

**NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD**

IRRIGATION WATER CONVEYANCE

CORRUGATED METAL PIPELINE

(No.)
CODE 430-II

DEFINITION

A pipeline installed in an irrigation system.

PURPOSE

To prevent erosion or loss of water quality or damage to land and to reduce water conveyance losses to make possible the proper management of irrigation water.

CONDITIONS WHERE PRACTICE APPLIES

This standard applies to circular corrugated metal pipe 48 inch in diameter or less and to arched pipe with span and rise dimensions of 58 inch by 38 inch or less.

The pipeline shall be planned and located to serve as an integral part of an irrigation water distribution or conveyance system that has been designed to help conserve soil and water resources on a farm.

Water quality, seasonal supplies and rates of irrigation delivery for the area served by the pipeline shall be sufficient to make irrigation practical for the methods to be used.

DESIGN CRITERIA

All planned work shall comply with all Federal, State, and local laws and regulations.

Friction losses. For design purposes, friction head losses shall be no less than those computed by the Manning's Formula, using a roughness coefficient of 'n' as shown Table 1 for circular pipe and Table 2 and Table 1 for arched pipe.

Flow velocity. The design velocity in the pipeline when operating at system capacity shall not exceed 7 ft/s.

Capacity. The design capacity of the pipeline shall be based on whichever of the following criteria is greater:

1. The capacity shall be sufficient to deliver the volume of water required to meet the peak irrigation demands of the crops for the area served by the pipeline.
2. The capacity shall be sufficient to provide an adequate irrigation stream for the methods of irrigation being used.

Working pressure. Pipelines shall normally be designed for partial pipe flow except that reaches of pipe under pressure flow may be designed at swales and inverted siphons or on the downstream end of pipelines on flattening grades provided the maximum design working pressure does not exceed:

1. 20 feet for helical pipe with sealed seams and watertight couplings.
2. 30 feet for helical pipe with welded seam, annular ends and watertight couplings.

Head is measured from the flow line of the pipe. Pipe with the seams not sealed may be used under partial pipe flow conditions. Watertight couplings shall be used for full pipe flow conditions.

Table 1
Manning's 'n' for Circular Corrugated Pipe

Corrugation Pattern and Construction Type										
Pipe Dia	Area	1-1/2" x 1/4"	2-2/3" x 1/2" ²				3" x 1"			
		H ³ 1/	H 1/	H 25% paved	A ³ 1/	A 25% paved	H 1/	H 25% paved	A	A 25% paved
6	0.20	0.010								
8	0.35	0.013								
10	0.55	0.016								
12	0.79		0.011			0.026				
15	1.23		0.013			0.025				
18	1.77		0.014			0.025				
21	2.41		0.016			0.025				
24	3.14		0.017	0.015		0.025	0.021			
30	4.91		0.018	0.016		0.025	0.021	0.019	0.018	0.027
36	7.07		0.019	0.017		0.025	0.021	0.020	0.019	0.027
42	9.62		0.020	0.019		0.024	0.021	0.020	0.019	0.027
48	12.57		0.020	0.020		0.024	0.021	0.020	0.020	0.027

1/ n values based upon results from St Anthony Falls Hydraulic Laboratory, Minn.

2 Some helical corrugations have a depth of 7/16 inch, use value for 1/2 inch

3 H = Helical, A = Annular

Table 2
Equivalent Values for Arched Pipe for Selecting Mannings 'n'¹

Aluminum			Steel			Diameter of Pipe of Equal Periphery (in.)
Size Span x Rise (in.) (in)	Area (Sq. Ft.)		Size Span x Rise (in.) (in.)	Area (Sq. Ft.)		
17 13	1.2		18 11	1.1		15
21 15	1.7		22 13	1.6		18
24 18	2.3		25 16	2.2		21
28 20	2.9		29 18	2.8		24
35 24	4.4		36 22	4.4		30
42 29	6.5		43 27	6.4		36
49 33	8.4		50 31	8.7		42
57 38	11.3		58 36	11.4		48

1 To determine 'n' value for arched pipe select equivalent circular pipe diameter and go to Table 1 to select 'n' for appropriate corrugation.

External load limit. Fill heights on corrugated metal pipe shall not exceed the

maximum depths given in Tables 3, 4 and 5 for the gauge, size, type and shape of pipe.

Table 3

Maximum Depth of Cover for Steel Corrugated Circular Pipe, H-20 Loading, with 5% pipe deflection

Corrugation Pattern			Specified Thickness (inches)					
1-1/2 x 1/4	2-2/3 x 1/2	3 x 1	0.052	0.064	0.079	0.109	0.138	0.168
			Equivalent Standard Gauge					
Diameter (inches)			18	16	14	12	10	8
Diameter (inches)			Maximum depth of cover (feet)					
10	12		98	51	145			
	15		58	119	83			
	18		41	69	55			
	21		32	47	41	51		
	24		27	36	33	40		
	27			30	28	33		
	30			24	25	29		
	36			21	22	24	26	
	42	36	31	25	39	48	57	67
	48	42	26	19	20	21	23	24
	42	26	25	31	36	42	48	
	48	21	18	19	20	21	22	
	48	21	20	26	30	34	38	

Table 4

Maximum Depth of Cover for Aluminum Corrugated Circular Pipe, H20 Loading, with 5% pipe deflection

Corrugation Pattern				Specified Thickness (inches)					
1-1/2 x 1/4	2-2/3 x 7/16	2-2/3 x 1/2	3 x 1	0.040	0.060	0.075	0.105	0.135	0.164
				Equivalent Standard Gauge					
Diameter (inches)				18	16	14	12	10	8
Diameter (inches)				Maximum Depth of Cover (feet)					
8 10				33	43				
				25	30				
		12			50	59	78		
		15			34	38	48		
		18			27	29	35		
		21			23	25	28		
		24			21	22	25	27	
		27			20	21	22	24	
			30	30		20	21	22	
			36	36	29	29	35	40	
		36	36		19	19	20		
		42	42	24	24	27	31		
		42	42			18	19		
		48	48	21	21	23	26		
		48	48			18	18	19	
		48	48	20	20	21	23	24	

Table 5

Maximum Depth of Cover for Steel and Aluminum Corrugated Arched Pipe, H-20 Loading

Aluminum-Helical & Riveted 2-2/3 x 1/2			Steel						
Size Span x Rise (in.) (in.)		Gauge ¹	Maximum Depth ² (ft.)	Size Span x Rise (in.) (in.)		2-2/3 x 1/2		3 x 1	
				Gauge	Max. Depth (ft.)	Gauge	Max Depth (ft.)		
17	13	16	13	18	11	16	13		
21	15	16	13	22	13	16	12		
24	18	16	12	25	16	16	10		
28	20	14	11	29	18	16	9		
35	24	14	11	36	22	16	9		
42	29	12	10	43	27	16	7	16	12
49	33	12	10	50	31	14	7	16	12
57	38	10	9	58	36	12	7	16	12

1 Gauges shown for information purposes only

2 Corner-bearing pressures assumed to be 2 tons per square foot for maximum depths given. maximum depth of cover based upon maximum 5% deflection. Reference Department U.S. Department of Commerce/Bureau of Public Roads, "Corrugated Metal Pipe Culverts Structural Design Criteria and Recommended Installation Practice"

Vents. Vents and air and vacuum-release valves shall be designed as needed on pipelines with full pipe flow and partial flow pipelines when design water depth exceeds 70 percent of the pipe diameter.

Outlets. Appurtenances for delivering water from the pipe to a field surface, to a ditch or a surface pipe system shall have the capacity to deliver the required flow to:

1. a point at least 6 inches above the field surface.
2. the hydraulic grade line of the ditch or pipeline.

Pipeline placement. Pipelines be buried, placed on the ground surface, or placed on saddles or suspended above the ground surface. Buried pipelines which are subject to hazards such as traffic crossings, farm operations, freezing temperatures, or soil cracking shall be placed deep enough to protect the pipeline from such hazards. The minimum cover shall be 1 foot, however in soils subject to deep cracking the minimum cover shall be 2 feet.

Pipelines laid on the ground shall be protected from hazards imposed from traffic crossings, farm operations and other hazards.

Above ground or suspended pipelines shall be adequately supported by vertical bents to prevent the pipe from moving to maintain proper grade and alignment. Spacing of vertical bents shall assure that neither the maximum beam stresses in the pipe span nor the maximum stress at the bent exceed design stress values.

Thrust Control. Above ground pipelines shall have movement of each pipe length restrained by steel holddown straps at the pipe supports or by anchor blocks.

Joints and connections. All connections shall be designed to withstand the maximum working pressure of the pipeline without leakage and to leave the inside of the pipeline free of any obstruction.

Draining and flushing. Provisions shall be made for completely draining the pipeline where freezing is a hazard. As needed drains will be provided at low points along the pipeline or provisions shall be made to empty the pipeline by pumping.

Corrosion protection. Interior protective coatings shall be provide when the pH of the water is less than or greater than the following values:

<u>Material</u>	<u>Water pH</u>
Aluminized steel	< 5-9 <
Galvanized steel	< 6-10 <
Aluminum alloy	<4-10 <

Galvanized or aluminum steel pipe shall not be used when the soil resistivity is less than 4000 ohm-cm. Aluminum alloy pipe shall not be used when the soil resistivity is less than 500 ohm-cm. Hot dipped asphalt, asbestos bonded bituminous or polymeric coated galvanized, or aluminized steel pipe shall be used if the soil resistivity along any part of the pipeline is between 3000 and 4000 ohm-cm. In addition to the above coatings, cathodic protection shall be provided for galvanized steel pipe if the soil resistivity is less than 3000 ohm-cm.

Aluminized steel pipe shall not be used when the soil resistivity is less than 3000 ohm-cm.

All metal fittings should be of similar materials as the pipe, where dissimilar metals are used the fittings shall be electrically isolated from the pipe with a rubber or plastic insulator. Other than aluminum alloy bolts used to join aluminum pipe all bolts used to join galvanized steel or aluminum pipe shall be galvanized, plastic coated, or otherwise coated to prevent galvanic corrosion.

Cathodic Protection. Refer to Practice Standard 430-FF for design of cathodic protection.

Materials. Pipe shall equal or exceed the requirements specified in one of the following standards:

ASTM A 760 "Pipe, Corrugated Steel, Zinc Coated

Federal Spec. WW-P-402C "Pipe, Corrugated (Aluminum Alloy (Amendment-1))"

Federal Spec. WW-405B "Pipe Corrugated (Iron or Steel, Zinc Coated (Amendment 1))"

AASHTO M 36 "Zinc Coated (Galvanized) Corrugated Iron or Steel Culverts and Underdrains"

AASHTO M 196 "Corrugated Aluminum Alloy Culverts and Underdrains (Amendment AASHTO M 196)"

AASHTO M 245 "Pre-coated, Galvanized Steel Culverts and Underdrains"

AASHTO M 274 "Steel Sheet, Aluminum Coated (Aluminum Type II) by Hot Dip Process for Sewer and Drainage Pipe"

Seams on pipe shall be welded or sealed. Helical pipe shall have annular ends.

Pipe coatings shall meet or exceed the requirements of either Federal Specification WW-P-405B, or AASHTO M 190-78 "Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches (Amendment M 190-801)" or AASHTO M 246-74 "Pre-coated, Galvanized Steel Sheets for Culverts and Underdrains".

Gaskets shall meet the requirements of ASTM C 443 "Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets".

CONSIDERATIONS

Underground pipelines should be tested for leaks before placing final backfill. All leaks should be repaired.

Consider costs for cathodic protection installation and operation and maintenance costs.

Consider effects on the water budget, especially on volumes and rates of runoff to downstream water users.

Consider the effects on wetlands and water related wildlife.

Consider effects on water flows and aquifers and the affect to other water uses and users.

Consider the potential effect on irrigation water management.

PLANS AND SPECIFICATIONS

Plans and specifications shall be prepared to show site specifics. The drawings and specifications shall show pipe location, pipe type and sizes, details for appurtenances, trench/backfill requirements or details for above ground placement, requirements for cathodic or corrosion protection as applicable.

OPERATION AND MAINTENANCE

The operation and maintenance of the system shall include typical items of flushing and draining pipeline, replacing anodes as needed, cleaning and repairing vents and/or air-vacuum release valves, replacing individual gaskets, etc.

REFERENCES

- Engineering Field Manual
 - Chapter 3, Hydraulics
 - Chapter 15, Irrigation
- NRCS Conservation Practices
 - Structure for Water Control, Code 587
 - Irrigation System, Surface and Subsurface, Code 443
 - Irrigation Water Conveyance, Irrigation Pipeline, Code 430AA to 430JJ