NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD
ARIZONA

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

Conservation Practices shall be designed on an individual basis to meet site conditions and functional requirements. They shall be part of an approved and overall engineering plan for irrigation, drainage, wildlife, recreation, channel improvement, or similar purposes.

Design and implementation of subsidiary components and/or structures shall meet all applicable Natural Resource Conservation Service (NRCS) standards. The criteria for the design of any components not specifically addressed in NRCS practice standards or specifications shall be consistent with sound engineering principles and/or manufacturer recommendations.

***Laws and Regulations**. Design, installation, and operation of all pipelines and appurtenances shall comply with all federal, state, Tribal and local laws, rules, and regulations. Laws and regulations of particular concern include those involving water rights, land use, pollution control, property easements, wetlands, preservation of cultural resources, and endangered species.*

The owner is responsible for securing necessary permits and water rights, complying with all laws and regulations, and meeting legal requirements applicable to the installation, operation, and maintenance of this practice and associated structures.

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 *and appurtenances* 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 73.4ºF. 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.

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.

Pressure-reducing valves (PRV) may be used for the tie-in to an existing system of lower pressure rating or to allow lateral pipelines to use materials of lower pressure rating.

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.

Continuous Acting Air Valves (CAV) shall be placed at all high points or summits in long delivery lines and at major changes in grade. Air Vents (non-continuous AV-VR) shall be included at 3,000 foot intervals (recommended), or as needed at shorter intervals depending on high points along the planned pipeline, and shall be placed upstream and downstream from all in-line valves. CAV's and AV-VR's shall have a minimum opening of one-fifth (1/5) the pipeline diameter.

Where manual air vents are used in-lieu of CAV's and AV-VR's, the Operation and Maintenance plan shall clearly describe how these vents will be operated during the filling or draining of the system.

A vented stand pipe or open air vent shall have a minimum freeboard of 1 foot above the hydraulic grade line and shall have a diameter of at least one third (1/3) of the pipeline being protected.

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. 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.

Aboveground/surface installation is permitted if ALL of the following conditions are documented and met:

a. Site/environmental restrictions (wetlands, bedrock or rock outcroppings within the estimated burial depth, steep slopes) or cultural resources limit pipe burial.
b. The pipe material shall be high density polyethylene (HDPE).
c. The pipe shall not exceed 4 inches in diameter.
d. The Pipe, fittings and appurtenances shall have a minimum pressure rating of 200 psi and the system design pressure will not exceed 50-percent of the pressure rating of the pipe;
e. Pipe and fitting materials shall be PE 3408 as per ASTM D3350 and shall be manufactured in accordance with ASTM D2239 Polyethylene (PE) plastic pipe (SIDR-PR) based on controlled inside diameter, or ASTM D3035 Polyethylene (PE) plastic pipe (SDR-PR) based on controlled outside diameter, also referred to as Iron Pipe Size (IPS) pipe. The pipe shall be black with 2% minimum carbon black. The pipe shall contain no recycled compounds except that generated in the manufacturer's own plant from resin of the same specification from the same raw material;
f. The planner and/or designer shall advise the cooperator of the potential hazard imposed by fire, livestock, vehicles, and vandalism;
g. High temperature is detrimental to an above ground plastic pipeline. All pipelines, particularly for high pressure applications, shall be placed, as far as practicable, to minimize exposure to the sun. When feasible, cover the pipeline with loose dirt or other non-abrasive material. Install the pipeline on the north side of a ridge and under trees or brush to provide shade when possible.
h. Above ground pipelines shall be installed in a slightly snaked pattern to allow for thermal expansion and contraction. Allow at least 4-feet extra length per 100-feet of pipeline.
i. Piping 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. The preferred method is to use butt fusion welding. Metal insert fittings shall be used for all clamp or band-type fittings to prevent pipe collapse. The inserts shall be galvanized steel, brass, or stainless steel. Double banding or double clamping with the heads offset 90° to 180° shall be used for all insert fittings. The ends shall be heated either with hot water or a hot air gun. Heating by open flame is not allowed. All damaged pipe ends shall be removed before joining. The pipe shall be allowed to cool before clamps or bands are installed.
j. Although HDPE PE 3408 pipe is not damaged by freezing, other components in the line may be susceptible to freeze damage. All fittings, gauges, pumps, valves and other components that need protection shall be adequately protected. Pipelines with pumps shall employ pressure release valves if needed to ensure the pipe is not over-pressured as a result of freeze blockage in the pipeline.
k. The heating effect of direct sunlight on a black pipeline, with no water flowing, can raise the temperature of the pipe and the water within the pipe to 50°F above the ambient air temperature. The generally used upper limit of pipeline temperature for pressure applications shall be 140° F. The area engineer shall approve all pressure pipelines located in a desert environment that are exposed to direct sunlight and are subject to sustained ambient air temperatures of 100°F or higher with no water flowing.

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.

HDPE pipelines may be installed by "plow-in" (ripper) equipment where the soil is free of rocks and boulders, which would be detrimental to the pipe.

The pipe shall be placed below the frost line, and not less than 18 inches in range land and 30

inches when crossing cultivated fields and road crossings. The minimum depth may be obtained by mounding soil over the pipeline on range land where site conditions such as shallow soils or rock make it impractical to attain the minimum depth of cover by usual means.

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).

Screens. *Screens, made of copper, plastic or galvanized steel, shall be placed at pipes exiting from storage tanks or ponds. Screens shall extend far enough above the tank bottom, to prevent entry of sediment into the pipe.*

Testing. *Pressure testing shall be performed for all installed pipeline systems.*

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.

Additional Criteria in Listed Species' Habitat.

This practice is not likely to adversely affect listed species or their critical habitat if the following conservation measures are implemented.

- *Use existing stream crossings for equipment access during practice installation.*
- *Minimize soil and vegetation disturbance during practice installation. Remove only targeted species and leave native herbaceous layer undisturbed to allow for regrowth.*
- *Ensure equipment does not have oil or fuel leaks, and maintenance work is done away from water*

- *Immediately clean any grease, oil, or other contaminant spills and remove from the site.*
- *Avoid planting of non native plants. NRCS will consult with Fish and Wildlife Service (FWS) if the planting of non native plants is unavoidable.*
- *Minimize upland soil compaction during practice installation by scheduling installation during dry periods.*
- *Reduce spread of non-native plants or animals by implementing the practice during the dormant season (e.g. avoid ground disturbance in riparian areas in the summer to reduce salt cedar spread).*
- *Use existing roads and limit cross country travel.*
- *Where clearing of vegetation is determined to be necessary during planned construction or maintenance, limit the width of clearance to 25 feet maximum.*
- *Flag or otherwise protect individual of a listed plant species for protection during construction.*
- *Do not demolish or remove existing vegetation, habitat structures, covers or nest materials located within a 250 feet wide undisturbed buffer.*
- *Alignments for planned construction (pipelines, fences) will be routed so as to avoid specific areas known to be occupied by listed species and known habitat features such as burrows and nests.*
- *Conduct a pre-installation, pedestrian survey for wildlife that may be trapped within a temporarily fenced construction area. Trapped wildlife will be allowed to escape prior to construction.*
- *Screen inlets and outlets to prevent non-native fish and amphibians from spreading into other habitats*
- *Clean equipment used in practice implementation (vehicles, farm equipment, and tools) before entering and leaving project site to prevent the spread of non-native plant/animals or disease*
- *Open trenches must provide wildlife safe ingress/egress if left open overnight. (ladder or dirt plugs to allow escape)*

Investigations, Surveys and Design Criteria*. Documentation requirements will be as outlined below, in additional to the documentation requirements of the practice components used in the system.*

Preliminary site assessment, investigation or reconnaissance to determine the complexity of the problem and/or site, including the number of livestock served in each pasture/range, total number in the system, season of use, and number and location of facilities served, and shall include:

1. *Soil or geological investigation to determine soil conditions, properties (physical and chemical), depths and topography along proposed alignment. Documentation shall include the following, at a minimum:*
   a. *Classification by the Unified Soil Classification System (SM, CL, etc.) and texture (silty sand, lean clay, etc.).*
   b. *Corrosion potential (metal pipe), resistivity readings or published data.*
2. *Water source (i.e., available flow rate, depth to water, and temperature) and water quality in areas of known water quality concerns.*
3. *Verify appropriate state or local laws for permitting and approval requirements and notify landowner of his/her responsibilities.*

To adequately plan and layout this practice, a detailed topographic survey is required, that adequately details:

1. *Site topography, as needed to show the physical features of the site, including existing features/practices, ground elevations, location of any utilities or markers, etc.*
2. *Profile along the centerline of the pipeline to determine pipeline control elevations and lengths. Where applicable, USGS 7.5-minute topographic Quadrangles combined with aerial photography may be used, provided design analysis verifies minimum hydraulic criteria (pressures and flows) are achievable at all locations.*
3. *If applicable, a permanent benchmark(s) shall be set and described. Preferably, the elevations and coordinates should be based on a local (assumed) or coordinate system (State or grid) and clearly stated on the plan. Datum may be in the form of Northing and Easting coordinates or Longitude and Latitude.*

The design of a practice is the application of Field Office Technical Guide practice standards, practical experience and judgment in the

development of a solution to the problem or the objective. All computations and decisions made during the design of a practice are to be checked by another qualified individual and appropriate notations made. Design computations, calculations or analysis shall meet the following criteria:

1. *Calculate design flow based on livestock served, tank and trough sizes, etc.*
2. *Hydraulic analysis and determinations to support pipe sizes and pressure requirements for each reach and design flow delivery to all locations or turnouts.*
3. *Material estimates (material volume computations), includes estimates of earthwork, pipe, fittings and appurtenances, concrete, vegetative components.*
4. *Subsidiary and applicable components shall be designed in accordance with applicable conservation practice standards (i.e., pipelines shall meet the requirements of Conservation Practice 614, Watering Facilities, etc.);*
5. *In the absence of verifiable survey data and/or hydraulic calculations, the following pipe diameters may be recommended for gravity flow systems only and do not apply to pump systems:*

- *For slopes > 1% use 1¼ inch diameter (minimum)*
- *Slopes 0.5 to 1% use 1 ½ inch diameter and for uniform slopes and controlled grade use 1 inch diameter*
- *Slopes < 0.5% use 2 inch diameter (minimum), and*
- *For slopes < 0.2% gravity flow systems are not recommended.*

***Installation and Basis of Acceptance**. For construction that does not meet State, OSHA, or Tribal criteria or requirements where deficient construction materials were used, NRCS may consider a waiver request for approval of construction after it has received a signed and sealed construction and/or material exemption from a licensed engineer. Required exemption shall be for installation of materials that do not meet minimum quality criteria as found in applicable Standards, Specifications, ASTM's, AWWA standards, etc.*

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.
- *Design alternatives presented to the client should address economics, ecological concerns and acceptable level of risk for design criteria as it relates to hazards to life or property.*

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. *Landforms, structural materials, water elements, and plant materials should visually and functionally complement their surroundings. Excavated material and cut slopes should be shaped to blend with the natural topography. Shorelines can be shaped and islands created to add visual interest and valuable wildlife habitat. Exposed concrete surfaces may be formed to add texture or finished to reduce reflection and to alter color contrast. Site selection can be used to reduce adverse impacts or create desirable focal points.*

6. Consider Short term and construction-related effects of this practice on the quality of downstream water.
7. Consider components needed for the safe operation of the proposed improvements such as railing, fencing, or warning signs as appropriate.

***Flow Measurement**. A water measurement device or structure (flow meter, ramp flume, weir, etc.) may be installed to manage water applications and for on-going evaluation of system performance. Manufacturer's recommendations or sound engineering guidance must be followed regarding size, placement, orientation, etc.*

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.

Use Arizona drawing templates to the extent possible. These may be supplemented by additional drawings or specification notes on the drawings to provide full installation instructions.

Use Arizona Construction and Material Specifications for each item of work and material, as applicable and available. Additional specifications may need to be written to provide full material and installation instructions. Fill in blanks and add or delete items from the specifications to make them fit the job as needed

Construction plans shall include all components needed for the safe operation of the proposed improvements such as railing, fencing, or warning signs as appropriate. The plans shall address operations near existing utilities, trench excavations and any other items related to construction of the structure that may pose a safety risk to those involved.

Plans for installing pipelines shall be in accordance with the National Engineering Manual Parts 54, and The National Engineering Handbook, Part 641.

The plans and specifications shall include all details, material requirements, quantities, construction requirements, equipment requirements, and all other documents necessary for construction and completion of this practice and shall include the following minimum documentation.

- *Project location map, including section, township and range, North arrow, cooperator/owner acknowledgement and certification signature blocks, engineering job class (cover sheet);*
- *References that the owner/cooperator are responsible for all permits, rights-of-way, easements and the contact, coordination and location determination of any existing utilities or clearances (buried utility disclaimer);*
- *If applicable, a map showing the location of the practice(s) or system in reference to a known or established benchmark or reference point with the location, description and elevation clearly shown. Topographical features and/or controls shall be shown, showing tie in with existing or other planned practices;*
- *Field surveys and notes, soil investigations or geologic soil boring locations and soil classifications, earthwork or material estimates/quantities (for excavation or backfill requirements);*
- *System overview and layout (i.e., location and orientation of practice in relation to existing or planned facilities; identify the water source and type; show pipeline alignment/stationing and profile, including installation depths, pipe grades, hydraulic and static grade lines; material type, diameter, pressure rating; connections to tanks or facilities; vegetative requirements; construction/installation criteria, including State and Federal [OSHA] safety requirements, etc.);*
- *Appurtenance or fitting details (i.e., hydrants, air vents, drain valves, pressure relief valves, etc.) as required, for proper system functionality.*

- *Construction notes, details or specifications to clarify a component and furnish directions or site specific requirement, i.e. quantities of materials.*

All designs completed by non-NRCS personal shall meet minimum State licensing board requirements and NRCS requirements and criteria as outlined in the General Manual, the National Engineering Manual (including Arizona Supplements), and the National Engineering Handbook.

ONCE ALL PARTIES HAVE ACCEPTED AND SIGNED THE PLANS AND SPECIFICATIONS, NO CHANGES SHALL BE MADE TO THE DRAWINGS OR SPECIFICATIONS WITHOUT PRIOR APPROVAL OF NRCS.

OPERATION AND MAINTENANCE

A site specific 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. *The plan shall document needed actions, provide specific instructions for operating and maintaining the system, including reference to periodic inspections and the prompt repair or replacement of damaged components 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.

The plan shall include, but not be limited to, the following provisions:

- *Check to make sure all valves and air vents are set at the proper operating condition so they may provide protection to the pipeline.*
- *Maintain the design depth of cover over the pipeline and avoid any sub-soiling operation that may disturb the pipeline.*
- *Limit traffic over the pipeline to designated sections that were designed for traffic loads and avoid travel over pipelines by tillage equipment when the soil is saturated.*
- *Remove all foreign debris that hinders system operation.*
- *Drain the system and components in areas that are subject to freezing. If parts of the system cannot be drained, an anti-freeze solution shall be added.*
- *Allow the pipe to fill gradually when being put into use after shut down or draining.*
- *Periodically check and repair all valves, gates and regulators to the system requirements following the manufacturer's recommendations.*
- *Checking coatings on fiberglass and plastic tanks and re-coating as needed to maintain effective ultraviolet resistance;*
- *Maintaining appurtenance features (valves, piping, floats, drains, fences, etc.) in functional and protected conditions;*
- *Eradicate or otherwise remove all rodents or burrowing animals that have or may potentially damage any part of the delivery or application facilities. Immediately repair any damage caused by their activity;*
- *Immediately repair any damage resulting from vandalism, vehicles, livestock or wildlife;*

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

- *Kings Handbook of Hydraulics.*

- *National Engineering Handbook - Part 650,* Engineering Field Handbook*, Chapter 1 – Surveying; Chapter 3 – Hydraulics; Chapter 4 – Elementary Soils Engineering; and Chapter 6 – Structures*
- *USDA-NRCS, TR-210-62 – Engineering Layout, Notes, Staking and Calculations.*
- *National Environmental Compliance Handbook.*
- *USDA NRCS, Engineering Design Standards – Far West States*
- *National Engineering Handbook (NEH), Part 634 – Hydraulic Engineering; Natural Resources Conservation Service*