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, other similar practices or flow concentrations 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 and a surface outlet is impractical because of stability problems, topography, climatic conditions, land use or equipment traffic.

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

General Criteria Applicable to All Purposes

Fire resistant materials shall be used for underground outlet components if fire is an expected hazard. All plastics must be UV resistant or protected from exposure to sunlight when installed above the ground surface and in direct sunlight. Outlet pipes that are expected to be shaded by vegetation do not require UV protection.

Components of underground outlets, including inlet collection boxes and conduit junction boxes, shall be designed with sufficient size to permit maintenance and cleaning operations.

Perforated components of underground outlets shall be designed to prevent soil particle movement into the underground outlet. Refer to Conservation Practice Standard 606, Subsurface Drain, for criteria for design of filters.

Capacity. The design capacity of the underground outlet will be based on the requirements of the structure or practice it serves. The underground outlet can be designed to function as the only outlet for a structure or in conjunction with other types of outlets. The capacity of the underground outlet shall be adequate for the intended purpose without causing inundation damage to crops, vegetation, or works of improvement. 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.

The underground outlet shall be designed to account for anticipated water surface conditions at the outlet during design flow.

Use the Caldwell Method flood routing technique to determine the relationship between flooding duration, underground release rate, and basin storage volume.

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

Underground outlets may be designed for either pressure or gravity flow. If designed as a pressure system, all pipes and joints must be adequate to withstand the design pressure, including surge pressure and vacuum conditions. To fully utilize conduit capacity in pressure systems, design the inlet to provide maximum flow in the conduit. 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.

For gravity flow systems, utilize a flow restricting device such as an orifice or weir to limit flow into the conduit and choose conduit sizes that are large enough to prevent pressure flow.

An underground outlet shall not be designed to discharge into a structure unless the structure is designed to accommodate the additional inflow.

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

Inlet. An inlet can be a collection box, blind inlet (gravel), perforated riser, perforated conduit, or other appropriate device.

Open inlets must have a trash guard. Design the inlet to permit trash or debris entering the inlet to pass through the flow restricting device and conduit without plugging.

Inlet caps shall be removable on inlets with orifice plates. Only closed top inlets shall be installed when an orifice is used.

Perforated riser inlets shall be durable, structurally sound, and resistant to damage by rodents or other animals. Perforations must be smooth, free of burrs, and have adequate capacity to prevent the riser from restricting flow in the underground outlet. Perforated risers shall have a minimum inside diameter of 6 inches. The riser top or riser side inlet holes shall not be used to control discharge. 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 riser are plugged and the water surface is at 70% of the maximum ridge height.

Blind inlets may be used where the installation of an open or above ground structure is impractical. Design the blind inlet to prevent soil particle movement into the conduit.

Conduit. The minimum allowable diameter of conduits is 4 inches. Conduit joints shall be hydraulically smooth and consistent with the manufacturer’s recommendation for the conduit material and installation.

Design the underground outlet to ensure that maximum allowable loads on the conduit are not exceeded for the type and size of conduit. Depth of cover requirements shall be assessed to prevent damage to the underground outlet from tillage operations and frost action. 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 required over all conduits where tillage will take place.

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.

Thrust blocking or anchoring shall be provided where needed to prevent undesired movement of the conduit. Placement and bedding requirements for the conduit are required to ensure integrity of the installation.

The flow velocity in the conduit must not exceed the maximum allowable design velocity for the conduit materials and installation condition. Gravity flow systems must maintain a positive grade throughout the conduit length towards the outlet.

Refer to Conservation Practice 606, Subsurface Drain, for criteria for design loading, thrust blocking, placement and bedding requirements, and minimum and maximum design velocity in the conduit.

Materials. All materials specified in Conservation Practice Standard 606, Subsurface Drain, may be used for underground outlets. Materials must meet applicable site specific design requirements for leakage, external loading, and internal pressure including vacuum conditions.

Underground outlets shall be conduits of continuous tubing, tile or pipe and may be perforated or non-perforated. Perforated outlets shall be designed to prevent soil particle movement into the conduit.

Outlet. The outlet must be stable and protected against erosion and undermining for the range of design flow conditions.

The outlet must consist of a continuous section of pipe, 10 feet or longer, without open joints or perforations, and with stiffness necessary to withstand expected loads, including those caused by ice.

A shorter section of closed conduit may be used if a headwall is used at the outlet of the conduit.

All outlets shall 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 large enough to restrict the flow in the conduit.

A vertical outlet may be used to discharge water to the ground surface where topography does not allow adequate conduit cover using a horizontal outlet, or where it is practical to discharge over a vegetated filter strip. 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 grassed waterway is to be used for the overflow, vegetation shall be established prior to installing the underground outlet. Vertical outlets shall be designed using procedures in the Missouri Supplement to EFH, Chapter 8 - Terrace.

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

The vertical outlet (relief well) shall be adequately perforated and placed in an envelope of coarsely graded aggregate, if necessary due to surrounding soil properties, to allow the system to drain during periods when not in use.

Stabilization. Reshape and regrade all disturbed areas so that they blend with the surrounding land features and conditions. For areas that will not be farmed, refer to Conservation Practice Standard 342, Critical Area Planting, for establishment of vegetation criteria. Permanent vegetation shall be established on all disturbed areas 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 and may be damaged by field equipment. Pressure relief wells and vertical outlet locations should be identified with a high visibility marker.

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

Consideration should be given to the effects that the underground outlet may have on water quantity downstream. Consider these long term environmental, social, and economic effects when making design decisions for the underground outlet and the structure or practice it serves. Refer to Conservation Practice Standard 554, Drainage Water Management, for criteria on flow restriction from natural basins.

Where wetlands may be affected, the cooperator will be advised and current NRCS wetland policy will apply.

Seasonal water sources can be beneficial for migratory waterfowl and other wildlife. Consider the use of a water control structure, on the inlet of an underground outlet, during non-cropping periods 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 effect on the visual resources of the corridor. Consider the visual quality of the riparian area when designing the underground outlet.

Consider potential effects of soil physical and soil chemical properties influence on area where a conduit or system of conduits are installed to convey surface water. Refer to soil survey data as a preliminary planning tool for assessment of areas. Consult the Web Soil Survey to obtain soil properties and qualities information.

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:

- A plan view of the layout of the underground outlet.
- Typical cross sections and bedding requirements for the underground outlet.
- Profile of the underground outlet.
- Details of the inlet and outlet.
- Seeding requirements if needed.
- 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 keep 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 Inspection 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.

Web Soil Survey:
http://websoilsurvey.nrcs.usda.gov/app/

University of Missouri Agricultural Guide Sheet G1501, "Operating and Maintaining Underground Outlet Terrace Systems" http://extension.missouri.edu/publications/