

NATURAL RESOURCES CONSERVATION SERVICE  
CONSERVATION PRACTICE STANDARD

LIVESTOCK PIPELINE

(Ft.)

CODE 516

**DEFINITION**

A pipeline and appurtenances installed to convey water for livestock or wildlife.

**PURPOSE**

This practice may be applied as part of a resource management system to achieve one or more of the following purposes:

- Convey water to points of use for livestock or wildlife.
- Reduce energy use.
- Develop renewable energy systems.

**CONDITIONS WHERE PRACTICE APPLIES**

This standard applies to the conveyance of water through a closed conduit, from a source of supply to a watering facility, for use by livestock or wildlife.

This practice does not apply to the use of pipelines for irrigation, which are addressed by NRCS Conservation Practice Standard, Irrigation Pipeline (430).

**CRITERIA**

**General Criteria Applicable to All Purposes**

The volume, quality, and rate of delivery by the pipeline shall be sufficient to make use for livestock or wildlife practical and feasible.

Pipelines shall be placed only in or on soils with environmental conditions suitable for the type of material selected.

**Capacity.** Capacity shall be sufficient to convey the design delivery flow rate for the planned conservation practices.

For livestock or wildlife, provide the capacity necessary to meet the seasonal high daily water requirements for the number and species of

animals to be supplied.

In computing the capacity requirements, allowance must be made for reasonable water losses during conveyance and use.

**Friction and Other Losses.** For design purposes, head loss for hydraulic grade line computations shall be based using one of the following equations: Hazen-Williams, Darcy-Weisbach, or Manning's. Equation selection shall be based on the given flow conditions and the pipe materials used. Other head losses (also called minor losses) from change in velocity and direction of flow due to inlet type, valves, bends, enlargements or contractions can be significant and shall be included as appropriate. For closed, pressurized systems, the hydraulic grade line for all pipelines shall be maintained above the top of the pipeline at all locations for all flows, unless specifically designed for negative internal pressures.

**Pipe Design.** Pipelines shall be designed to meet all service requirements such that internal pressure, including hydraulic transients or static pressure at any point is less than the pressure rating of the pipe.

Flexible conduits such as plastic and metal pipe shall be designed using NRCS National Engineering Handbook (NEH), Part 636, Chapter 52, Structural Design of Flexible Conduits, and the following criteria:

**Plastic Pipe.** When operating at design capacity, the full-pipe flow velocity should not exceed 5 feet per second in pipelines with valves or some other flow control appurtenances placed within the pipeline or at the downstream end. As a safety factor against transient pressures, the working pressure at any point should not exceed 72 percent of the pressure rating of the pipe. If either of these limits is exceeded, special design consideration must be given to the flow conditions, and measures must

be taken to adequately protect the pipeline against transient pressures.

Pressure ratings for pipes are normally based on a pipe temperature of 73.4°F. When operating temperatures are higher, the effective pressure rating of the pipe shall be reduced accordingly.

**Metal Pipe.** The specified maximum allowable pressure shall be determined using the hoop stress formula, limiting the allowable tensile stress to 50 percent of the yield-point stress for the material selected. Design stresses for commonly used metal pipes are shown in NEH, Part 636, Chapter 52.

**Support of Pipe.** Pipelines installed above ground shall be supported, where needed, to provide stability against external and internal forces. Pipe support shall be designed using NEH, Part 636, Chapter 52.

**Joints and Connections.** All connections shall be designed and constructed to withstand the pipeline working pressure without leakage and leave the inside of the pipeline free of any obstruction that would reduce capacity.

Permissible joint deflection shall be obtained from the manufacturer for the type of joint and pipe material used.

For sloping metal pipe, expansion joints shall be placed adjacent to and downhill from anchors or thrust blocks.

For welded pipe joints, expansion joints shall be installed, as needed, to limit pipeline stresses to the allowable values.

The allowable longitudinal bending for the pipeline shall be based on type of material and the pressure rating, and shall be in accordance with industry standards, or as described in NEH, Part 636, Chapter 52.

For suspended pipelines, joints shall be designed for pipe loading, including the water in the pipe, wind, ice, and the effects of thermal expansion and contraction.

Joints and connections for metal pipes should be of similar materials whenever possible. If dissimilar materials are used, the joints or connections shall be protected against galvanic corrosion.

**Depth of Cover.** Buried pipe shall be installed at sufficient depth below the ground surface to provide protection from hazards imposed by

traffic loads, farming operations, freezing temperatures, or soil cracking, as applicable.

Pipelines shall have sufficient strength to withstand all external loads on the pipe for the given installation conditions. Appropriate live loads shall be used for the anticipated traffic conditions.

Where it is not possible to achieve sufficient cover or sufficient strength, a carrier (encasement) pipe or other mechanical measures shall be used.

**Pressure Reduction.** Pressure Reducing Valves or Breaker Tanks shall be incorporated in circumstances such as head gain exceeding pressure loss by a significant amount, excessive static pressures, or excessive flow rates.

**Valves and Other Appurtenances.** Pressure ratings of valves and other appurtenances shall equal or exceed the design working pressure. When lever operated valves are used, an analysis shall be performed to evaluate potential transient pressures, assuming rapid valve closure.

**Check Valves and Backflow Prevention.** A Check Valve shall be installed between the pump discharge and the pipeline if detrimental backflow may occur.

Approved backflow prevention devices shall be used on all pipelines where back flow may contaminate the source water supply or groundwater. Specific criteria for the type of backflow prevention device needed are dependent on applicable state and local regulations.

**Sanitary protection.** If water from the pipeline is to be used for human consumption, applicable state and local regulations shall be met. The design shall meet the requirements of the Kentucky Department of Health.

**Pressure Relief Valves.** A Pressure Relief Valve shall be installed between the pump discharge and the pipeline if excessive pressure can build up when all valves are closed. If needed to protect the pipeline against malfunction or failure of Pressure Reducing Valves, Pressure Relief Valves shall be installed downstream of Pressure Reducing Valves.

Pressure Relief Valves shall be set to open at a pressure as low as practical, but no greater than 5 pounds per square inch above the design

working pressure rating or maximum allowable pressure of the pipe. The valves shall have sufficient flow capacity to reduce the excessive pressures in the pipeline. The pressure at which the valves start to open shall be marked on each Pressure Relief Valve. Adjustable Pressure Relief Valves shall be sealed or otherwise altered to prevent changing the adjustment from that marked on the valve.

In lieu of a detailed transient pressure analysis, the minimum size of Pressure Relief Valve shall be ¼ inch nominal valve size per inch of the nominal pipeline diameter.

Air Vents. Provide for entry and removal of air along the pipeline, as needed to prevent air locking, hydraulic transients, or pipe collapse. Include provisions for air release and vacuum relief, as needed to protect the pipeline. Design the pipeline to remain below the hydraulic grade line during operation. If parts of the pipeline will be located above the hydraulic gradient, periodic use of an air pump may be required.

Surge Tanks and Air Chambers. Where surge tanks or air chambers are required for control of hydraulic transients or water column separation, they shall be of adequate size to ensure the water volume needs of the pipeline are met without the tank/chamber being emptied, and the required flow rate into the pipeline for the calculated pressure drop is met.

Outlets and Water Level Control.

Appurtenances to deliver water from the pipe to the watering facility shall have adequate capacity to deliver the required flow. Where water is supplied continuously to the watering facility, use automatic water level controls (such as Float Valves) to control the flow of water and to prevent unnecessary overflows.

Design outlets and water level controls to withstand or be protected from damage by livestock, wildlife, freezing and ice damage. Outlets shall be designed to minimize erosion, physical damage, or deterioration due to exposure.

**Thrust Control.** Abrupt changes in pipeline grade, horizontal alignment, or size reductions, may require an anchor or thrust blocks to absorb pipeline axial thrust. Thrust control is typically needed at the end of the pipeline, and at in-line control valves. The pipe manufacturer's recommendations for thrust control shall be followed. In absence of manufacturer's data,

thrust blocks shall be designed using NEH, Part 636, Chapter 52.

**Thermal Effects.** For plastic pipe, thermal effects must be properly factored into system design. Values and procedures for pressure rating reduction shall follow information described in the NEH, Part 636, Chapter 52.

**Physical Protection.** When steel pipe is used, interior protective coatings shall be provided in accordance with NRCS Kentucky Conservation Practice Standard *Irrigation Pipeline (Code 430)*. If a coal-tar enamel protective coating is needed for corrosion protection, the coating shall meet the requirements of AWWA Specification C-203.

Steel pipe installed above ground shall be galvanized or shall be protected with a suitable protective paint coating.

Plastic pipe installed above ground shall be resistant to ultraviolet light throughout the intended life of the pipe, or measures must be taken to protect the pipe from damage due to ultraviolet light.

All pipes shall be protected from hazards presented by traffic loads, farm operations, freezing temperatures, fire, thermal expansion and contraction. Reasonable measures shall be taken to protect the pipe from potential vandalism.

**Filling.** The pipeline system shall have a means of controlling the filling of the pipeline to prevent entrapment of air or excessive transient pressures.

Filling velocities greater than 1 foot per second in a closed to the atmosphere pipe system (i.e., all outlets closed), requires special evaluation and provisions to remove entrapped air and prevent excessive transient pressures.

If filling at a low flow rate is not possible, the system shall be open to the atmosphere (outlets open) prior to pressurizing. The system shall be designed for air removal and excessive transient pressures that may develop at higher filling rates.

**Flushing.** If the sediment load in the water is significant, the pipeline shall have adequate velocity to ensure that sediment is moved through and flushed out of the pipeline.

If provisions are needed for flushing sediment or other foreign material, a suitable valve shall be installed at the distant end or low point of the pipeline.

**Draining.** Provisions shall be made for the complete removal of water from the pipeline by gravity or other means when:

- Freezing temperatures are a hazard.
- Draining is required by the pipe manufacturer.
- Draining of the pipeline is otherwise specified.

The water drained from pipelines shall not cause water quality, soil erosion, or safety problems upon release.

**Safe Discharge of Water.** Provisions shall be made for water being discharged from valves, especially air valves and pressure relief valves. These valves shall be located such that flows are directed away from system operators, livestock, electrical equipment, or other control valves.

**Vegetation.** Reestablish vegetation or otherwise stabilize disturbed areas as soon as practical after construction. Seedbed preparation, seeding, fertilizing, and mulching shall meet applicable criteria in NRCS Conservation Practice Standard, Critical Area Planting (342).

#### **Additional Criteria Applicable to Reduce Energy Use**

Provide analysis to demonstrate reduction of energy use from practice implementation.

Reduction of energy use is calculated as average annual or seasonal energy reduction compared to previous operating conditions.

#### **Additional Criteria Applicable to Develop Renewable Energy Systems**

Renewable energy systems shall meet applicable design criteria in NRCS and/or industry standards, and shall be in accordance with manufacturer's recommendations. Hydropower systems shall be designed, operated, and maintained in accordance with the Microhydropower Handbook, Sections 4 and 5, as appropriate.

## **CONSIDERATIONS**

**Safety.** Pipeline systems may present a hazard to the safety of people, during installation and operation. Consider safety as follows:

- Address trench safety in design and during construction.
- Provide protection for people from high pressure water blowing from Pressure Relief, Air Release, and other valves.
- Determine the existence or non-existence of underground utilities prior to construction.

**Economics.** Consider economics in pipeline design, as follows:

- Select pipe sizes based on lifetime energy requirements, versus initial costs of materials.
- Select pipe material based upon the expected service life of practice.
- Consider hydropower applications as alternatives to the use of Pressure Reducing valves or reduced pipe diameters to induce friction loss.

**Other Resources.** Consider potential impacts to other resources as follows:

- Address rare plant species and cultural resources during the installation of buried pipelines. When possible, avoid these resources, as well as wetlands and other habitats that are highly sensitive to disturbance, or include measures to minimize impacts.
- Consider the visual design of pipelines and appurtenances, especially in areas of high public visibility.

Pipeline Chart (K-L-20) attached, can be used in designing the pipeline for animal drinking facilities only.

Other design aids (charts, computer programs, etc.) may be used as determined technically sound and approved by the engineer.

Where the pipeline is installed under a pond embankment the minimum inside diameter shall be 1 inch for PVC or HDPE pipe and 1¼ inch for galvanized iron or welded steel pipe.

Where the minimum static head is less than 12 feet or 5 psi, the minimum inside diameter shall be 1 inch for PVC or HDPE pipe and 1¼ inch for galvanized iron or welded steel pipe.

### **PLANS AND SPECIFICATIONS**

Prepare plans and specifications for Livestock Pipelines that describe the requirements for applying the practice according to this standard. As a minimum, the plans and specifications shall include:

- A plan view of the layout of the pipeline.
- Profile view of the pipeline.
- Pipe sizes and materials.
- Pipe joint requirements.
- Site specific construction specifications that describe in writing the installation of the pipeline. Include requirements for pressure testing of the pipeline.
- Depth of cover and backfill requirements.
- Vegetative establishment requirements.

### **OPERATION AND MAINTENANCE**

An Operation and Maintenance (O&M) Plan shall be developed for each Livestock Pipeline system installed. The plan should document needed actions to ensure that practices perform adequately throughout their expected life.

O&M requirements shall be included as an identifiable part of the design. Depending on the scope of the project, this may be accomplished

by written statements in the plans and specifications, the conservation plan narrative, or as a separate O&M Plan.

Other aspects of O&M, such as draining procedures, marking crossing locations, valve operation to prevent pipe or appurtenant damage, appurtenance or pipe maintenance, and recommended operating procedures, should be described as needed within the O&M Plan.

Monitoring of any cathodic protection systems shall be performed as specified in the O&M Plan.

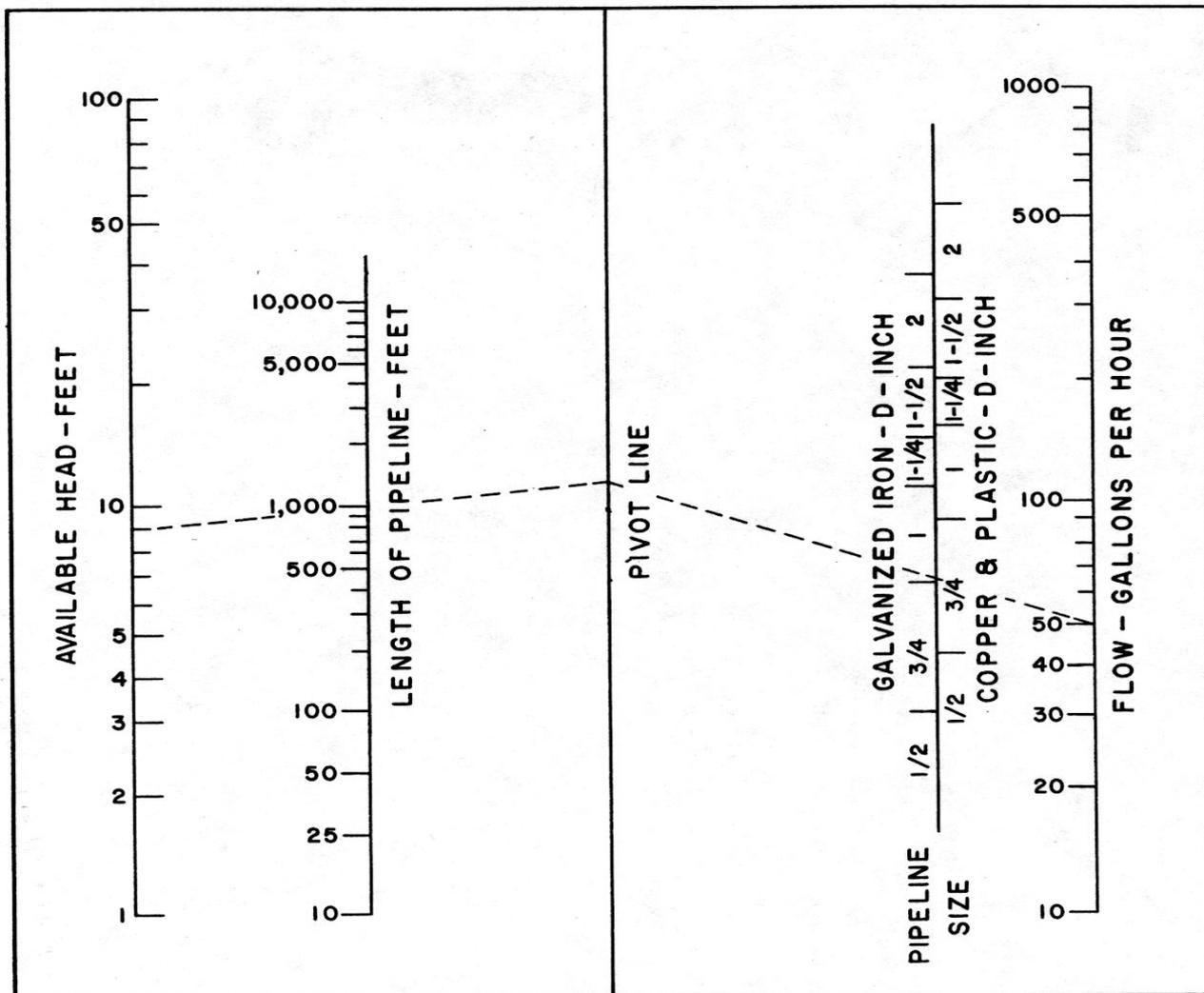
A filling procedure shall be developed, which details allowable flow rates and appurtenance operation at the various phases of the filling process, required to assure safe filling of the pipeline. Flow measuring devices, such as flow meters or other means (e.g., number of turns of a gate valve), should be used to determine the rate of flow into the pipeline system. This information shall be provided to the operator, and shall be incorporated into the O&M Plan as appropriate.

### **REFERENCES**

McKinney, J.D., et al. Microhydropower Handbook, IDO-10107, Volumes 1 & 2. U.S. Department of Energy, Idaho Operations Office.

USDA-NRCS, National Engineering Handbook, Part 636, Chapter 52, Structural Design of Flexible Conduits.

## PIPELINE DESIGN CHART FOR LIVESTOCK WATER FACILITIES (K-L-20)<sup>1/2/</sup>



<sup>1/</sup> An allowance for estimated bend losses (elbows, tees, etc.) has been included in the design of the chart.

<sup>2/</sup> Use Copper/Plastic line for PVC pipelines also. Use galvanized iron line for steel pipelines also.

EXAMPLE: The available head is 9 feet, pipeline length is 1000 feet, and flow rate is 50 gallons per hour. Find size of pipe from K-L-20.

1. Extend line from available head (9) through length of pipeline (1000) to intersection with pivot line.
2. Extend line from pivot line to intersection with flow – gallons per hour (50).

The location at which this line intersects the pipeline size is within the ¾" plastic, PVC, PE, and copper pipe. The line also intersects within the 1" galvanized iron or steel pipe.

## How to Use the Chart:

## 1. Determine available head in feet.

a. For Gravity Flow - This is the difference in elevation of water surface at the source of supply and the discharge elevation at the livestock water tank or fountain .

b. Pressure Flow - This includes water supply from pumps and water mains.

(1) Pumps - The capacity and operating head of the pump should be known. Convert the pump pressure to the pump's operating head in feet. Discharge head is the difference in elevation between the pump elevation and water elevation at the discharge point (tank).

$$[\text{Pump Pressure (psi)}] \times [2.31] = \text{Operating Pump Head (ft.)}$$

Determine Available Head:

$$[\text{Operating Pump Head (ft.)}] - [\text{Discharge Head (ft.)}] = \text{Available Head (ft.)}$$

(2) Water Mains - The pressure head at the water meter should be known or measured. Discharge head is the difference in elevation between the meter elevation and the water elevation at the discharge point (tank).

$$[\text{Pressure at meter (psi)}] \times [2.31] = \text{Pressure Head at meter (ft.)}$$

$$\text{Determine Available Head: } [\text{Meter Head (ft.)}] - [\text{Discharge Head (ft.)}] = \text{Available Head (ft.)}$$

If the pressure head at the meter cannot be determined, assume 50 feet of head.

If the pressure at the meter is known to exceed 50 psi, a pressure regulator should be considered.

## 2. Determine Flow - Gallons Per Hour.

To determine the diameter of the pipeline and size of the tank the amount of desired storage should be determined. Table 1 gives livestock needs. Table 2 lists the tank sizes and pipe flow for various water needs.

**Table 1** – Daily consumption of water by livestock

Livestock Type	Daily Requirement Gallons/Head/Day	Daily Water Need Gallons/Head/Hour*
Beef Cattle and Dry Dairy Cows	12-15	9
Dairy Cows (lactating)	20-30	15
Horses	8-12	6
Hogs	2-4	2
Sheep	1-4	2

**Table 2 - Flow-rate in Pipeline – Gallons per Hour with Storage <sup>1/</sup>**

<b>Water Needs</b>	<b>Tank Capacity Gallons</b>										
<b>Gallons /Hour</b>	100	200	300	400	500	750	1000	1250	1500	2000	
50	10	10									
100	25	10	10								
150	50	25	15	15							
200	100	50	25	20	20						
250	150	75	50	25	25						
300	200	100	75	50	30	25					
350	250	150	100	75	50	35	35				
400	300	200	125	100	75	40	40				
450	350	250	150	125	100	45	45				
500	400	300	200	150	125	75	50	50			
600	500	400	300	200	175	125	60	60			
700	600	500	400	300	200	175	100	70	70		
800	700	600	500	400	300	225	150	90	75	75	
900	800	700	600	500	400	275	200	150	75	75	
1000	900	800	700	600	500	325	250	200	125	100	

<sup>1/</sup> Automatic livestock water facilities require 900 gallons per hour flow-rate in pipeline each.

#### REFERENCES

1. Engineering Field Handbook, Part 650
2. GM-190, ECOL SCI, Part 410, Compliance with NEPA.
3. Midwest Plan Service, Structures and Environment Handbook: MWPS-1.