NRCS Conservation Practice Standards

Field **O**ffice **T**echnical **G**uide

Available on the internet:
http://www.nrcs.usda.gov/technical/efotg/

Conservation Practice Standards

- Standards contain technical information for design and installation of conservation practices.
- Standards are customized for use in each State.
- Missouri currently maintains 141 Standards.

Conservation Practice Standards

- Standards are organized with the following sections:
  - DEFINITION
  - PURPOSE
  - CONDITIONS WHERE PRACTICE APPLIES
  - CRITERIA
  - CONSIDERATIONS
  - PLANS AND SPECIFICATIONS
  - OPERATION AND MAINTENANCE

SUBSURFACE DRAIN – 606
Conservation Practice Standard

- ***CRITERIA Highlights***
  - Drainage Coefficients (Page 606-1, column 2)
  - Nominal Diameter (Page 606-2, column 1)
  - Minimum Depth of Cover (Page 606-2, column 1)
  - Maximum Depth of Cover (Page 606-2, column 1)
  - Minimum Velocities (Page 606-2, column 2)
  - Maximum Velocities (Page 606-2, column 2)
  - Placement and Bedding (Page 606-5, column 2)

Drainage Coefficients
(Page 606-1, column 2)

Question:

What is the range of DC for a mineral soil growing field crops?

CONDITIONS WHERE PRACTICE APPLIES

This standard applies to agricultural land where a shallow water table exists and where a subsurface drainage system can mitigate the following adverse conditions caused by excessive soil moisture:

- Poor health, vigor and productivity of plants.
- Poor field trafficability.
- Accumulation of salts in the root zone.
- Health risk and livestock stress due to pests such as flukes, flies, or mosquitoes.
- Contributions from surface inlets based on hydrologic analysis or flow measurements

Table 1: Drainage Coefficients

Soil	(inches to be removed in 24 hours)	
	Field crops	Truck crops
Mineral	3/8 – 1/2	1/2 – 3/4
Organic	1/2 – 3/4	3/4 – 1 1/2

Size. The size of subsurface drains shall be computed by applying Manning's formula

Nominal Diameter
(Page 606-2, column 1)

Question:

What is the minimum nominal diameter for subsurface drainage pipe?

606-2 SUBSURFACE DRAIN

- Conduit flowing under internal pressure with hydraulic grade line set by site conditions, which differs from the bottom grade of the subsurface drain.

All subsurface drains shall have a nominal diameter that equals or exceeds 4 inches.

Internal Hydraulic Pressure. Drains are normally designed to flow with no internal pressure, and the flow is normally classified as open channel. The design internal pressure of drains shall not exceed the limits recommended by the manufacturer of the conduit.

Chapter 52, Structural Design of Flexible Conduits.

For computation of maximum allowable loads on subsurface drains of all materials, use the trench and bedding conditions specified, and the compressive strength of the conduit. The design load on the conduit shall be based on a combination of equipment loads, trench loads, and road traffic, as applicable.

Equipment loads shall be based on the maximum expected wheel loads for the equipment to be used, the minimum height of cover over the conduit, and the trench width.

Depth of Cover
(Page 606-2, column 1)

Question:

What is minimum depth of cover for drains in mineral soils?

Location, Depth, and Spacing. The location, depth, and spacing of the subsurface drain shall be based on site conditions including soils, topography, groundwater conditions, crops, land use, outlets, saline or sodic conditions, and proximity to wetlands.

The minimum depth of cover over subsurface drains may exclude sections of conduit near the outlet or through minor depressions, providing these sections of conduit are not subject to damage by frost action or equipment travel.

In mineral soils, the minimum depth of cover over subsurface drains shall be 2.0 feet.

where sedimentation is not a hazard, minimum grades shall be based on site conditions and a velocity of not less than 0.5 feet per second. If a sedimentation hazard exits, a velocity of not less than 1.4 feet per second shall be used to establish the minimum grades. Otherwise, provisions shall be made for preventing sedimentation by use of filters or by collecting and periodically removing sediment from installed traps, or by periodically cleaning the lines with high-pressure jetting systems or cleaning solutions.

Maximum Velocity. Design velocities for perforated or open joint pipe shall not exceed those given in Table 1, unless special

Velocities
(Page 606-2, column 2, Table 1)

Question:

What is the maximum velocity for water in tile surrounded by a silt loam soil?

travel.

In mineral soils, the minimum depth of cover over subsurface drains shall be 2.0 feet.

In organic soils, the minimum depth of cover after initial subsidence shall be 3.0 feet. If water control structures are installed and managed to limit oxidation and subsidence of the soil, the minimum depth of cover may be reduced to 2.5 feet.

For flexible conduits, maximum burial depths shall be based on manufacturer's recommendations for the site conditions, or based on a site-specific engineering design consistent with methods in NRCS National Engineering Handbook (NEH), Part 636,

Maximum Velocity. Design velocities for perforated or open joint pipe shall not exceed those given in Table 1, unless special protective measures are installed. Design velocities with protective measures shall not exceed manufacturer's recommended limits.

Table 1. Maximum Flow Velocities by Soil Texture.

Soil Texture	Velocity, ft./sec.
Sand and sandy loam	3.5
Silt and silt loam	5.0

NRCS MOFOTG
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Placement and Bedding
(Page 606-5, column 2)

Question:

Can a 6" CPT be bedded with 3" crushed limestone?

strength, durability, and permeability are adequate to prevent soil movement into the drain throughout the expected life of the system. Geotextile filter material shall not be used where the silt content of the soil exceeds 40 percent.

Envelopes and Envelope Material. Envelopes shall be used around subsurface drains if needed for proper conduit bedding or to improve flow characteristics into the conduit.

Materials used for envelopes do not need to meet the gradation requirements of filters, but they must not contain materials that will cause an accumulation of sediment in the conduit, or materials that will render the envelope unsuitable for bedding of the conduit.

Envelope materials shall consist of sand-gravel, organic, or similar material. 100 percent of sand-gravel envelope materials

made in materials such as soil slurries.

For the installation of Corrugated Plastic Pipe with diameters of 8 inches or less, one of the following bedding methods shall be specified:

1. A shaped groove providing an angle of support of 90 degrees or greater shall be provided in the bottom of the trench for tubing support and alignment.
2. A sand-gravel envelope, at least 3 inches thick, to provide support.
3. Compacted bedding material beside and to 3 inches above the conduit.

For the installation of Corrugated Plastic Pipe with diameters larger than 8 inches, the same bedding requirements shall be met except that a semi-circular or trapezoidal groove shaped to fit the conduit with a support angle of 120

Construction Specifications

- NRCS has developed Construction Specifications that comply with the Practice Standard's design and installation requirements.
- Construction Specifications complement the Construction Drawings and are a part of the plans.
- Specifications provide details and descriptions of allowable materials and acceptable fabrication, installation and construction techniques.

SUBSURFACE DRAIN – 606
Construction Specification

- Materials (Page 606-1)
  - PE Tubing
  - PVC Pipe
  - Metal Pipe
  - Vitrified Clay Tile
  - Concrete Tile
- Conduit Perforations (Page 606-2)
  - Round
  - Slotted
- Trenching and Bedding (Page 606-2)
  - Width
  - Shape
  - Backfill material

Materials
(Page 606-1)

Question:

To what ASTM must a 4" diameter corrugated PE tubing be manufactured?

MATERIALS

The following specifications pertain to products currently acceptable for use as subsurface drains. These specifications are also to be applied in determining the quality of materials referenced by other standards:

Type	Specification
Plastic	
Corrugated polyethylene (PE) tubing and fittings 3-6 inches	ASTM F405
Corrugated polyethylene (PE) tubing and fittings 8-24 inches	ASTM F667
Polyvinyl chloride (PVC) corrugated sewer pipe with a smooth interior and fittings 4-8 inches	ASTM F949
Polyvinyl chloride (PVC) sewer pipe and fittings	ASTM D2729, ASTM D3034 type PSM or PSP
Metal	
Pipe, corrugated (aluminum alloy)	ASTM B745
Pipe, corrugated (iron or steel, zinc coated)	ASTM A760, A762, or A885

Conduit Perforations
(Page 606-2)

Question:

What is the largest acceptable slot width?

606-2 SUBSURFACE DRAIN

CONDUIT PERFORATIONS SPECIAL REQUIREMENTS

Where perforated conduit is required, the water inlet area shall be at least 1 square inch per foot of conduit length. Round perforations shall not exceed 3/16-inches in diameter except where filters, envelopes, or other protection is provided or for organic soils, where a maximum hole diameter of ½-inches may be used. Slotted perforations shall not exceed 1/8-inches in width.

NRCS Natural Resources Conservation Service
United States Department of Agriculture

NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

SUBSURFACE DRAIN

(Ft.)

CODE 606

DEFINITION

A conduit installed beneath the ground surface to collect and/or convey excess water.

PURPOSE

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

- Remove or distribute excessive soil water.
- Remove salts and other contaminants from the soil profile.

CONDITIONS WHERE PRACTICE APPLIES

This standard applies to agricultural land where a shallow water table exists and where a subsurface drainage system can mitigate the following adverse conditions caused by excessive soil moisture:

- Poor health, vigor and productivity of plants.
- Poor field trafficability.
- Accumulation of salts in the root zone.
- Health risk and livestock stress due to pests such as flukes, flies, or mosquitoes.
- Wet soil conditions around farmsteads, structures, and roadways.

This standard also applies where collected excess water can be distributed through a subsurface water utilization or treatment area.

CRITERIA

Capacity. Design capacity shall be based on the following, as applicable:

- Application of a locally proven drainage coefficient for the acreage drained.
- Yield of groundwater based on the expected deep percolation of irrigation water from the overlying fields.
- Comparison of the site with other similar sites where subsurface drain yields have been measured.
- Measurement of the rate of subsurface flow at the site during a period of adverse weather and groundwater conditions.
- Application of Darcy's law to lateral or artesian subsurface flow.
- Contributions from surface inlets based on hydrologic analysis or flow measurements

Table 1: Drainage Coefficients

Soil	(inches to be removed in 24 hours)	
	Field crops	Truck crops
Mineral	3/8 – 1/2	1/2 – 3/4
Organic	1/2 – 3/4	3/4 – 1 1/2

Size. The size of subsurface drains shall be computed by applying Manning's formula, using roughness coefficients recommended by the manufacturer of the conduit. The size shall be based on the maximum design flow rate and computed using one of the following assumptions:

- The hydraulic grade line parallel to the bottom grade of the subsurface drain with the conduit flowing full at design flow (normal condition, no internal pressure).
- Conduit flowing partly full where a steep grade or other conditions require excess capacity.

- Conduit flowing under internal pressure with hydraulic grade line set by site conditions, which differs from the bottom grade of the subsurface drain.

All subsurface drains shall have a nominal diameter that equals or exceeds 4 inches.

Internal Hydraulic Pressure. Drains are normally designed to flow with no internal pressure, and the flow is normally classified as open channel. The design internal pressure of drains shall not exceed the limits recommended by the manufacturer of the conduit.

Horizontal Alignment. A change in horizontal direction of the subsurface drain shall be made by one of the following methods:

1. The use of manufactured fittings.
2. The use of junction boxes or manholes.
3. A gradual curve of the drain trench on a radius that can be followed by the trenching machine while maintaining grade.

Location, Depth, and Spacing. The location, depth, and spacing of the subsurface drain shall be based on site conditions including soils, topography, groundwater conditions, crops, land use, outlets, saline or sodic conditions, and proximity to wetlands.

The minimum depth of cover over subsurface drains may exclude sections of conduit near the outlet or through minor depressions, providing these sections of conduit are not subject to damage by frost action or equipment travel.

In mineral soils, the minimum depth of cover over subsurface drains shall be 2.0 feet.

In organic soils, the minimum depth of cover after initial subsidence shall be 3.0 feet. If water control structures are installed and managed to limit oxidation and subsidence of the soil, the minimum depth of cover may be reduced to 2.5 feet.

For flexible conduits, maximum burial depths shall be based on manufacturer's recommendations for the site conditions, or based on a site-specific engineering design consistent with methods in NRCS National Engineering Handbook (NEH), Part 636, Chapter 52, Structural Design of Flexible Conduits.

For computation of maximum allowable loads on subsurface drains of all materials, use the trench and bedding conditions specified, and the compressive strength of the conduit. The design load on the conduit shall be based on a combination of equipment loads, trench loads, and road traffic, as applicable.

Equipment loads shall be based on the maximum expected wheel loads for the equipment to be used, the minimum height of cover over the conduit, and the trench width. Equipment loads on the conduit may be neglected when the depth of cover exceeds 6 feet. Trench loads shall be based on the type of backfill over the conduit, the width of the trench, and the unit weight of the backfill material. A safety factor of not less than 1.5 shall be used in computing the maximum allowable depth of cover for a particular type of conduit.

Minimum Velocity and Grade. In areas where sedimentation is not a hazard, minimum grades shall be based on site conditions and a velocity of not less than 0.5 feet per second. If a sedimentation hazard exits, a velocity of not less than 1.4 feet per second shall be used to establish the minimum grades. Otherwise, provisions shall be made for preventing sedimentation by use of filters or by collecting and periodically removing sediment from installed traps, or by periodically cleaning the lines with high-pressure jetting systems or cleaning solutions.

Maximum Velocity. Design velocities for perforated or open joint pipe shall not exceed those given in Table 1, unless special protective measures are installed. Design velocities with protective measures shall not exceed manufacturer's recommended limits.

Table 1. Maximum Flow Velocities by Soil Texture.

Soil Texture	Velocity, ft./sec.
Sand and sandy loam	3.5
Silt and silt loam	5.0

Silty clay loam	6.0
Clay and clay loam	7.0
Coarse sand or gravel	9.0

Ref: NEH 624, Chapter 4, Subsurface Drainage.

On sites where topographic conditions require drain placement on steep grades and design velocities greater than indicated in Table 1, special measures shall be used to protect the conduit or surrounding soil.

Protective measures for high velocities shall include one or more of the following, as appropriate:

1. Enclose continuous perforated pipe or tubing with fabric type filter material or properly graded sand and gravel.
2. Use non-perforated continuous conduit or a watertight pipe, and sealed joints.
3. Place the conduit in a sand and gravel envelope, or initial backfill with the least erodible soil available.
4. Select rigid butt end pipe or tile with straight smooth sections and square ends to obtain tight fitting joints.
5. Wrap open joints of the conduit with tar-impregnated paper, burlap, or special fabric-type filter material.
6. Install larger diameter drain conduit in the steep area to help assure a hydraulic grade line parallel with the conduit grade.
7. Install open air risers for air release or entry at the beginning and downstream end of the high velocity section.

Releases from drainage water management structures shall not cause flow velocities in perforated or open joint drains to exceed allowable velocities in Table 1, unless protective measures are installed.

Thrust Control. Follow pipe manufacturer's recommendations for thrust control or anchoring, where the following conditions exist:

- Axial forces that tend to move the pipe down steep slopes.
- Thrust forces from abrupt changes in pipeline grade or horizontal alignment, which exceed soil bearing strength.
- Reductions in pipe size.

In the absence of manufacturer's data, thrust blocks shall be designed in accordance with NEH, Part 636, Chapter 52, Structural Design of Flexible Conduits.

Outlets. Drainage outlets shall be adequate for the quantity and quality of water to be discharged.

Outlets to surface water shall be designed to operate without submergence under normal conditions.

For discharge to streams or channels, the outlet invert shall be located above the elevation of normal flow and at least 1.0 foot above the channel bottom.

Outlets shall be protected against erosion and undermining of the conduit, entry of tree roots, damaging periods of submergence, and entry of rodents or other animals into the subsurface drain.

A continuous section of pipe without open joints or perforations, and with stiffness necessary to withstand expected loads, shall be used at the outlet end of the drain line. Minimum lengths for the outlet section of conduit are provided in Table 2. Single-wall Corrugated Plastic Pipe is not suitable for the section that outlets into a ditch or channel.

For outlets into sumps, the discharge elevation shall be located above the elevation at which pumping is initiated.

Table 2. Minimum Length of Outlet Pipe Sections.

Pipe Diameter, in.	Min. Section Length, ft.
8 and smaller	10
10 to 12	12
15 to 18	16
Larger than 18	20

The use and installation of outlet pipe shall conform to the following requirements:

- If burning vegetation on the outlet ditch bank is likely to create a fire hazard, the material from which the pipe is fabricated must be fireproof.
- At least two-thirds of the pipe section shall be buried in the ditch bank, and the cantilever section must extend to the toe of the ditch side slope, or the side slope shall be protected from erosion.
- If ice or floating debris may damage the outlet pipe, the outlet shall be recessed to the extent that the cantilevered part of the pipe will be protected from the current of flow in the ditch or channel.
- Headwalls used for subsurface drain outlets must be adequate in strength and design to avoid washouts and other failures.

Protection from Biological and Mineral Clogging. Drains in certain soils are subject to clogging of drain perforations by bacterial action in association with ferrous iron, manganese, or sulfides. Iron ochre can clog drain openings and can seal manufactured (fabric) filters. Manganese deposits and sulfides can clog drain openings.

Where bacterial activity is expected to lead to clogging of drains, access points for cleaning the drain lines shall be provided.

Where possible, outlet individual drains to an open ditch to isolate localized areas of contamination and to limit the translocation of contamination throughout the system.

Protection from Root Clogging. Problems may occur where drains are in close proximity to perennial vegetation. Drain clogging may result from root penetration by water-loving trees, such as willow, cottonwood, elm, soft maple, some shrubs, grasses, and deep-rooted perennial crops growing near subsurface drains.

The following steps may reduce the incidence of root intrusion:

- Install a continuous section of non-perforated pipe or tubing with sealed joints, through the root zone.
- Remove water-loving trees for a distance of at least 100 feet on each side of the drain, and locate drains a distance of 50 feet or more from non-crop tree species.
- Provide for intermittent submergence of the drain to limit rooting depth by installing a structure for water control (e.g. an inline weir with adjustable crest) that allows for raising the elevation of the drain outlet.

Water Quality. Septic systems shall not be directly connected to the subsurface drainage system, nor shall animal waste be directly introduced into the subsurface drainage system.

Materials. Subsurface drains include flexible conduits of plastic, bituminized fiber, or metal; rigid conduits of vitrified clay or concrete; or other materials of acceptable quality.

The conduit shall meet strength and durability requirements for the site. All conduits shall meet or exceed the minimum requirements of the appropriate specifications published by the American Society for Testing and Materials (ASTM), American Association of State Highway Transportation Officials (AASHTO), or the American Water Works Association (AWWA).

Foundation. If soft or yielding foundations are encountered, the conduits shall be stabilized and protected from settlement. The following methods are acceptable for the stabilization of yielding foundations:

- Remove the unstable material and provide a stable bedding of granular envelope or filter material.
- Provide continuous cradle support for the conduit through the unstable section.
- Bridge unstable areas using long sections of conduit having adequate strength and stiffness to ensure satisfactory subsurface drain performance.
- Place conduit on a flat, treated plank. This method shall not be used for flexible (e.g. Corrugated Plastic Pipe) without proper bedding between the plank and conduit.

Filters and Filter Material. Filters shall be used around conduits, as needed, to prevent movement of the surrounding soil material into the conduit. The need for a filter shall be determined by the characteristics of the surrounding soil material, site conditions, and the velocity of flow in the conduit. A suitable

filter shall be used if any of the following conditions exist:

- Local experience with soil site conditions indicates a need.
- Soil materials surrounding the conduit are dispersed clays, silts with a Plasticity Index less than 7, or fine sands with a Plasticity Index less than 7.
- The soil is subject to cracking by desiccation.
- The method of installation may result in inadequate consolidation between the conduit and backfill material.

If a sand-gravel filter is specified, the filter gradation shall be designed in accordance with NEH, Part 633, Chapter 26, Gradation Design of Sand and Gravel Filters.

Specified filter material must completely encase the conduit such that all openings are covered with at least 3 inches of filter material, except where the top of the conduit and side filter material are be covered by a sheet of plastic or similar impervious material to reduce the quantity of filter material required. In all cases, the resulting flow pattern through filter material shall be a minimum of 3 inches in length.

Geotextile filter materials may be used, provided that the effective opening size, strength, durability, and permeability are adequate to prevent soil movement into the drain throughout the expected life of the system. Geotextile filter material shall not be used where the silt content of the soil exceeds 40 percent.

Envelopes and Envelope Material. Envelopes shall be used around subsurface drains if needed for proper conduit bedding or to improve flow characteristics into the conduit.

Materials used for envelopes do not need to meet the gradation requirements of filters, but they must not contain materials that will cause an accumulation of sediment in the conduit, or materials that will render the envelope unsuitable for bedding of the conduit.

Envelope materials shall consist of sand-gravel, organic, or similar material. 100 percent of sand-gravel envelope materials shall all pass a 1.5-inch sieve; not more than 30 percent shall pass a Number 60 sieve; and not more than 5 percent shall pass the Number 200 sieve.

Organic or other compressible envelope materials shall not be used below the centerline of flexible conduits. All organic or other compressible materials shall be of a type that will not readily decompose.

Placement and Bedding. Placement and bedding requirements apply to both excavation trenching and plow type installations.

Place the conduit on a firm foundation to ensure proper alignment.

Conduits shall not be placed on exposed rock, or on stones greater than 1½ inches for conduits 6 inches or larger in diameter, or on stones greater than ¾ inch for conduit less than 6 inches in diameter. Where site conditions do not meet this requirement, the trench must be over-excavated a minimum of 6 inches and refilled to grade with a suitable bedding material.

If installation will be below a water table or where unstable soils are present, special equipment, installation procedures, or bedding materials may be needed. These special requirements may also be necessary to prevent soil movement into the drain or plugging of the envelope, if installation will be made in materials such as soil slurries.

For the installation of Corrugated Plastic Pipe with diameters of 8 inches or less, one of the following bedding methods shall be specified:

1. A shaped groove providing an angle of support of 90 degrees or greater shall be provided in the bottom of the trench for tubing support and alignment.
2. A sand-gravel envelope, at least 3 inches thick, to provide support.
3. Compacted bedding material beside and to 3 inches above the conduit.

For the installation of Corrugated Plastic Pipe with diameters larger than 8 inches, the same bedding requirements shall be met except that a semi-circular or trapezoidal groove shaped to fit the conduit with a support angle of 120

degrees will be used rather than a V-shaped groove.

For rigid conduits installed in a trench, the same requirements shall be met except that a groove or notch is not required. For trench installations where a sand-gravel or compacted bedding is not specified, the initial backfill for the conduit shall be selected material containing no hard objects (e.g. rocks or consolidated chunks of soil) larger than 1.5 inches in diameter. Initial backfill shall be carried to a minimum of 3 inches above the conduit.

Auxiliary Structures and Protection. The capacity of any structure installed in the drain line shall be no less than that of the line or lines feeding into or through them.

Structures for water table management, with provisions to elevate the outlet and allow submergence of the upstream drain, shall meet applicable design criteria in NRCS Conservation Practice Standards, Structure for Water Control (587), and Drainage Water Management (554).

If the drain system is to include underground outlets, the capacity of the surface water inlet shall not be greater than the maximum design flow in the downstream drain line or lines. Covers or trash racks shall be used to ensure that no foreign materials are allowed in the drain lines. Inlets shall be protected from entry of animals or debris. If sediment may pose a problem, sediment traps shall be installed.

The capacity of a relief well system shall be based on the flow from the aquifer, the well spacing, and other site conditions, and shall be adequate to lower the artesian water head to the desired level. Relief wells shall not be less than 4 inches in diameter.

Junction boxes, manholes, catch basins, and sand traps must be accessible for maintenance. A clear opening of not less than 2.0 feet will be provided in either circular or rectangular structures.

The drain system shall be protected against turbulence created near outlets, surface inlets or similar structures. Continuous non-perforated or closed-joint pipe shall be used in drain lines adjoining the structure where excessive velocities will occur.

Junction boxes shall be installed where three or more lines join or if two lines join at different elevations. If the junction box is buried, a solid cover should be used, and the junction box should have a minimum of 1.5 feet of soil cover. Buried boxes shall be protected from traffic.

If not connected to a structure, the upper end of each subsurface drain line will be closed with a tight-fitting cap or plug of the same material as the conduit, or other durable materials.

Watertight conduits designed to withstand the expected loads shall be used where subsurface drains cross under irrigation canals, ditches, or other structures.

CONSIDERATIONS

When planning, designing, and installing this practice, the following items should be considered:

- Protection of shallow drains, auxiliary structures, and outlets from damage due to freezing and thawing.
- Proper surface drainage to reduce the required intensity of the subsurface drainage system.
- Designs that incorporate drainage water management practices (or facilitate its future incorporation) to reduce nutrient loading of receiving waters.
- Drainage laterals oriented along elevation contours to improve the effectiveness of drainage water management structures.
- The effects of drainage systems on runoff volume, seepage, and the availability of soil water needed for plant growth.
- Confirmation of soil survey information with site investigation, including auguring and shallow excavations to identify soil profile hydraulic characteristics, soil texture layering, water table depth, etc.
- The effects of drainage systems on the hydrology of adjacent lands.

- Subsoiling or ripping of soils with contrasting texture layers to improve internal drainage.
- Installations in dry soil profile to minimize problems of trench stability, conduit alignment, and soil movement into the drain.
- The effects to surface water quality.
- Use of temporary flow blocking devices to reduce risk of drain water contamination from surface applications of manure.

PLANS AND SPECIFICATIONS

Plans and specifications for installing subsurface drains shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

At a minimum, plans specifications shall include, as applicable: location of drainage system; wetland delineation(s); conduit lengths, grades, sizes, and type of materials; structure locations, dimensions, and elevations; outlet locations, elevations, and protection required; and normal water level elevations in outlet ditches or streams.

OPERATION AND MAINTENANCE

The Operation and Maintenance (O&M) Plan shall provide specific instructions for operating and maintaining the system to insure proper function as designed. At a minimum, the O&M Plan shall address:

- Necessary periodic inspection and prompt repair of system components (e.g. structures for water control, underground outlets, vents, drain outlets, trash and rodent guards).
- Winterization protection from freezing conditions for drainage systems in cold climates.

REFERENCES

USDA-NRCS, National Engineering Handbook, Part 624, Chapter 4, Subsurface Drainage.

USDA-NRCS, National Engineering Handbook, Part 633, Chapter 26, Gradation Design of Sand and Gravel Filters.

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

NATURAL RESOURCES CONSERVATION SERVICE

MISSOURI CONSTRUCTION SPECIFICATION

SUBSURFACE DRAIN

FLEXIBLE CONDUIT

CODE 606

GENERAL

Construction operations shall be carried out in such a manner and sequence such that erosion and air and water pollution will be minimized and held within legal limits. Work shall comply will all required permits. A land disturbance permit from the Missouri Department of Natural Resources may be needed if the disturbed area is greater than one (1) acre in size.

The completed job shall present a workmanlike appearance and shall conform to the line, grades, and elevations shown on the drawings or as staked in the field.

All operations shall be carried out in a safe and skillful manner. Safety and health regulations shall be observed and appropriate safety measures used. The contractor shall be assured that all state laws concerning buried utilities are met prior to beginning work.

Construction shall be according to the requirements as specified for the job, in the plans and specifications.

All conduits shall be laid to line and grade in such a way that the side walls are continuously and uniformly supported with suitable bedding material. Such material shall be properly placed and compacted to provide lateral restraint against deflection and to protect the conduit against collapse during backfilling.

SITE PREPARATION

All trees, stumps, roots, brush, weeds, and other objectionable material in the work area shall be removed from the site and disposed of without degrading the environment or visual resources.

MATERIALS

The following specifications pertain to products currently acceptable for use as subsurface drains. These specifications are also to be applied in determining the quality of materials referenced by other standards:

Type	**Specification**
Plastic	
Corrugated polyethylene (PE) tubing and fittings 3-6 inches	ASTM F405
Corrugated polyethylene (PE) tubing and fittings 8-24 inches	ASTM F667
Polyvinyl chloride (PVC) corrugated sewer pipe with a smooth interior and fittings 4-8 inches	ASTM F949
Polyvinyl chloride (PVC) sewer pipe and fittings	ASTM D2729, ASTM D3034 type PSM or PSP
Metal	
Pipe, corrugated (aluminum alloy)	ASTM B745
Pipe, corrugated (iron or steel, zinc coated)	ASTM A760, A762, or A885

CONDUIT PERFORATIONS SPECIAL REQUIREMENTS

Where perforated conduit is required, the water inlet area shall be at least 1 square inch per foot of conduit length. Round perforations shall not exceed 3/16-inches. in diameter except where filters, envelopes, or other protection is provided or for organic soils, where a maximum hole diameter of ½-inches may be used. Slotted perforations shall not exceed 1/8-inches in width.

INSTALLATION

All materials shall be inspected and handled properly prior to installation. Material for subsurface drains shall be carefully inspected before the drains are installed. Plastic pipe and tubing shall be protected from hazard-causing deformation or warping. Plastic pipe and tubing with physical imperfections shall not be installed. A damaged section shall be removed and a suitable joint made connecting the retained sections. All material shall be satisfactory for its intended used and shall meet applicable specifications and requirements.

TRENCHING

Trench widths must be adequate for proper installation of the conduit, allow proper joining of sections, and allow proper placement of filter, envelope, or blinding materials. The trench bottom shall be constructed to proper grade before placement of the conduit.

Where rock is encountered the trench will be overexcavated a minimum of 6 inches and refilled to the proper grade with a suitable bedding material.

Provisions for safety during trenching operations shall be in compliance with the applicable safety and health regulations for construction - Occupational Safety and Health Administration (OSHA) regulations.

PLOW INSTALLATION

Plow installation has been satisfactorily used in many situations. Special care needs to be exercised relative to grade control and bedding conditions.

BEDDING

The trench bottom shall be smooth and free of clods and loose or exposed rock. Where a gravel envelope is not specified, the bottom of the trench shall be shaped to conform to the pipe. The groove may be semi-circular, trapezoidal, or a 90 degrees “V”-shape (90 degree “V” suitable for 3-8 inches only) and shall be of such dimensions that the bottom quarter of the pipe is below the contact points of the groove.

In unstable soils a firm foundation shall be provided by overexcavation and backfilling with processed stone or gravel, suitably graded so as to act as a mat into which unstable soil will not penetrate.

FILTERS AND ENVELOPES

If a sand-gravel filter is specified, it shall be clean, hard, durable material and of the gradation specified.

When sand-gravel envelopes are used they will be of clean, hard, durable material with less than 5 percent passing the No. 200 sieve, not more than 30 percent passing the No. 60 sieve, and with a maximum size of 1-½ inch.

PLACEMENT

Conduit will be placed in such a way that maximum stretch does not exceed 5 percent.

Fittings shall be installed in accordance with instructions furnished by the manufacturer. Couplers are recommended at all joints and fittings, at all changes in direction (where the centerline radius is less than three times the tubing diameter), at changes in diameter, and at junction(s) with another line.

Caps are needed at the ends of lines. All fittings shall be compatible with the tubing materials. Where certain fittings are not available, handcut holes are acceptable provided care is taken when making the connection not to create a means of obstructing flow, catching debris, or allowing soil to enter the line. Place selected bedding material, containing no hard object larger than 1-½ inches in diameter in the trench to a minimum depth of 6 inches over the conduit. The conduit will be held in place mechanically until secured by blinding.

BACKFILLING

Place backfill material so that displacement or deflection of the conduit will not occur. This is preferably on an angle, so the material flows down the front slope. Avoid large stones, frozen material, and dry clods that cause concentrated point loads on the tubing. The trench should be backfilled as soon as practical. When installing the tubing on a hot day, backfilling should be delayed until tubing temperature cools to the soil temperature.

CERTIFICATION

The installing contractor shall certify that the installation complies with the requirements of these specifications. The contractor shall provide the name(s) of the material source(s).

Additional Details:

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NATURAL RESOURCES CONSERVATION SERVICE

MISSOURI CONSTRUCTION SPECIFICATION

SUBSURFACE DRAIN

RIGID CONDUIT

CODE 606

GENERAL

Construction operations shall be carried out in such a manner and sequence such that erosion and air and water pollution will be minimized and held within legal limits. A land disturbance permit from the Missouri Department of Natural Resources may be needed if the disturbed area is greater than five acres in size.

The completed job shall present a workmanlike appearance and shall conform to the line, grades, and elevations shown on the drawings or as staked in the field.

All operations shall be carried out in a safe and skillful manner. Safety and health regulations shall be observed and appropriate safety measures used. The contractor shall be assured that all state laws concerning buried utilities are met prior to beginning work.

Construction shall be according to the requirements as specified for the job, in the plans and specifications.

SITE PREPARATION

All trees, stumps, roots, brush, weeds, and other objectionable material shall be removed from the site and disposed of without degrading the environment or visual resources.

INSTALLATION

All materials shall be inspected and handled properly prior to installation. Material for subsurface drains shall be carefully inspected before the drains are installed. Plastic pipe and tubing shall be protected from hazard-causing deformation or warping. Plastic pipe and tubing with physical imperfections shall not be installed. A damaged section shall be removed and a suitable joint made connecting the retained sections. Clay and concrete tile shall be checked for damage from freezing and thawing before it is installed. All material shall be satisfactory for its intended used and shall meet applicable specifications and requirements.

MATERIALS

The following specifications pertain to products currently acceptable for use as subsurface drains. These specifications are also to be applied in determining the quality of materials referenced by other standards:

Type	Specification
Vitrified clay	
Vitrified clay pipe, perforated, standard and extra strength	ASTM C700
Vitrified clay pipe, testing	ASTM C301
Concrete	
Concrete drain tile	ASTM C4
Concrete pipe for irrigation or drainage	ASTM C118
Concrete pipe or tile, determining physical properties of	ASTM C497
Concrete sewer, storm drain, and culvert pipe	ASTM C14
Reinforced concrete culvert, storm drain, and sewer pipe	ASTM C444
Perforated concrete pipe	ASTM C76
Portland cement	ASTM C150

CLAY AND CONCRETE DRAIN TILE SPECIAL REQUIREMENTS

If clay tile will not be exposed to freezing and thawing before or during installation and if the average frost depth will be less than 18 inches, the freezing and thawing and adsorption tests may be modified or waived.

The use of concrete tile in acid and sulfate soils shall be in accordance with the following limitations:

Acid soils:

Class of tile	***Lower permissible limits of pH values***	
	Organic and sandy soils	Medium and heavy-textured soils
ASTM C412		
Standard quality	6.5	6.0
Extra quality	6.0	5.5
Heavy duty extra quality	6.0	5.5
Special quality	5.5	5.0
ASTM C14, C118, C444	5.5	5.0

NOTE: Figures represent the lowest reading of pH values for soil or soil water at subsurface drain depth.

Sulfate soils:

Type of tile and cement (minimum)		***Permissible maximum limit of sulfates, singly or in combination (ppm)***
Tile:	ASTM C412 Special quality C14, C118, C444	7,000
Cement:	ASTM C150, Type V	
Tile:	ASTM C412 Extra quality, Heavy-duty extra quality C14, C118, C444	3,000
Cement:	ASTM C150, Type II or V	
Tile:	ASTM C412 Standard quality C14, C118, C444	1,000
Cement:	ASTM C150, any type	

NOTE: Figures represent the highest reading of sulfates for soil or soil water at subsurface drain depth.

Bell and spigot, tongue and groove, and other types of pipe that meet the strength, absorption, and other requirements of clay or concrete tile as specified in the preceding paragraphs, except for minor imperfections in the bell, the spigot tongue, or the groove, and ordinarily classed by the industry as “seconds,” may be used for drainage conduits, provided that the pipe is otherwise adequate for the job.

TRENCHING

Trench widths must be adequate for proper installation of the conduit; must allow proper joining of sections; and must allow proper placement of filter, envelope, or blinding materials. The trench width will be a minimum of 3 to 6 inches on both sides of conduit. The trench bottom shall be constructed to proper grade and shape before placement of the conduit.

Where rock is encountered the trench will be over excavated a minimum of 6 inches and refilled to the proper grade with a suitable bedding material.

Provisions for safety during trenching operations shall be in compliance with the applicable safety and health regulations for construction (OSHA regulations).

BEDDING

If unstable soil conditions are encountered, the trench bottom must be stabilized before placement of conduit. Where necessary the unstable material will be removed and replaced with sand-gravel or a similar suitable stabilizing material. Where an envelope is not specified, the bottom of the trench shall be shaped to ensure good alignment of the conduit.

Where the conduit is to be laid in a rock trench, or where rock is exposed at the bottom of the trench, the rock shall be removed below grade enough that the trench may be backfilled, compacted, and bedded; and when completed, the conduit shall be a minimum of 6 inches from rock.

FILTERS AND ENVELOPES

If a sand-gravel filter is specified, it shall be of clean, hard durable material and of the gradation specified.

When sand-gravel envelopes are used they will be of clean, hard, durable material with less than 5 percent passing the No. 200 sieve, not more than 30 percent passing the No. 60 sieve, and with a maximum size of 1 ½ inches ASTM C33 fine aggregate for concrete will meet these requirements.

PLACEMENT

All conduits shall be laid to line and grade and covered with the specified blinding, envelope, or filter material to a depth of not less than 3 inches around the drain. Blinding material shall contain no hard objects larger than 1-½ inches in diameter.

When a sand-gravel filter is specified, all openings in the conduit must be covered with at least 3 inches of filter material except that the top of the conduit and the side filter material may be covered with a sheet of plastic or similar impervious material. The impervious sheet will be covered with at least 3 inches of blinding material.

Joints between drain tile shall not exceed 1/8-inches except in sandy soils, where the closest possible fit must be obtained, and in organic soils where some of the more fibrous types make it desirable to increase slightly the space between tile.

BACKFILL

Backfill will be placed in such a manner as to avoid displacement of the conduit. Backfill should be moved into the trench at an angle so that material slows down the front slope of previously placed material. Backfill shall not contain frozen material, stones, clods, or objects large enough to damage the conduit. The trench should be backfilled as soon as possible after blinding.

CERTIFICATION

The installing contractor shall certify that the installation complies with the requirements of these specifications. The contractor shall provide the name(s) of the material source(s).

Additional Details:

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NATURAL RESOURCES CONSERVATION SERVICE
MISSOURI OPERATION AND MAINTENANCE

SUBSURFACE DRAIN

CODE 606

OPERATION AND MAINTENANCE ACTIVITIES

A maintenance program shall be established by the landowner/user to maintain the functional capacity of the subsurface drain. Items to consider are:

- Keep inlets, trash guards, collection boxes, and structures clean and free of materials that can reduce the flow.
- Repair all broken or crushed lines to insure proper functioning of the drain.
- Repair or replace broken or damaged inlets, breathers, or vents damaged by livestock or machinery.
- Periodically inspect outlet conduit and animal guards for proper functioning.

Additional Details:

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These deliverables apply to this individual practice. For other planned practice deliverables refer to those specific Statements of Work.

DESIGN

Deliverables:

1. Design documents that demonstrate criteria in practice standard have been met and are compatible with planned and applied practices
    a. Practice purpose(s) as identified in the conservation plan.
    b. List of required permits to be obtained by the client
    c. Compliance with NRCS national and state utility safety policy (NEM part 503-Safety, Section 503.00 through 503.22)
    d. Practice standard criteria related computations and analyses to develop plans and specifications including but not limited to:
        i. Capacity
        ii. Hydraulics
        iii. Materials
2. Written plans and specifications including sketches and drawings shall be provided to the client that adequately describes the requirements to install the practice and obtain necessary permits.
3. Operation and maintenance plan
4. Certification that the design meets practice standard criteria and comply with applicable laws and regulations (NEM Subpart A, 505.03(b) (2)).
5. Design modifications during installation as required

INSTALLATION

Deliverables

1. Pre-installation conference with client and contractor
2. Verification that client has obtained required permits
3. Staking and layout according to plans and specifications including applicable layout notes
4. Installation inspection
    a. Actual materials used
    b. Inspection records
5. Facilitate and implement required design modifications with client and original designer
6. Advise client/NRCS on compliance issues with all federal, state, tribal, and local laws, regulations and NRCS policies during installation
7. Certification that the installation process and materials meets design and permit requirements (NEM Subpart A, 505.03(c) (1)).

CHECK OUT

Deliverables

1. As-built documentation
    a. Extent of practice units applied
    b. Drawings
    c. Final quantities
2. Certification that the installation meets NRCS standards and specifications and is in compliance with permits
3. Progress reporting

REFERENCES

- Field Office Technical Guide (eFOTG), Section IV, Conservation Practice Standard – Subsurface Drain, 606.
- National Engineering Manual
- NRCS National Environmental Compliance Handbook
- NRCS Cultural Resources Handbook

NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

DRAINAGE WATER MANAGEMENT

(Ac.)

CODE 554

DEFINITION

The process of managing water discharges from surface and/or subsurface agricultural drainage systems.

PURPOSE

The purpose of this practice is:

- Reduce nutrient, pathogen, and/or pesticide loading from drainage systems into downstream receiving waters
- Improve productivity, health, and vigor of plants
- Reduce oxidation of organic matter in soils
- Reduce wind erosion or particulate matter (dust) emissions
- Provide seasonal wildlife habitat

CONDITIONS WHERE PRACTICE APPLIES

This practice is applicable to agricultural lands with surface or subsurface agricultural drainage systems that are adapted to allow management of drainage discharges.

The practice may not apply where saline or sodic soil conditions require special considerations.

This practice does not apply to the management of irrigation water supplied through a subsurface drainage system. For that purpose, use NRCS Conservation Practice Standard, Irrigation Water Management (449).

CRITERIA

General Criteria Applicable to All Purposes

The management of gravity drained outlets shall be accomplished by adjusting the elevation of the drainage outlet.

The management of pumped drainage outlets shall be accomplished by raising the on-off elevations for pump cycling.

Structures and pumps shall be located where they are convenient to operate and maintain.

Raising the outlet elevation of the flowing drain shall result in an elevated free water surface within the soil profile.

When operated in free drainage mode, water control structures shall not restrict the flow of the drainage system.

Drainage discharges and water levels shall be managed in a manner that does not cause adverse impacts to other properties or drainage systems.

Release of water from control structures shall not allow flow velocities in surface drainage system components to exceed acceptable velocities prescribed by NRCS Conservation Practice Standard, Surface Drainage, Main or Lateral (608).

The effect of drainage systems on wetlands shall be evaluated.

The effect of managing the drainage system on adjacent fields shall be evaluated. The installation and operation of a water level control structure should not impact adjacent fields or drainage systems.

Release of water from flow control structures shall not allow flow velocities in subsurface drains to exceed velocities prescribed by

NRCS Conservation Practice Standard, Subsurface Drain (606).

Additional Criteria to Reduce Nutrient, Pathogen, and/or Pesticide Loading

During non-cropped periods, the system shall be in managed drainage mode within 30 days after the season's final field operation, until at least 30 days before commencement of the next season's field operations, except during system maintenance periods or to provide trafficability when field operations are necessary.

The drain outlet shall be raised prior to and during liquid manure applications to prevent direct leakage of manure into drainage pipes through soil macro pores (cracks, worm holes, root channels).

Manure applications shall be in accordance with NRCS Conservation Practice Standards, Nutrient Management (590) and Waste Utilization (633).

Additional Criteria to Improve Productivity, Health, and Vigor of Plants

When managing drainage outflow to maintain water in the soil profile for use by crops or other vegetation, the elevation at which the outlet is set shall be based on root depth and soil type.

The combined capacity of the surface and subsurface facilities shall satisfy the appropriate drainage coefficient for the crops to be grown. (Refer to NRCS Conservation practice standard Subsurface Drain (606) for guidance.)

If using this practice to control rodents, apply in conjunction with NRCS Conservation Practice Standard, Pest Management (595).

Additional Criteria to Reduce Oxidation of Organic Matter in Soils

Drainage beyond that necessary to provide an adequate root zone for the crop shall be minimized.

To reduce oxidation of organic matter, the outlet elevation shall be set to enable the water table to rise to the ground surface, or to a designated maximum elevation, for sufficient time to create anaerobic soil conditions. The implementation of this practice must result in a reduced average annual thickness of the aerated layer of the soil.

Additional Criteria to Reduce Wind Erosion or Particulate Matter (Dust) Emissions

When the water table is at the design elevation, the system shall provide a moist field soil surface, either by ponding or through capillary action from the elevated water table.

Additional Criteria to Provide Seasonal Wildlife Habitat

During the non-cropped season, the elevation of the drainage outlet shall be managed in a manner consistent with a habitat evaluation procedure that addresses targeted species.

CONSIDERATIONS

In-field water table elevation monitoring devices can be used to improve water table management.

Reducing mineralization of organic soils may decrease the release of soluble phosphorus, but water table management may increase the release of soluble phosphorus from mineral soils.

The concept of drainage water management is based on the premise that the same drainage intensity is not required at all times during the year.

Elevated water tables may increase the runoff portion of outflow from fields. Consider conservation measures that control sediment loss and associated nutrient discharge to waterways.

Elevate the drainage outlet for subsurface drains during and after manure applications to decrease potential for nutrient and pathogen loading to receiving waters.

Consider manure application setbacks from streams, flowing drain lines, and sinkholes, to reduce risk of contamination.

In order for the practice to be economical and practical, each control structure needs to influence a significant amount of the field.

Drainage water management is generally limited to very flat fields with slopes typically less than 0.5 percent. It is possible to apply the practice on very moderate slopes if the tile system is designed with the laterals on the contour and a series of control structures are installed to step down the control elevations. This increases both drainage system cost and management.

Drainage water management may affect the water budget, especially volumes and rates of runoff, infiltration, evaporation, transpiration, possible deep percolation and groundwater recharge because of the increase in the amount of water stored in the field.

To maintain proper root zone development and aeration, downward adjustments of the drainage outlet control elevation may be necessary, especially following significant rainfall events.

Drainage water management may increase base flow because of increased gradient from fields to surface water conduits. Higher field water tables may also increase deep seepage and lateral losses. Since this soil water will pass through reduced (low oxygen) zones it will be somewhat denitrified before leaving the field. Drainage water management may increase runoff, which would reduce tile flow and lower nitrate loading to surface water, since runoff generally has a lower concentration of nitrate than tile flow water.

Avoid traffic on finer textured wet soil to minimize soil compaction.

Monitoring of root zone development may be necessary if the free water surface in the soil profile is raised during the growing season.

PLANS AND SPECIFICATIONS

Plans and specifications shall be prepared in accordance with the criteria of this standard as necessary and shall describe the requirements for applying the practice to achieve its intended purpose(s).

OPERATION AND MAINTENANCE

An Operation and Maintenance plan shall be provided that identifies the intended purpose of the practice, practice life safety requirements, and water table elevations and periods of operation necessary to meet the intended purpose. If in-field water table observation points are not used, the relationship of the control elevation settings relative to critical field water table depths shall be provided in the operation plan.

The Operation and Maintenance Plan shall include instructions for operation and maintenance of critical components of the drainage management system, including instructions necessary to maintain flow velocities within allowable limits when lowering water tables and should address the following objectives as applicable:

1. Prior to tillage, harvest, and other field operations, the water table should be at depth to provide trafficability throughout the field.
2. After planting and other necessary field operations, the water table control device can be set to allow infiltration from rainfall to bring the water table to the desired level and provide capillary water to the plant root zone. This level will vary with the cop and stage of growth.
3. Operation of the water level control structure during the crop season should be such that prolonged saturation of the root zone does not occur.
4. During the fallow period, the control structure should be operated to allow the water table to rise to the soil surface or to a designated maximum control elevation.
5. Field water table observation wells should be installed and the water table levels observed as part of the operation plan.
6. To prevent leakage of liquid manure applications into drain pipes, the plan shall specify the elevation of the raised drainage outlet and the number of days prior to and after the application that a raised outlet elevation is to be maintained.

7. Replace warped flashboards that cause structure leakage.

REFERENCES

USDA, NRCS. 2001. National Engineering Handbook, Part 624, Sec. 16, Drainage of agricultural land.

USDA, NRCS. 2001. National Engineering Handbook, Part 650, Engineering Field Handbook, Chapter 14, Water management (Drainage).

STATEMENT OF WORK
DRAINAGE WATER MANAGEMENT (554)
Missouri

These deliverables apply to this individual practice. For other planned practice deliverables refer to those specific Statements of Work.

DESIGN

Deliverables:

1. Design documentation that will demonstrate that the criteria in NRCS practice standard have been met and are compatible with other planned and applied practices.
    a. Practice purpose(s) as identified in the conservation plan
    b. List of required permits to be obtained by the client
    c. Compliance with NRCS national and state utility safety policy (NEM Part 503-Safety, Subpart A - Engineering Activities Affecting Utilities 503.00 through 503.06)
    d. List of facilitating/component practices
    e. Practice standard criteria related computations and analyses to develop plans and specifications including but not limited to:
        i. Geology and Soil Mechanics (NEM Subpart 531a)
        ii. Hydrology/Hydraulics
        iii. Structural
        iv. Vegetation
        v. Environmental Considerations
        vi. Safety Considerations (NEM Part 503-Safety, Subpart A, 503.10 through 503.12)
2. Written plans and specifications including sketches and drawings shall be provided to the client that adequately describes the requirements to install the practice and obtain necessary permits...
3. Operation and Maintenance Plan (National Operation and Maintenance Manual 500.70 and 500.40 through 500.42)
4. Certification that the design meets practice standard criteria and comply with applicable laws and regulations (NEM Subpart A, 505.03 (a) (3)).
5. Design modifications during installation as required.

INSTALLATION

Deliverables

1. Pre Installation conference with client and contractor.
2. Verification that client has obtained required permits.
3. Staking and layout according to plans and specifications including applicable layout notes.
4. Installation inspection (according to inspection plan as appropriate).
    a. Actual materials used (Part 512, Subchapter D Quality Assurance Activities, 512.33)
    b. Inspection records
5. Facilitate and implement required design modifications with client and original designer
6. Advise client/NRCS on compliance issues with all federal, state, tribal, and local laws, regulations and NRCS policies during installation.
7. Certification that the installation process and materials meets design and permit requirements.

CHECK OUT

Deliverables

1. As-Built documentation.
    a. Location and extent of practice units applied
    b. Drawings
    c. Final quantities
2. Certification that the installation meets NRCS standards and specifications and is in compliance with permits (NEM Subpart A, 505.03 (c) (1)).
3. Progress reporting.

STATEMENT OF WORK
DRAINAGE WATER MANAGEMENT (554)
Missouri

REFERENCES

- NRCS Field Office Technical Guide (eFOTG), Section IV, Conservation Practice Standard - Drainage Water Management, 554
- NRCS National Engineering Manual (NEM).
- NRCS National Environmental Compliance Handbook
- NRCS Cultural Resources Handbook

NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

STRUCTURE FOR WATER CONTROL

(No.)

CODE 587

DEFINITION

A structure in a water management system that conveys water, controls the direction or rate of flow, maintains a desired water surface elevation or measures water.

PURPOSE

The practice may be applied as a management component of a water management system to control the stage, discharge, distribution, delivery or direction of water flow.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies wherever a permanent structure is needed as an integral part of a water-control system to serve one or more of the following functions:

- Convey water from one elevation to a lower elevation within, to or from a water conveyance system such as a ditch, channel, canal or pipeline designed to operate under open channel conditions. Typical structures: drops, chutes, turnouts, surface water inlets, head gates, pump boxes and stilling basins.
- Control the elevation of water in drainage or irrigation ditches. Typical structures: checks, flashboard risers and check dams.
- Control the division or measurement of irrigation water. Typical structures: division boxes and water measurement devices.
- Keep trash, debris or weed seeds from entering pipelines. Typical structure: debris screen.
- Control the direction of channel flow resulting from tides and high water or back-flow from flooding. Typical structures: tide and water management gates.
- Control the water table level, remove surface or subsurface water from adjoining land, flood land for frost protection or manage water levels for wildlife or recreation. Typical structures: water level control structures, flashboard risers, pipe drop inlets and box inlets.
- Convey water over, under or along a ditch, canal, road, railroad or other barriers. Typical structures: bridges, culverts, flumes, inverted siphons and long span pipes.
- Modify water flow to provide habitat for fish, wildlife and other aquatic animals. Typical structures: chutes, cold water release structures and flashboard risers.
- Provide silt management in ditches or canals. Typical structure: sluice.
- Supplement a resource management system on land where organic waste or commercial fertilizer is applied.
- Create, restore or enhance wetland hydrology.

CRITERIA

General Criteria Applicable to All Purposes

Vegetation complying with Critical Area Planting standard (code 342) shall be established on all disturbed earth surfaces. Where soil, climate or site specific conditions preclude establishing permanent vegetation, other protective means such as mulches or gravels, shall be used.

The structure shall be fenced, if necessary, to protect the vegetation.

Structures shall not be installed that have an adverse effect on septic filter fields.

The water level upstream of water control structures shall not be raised on adjacent landowners without their permission.

CONSIDERATIONS

When planning, designing, and installing this practice, the following items should be considered:

- Effects on the water budget, especially on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation and ground water recharge.
- Potential for a change in the rate of plant growth and transpiration because of changes in the volume of soil water.
- Effects on downstream flows or aquifers that would affect other water uses or users.
- Effects on the field water table to ensure that it will provide a suitable rooting depth for the anticipated crop.
- Potential use for irrigation management to conserve water.
- Effect of construction on aquatic life.
- Effects on stream system channel morphology and stability as it relates to erosion and the movement of sediment, solutes and sediment-attached substances carried by runoff.
- Effects on the movement of dissolved substances below the root zone and to ground water.
- Effects of field water table on salt content in the root zone.
- Short term and construction-related effects of this practice on the quality of downstream water.
- Effects of water level control on the temperatures of downstream waters and their effects on aquatic and wildlife communities.
- Effects on wetlands or water-related wildlife habitats.
- Effects on the turbidity of downstream water resources.
- Existence of cultural resources in the project area and any project impacts on such resources.
- Conservation and stabilization of archeological, historic, structural and traditional cultural properties when appropriate.

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.

PLANS AND SPECIFICATIONS

Plans and specifications for installing structures for water control shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

The plan shall specify the location, grades, quantities, dimensions, materials, and hydraulic and structural requirements for the individual structure. Provisions must be made for necessary maintenance. Care must be used to protect the surrounding visual resources. If watercourse fisheries are important, special precautions or design features may be needed to facilitate continuation of fish migrations.

OPERATION AND MAINTENANCE

An operation and management plan shall be provided to and reviewed with the land manager. The plan shall be site specific and include but not be limited to the following: Structures will be checked and necessary maintenance, including removal of debris, shall be performed after major storms and at least semi-annually. Water level management and timing shall be adequately described wherever applicable.

NATURAL RESOURCES CONSERVATION SERVICE

MISSOURI CONSTRUCTION SPECIFICATION

FOR

STRUCTURE FOR WATER CONTROL

(NO.)

CODE 587

SCOPE

The work will consist of installing the structure for water control and all appurtenances to the lines, grades, and elevations as shown on the drawings.

GENERAL

Construction operations shall be done in such a manner that erosion and air and water pollution are minimized and held within legal limits. The owner, operator, Contractor or other persons will conduct all work and operations in accordance with proper safety codes for the type of construction being performed with due regards to the safety of all persons and property.

The completed job shall be workmanlike and present a good appearance.

MATERIALS

A. Timber and Lumber. Timber and lumber shall be of the dimensions, species, and preservative treatment as specified on the drawings. Timber and lumber shall be accurately cut and assembled to a close fit and shall have an even bearing on the entire contact surface. No open or shimmed joints will be accepted. All cuts, holes, and abrasions shall be swabbed with not less than three coats of the same preservative used in the original treatment. Fasteners shall be as shown on the drawings and shall be compatible with the wood treatment to limit corrosion.

B. Rock Riprap. Rock riprap shall consist of hard, durable, well graded angular to subangular rock conforming to the gradation shown on the drawings. Rock riprap and source shall be approved prior to commencement of work. Bedding or geotextile shall be as specified on the drawings. Geotextile shall conform to Construction Specification 753.

C. Metals. Unless specified otherwise, all structural steel shall have a minimum yield stress of 36,000 psi. All metal, not galvanized, stainless, aluminum, or painted by the manufacturer, shall be protected by paint, powder coating, and/or cathodic protection, or other approved coating as specified and appropriate for the exposure conditions of the metal.

D. Pipe. Corrugated metal pipe shall conform to the requirements of ASTM A760, A762, A885, B745, or B790 as appropriate. Plastic pipes through a dam shall be polyvinyl chloride pipe, PVC 1120 or 1220 conforming to ASTM D1785, ASTM D2241, or ANSI/AWWA C900. The SDR PVC plastic sewer pipe shall conform to ASTM D3034. Ductile iron pipe shall conform to ANSI/AWWA C151/A21.51 or ASTM A674. Welded steel pipe shall meet tolerance requirements of ASTM A53 or equivalent specifications. Anti-seep collars shall be of materials compatible with the pipe. Reinforced concrete culvert pipe shall conform to the requirements of ASTM Specification C76 for the class of pipe specified on the plans. The pipe shall be joined with rubber gasket joints and in accordance with the gasket manufacturer's recommendations except as otherwise specified on the drawings. Pipe joints shall be sound and watertight. The pipe gasket shall conform to the requirements of ASTM Specification C443.

CONCRETE

Concrete and reinforcing steel shall conform to Construction Specification 750. Concrete and reinforcing steel shall be as shown on the drawings.

SITE PREPARATION

Foundation Area. The entire structure area shall be cleared of all trees, brush, roots, sod, soil containing excess amounts of organic matter and other objectionable materials and shall be disposed of at sites away from the area of work. All trees with root systems hazardous to any structure shall be removed.

Clearing and disposal methods shall be in accordance with applicable state and county laws with due regard to the safety of persons and property.

EXCAVATION

Excavation for the structure shall conform to the lines, grades, and elevations shown on the drawings or as staked in the field. Unsuitable material, as shown on the drawings or as determined by the Engineer, shall be removed and backfilled with firmly compacted material. Excavated materials meeting the specified fill requirements may be used in embankments or other fill areas. Excess material shall be wasted at locations noted on the drawings or as staked in the field.

INLET AND OUTLET APPURTENANCES.

The inlet and outlet appurtenances shall conform to materials, sizes and installation as shown on the drawings. Pipe bedding conditions and depths of cover shall be as shown on the drawings. Water control gates, when required, shall conform to the details shown on the drawings and shall be installed according to the manufacturer's recommendation.

The pipe conduit shall be placed on a firm foundation to the lines and grades shown on the drawings. Installation shall be conducted in a skillful and workmanlike manner.

Antiseep collars are to be installed at locations shown on the drawings with watertight connections. When the bottom half is placed in a trench, special backfill and compaction will be required to prevent leakage.

Where no cradle is provided under the pipe, the foundation shall be covered with one (1) inch of loose, friable ML or CL soil material (Unified Soil Classification System) immediately prior to placing the pipe. This material should be saturated before additional backfill is placed.

STRUCTURAL BACKFILL

Materials. The fill materials shall be the in place excavated materials unless otherwise stated and shown on the drawings.

Placement. The fill shall be placed so that the distribution of materials will be to the limits shown on the drawings and shall be free from lenses, pockets, streaks, or layers of material differing substantially in texture or gradation from the surrounding material. No fill shall be placed upon a frozen surface nor shall snow, ice or frozen material be incorporated in the fill.

Selected backfill of friable ML or CL material shall be placed around structures, pipe conduits, and antiseep collars at approximately the same rate on all sides to prevent unequal pressures. Water packing is permitted for smooth steel conduits 36 inches or less in diameter when total fill over the conduit will be ten (10) feet or less. Rubber tire, hand, or manually directed power tamper will be used on backfill around

all conduits or structures. Where water packing is not permitted or used. Extreme caution must be exercised in backfill and compaction around structures or conduits to prevent damage, movement, or deflection. Compaction on the bottom half of conduits must be firm to fill all voids and supply lateral support but not to the point where uplift pressure is exerted. Fill will be placed in 4 inch lifts around conduits, structures, and antiseep collars.

Moisture Content. The minimum moisture content of the fill material and foundation shall be such that when kneaded in the hand, the fill material will form a ball which does not readily separate. The maximum moisture content is when conditions are too wet for efficient use of the hauling and compaction equipment.

Compaction. The fill material shall be compacted to a density equal to that of the adjacent materials. Compaction shall be accomplished by hand tampers, manually directed power tampers, plate vibrators, or other acceptable means excluding heavy equipment. Heavy equipment shall not be operated within two feet of any structure.

VEGETATIVE COVER

Unless otherwise specified, a protective cover of vegetation shall be established on the disturbed area. The planting of vegetative materials shall conform to the requirements of Agron-25.

ADDITIONAL DETAILS

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OPERATION AND MAINTENANCE PLAN

STRUCTURE FOR WATER CONTROL
CODE 587

Landowner/Operator: _____

Job Location _____ Sec: _____ T: _____ R: _____

Prepared By: _____ Date: _____

OVERVIEW

A properly operated and maintained structure for water control is an asset to the farm. The structure was designed and installed to control water stage, discharge, distribution, delivery, and/or direction of flow. Estimated life span of this installation is at least 20 years. The life of the structure can be assured and usually increased by developing and carrying out an effective operation and maintenance program.

GENERAL RECOMMENDATIONS

An effective operation and maintenance program includes:

1. Maintain the width, height, and side slopes of soil berms and embankments.
2. Periodically inspect control gates, valves and weirs for proper functioning and their ability to maintain the water level to design elevations. Remove debris or flow blockages.
3. Inspect metal surfaces for rust and other damage. Especially inspect sections in contact with earthfill and/or other materials. Repair or replace damaged sections and apply a protective covering.
4. Investigate settlement or cracks in earthen sections to determine the cause and make all necessary repairs.
5. Check concrete surfaces for accelerated weathering, spalling, settlement, alignment or cracks. Repair damaged concrete.
6. Check all rock riprap and erosion control matting sections for accelerated weathering and displacement of materials. Replace to original shape and grade if necessary.
7. Maintain vigorous growth of vegetative coverings. This includes reseeding, fertilizing and application of herbicides when necessary. Periodic mowing or short term grazing may also be needed to control height.

8. Drain structures when not being used. Remove accumulated soil and debris and any blockage that may restrict capacity.
9. If livestock are present, prevent access to components subject to damage by livestock.
10. Repair any vandalism, vehicular, or livestock damage.
11. Other: _____

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These deliverables apply to this individual practice. For other planned practice deliverables refer to those specific Statements of Work.

DESIGN

Deliverables:

1. Design documents that demonstrate criteria in practice standard have been met and are compatible with planned and applied practices
    a. Practice purpose(s) as identified in the conservation plan.
    b. List of required permits to be obtained by the client
    c. Compliance with NRCS national and state utility safety policy (NEM part 503-Safety, Section 503.00 through 503.22)
    d. Practice standard criteria related computations and analyses to develop plans and specifications including but not limited to:
        i. Geology and Soil Mechanics (NEM Subpart 531a)
        ii. Hydrology/Hydraulics
        iii. Structural including hazard class as appropriate
        iv. Vegetation
2. Written plans and specifications including sketches and drawings shall be provided to the client that adequately describes the requirements to install the practice and obtain necessary permits.
3. Design Report and Inspection Plan as appropriate (NEM Part 511, Subpart B Documentation, 511.11 and Part 512, Subpart D Quality Assurance Activities, 512.30 through 512.32).
4. Operation and maintenance plan
5. Certification that the design meets practice standard criteria and comply with applicable laws and regulations (NEM Subpart A, 505.03(b)(2))
6. Design modifications during installation as required

INSTALLATION

Deliverables

1. Pre-installation conference with client and contractor
2. Verification that client has obtained required permits
3. Staking and layout according to plans and specifications including applicable layout notes
4. Installation inspection
    a. Actual materials used
    b. Inspection records
5. Facilitate and implement required design modifications with client and original designer
6. Advise client/NRCS on compliance issues with all federal, state, tribal, and local laws, regulations and NRCS policies during installation
7. Certification that the installation process and materials meets design and permit requirements

CHECK OUT

Deliverables

1. As-built documentation
    a. Extent of practice units applied
    b. Drawings
    c. Final quantities
2. Certification that the installation meets NRCS standards and specifications and is in compliance with permits (NEM Subpart A, 505.03(c)(1))
3. Progress reporting

REFERENCES

- Field Office Technical Guide (eFOTG), Section IV, Conservation Practice Standard, Structure for Water Control, 587.
- National Engineering Manual
- NRCS National Environmental Compliance Handbook
- NRCS Cultural Resources Handbook

NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

UNDERGROUND OUTLET

(Ft.)

CODE 620

DEFINITION

A conduit or system of conduits installed beneath the surface of the ground to convey surface water to a suitable outlet.

PURPOSE

To carry water to a suitable outlet from terraces, water and sediment control basins, diversions, waterways, surface drains or other similar practices without causing damage by erosion or flooding.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where:

- Disposal of surface water is necessary.
- An outlet is needed for a terrace, diversion, water and sediment control basin or similar practice but a surface outlet is impractical because of stability problems, topography, climatic conditions, land use or equipment traffic.
- The site is suitable for an underground outlet.

This practice is not applicable where construction would destroy woody wildlife cover and the present or future outlet is capable of handling the concentrated runoff without serious erosion. Such situations are usually recognized by a meandering condition, steep side slopes which are stabilized by woody plants or herbaceous vegetation, and the watercourse is without rapidly advancing overfalls. Where wetlands will be affected, the cooperator will be advised and current NRCS wetland policy will apply. Refer to NRCS booklet "Wetland Types in Missouri," or Fish and Wildlife Circular 39 for classification.

CRITERIA

Capacity. The design capacity of the underground outlet is based on requirements of the structure or practice it serves. The underground outlet can be designed to function as the only outlet for a structure or it can be designed to function with other types of outlets. The capacity of the underground outlet for natural or constructed basins shall be adequate for the intended purpose without causing inundation damage to crops, vegetation, or works of improvements. The minimum discharge capacity for underground outlets shall be sufficient to remove water from the storage basin in 48 hours or less. Release times of less than 24 hours may be required to prevent damage to specific crops from prolonged inundation.

Underground outlets may be designed for either pressure or gravity flow. If a pressure system is designed, all pipe and joints must be adequate to withstand the design pressure, including surges and vacuum. To fully utilize conduit capacity, design the inlet to provide maximum flow in the conduit. To prevent pressure flow or overloading of the conduit a flow restricting device such as an orifice or weir can be used to limit flow into the conduit.

Orifice plates, when used, shall be made of metal or durable plastic, fit tight against the seat of connectors and have a smooth edge. Use the exhibit in EFH, Chapter 8 -Terrace to determine capacity of orifice plates. Appropriate equations should be used to determine the capacity of other types of devices which restrict flow. Submergence of the orifice will reduce the orifice head. Use the reduced head to determine submerged orifice capacity.

If there are multiple structures flowing into an underground outlet, design the system so that upstream structures do not discharge into downstream structures unless the downstream structure is designed to accommodate the extra flow.

Pressure-relief wells may be used to allow excess flow to escape the conduit and flow over the surface. Only use pressure relief wells where there is a stable outlet for the flow from the relief well. Cover pressure relief wells with a grate or other appropriate covering to prevent the entry of small animals and debris.

Inlet. An inlet can be a collection box, a perforated riser, or other appropriate device. For perforated risers, use durable, structurally sound material that is resistant to damage by rodents or other animals. Use fire resistant materials for the inlet if fire is an expected hazard.

Inlets shall have a minimum inside diameter of 6 inches. The inlet or inlet holes shall not be used to control discharge. All intake openings shall be smooth and burr free. The inlet capacity shall be equal to or greater than the design discharge rate used to compute basin storage volume. The inlet capacity shall be calculated assuming at least 50% of the openings on the side of the inlet are plugged and the water surface is at a maximum of 70% of the maximum ridge height.

Table 2 in the Missouri Supplement to EFH, Chapter 8 - Terrace may be used to select an adequate inlet.

Inlet caps or screens shall be removable on inlets with orifice plates. The maximum screen opening dimension shall not exceed one half (1/2) the orifice diameter on inlets with orifices.

Inlets must have an appropriate trash guard to ensure that trash or other debris entering the inlet passes through the conduit without plugging.

Design collection boxes large enough to allow maintenance and cleaning operations. Use blind inlets where the installation of an open or above ground structure is impractical. Design the blind inlet with a graded granular filter around the conduit. Design the filter based on the particle size of the surrounding soil and the desired flow rate. Refer to NEH Part 650, Engineering Field Handbook, Chapter 14 for the design of blind inlets.

Conduit. Underground outlets shall be conduits of tubing, tile or pipe. The minimum allowable conduit diameter is 4 inches. Design hydraulically smooth joints using materials and methods recommended by the manufacturer of the conduit.

The maximum design velocity must not exceed the safe velocity for the conduit materials and installation according to the conduit manufacturer's recommendation. Refer to Conservation Practice 606, Subsurface Drainage for design criteria for safe velocity.

If junction boxes and other structures are needed, design them to allow cleaning and other maintenance activities. Maintain a downward grade towards the outlet in all sections of the underground outlet.

The hydraulic grade line (HGL) between successive inlets will approximate the difference in ground elevations at the inlets for:

(a) all inlets orificed

(b) no inlets orificed

The HGL slope must be determined if there is a mixing of inlets with and without orifice plates on a conduit line. Orifices when mixed with non-orificed inlets must be checked for submergence. Vertical drop from the last inlet to the outlet flow line should be used to determine HGL slope for that section. Vertical drop in this section should be taken from the maximum water surface elevation at the last inlet for a non-orificed inlet and from the orifice elevation for an orificed inlet. The vertical drop shall be corrected for tailwater and for special outlet installations.

Changes in conduit diameter on pressure systems shall be made at the tee joint immediately upstream from the inlet to prevent constriction in outlet flow. The tee diameter must be equal to or greater than the diameter of the conduit downstream from the inlet.

Conduit line capacity will be determined by using the information in the Missouri Supplement to EFH, Chapter 8 - Terrace. Manning's "n" (coefficient of roughness) values are:

0.011 - smooth plastic pipe

0.015 - smooth steel or corrugated plastic tubing 4 to 8 inch diameter

0.017 - corrugated plastic tubing 10 to 15 inch diameter

0.025 - corrugated metal pipe

Conduit line capacity downstream from any non-orificed inlet in a multiple inlet line shall be increased a minimum of 0.05 cubic feet per second per inlet-acre over the flow in the conduit upstream from the respective inlet.

Materials. Plastic, concrete, aluminum, and steel pipe shall meet the requirements specified in the applicable ASTM standard. All materials specified in Conservation Practice Standard (606), Subsurface Drains can be used for underground outlets. Materials must meet applicable site specific design requirements for leakage, external loading, internal pressure or vacuum.

The fill height over the plastic pipe or tubing shall not exceed the values shown in Appendix A of EFH, Chapter 14 - Drainage or as computed by NRCS procedures contained in Part 636 National Engineering Handbook Chapter 52 Structural Design of Flexible.

Underground outlet conduits can be perforated or nonperforated, depending on the design requirements. Use a filter fabric wrap (sock) or appropriately designed granular filter if migration of soil particles into the conduit is anticipated. Design the filter based on the particle size of the surrounding soil to prevent rapid clogging of the filter. Refer to Conservation Practice 606, Subsurface Drainage for criteria for the design of filter media. Protect all exposed plastic materials from degradation due to exposure to sunlight.

Outlet. The outlet must be stable for anticipated design flow conditions from the underground outlet. Design the underground outlet for water surface conditions at the outlet expected during the design flow conditions.

The outlet must consist of a continuous 10 foot section or longer of closed conduit or a headwall at the outlet. If a closed conduit is used, the material must be durable and strong enough to withstand anticipated loads, including those caused by ice. Do not design outlets to be placed in areas of active erosion. Use fire resistant materials if fire is an expected hazard. All outlets must have animal guards to prevent the entry of rodents or other animals. Design animal guards to allow passage of debris while blocking the entry of animals that cannot easily escape from the conduit.

Vertical Outlet. A vertical outlet can be used to discharge water to the ground surface and reduce conduit size downstream where steep slopes change to flatter sections, where topography does not allow adequate conduit cover using a horizontal outlet, or where it is practical to discharge over vegetated filter strips.

An adequate and stable surface outlet for the design outflow rate and velocity shall be provided for the overflow from the vertical outlet. When a vegetated channel or waterway is to be used for the overflow, vegetation shall be established prior to installing the underground outlet. The minimum vertical outlet size shall be one conduit size larger than the incoming underground line. In the case of multiple lines entering the relief well, the cross sectional area of the relief well shall be at least 1.5 times the sum of the cross sectional areas of the incoming lines. In no case shall the relief well diameter be smaller than 6 inches. Relief well diameter shall be large enough to provide enough space along the circumference of the relief well for fabricating tile stubs (both incoming and outgoing lines) and allow for proper maintenance. The relief well shall extend at least to the ground surface but no more than 6 inches above the surrounding ground surface. The minimum depth from ground surface to relief well bottom shall be that which will provide the required depth of cover for the attached tile lines.

Vertical outlets and relief wells require adequate grating for safety and operation and maintenance purposes.

Stabilization. Reshape and regrade all disturbed areas so that they blend with the surrounding land features and conditions. Revegetate or otherwise protect from erosion, disturbed areas that will not be farmed, as soon as possible after construction.

CONSIDERATIONS

Pressure relief wells and vertical outlets, if not properly covered, can present a safety hazard

for people or animals stepping into the well. In addition, pressure relief wells can be easily damaged by field equipment. To prevent accidents mark the location of pressure relief wells with a high visibility marker.

The rapid removal of water through an underground outlet will affect the water budget where it is installed. It can reduce infiltration. It can increase or decrease peak flows to receiving waters and reduce long term flows into the same waters. Consider these long term environmental, social, and economic effects when making design decisions for the underground outlet and the structure or practice it serves.

If perforated pipe is used for the subsurface conduit, locate the practice so that it has a minimal effect to the hydrology of wetlands.

To prevent sediment from collecting in the conduit, underground outlets should be designed with a minimum velocity of 1.4 ft/sec.

Where perforated risers are used, often the risers are perforated below the surface of the ground to facilitate drainage. In this situation, if soil entry into the riser perforations is a problem, use an appropriately designed gravel or geotextile filter around the buried portion of the riser.

Seasonal water sources can be very important for migratory waterfowl and other wildlife. The use of a water control structure, on the inlet of an underground outlet during non-cropping times of the year, can allow water to pond in the structure to provide water for wildlife. Refer to Conservation Practice Standard (646) Shallow Water Development and Management for information on managing seasonal water sources for wildlife.

Underground outlets can provide a direct conduit to receiving waters for contaminated runoff from crop land. Underground outlets and the accompanying structure or practice should be installed as part of a conservation system that addresses issues such as nutrient and pest management, residue management and filter areas.

The construction of an underground outlet in a riparian corridor can have an adverse affect on the visual resources of the corridor. Consider the visual quality of the riparian area when designing the underground outlet.

The construction of an underground outlet can disturb large areas and potentially affect cultural resources. Be sure to follow state cultural resource protection policies before construction begins.

If an installation in a crop field is too shallow, tillage equipment can damage an underground outlet. Consider the type and depth of tillage that will likely occur when designing the depth of an underground outlet. A minimum of 2 feet of cover is recommended over all conduits.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for underground outlets that describe the requirements for applying this practice according to this standard. The plans and specifications for an underground outlet may be incorporated into the plans and specifications for the structure or practice it serves. As a minimum the plans and specifications shall include:

1. A plan view of the layout of the underground outlet.
2. Typical cross sections or bedding requirements for the underground outlet.
3. Profile of the underground outlet.
4. Details of the inlet and outlet.
5. Seeding requirements if needed.
6. Construction specifications that describe in writing the site specific installation requirements of the underground outlet.

OPERATION AND MAINTENANCE

Prepare an operation and maintenance plan for the operator. University of Missouri Agricultural Guide Sheet 1501, "Operating and Maintaining Underground Outlet Terrace Systems" provides information on the operation and maintenance of underground outlets. The minimum requirements to be addressed in a written operation and maintenance plan are:

- Periodic inspections, especially immediately following significant runoff events, to keeping inlets, trash guards, and collection boxes and structures clean and free of materials that can reduce flow.
- Prompt repair or replacement of damaged components.
- Repair or replacement of inlets damaged by farm equipment.
- Repair of leaks and broken or crushed lines to insure proper functioning of the conduit.
- Periodic checking of the outlet and animal guards to ensure proper functioning.
- Repair of eroded areas at the pipe outlet.
- Maintenance of adequate backfill over the conduit.
- To maintain the permeability of surface materials on blind inlets, periodic scouring or removal and replacement of the surface soil layer may be necessary.

REFERENCES

USDA, NRCS. National Engineering Handbook, Part 650 Engineering Field Handbook, Chapters 6, 8, 14.

University of Missouri Agricultural Guide Sheet 1501, "Operating and Maintaining Underground Outlet Terrace Systems"

NATURAL RESOURCES CONSERVATION SERVICE

MISSOURI CONSTRUCTION SPECIFICATION

UNDERGROUND OUTLET

INLET

CODE 620

GENERAL

Construction operations shall be carried out in a manner and sequence that erosion and air and water pollution are minimized and held within legal limits.

The completed job shall present a workmanlike appearance and shall conform to the line, grades, and elevations shown on the drawings or as staked in the field.

All operations shall be carried out in a safe and skillful manner. Safety and health regulations shall be observed and appropriate safety measures used. Contractor shall be assured that all state laws concerning buried utilities have been met.

MATERIALS

Inlets may be fabricated from plastic or metal according to the following requirements:

1) Smooth Plastic Pipe:

    a) Polyvinyl Chloride (PVC) with SDR or DR equal to 41 or less conforming to ASTM D1785, D2241, D3034 or AWWA C900.

    b) High Density Polyethylene (HDPE) with SIDR, SDR, or DR equal to 21 or less conforming to ASTM D2239, D3035, or F714.

    c) Molded inlets made of PVC or HDPE shall be of equivalent strength to the pipes listed in (1) or (2).

2) Corrugated Plastic Pipe:

    a) Polyethylene (PE) Smooth Interior AASHTO-M-294, Type S or AASHTO-M-252, Type S. Pipe stiffness equals 30 pounds per square inch at 5% deflection and 25 pounds per square inch at 10% deflection.

    b) Polyvinyl Chloride (PVC) Sewer Pipe with a Smooth Interior conforming to ASTM F949. Pipe stiffness equals 46 pounds per square inch at 5% deflection.

3) Metal pipe:

    Smooth steel pipe with 3/16" minimum wall thickness or 16 gage corrugated metal pipe (galvanized or aluminum).

All plastic inlets shall include an ultra-violet stabilizer or coating to protect from solar degradation.

FABRICATION

Inlet holes shall be smooth and burr free. Holes shall not remove more than 50 percent of material in any horizontal or vertical row of holes. For inlets fabricated from metal or smooth plastic, 1" x 4" slots may be used in lieu of 1" diameter holes as long as the openings provide an equal cross-sectional area.

Holes larger than 5/16" diameter that are more than 6 inches below the channel bottom shall be covered with plastic, fiberglass, nylon, gravel or other filter material to prevent soil from entering the inlet.

Other combinations of the number and size of holes may be acceptable if approved prior to fabrication. Other materials and methods of fabrication may be used for the inlet, tee and other appurtenances as long as the functional intent of the inlet is satisfied and it is approved prior to installation.

ORIFICES

Flow may be restricted by use of an orifice plate installed above the tee. It should be firmly supported and able to be removed for maintenance. Orifice plates shall be made from durable plastic or metal. The opening shall be burr free.

TRASH GUARDS

The trash guard for Type II inlets shall be securely fastened to the inlet. Trash guards may be fabricated from metal rods (1/4" diameter or larger) or galvanized welded wire fabric (16 gage or larger). The spacing between vertical members should be 1 inch. If welded wire fabric is used, the spacing between the horizontal members should be 2 inches (1 inch if orifice plates are used.)

As approved by NRCS, other equivalent designs may be used.

INSTALLATION

Refer to construction drawings and specifications for installation details.

Additional Details: _____

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Maximum fill height over plastic pipe or tubing = _____ feet

Minimum fill height over plastic pipe or tubing prior to tamping with construction equipment or crossing with heavy equipment such as a loaded scraper = _____ feet

NATURAL RESOURCES CONSERVATION SERVICE

MISSOURI CONSTRUCTION SPECIFICATION

UNDERGROUND OUTLET

UGO CONDUIT

CODE 620

GENERAL

Construction operations shall be carried out in a manner and sequence that erosion and air and water pollution are minimized and held within legal limits.

The completed job shall present a workmanlike appearance and shall conform to the line, grades, and elevations shown on the drawings or as staked in the field.

All operations shall be carried out in a safe and skillful manner. Safety and health regulations shall be observed and appropriate safety measures used.

MATERIALS

Conduits shall be plastic or metal pipe or tubing conforming to the following requirements:

1) Smooth Plastic Pipe:

    a) Polyvinyl Chloride (PVC) with SDR or DR equal to 41 or less conforming to ASTM D1785, D2241, D3034 or AWWA C900.

    b) High Density Polyethylene (PE) with SIDR, SDR, or DR equal to 21 or less conforming to ASTM D2239, D3035, or F714.

2) Corrugated Plastic Tubing/Pipe:

    a) Polyethylene (PE) Heavy Duty conforming to ASTM F405, F667 AASHTO-M-252 or AASHTO-M-294. Pipe stiffness equals 30 pounds per square inch at 5% deflection and 25 pounds per square inch at 10% deflection.

    b) Polyvinyl Chloride (PVC) Sewer Pipe with a Smooth Interior conforming to ASTM F949. Pipe stiffness equals 46 pounds per square inch at 5% deflection.

3) Metal Pipe:

    Smooth steel pipe with 3/16” minimum wall thickness or 16 gage corrugated metal pipe (galvanized or aluminum).

TRENCH EXCAVATION

Unless otherwise shown in the “Additional Details” section of this specification, the trench excavation shall be sufficient to provide 24 inches or more cover over all conduit lines except metal pipe. The cover over metal pipe shall be 12 inches or more.

The bottom of the trench shall be grooved for proper conduit bedding. The groove should be at the side of the trench when backhoes are used. Maximum trench width shall be 24 inches measured 12 inches above top of conduit. Minimum trench width shall be conduit outside diameter plus four (4) inches except when the trench is shaped to fit the conduit.

A properly sized mole plow may be used.

INSTALLATION

Underground outlet systems shall be installed as shown on the construction drawings. Conduits shall be installed with a positive grade toward the outlet throughout their entire length. Conduit lines should be installed and properly backfilled prior to placement of earth fill for the storage basin or terrace ridge.

Provide at least 2 inches of compacted earth or sand filter bedding when the conduit line is to be installed in a rock trench or where rock is exposed in the trench bottom.

Changes in conduit line size shall be made at the tee joint immediately upstream from the inlet. The tee diameter must be equal to or larger than the diameter of the conduit line downstream from the inlet.

Conduit lines shall be joined with standard factory couplers. Conduit ends shall be protected during installation. All conduit ends except the outlet and inlets with screens shall be capped with standard factory end caps or concrete. When corrugated plastic tubing is used no more than five (5) percent stretch will be allowed.

Outlet section shall be of rigid pipe and have an animal guard installed.

TRENCH BACKFILL

Conduits shall be bedded and backfilled as shown on the drawings or described in the specifications. Friable soil material shall be used for blinding around the conduit prior to machine backfilling. The conduit shall not be displaced during backfilling. Mound excess material over the trench.

Trench backfill under the basin embankment or terrace ridge shall be placed in successive 6 inch layers and tamped until a depth of at least 12 inches over the top of the conduit is reached. Water packing of the backfill material may be used in lieu of tamping, except where high clay content (CH) backfill is used. The remainder of the trench shall be sloped to 1.5:1 or flatter and be machine compacted

INLET INSTALLATION

The inlet shall be installed as plumb as possible. The maximum length of inlet with holes or slots below channel bottom shall be 6 inches. A trash guard, end cap, or screen shall be installed with each inlet. Backfill shall have sufficient moisture and compaction.

Additional Details: _____

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_____

Maximum fill height over plastic pipe or tubing = _____ feet

Minimum fill height over plastic pipe or tubing prior to tamping with construction equipment or crossing with heavy equipment such as a loaded scraper = _____ feet

NATURAL RESOURCES CONSERVATION SERVICE

MISSOURI OPERATION AND MAINTENANCE

UNDERGROUND OUTLET

INLET

CODE 620

OPERATION AND MAINTENANCE

The following University of Missouri Agricultural Guides provide information on the operation and maintenance of terrace systems and their outlets:

1501 "Operating and Maintaining Under-ground Outlet Terrace Systems"

Other operation and maintenance items to address:

- Periodic inspections, especially immediately following significant runoff events, to keeping inlets, trash guards, and collection boxes and structures clean and free of materials that can reduce flow.
- Prompt repair or replacement of damaged components.
- Repair or replacement of inlets damaged by farm equipment.

Additional Details: _____

_____

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NATURAL RESOURCES CONSERVATION SERVICE

MISSOURI OPERATION AND MAINTENANCE

UNDERGROUND OUTLET

UGO CONDUIT

CODE 620

OPERATION AND MAINTENANCE

The following University of Missouri Agricultural Guides provide information on the operation and maintenance of terrace systems and their outlets:

1501 "Operating and Maintaining Under-ground Outlet Terrace Systems"

Other operation and maintenance items to address:

- Periodic inspections, especially immediately following significant runoff events, to keeping inlets, trash guards, and collection boxes and structures clean and free of materials that can reduce flow.
- Prompt repair or replacement of damaged components.
- Repair of leaks and broken or crushed lines to insure proper functioning of the conduit.
- Periodic checking of the outlet and animal guards to ensure proper functioning.
- Repair of eroded areas at the pipe outlet.
- Maintenance of adequate backfill over the conduit.

Additional Details: _____

_____

_____

_____

_____

These deliverables apply to this individual practice. For other planned practice deliverables refer to those specific Statements of Work.

DESIGN

Deliverables:

1. Survey notes which show that a thorough and detailed site survey was completed.
    a. Survey notes shall be in accordance with NRCS Technical Release 62, Engineering Field Handbook, Chapter 1 and/or standard industry practice.
    b. If survey equipment with automatic / electronic data collection devices is used, a print out of the data and a disk with the electronic files shall be included in the file.
    c. Elevations shall be referenced to a bench mark. A temporary bench mark with an assumed elevation is acceptable.
2. A plot of the survey data with the scale shown as a bar scale shall be maintained in the file.
3. Design documents that demonstrate criteria in practice standard have been met and are compatible with planned and applied practices
    a. Practice purpose(s) as identified in the conservation plan.
    b. List of required permits to be obtained by the client
    c. Compliance with NRCS national and state utility safety policy (NEM part 503-Safety, Section 503.00 through 503.06)
    d. Practice standard criteria related computations and analyses to develop plans and specifications including but not limited to:
        i. Inlet Type
        ii. Hydraulics
            - Profile and horizontal location of inlets, lines, junctions, relief wells and outlets
            - Design discharges and velocities
        iii. Materials
        iv. Outlet Capacity and Stability
4. Written plans and specifications including sketches and drawings shall be provided to the client that adequately describes the requirements to install the practice and obtain necessary permits.
5. Operation and maintenance plan
6. Certification that the design meets practice standard criteria and comply with applicable laws and regulations (NEM Subpart A, 505.03(b) (2)).
7. Design modifications during installation as required

INSTALLATION

Deliverables

1. Pre-installation conference with client and contractor
2. Verification that client has obtained required permits
3. Staking and layout according to plans and specifications including applicable layout notes
4. Installation inspection
    a. Actual materials used
    b. Inspection records
5. Facilitate and implement required design modifications with client and original designer
6. Advise client/NRCS on compliance issues with all federal, state, tribal, and local laws, regulations and NRCS policies during installation
7. Certification that the installation process and materials meets design and permit requirements (NEM Subpart A, 505.03(c) (1)).

CHECK OUT

Deliverables

1. As-built documentation
    a. Extent of practice units applied
        - Profile and horizontal location of inlets, lines, junctions, relief wells and outlets
        - Type and lengths of conduit by size; number, type and size of inlets and outlets and adequacy of soil cover
    b. Drawings
    c. Final quantities
2. Certification that the installation meets NRCS standards and specifications and is in compliance with permits
3. Progress reporting

REFERENCES

- Field Office Technical Guide (eFOTG), Section IV, Conservation Practice Standard – Underground Outlet, 620.
- National Engineering Manual
- NRCS National Environmental Compliance Handbook
- NRCS Cultural Resources Handbook