SOIL CONSERVATION SERVICE

WEST VIRGINIA

ENGINEERING STANDARD

UNDERGROUND OUTLET (Ft.)

Definition

A conduit installed beneath the surface of the ground to collect surface water and convey it to a suitable outlet.

Scope

This standard applies to underground conduits designed to dispose of excess surface water. It does not apply to trickle tubes or to principal spillways in ponds or to subsurface drains (606).

Purpose

To dispose of excess water from terraces, diversions, subsurface drains, surface drains, trickle tubes or principal spillways from dams (outside the dam area only), or other concentrations without causing damage by erosion or flooding.

Conditions Where Practice Applies

This practice applies where: (1) excess surface water needs to be disposed of; (2) a buried outlet is needed for diversions (362), terraces (600), or similar practices; (3) an underground outlet can be installed that will safely dispose of excess water; and (4) surface outlets are impractical because of stability problems, climatic conditions, land use, or equipment traffic.

Effects on Water Quantity and Quality

This practice is always installed in conjunction with terraces, diversions, sediment and water control structures, waterways, surface and subsurface drains, access. Roads, and other practices where an underground outlet is required for safe disposal of excess surface water. This practice will have a negligible effect on the quantity of surface and ground water.

620-2 UNDERGROUND OUTLET

This practice is used in places in which a surface outlet is impractical because of stability problems or because of the wishes of the operator. There may be a decrease in the sediment delivered to the receiving waters because there is no bank and channel erosion with the flow in the underground outlet. There is reduced infiltration of water within the reach the underground outlet occupies. This may reduce slightly the amount of soluble substances which percolate toward the ground water. Any substances which enter the underground outlet will be delivered to the receiving waters, because there is no opportunity for substances attenuation by degradation, filtering, or adsorption within the underground outlet.

This practice may reduce the volume and rate of discharge by using either underground outlets or soil infiltration outlets. When underground outlets are used, infiltration through the catchment area will be increased and runoff decreased. Peak flows will be reduced by temporary storage. When soil infiltration outlets are used, infiltration may absorb most of the runoff. Deep percolation and ground-water recharge may occur when conditions permit. Where snow is available, it is often trapped in the channels and catchments of the practice and it infiltrates into the soil.

The practice traps and removes sediment and sediment-attached substances from runoff. Trap efficiencies for sediment and total phosphorous, that are transported by runoff, may exceed 90 percent in silt loam soils. Dissolved substances, such as nitrates, may also be removed from discharge to downstream areas because of the increased infiltration. Where geologic conditions permit, the practice will lead to increased loadings of dissolved substances toward ground water. Water temperatures of surface runoff, released through underground outlets, may increase slightly because of the longer exposure to warming during its impoundment.

Federal, State, and Local Laws

All federal, state, and local laws, rules, and regulations governing discharge to natural channels, pollution abatement, health, and safety shall be adhered to. The owner or operator shall be responsible for securing all required permits or approvals and for performing in accordance with such laws and regulations. SCS employees are not to assume responsibility for procuring these permits, rights, or approvals or for enforcing laws and regulations. They may provide the landowner or operator with technical information needed to obtain the required rights, or approvals to construct, operate and maintain the practice.

Design Criteria

Capacity

The underground outlet shall be designed, alone or in combination with other practices, with adequate capacity to insure that the terrace, diversion, or other practices function according to the standard for the specific practice. For example, an underground outlet can be used in combination with a grassed waterway or a surface drain to carry part of the design flow. The capacity of the underground outlet for natural basins shall be adequate for the intended purpose without causing excessive damage to crops, vegetation, or improvements.

Procedures contained in the Engineering Field Manual for Conservation Practices, Chapter 3 and National Engineering Handbook, Section 5, Hydraulics will be used as appropriate.

Inlet

Inlets can be drop inlets, perforated risers, hood inlets with baffle or canopy inlets. The capacity shall be adequate to provide the maximum design flow in the conduit. Flow-control devices shall be installed as necessary. Inlets must be of durable material, structurally sound, and resistant to damage by rodents or other animals. If burning of vegetation is likely to create a fire hazard, the inlet shall be fire resistant. Blind inlets can be used where they are effective. Blind inlets will meet the requirements of WV Engineering Standard 606. Collection boxes must be large enough to facilitate maintenance and cleaning operations. The inlet must have an appropriate trash guard to insure that trash or other debris entering the inlet passes through the conduit without plugging. It must also have an animal guard to prevent the entry of rodents or other animals.

Inlets will be designed with sufficient anchorage to prevent flotation, with a factor of safety of 1.5. Concrete inlets, 5 ft. or less in height, shall have a minimum wall thickness of 6 inches and be reinforced with one layer of welded wire fabric (6"x6"-8 gauge x 8 gauge minimum). All other concrete inlets will be designed according to the procedures contained in NEH-6, Structural Design.

When more than one inlet is used, the upper inlets will be designed to control the flow so discharge will not occur through the lower inlets.

Conduits

Underground outlets shall be continuous conduits, tubing or tile with a minimum diameter of 3 inches. They can be perforated or nonperforated, depending on the design requirements.

Pipe will meet the design requirements for internal pressure or vacuum and external loading. Thrust protection will be provided at elbows, bends and other fittings as necessary.

620-4 UNDERGROUND OUTLET

Conduits will be designed with a minimum velocity of 0.5 ft. per second when there is no hazard of siltation and with a minimum velocity of 1.4 ft. per second if siltation is a problem. If site conditions are such that minimum velocity cannot be met, then provisions will be made for preventing sedimentation by use of filters or by collecting and periodically removing sediment from installed traps. Planned cleaning of lines with high-pressure jetting systems may also be considered.

When perforated pipe or open joint tile are used, the maximum design velocities and/or required protection of the conduit as specified in WV Engineering Standard 606, Subsurface Drain shall apply.

Pipe may be any of those specified for subsurface drains, WV Engineering Standard 606, or for irrigation water conveyance pipeline, National Engineering Standards 430-AA through 430-GG. The pipe will meet the requirements for external load, internal pressure, testing and installation required by those standards. Pipe which is not pressure rated for water, such as corrugated polyethylene drainage tubing, will only be used when inlet controls, such as orifice plates, are used to restrict flow to that capacity at which the pipe just begins to flow full; determined by the equation:

$$Q = \frac{1.486}{n} A_p \gamma^{2/3} s^{1/2}$$

where: n = Manning's Roughness Coefficient
A_p = Area of the Pipe (sq. ft.)

γ = Hydraulic radius = $\frac{\text{pipe diameter (ft.)}}{4}$
s = Conduit slope (ft./ft.)

When inlet control is not provided and pressure flow occurs, pipe with pressure ratings equal to or higher than design pressures will be used. Joints will be capable of withstanding the same pressures.

All systems will be designed to protect the pipe from excessive vacuum and surge pressures at elbows and other fittings when:

1. The pipe grade increases in the direction of flow by 10% or more, or

2. The pipe grade decreases in the direction of flow by 5% or more, or

3. The velocity in the pipe exceeds 15 ft. per second.

This protection may be provided by:

1. Designing pipe and joints to withstand the pressures, or
2. Installing vents or vacuum release valves where pipe grade increases, or
3. Installing pressure relief wells, pressure relief valves, or surge tanks where pipe grade decreases.

Vents, wells or other structures installed to provide protection from vacuum or surge will be designed according to requirements in National Engineering Standards 430-AA through 430-GG.

Outlets

Outlets will be designed to be stable and provide for release of flow at non-erosive velocities, as follows. Cantilever outlet sections, if used, shall be designed to withstand the cantilever load, and pipe supports shall be provided when needed. Pipe supports will be installed on all pipes where:

1. The exit velocity is 10 ft. per second or greater.

2. The length of the cantilever portion, measured along the pipe invert, is more than 35% of the total length of the last joint of pipe for pipe diameters 15 inches or less.

3. The length of the cantilever portion is more than 20% of the total length of the last joint for pipe diameters greater than 15 inches.

Energy dissipating outlet structures such as an impact basin, SAF outlet or those meeting the requirements of procedures contained in the EFM, Chapter 7, Design Note 6, will be installed for all pipe outlets, unless the outlet is on rock, into a permanent pool of water or other location where erosion will not be a problem.

If fire is a hazard, the outlet shall be fire resistant.

Small animal guards or gates will be installed on all outlets.

The invert elevation of all conduit outlets shall be a minimum of 1.0 ft. above the outlet channel.

Vegetation and Fencing

Vegetation of all disturbed areas that are not to be used for farming operations or will be covered with structures shall be accomplished in accordance with WV Standards 342, Critical Area Planting or 512, Pasture and Hayland Planting.

Fencing necessary to exclude livestock or humans for safety or protection of the practice, shall be constructed around inlets, outlets and along the pipe according to WV Standards 472, Livestock Exclusion, or 382, Fencing.

Operation and Maintenance

An operation and maintenance plan shall be developed for the installed underground outlet. The plan shall outline the minimum maintenance necessary to ensure the outlet functions for its design life.

As a minimum, the plan shall address the following:

1. Annual inspections and inspections after each major storm occurrence to assess the need for repair.

2. Removal of debris accumulations and sediment deposits at inlets and outlets.

3. Liming, fertilizing and mowing of vegetation to maintain a healthy growth.

4. Repair of damaged inlets, outlets, trash racks, animal guards, fences, safety measures and other items to maintain the system in good operating order.

5. Repair of eroding areas by revegetating or mechanical treatment such as riprap.

Plans and Specifications

Plans and specifications for installation of underground outlets shall be in keeping with this standard, and shall describe the requirements for application for the practice to achieve its intended purpose.

Specifications will be prepared in conformance with NEH-20 specifications, WV "700 Series" specifications, or the attached specification with the following guidelines:

1. The applicable specification for pipe will be shown on the drawings.

2. If riprap and/or drainfill is used, the quality, size and gradation will be shown on the drawings.

3. Application rates for seeding and mulching materials will be shown on the drawings.

4. Details and dimensions of inlet and outlet structures, thrust blocks, vents, relief wells, riprap slope protection, safety measures, and fences shall be shown on the drawings.

CONSTRUCTION SPECIFICATION

WEST VIRGINIA

Underground Outlet

Excavation for installation of underground outlets will be to the line and grade shown on the drawings. Trench width will be maintained to that shown on the drawings.

Soft compressible material found in the trench bottom will be removed by overexcavation and the area backfilled with gravel or hand compacted earthfill.

Caution will be exercised when working in or around trenches with unstable sideslopes. Workers will not enter any trench over 4 ft. deep without proper shoring or sloping of the trench walls to a minimum of 2:1 above the 4 ft. depth.

Pipe, fittings and connectors will meet the requirements of the applicable ASTM specifications shown on the drawings, and will be installed according to the manufacturer's recommendations.

Inlet structures, outlet structures, thrust blocks (if used) and vents or relief wells (if used) will be installed as shown on the drawings.

Concrete used in construction of inlets, thrust blocks, and outlets shall be ready-mixed concrete (3000 psi - 6 bags/c.y. mix.), pre-bagged commercially available concrete mix, or be hand mixed on-site. Cement will be Type I or IA meeting requirements of ASTM C150 and aggregates will meet the requirements of ASTM C33. Coarse aggregate will be Size No. 57 or No. 67 for ready-mix and hand mixed concrete. Hand mixed concrete shall be mixed at a ratio of 1 part cement, 2 parts sand, and 3 parts coarse aggregate. Pre-bagged concrete mix will be mixed according to the manufacturers' recommendation. Mixing water will be clean and free of substances that would effect the strength of durability of the concrete. Concrete will be mixed to a consistency that will allow consolidation in the forms, but not so wet that aggregates separate from the mortar (approximately 3"-6" slump).

Concrete will be mixed and placed in the forms in a timely manner so that it does not begin to set prior to placement, or cold joints are not formed between successive layers. Forms shall be mortartight and unyielding as concrete is placed.

Reinforcing steel shall be placed as shown on the drawings and held securely in place while concrete is placed.

Riprap for slope or pipe outlet protection, if required, will be commercially available limestone riprap or on-site field stone that has demonstrated its durability against weathering. Riprap size, gradation and details of installation will be as shown on the drawings.

620-8 UNDERGROUND OUTLET

Gravel for pipe bedding or as a filter under riprap, if required, will meet the grading and quality requirements shown on the drawings and will be installed as detailed on the drawings.

Selected backfill material shall be placed, in layers not exceeding 4" in thickness, around structures and pipe conduits at approximately the same rate on all sides to prevent damage from unequal loading, and hand compacted. Construction equipment shall not be permitted within 2 ft. of structures or conduits. Rocks and other sharp objects that may damage structures or pipe will be removed from the fill adjacent to the pipe or structure. When the surface level of the fill reaches 2 ft. above the pipe and at other locations more than 2 ft. from structures or pipe, the fill may be placed in 8-inch layers and compacted by a minimum of two passes with construction equipment.

The moisture content of fill material shall be adequate to permit the degree of compaction specified. The moisture content shall be sufficient to permit molding a firm ball when firmly squeezed in one's fist. The soil shall not be so wet that water runs out when squeezed nor so dry that the ball easily crumbles when slightly deformed. Water may need to be added if too dry.

Appropriate safety measures, such as warning signs, fencing, etc., will be installed as shown on the drawings.

Upon completion of construction, all disturbed areas shall be graded smooth and blend with the surrounding ground.

A protective cover of vegetation shall be established on all disturbed areas where soil and climatic conditions permit. Lime and fertilizer will be spread at the rate shown on the drawings and will be disked into the soil to a depth of 4 inches to prepare a seedbed. Seed and mulch will be spread at the rate shown on the drawings. Where soil or climatic conditions preclude the use of vegetation and protection is needed, nonvegetative means such as mulches or gravel may be used. In some cases, temporary vegetation may be used until conditions are right for establishment of permanent vegetation.

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