NATURAL RESOURCES CONSERVATION SERVICE
MONTANA CONSERVATION PRACTICE STANDARD

PIPELINE (FEET)

CODE 516

DEFINITION

Pipeline having an inside diameter of 8 inches or less.

PURPOSE

To convey water from a source of supply to points of use for livestock, wildlife, or recreation.

CONDITIONS WHERE PRACTICE APPLIES

Where it is desirable or necessary to convey water in a closed conduit from one point to another.

CRITERIA

Capacity. For livestock water, the installation shall have the capacity to provide the seasonal high daily requirements for the number and species of animals to be supplied. **Minimum consumption rates are shown below.**

Conventional Grazing Drinking Water Requirements		**Maximum Water Spacing (Miles)**	
Animal	**Gal/ Day (Min.)**	**Rough Relief**	**Gentle Relief**
Cow and Small Calf	**20**	**0.5**	**1**
Range Cow	**15**	**0.5**	**1**
Horses and Mules	**15**	**0.5**	**1**
Sheep and Goats	**2**	**0.5**	**1**
Dairy Cow	**25**	**--**	**--**
Hog	**2**	**--**	**--**
Daily water consumption for feeder cattle may be calculated at one gallon per day per 100 lbs.			
For summer conditions, a minimum of two gallons per day per 100 lbs. of body weight is recommended for range cattle.			

For recreation areas, the water capacity shall be adequate for all planned uses. Typical examples are drinking water, fire protection, showers, flush toilets, and irrigation of landscaped areas.

Additional water capacity **shall** be provided for wildlife when applicable **(see Field Office Technical Guide (FOTG), Section IV, Watering Facility - Wildlife (Code 614) specification)**.

Sanitary protection. If water from the pipeline is to be used for human consumption, applicable state and local regulations shall be met. **Include backflow prevention such as an air gap, double check valve assembly, or reduced pressure assembly on facilities connected to domestic or municipal water systems. An air gap is acceptable only when the watering facility is owned by the population at risk. If an air gap is used, the valve outlet shall be located above the rim of the tank a minimum of 2 inches (see National Engineering Manual (NEM), Part 503, Safety).**

Pipe. All pipe must withstand the pressure it will be subjected to, including hydraulic transients, internal pressures and external pressures. As a safety factor against surge or water hammer, the working pressure should not exceed 72% of the pressure rating of the pipe and the design flow velocity at system capacity should not exceed 5 ft/sec. If either of these limits is exceeded, special consideration must be given to flow conditions and measures must be taken to adequately protect the pipeline against surge.

Special Considerations. Maximum pressure shall not exceed the pressure rating of the pipe or appurtenances at any point in the pipeline. Pressure rating of plastic pipe and fittings shall be based on maximum water temperature.

Where pipeline velocities are between 1.5 and 5 feet per second, and valve closure or frequent on/off

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cycling is possible, maximum system pressure shall not exceed 90 percent of the pipe's pressure rating, or the design shall be based on a surge analysis.

For design purpose, the friction head losses shall be computed using Manning's, Hazen-Williams, or Darcy-Weisbach equations. The applicable equation and friction roughness coefficient used shall be in accordance with design procedures in the National Engineering Handbook, Part 650-Engineering Field Handbook, Chapter 3, Hydraulics, for the applicable material(s).

Steel pipe shall meet the requirements of AWWA **Standard** C-200 **or ASTM A 53.**

Plastic pipe shall conform to the requirements of the following ASTM specifications, as applicable:

D 1527 Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe, Schedules 40 and 80

D 1785 Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120

D 2104 Polyethylene (PE) Plastic Pipe, Schedule 40

D 2239 Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter

D 2241 Poly(Vinyl Chloride) (PVC), Pressure-Rated Pipe (SDR)

D 2282 Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe (SDR-PR)

D 2447 Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter

D 2513 Thermoplastic Gas Pressure Pipe, Tubing and Fittings

D 2737 Polyethylene (PE) Plastic Tubing

D 2672 Joints for IPS PVC Using Solvent Cement

D 3035 Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Controlled Outside Diameter

AWWA C900 Polyvinyl Chloride (PVC) Pressure Pipe, 4 inches through 12 inches

AWWA C901 Polyethylene (PE) Pressure Pipe and Tubing, ½ inch through 3 inches

Plastic pressure pipe fittings shall conform to the following ASTM specifications, as applicable:

D 2464 Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80

D 2466 Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40

D 2467 Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80

D 2468 Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe Fittings, Schedule 40

D 2609 Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe

D 2683 Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing

D 3139 Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals

D 3261 Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing

Solvents for solvent-welded plastic pipe joints shall conform to the following ASTM specifications, as applicable:

D 2235 Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings

D 2564 Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings

D 2855 Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings

Rubber gaskets for pipe joints shall conform to the requirements of ASTM F477, Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

Drainage. Valves or unions shall be installed at low points in the pipeline so that the line can be drained as needed. **Blowing water out of the pipeline with an air compressor is not allowed.** Check valves shall be installed as needed to protect groundwater quality or maintain a full pipeline.

Pipeline protection below frost depth. Where the pipeline is buried below probable frost (5 feet minimum), drains may be omitted provided appurtenances are not affected.

Pipeline protection with minimum (18") cover. Drains at low points shall be included on all pipelines. HDPE pipelines can be an exception provided the pipelines are depressurized and appurtenances are not affected.

Vents and Valves. Design shall provide for entry and removal of air along the pipeline, as needed, to prevent air locking or pipe collapse. If parts of the line are above the hydraulic gradient, periodic use of an air pump may be required. Provisions shall be made for pressure relief, air and vacuum relief, **pressure reducing, check valves, hydrants, surge chambers, pressure tanks, and other appurtenances** as needed to protect the pipeline.

Air vent size shall be based on pipeline size, pipe slope towards drains, and filling requirements. For pipeline size up to 3-inch diameter, 1/2-inch valves are generally adequate for filling operations, or preventing a vacuum from forming during emptying. For larger pipeline size, refer to the "Pipe Collapse Pressure and Air Valve Sizing" spreadsheet found on the NRCS web site under Engineering Software, Montana Engineering Spreadsheet List.

Pipelines where static or operating pressures exceed 10 psi. An air-and-vacuum release and continuous acting air-release (3-way) valve shall be installed at the first summit from the water source and on all major summits. Major summits are defined as a high point in the line that is more than 50 feet above an adjacent low point.

An air-and-vacuum (2-way) valve shall be installed downstream of shutoffs if vacuum relief is needed to protect the pipeline from collapse, or allow pipe drainage. These valves are not continuous acting. If needed, an air-and-vacuum valve shall be installed at the end of the pipeline to exhaust large volumes of air during filling. The need for valves at the end of pipelines shall be evaluated on a case-by-case basis. The need is based on an uphill grade at the end of the line and whether or not further escape of air is needed.

A continuous-acting air release (1-way) valve or manually-operated air vent shall be installed at all locations where the pipeline is more than 10 feet, but less than 50 feet above an adjacent low point. A frost-free hydrant may be considered a manually-operated air vent.

Pipelines where static or operating pressures are less than 10 psi. The pipe shall be laid to grade such that all summits are well defined and can be vented. An open vent or continuous-acting air release (1-way) valve shall be installed at all summits.

In order to seat properly, air valves shall meet the manufacturer's seating requirements. They shall only be used where working pressure is at least 2 psi.

Pressure Relief Valves. A pressure-relief valve shall be installed between the pump discharge and the pipeline in case the shutoff switch fails. Pressure-relief valves shall also be installed downstream of pressure-reducing valves to prevent the pressure rating of the pipe being exceeded should erratic operation of the pressure-reducing valve occur.

Pressure-relief valves shall be no smaller than ¼ inch nominal size for each inch of the pipeline diameter, and shall be set to open at a pressure no greater than 5 psi above the pressure rating of the pipe.

Joints. Watertight joints that have a strength equal to that of the pipe shall be used. Couplings must be of material compatible with that of the pipe. **Couplings** made of material susceptible to corrosion **must have a protective coating.**

HDPE shall be joined in accordance with the manufacturer's recommendations for the particular pipe to be installed. Piping can be joined either mechanically or thermally. Except for cost, either joint method is acceptable for all pressures. Insert fittings used for mechanical joints shall be galvanized steel, brass, stainless steel or plastic meeting ASTM D2609 requirements.

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

Minimum pipe size for stockwater pipelines shall be 1-1/4 inch nominal diameter. A 1-inch pipeline may be used on very short pipelines, with no potential for expansion, with Senior Engineer approval.

The minimum cover for buried pipelines shall be 18 inches unless other means are provided to limit hazards from traffic and farm operations (i.e., earth

mounding, fencing, etc.). Pipelines designed for winter use shall be designed with a minimum of 5 feet of cover.

Above Ground Pipe. In areas where it is not possible to bury the pipe due to shallow soils, rock, slopes, easement limitations for pipe burial, etc., the pipe shall be steel or High Density Polyethylene (HDPE).

The ground surface shall be as smooth as practical without projecting sharp rocks, crevices, or other irregularities that can create a point load or cause abrasion to the pipe. Avoid placement of above ground pipe on or near cattle trails, or in direct sunlight where water temperatures could deter livestock from drinking. Data indicates cattle prefer to drink water with moderate temperatures (63-82ºF).

Steel pipe installed above ground shall be galvanized or protected with a suitable protective paint coating, including a primer coat and two or more final coats.

For above ground steel pipelines with welded joints, anchor blocks and expansion joints shall be installed. The spacing shall limit pipe movement due to expansion or contraction to 40 percent of the sleeve length of the expansion coupling. The maximum pipe length between expansion joints shall be 500 feet.

Above ground steel pipelines with rubber gasket joints shall include steel hold-down straps at pipe supports or uniformly-spaced anchor blocks.

For the design of above ground HDPE pipe (see Idaho Technical Note #17, Above-Ground Applications for Polyethylene Pipe).

Above ground HDPE pipe shall have adequate slack for thermal movement to protect fittings and joints. A minimum of 5 percent slack is required.

On sloping ground, HDPE pipe shall be adequately anchored to avoid pipe wall, joint, and connection stresses due to continuous downhill creep of the pipe. Anchors are required at all points of abrupt changes in grade, horizontal alignment, reduction in size, tees, wyes, and connections to livestock tanks, storage tanks, and pumps. The blocks shall be of sufficient size to withstand momentum, working pressure, and expansion and contraction forces that might cause pipe movement.

Above ground pipe shall be buried within 50 feet of a tank.

The pipe pressure rating shall be reduced where pipe temperatures may exceed 73.4° F using the factors in Table 1, or factors obtained from the manufacturer. Tests have shown HDPE pipe exposed to the sun reached temperatures of 130° F. when ambient temperatures were 85ºF.

TABLE 1

Strength Reduction Factors for High Temperatures		
Temperature, ºF	Buried PVC Pipe	PE Pipe
≤ 73.4	1.0	1.0
80	0.88	0.92
90	0.75	0.81
100	0.62	0.72
110	0.50	0.63
120	0.40	0.60
130	0.30	0.55
140	0.22	0.50

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

Vegetation. Disturbed areas shall be established with vegetation, **such as scraping topsoil back over disturbed areas,** or otherwise stabilized as soon as practical after construction. Seedbed preparation, seeding, fertilizing, and mulching shall conform to NRCS**, FOTG, Section IV,** Conservation Practice Standard, Critical Area Planting **(Code** 342**)**.

Visual resources. The visual design of pipelines and appurtenances in areas of high public visibility shall be carefully considered.

CONSIDERATIONS

Select the pipeline route to eliminate or minimize undulating grade changes and/or impacts to cultural resources.

Consider more frequent air venting for artesian systems that contain gas, summits with extremely low operating heads (less than 20 psi), and summits collecting air from multiple laterals or long reaches.

For shallow bury HDPE pipelines where drains are not included, consideration shall be given to the need for pipeline operation during cold weather.

Consider the potential for future expansion of the pipeline. Consider the effects of erosion and sedimentation from disturbed areas during and following construction.

On above ground pipelines, consider route selection or shallow earth cover to minimize potential fire hazards and reduce the effects of direct sunlight.

PLANS AND SPECIFICATIONS

Plans and specifications for installing pipelines shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. If the pipeline is a component of a system that includes additional conservation practices, the information necessary to construct these additional practices will also be conveyed on the plans.

The Engineering Field Handbook, Chapter 5, will guide the development of plans.

OPERATION AND MAINTENANCE

An O&M plan specific to the type of installed pipeline shall be provided to the landowner. The plan shall include, but not be limited to, the following provisions:

- Opening/closing valves to prevent excessive water hammer;
- **Trench backfill maintenance to fill in areas of settlement.**
- Filling at the specified rate requirements;
- Inspecting and testing valves, pressure regulators, pumps, switches and other appurtenances;
- Maintaining erosion protection at outlets;
- Checking for debris, minerals, algae and other materials which may restrict system flow; and
- Draining and/or providing for cold weather operation of the system.

REFERENCES

Engineering Field Handbook**, Part 650.**
Montana Stockwater Pipeline Manual

National Engineering Manual.

Plastic Pipe Institute, "Above Ground Applications for Polyethylene Pipe".

Unibell, Handbook of PVC Pipe.

USDA NRCS, Idaho, Technical Note #17, Above-Ground Applications for Polyethylene Pipe.