100 ohm/cm	Severe > 15 ft./sec.

Details of each of these production materials, along with recommended specifications, can be supplied upon request. We feel confident that one of these materials will satisfy even the most stringent of designer demands.

Information supplied in this literature is an overview of **Hydra-Cor**'s capabilities. Specific application, or additional information and performance data can be obtained through your Cherokee Culvert representative. We welcome your requests to see how **Hydra-Cor** can offer you a cost-effective, durable, and structurally sound storm sewer system.

CONNECTION POINTS ARE NOT A LIABILITY FOR *HYDRA-COR*

Though *Hydra-Cor*'s corrugation configuration is new, joints between pipe sections remain as strong as ever. The ends of each pipe section are recorruagated with a minimum of two annular corrugations having a 2-2/3"x1/2" profile. This process allows for the use of annular connecting bands to provide a positive, silt tight connection. Tests confirm that only twelve inches of recorruagated ends per section has very little influence on the roughness coefficient of the pipe material.



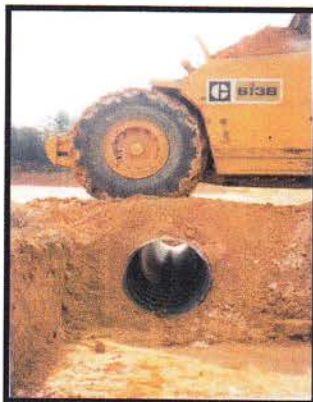
Annular bands ensure that field connections prevent displacement of the pipe due to backfilling operations, fill settlement, or traverse earth pressure.

These connections prevent displacement of the pipe from the stresses of backfilling, external loadings, and traverse earth pressure. This is particularly critical when a storm sewer system is being designed on a hydraulically smooth interior roughness coefficient. Joint displacement could seriously alter the hydraulic function from its intended design. Where watertight connections are required, 3/4" diameter neoprene o-ring gaskets may be utilized under each connecting band.

*Steel Connecting Band
12" or 18" width*



*Aluminum Connecting
Band
12" or 18" width*



This 24", 16 gage pipe (.66" profile) was subjected to repeated passes of a loaded scraper. Installation of the pipe was intentionally substandard to resemble "worst-case" field conditions. Even this abusive site caused no structural problems for *Hydra-Cor*.

Measurements after load testing show that the material was under approximately 8" of cover. This is substantially below the recommended minimum cover requirements for *Hydra-Cor*, but is indicative of the structural integrity in even the most stringent conditions.



*Suggested Specifications For **Hydra-Cor** Corrugated Metal Pipe:*

Materials:

*The galvanized sheet used in the manufacture of **Hydra-Cor** shall be in compliance with AASHTO M-218 for 2 oz./ft.² galvanized, AASHTO M-274 for Aluminized Steel Type 2, or AASHTO M-246 M-86 for polymer coated. When specified in the purchase order or contract, a manufacturer's certification shall be furnished to the purchaser of the finished pipe stating that the material was manufactured, sampled, tested, and inspected in accordance the applicable specifications and has been found to meet the requirements for the material described in the purchase order or contract.*

*The aluminum alloy used in the manufacture of **Hydra-Cor** shall be in compliance with AASHTO M-197, with the material being designated as Alclad 3004-H34. Only after a thorough discussion with the engineer shall Alclad 3004-H32 be allowed. Specific areas of concern should address minimum and maximum fill requirements for both construction and HS-20 vehicles. A certification of materials consistent with the above referenced requirements will be supplied upon request.*

Construction:

***Hydra-Cor** shall be supplied in one of the following patterns:*

*1.0" x .90" x 9.0" centers
.75" x .90" x 9.50" centers
.66" x .90" x 9.68" centers*

Construction of applicable components shall be in compliance with AASHTO M-36. Lockseams, located in the tubular sections between the corrugations shall be flat and cause no disruption of the interior pipe wall. Ends of the pipe sections shall be reformed to a minimum of two annular corrugations having a profile of 2-2/3"x1/2". Connecting bands shall be designed to fully engage at least one corrugation of each section to be joined. Band widths shall be a minimum of 12.25" wide for pipe diameters 15" to 60", and 17.50" wide for diameters 66" and larger. Where watertight connections are required, o-ring gaskets 3/4" in diameter shall be used.

Installation:

Installation practices shall be used as outlined in AASHTO Specifications for Highway Bridges, Section 2.23. Compaction requirements should be specified no less than 90% proctor density. Proper cover should be maintained, especially during construction, to adequately protect the pipe against unnecessary superimposed loadings for which the material is not designed. Where cover versus loadings are in question, a minimum of four feet of compacted fill should be placed over the pipe during the construction phase. This can later be adjusted to final grade near completion of the project. A Cherokee Culvert representative should be consulted regarding additional installations questions.

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