**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.

## 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.

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.

If there are multiple structures flowing into an underground outlet, design the system so that upstream structures do not discharge into down-stream 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.

The outlet for terraces and diversions will have the capacity to discharge the runoff from a 10-year frequency, 24-hour duration rainfall in 60 hours or less. Release rates will be determined by the procedure in the Kansas Supplement to Chapter 8 in National Engineering Handbook Part 650 (NEH 650), *Engineering Field Handbook*. The Terrace (Storage) Spreadsheet (or equivalent) may be used.

**Inlet.** An inlet can be a collection box, a perforated riser, canopy inlet, or other appropriate device. For perforated risers, use durable, structurally sound material that is resistant to damage by rodents or other animals. Polyvinyl chloride (PVC) inlets shall be Standard Dimension Ratio (SDR) 41 or stronger. Polyethylene (PE) inlets shall meet American

Society for Testing and Materials (ASTM) F405. Use fire-resistant materials for the inlet if fire is an expected hazard.

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 aboveground 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 Chapter 14 in NEH 650 for the design of blind inlets.

Perforated risers will have a minimum diameter of 4 inches. Minimum capacity shall equal the release rate for the terrace or diversion. The computed capacity shall be reduced to account for potential plugging of perforations due to debris. Intake holes shall be no smaller than 1 inch in diameter. See the Kansas Supplement to Chapter 8 in NEH 650, or the Terrace (Storage) Spreadsheet for capacity of perforated risers.

The discharge into the main conduit shall be controlled by an orifice located in the inlet. The orifice plate may be eliminated where full pipe flow is allowed in the main conduit.

Orifices used to control the discharge shall be round, smooth, and burr-free. Orifice plates will fit tightly against the seat to minimize leakage.

Access to the orifice, offset lateral, or main conduit shall be provided by a removable, durable cap on the top of the riser; a removable riser; or other approved means.

Flexible risers will be supported by a wood, metal, or plastic post that is capable of supporting the riser in an upright position. Risers that are made from rigid materials and are set in the ground 2 or more feet need not have supporting posts but may require a marker post to indicate the riser location that can be seen from machinery.

**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 Standard (CPS) 606, Subsurface Drain, 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 toward the outlet in all sections of the underground outlet.

Conduit capacity will be determined using a Manning's equation roughness coefficient "*n*" value as follows.

| Pipe Material | Diameter (inches) | "*n*" Value |
|---|---|---|
| Smooth wall PE; smooth wall PVC; and corrugated PVC, smooth interior | all | .009 |
| Smooth wall metal and dual wall corrugated PE, smooth interior | all | .012 |
| Concrete | all | .013 |
| Single wall corrugated PE pipe | 3-6<br>8-10<br>12-15<br>18-24 | .015<br>.017<br>.018<br>.020 |
| Corrugated metal pipe:<br>Annular<br>Helical<br>Helical | <br>all<br>6-18<br>21-24 | <br>.025<br>.014<br>.017 |

Conduits shall be sized to carry the design flow with the hydraulic grade line parallel to the grade of the conduit and with the conduit flowing full or nearly full (non-pressure flow). However, the outlet pipe below the bottom terrace may be designed for pressure flow, provided that a corrugated plastic pipe or a perforated conduit is not used. Pipe designed for pressure flow shall have watertight joints for the maximum pressure expected. See Chapter 3 in NEH 650 or the Terrace (Storage) Spreadsheet for discharge in circular pipes.

When the conduit size needs to be increased because of additional inflow volume or reduced

grade, the change shall be made at or slightly upstream from the feature causing the increase. Joints shall be made with standard couplers that are recommended by the manufacturer and shall be hydraulically smooth. Fittings that reduce conduit area shall not be used.

The conduit shall be buried to a depth where the dead load due to the backfill and the live load due to farm equipment will not overstress the pipe. The trench shall be wide enough to provide room for compaction around the conduit and a minimum of 8 inches wider than the pipe diameter. The conduit shall be bedded in a circular groove in the bottom of the trench that is shaped to fit the lower 120 degrees of circumference.

More than 1 conduit may be placed in a trench. The conduits shall be placed side by side with a minimum of 4 inches clearance between them.

**Materials.** Plastic, concrete, aluminum, and steel pipe shall meet the requirements specified in the applicable ASTM standard. All materials specified in CPS 606 can be used for underground outlets. Materials must meet applicable site-specific design requirements for leakage, external loading, internal pressure, or vacuum.

Underground outlet conduits can be perforated or nonperforated, depending on the design requirements. The use of perforated conduit is limited to outside the terrace or diversion ridge. 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 CPS 606 for criteria for the design of filter media. Protect all exposed plastic materials from degradation due to exposure to sunlight.

**Loading.** The allowable loads on the conduits shall be based on the trench and bedding conditions specified for the job. Appropriate design procedures shall be used to determine the maximum allowable depth of cover for a particular type of conduit. Table 1 can be used where the stated conditions apply.

**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. Where a fire or crushing hazard exists, the outlet pipe shall be rigid, non-perforated, smooth, or corrugated metal pipe buried a minimum of 2 feet at the connection with the main conduit. Do not design outlets to be placed in areas of active erosion.

All outlets must have animal guards to prevent the entry of rodents or other animals, except for outlets at least 15 inches in diameter. Design animal guards to allow passage of debris while blocking the entry of animals that cannot easily escape from the conduit.

Special conditions apply to underground outlets that require the Regional General Permit GP-40 from the U.S. Army Corps of Engineers.

Sufficient excavation and back sloping should be done around the outlet end of the main conduit and outlet channel to prevent any blockage of the outlet or the animal guard by sloughing or siltation.

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

## CONSIDERATIONS

Pressure relief wells (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.

**Table 1–Fill height for pipe types**

| Pipe Type | | Use | Fill Height Over Pipe | |
|---|---|---|---|---|
| Material | Reference Specification | Soil Type | Minimum (feet) | Maximum[1/] (feet) |
| Single wall corrugated PE pipe | | | | |
| 3" through 6" diameter | ASTM F405 | non-rocky | 2 | 15[2/] |
| 8" through 24" diameter | ASTM F667 | non-rocky | 2 | 13[2/] |
| Dual wall corrugated PE pipe, smooth interior | | | | |
| 4" through 12" diameter | AASHTO[3/] M 252 | non-rocky | 2 | 11 |
| 15" through 30" diameter | AASHTO M 294 | non-rocky | 2 | 9 |
| 36" through 48" diameter | AASHTO M 294 | non-rocky | 2 | 8 |
| Corrugated PVC pipe, smooth interior | | | | |
| 4" through 36" diameter, pipe stiffness = 46 | ASTM F949 | non-rocky | 2 | 11 |
| 8" through 10" diameter, pipe stiffness = 115 | ASTM F949 | non-rocky | 2 | 17 |
| Smooth wall PVC pipe, gasket or glue joints | | | | |
| 4" through 24" diameter, SDR 41 | ASTM D2241 | any | 2 | 6 |
| 4" through 15" diameter, SDR 35 | ASTM D3034 | any | 2 | 8 |
| 18" through 24" diameter, SDR 35 | ASTM F679 | any | 2 | 8 |
| 4" through 24" diameter, SDR 32.5 | ASTM D2241 | any | 2 | 9 |
| 4" through 18" diameter, SDR 26 | ASTM D2241 | any | 2 | 13 |
| 4" through 15" diameter, SDR 21 | ASTM D2241 | any | 2 | 18 |
| 4" through 12" diameter, DR 25 | AWWA[4/] C 900 | any | 2 | 13 |
| 4" through 12" diameter, DR 18 | AWWA C 900 | any | 2 | 22 |
| 14" through 24" diameter, DR 25 | AWWA C 905 | any | 2 | 13 |
| 14" through 24" diameter, DR 18 | AWWA C 905 | any | 2 | 22 |
| Smooth wall iron or steel | | | | |
| 4" through 24" diameter, 3/16” minimum | ASTM A53 | any | 2 | 19 |
| Corrugated iron or steel | | | | |
| 4" through 48" diameter, 16-gauge minimum | ASTM A760 | any | 2 | 25 |
| Corrugated aluminum | | | | |
| 4" through 48" diameter, 16-gauge minimum | ASTM B745 | any | 2 | 25 |

[1/] Based on Chapter 52 in National Engineering Handbook Part 636, *Structural Engineering*, with values of E' = 200 pounds per square inch (psi), 7.5 percent deflection, a soil unit weight of 120 pounds per cubic foot (pcf), and a 10,000-pound wheel load for allowable deflection—for allowable buckling pressure, E = 140,000 psi

[2/] Indicates manufacturer’s recommendation for maximum fill over pipe

[3/] American Association of State Highway Transportation Officials (AASHTO)

[4/] American Water Works Association (AWWA)

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 feet per second.

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 CPS 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 cropland. 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:

- A plan view of the layout of the underground outlet.
- Typical cross sections or bedding requirements for the underground outlet.
- Profile of the underground outlet.
- Details of the inlet and outlet (including splash pad) if applicable.
- 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. The minimum requirements to be addressed in a written operation and maintenance plan are the following:

- 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 ensure 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.

## REFERENCES

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