

**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 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 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 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.

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.

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 exists, 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.

Materials. Plastic, concrete, aluminum, and steel pipe shall meet the requirements specified in the applicable ASTM standard. 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. 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. Protect all exposed plastic materials from degradation due to exposure to sunlight.

The pipe shall conform to or exceed the requirements of the appropriate specification listed below:

ASTM Specifications:

- A 760 A, Metallic Coated for Sewer and Drains
- B 745 Corrugated Aluminum Pipe or Sewers and Drains
- C 700 Vitrified Clay Pipe, Extra Strength, Standard Strength and Perforated

Specifications for C 700, Vitrified Clay Pipe, Standard Strength and Perforated, may be modified as follows:

Where clay pipe will not be subject to freezing and thawing hazards, before or during installation, and where the average frost depth is less than 18 inches, the freezing and thawing and absorption tests may be modified or waived.

- C 412 Concrete Drain Tile
- C 118 Concrete Pipe for Irrigation or Drainage
- C 497 Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile
- C 14 Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe
- C 76 Reinforced Concrete Culvert, Storm Drain and Sewer Pipe
- D 2729 Poly(vinyl Chloride) (PVC) Sewer Pipe and Fittings
- D 1527 Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe, Schedules 40 and 80
- D 1785 Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
- D 2104 Polyethylene (PE) Plastic Pipe, Schedule 40
- D 2239 Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
- D 2241 Poly(Vinyl Chloride) (PVC), Pressure-Rated Pipe (SDR Series)
- D 2447 Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter
- D 2513 Thermoplastic Gas Pressure Pipe, Tubing and Fittings
- D 2737 Polyethylene (PE) Plastic Tubing
- D 2672 Joints for IPS PVC Pipes Using Solvent Cement

- D 3035 Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
- F 405 Corrugated Polyethylene (PE) Tubing and Fittings
- F 667 Large Diameter Corrugated Polyethylene Pipe and Fittings
- AWWA C900 Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 inches through 12 inches
- AWWA C901 Polyethylene (PE) Pressure Pipe and Tubing, ½ inch through 3 inches

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

1. Local experience indicated a need.
2. 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.
3. Deep soil cracking is expected, or
4. The method of installation may result in voids between the conduit and backfill material.

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

Specified filter material must completely encase the conduit so that all openings are covered with at least 3 inches of filter material except that the top of the conduit and side filter material may 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.

Artificial fabric or mat-type 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.

Envelopes and Envelope Material.

Envelopes shall be used around subsurface drains if they are needed for proper bedding of the conduit or to improve the characteristics of flow of ground water 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 that will render the envelope unsuitable for bedding of the conduit.

Envelope materials shall consist of sand-gravel, organic, or similar material. Sand-gravel envelope materials shall all pass a 1.5-inch sieve; not more than 30 percent shall pass a No. 60 sieve; and not more than 5 percent shall pass the No. 200 sieve. ASTM-C-33 fine aggregate for concrete has been satisfactorily used and is readily available.

Where organic or other compressible materials are used, they shall be used only around a rigid wall conduit and above the centerline of flexible tubing. All organic or other compressible material shall be of a type that will not readily decompose.

Anti-seep Collars. Consideration must be given to prevent piping in the backfill along the pipeline. Failure of the system can result if this is not considered. Piping is controlled at many sites by sloping of the trench banks and compacting the backfill (see figure 8-78, page 8-83 of the Engineering Field Manual). Moisture content of the backfill should be adjusted to aid compaction. Highly angular material which may bridge should not be used for backfill where piping is a concern. Protection can be provided by the use of anti-seep collars to increase the path of percolation.

Sufficient anti-seep collars shall be installed on an underground outlet to prevent the surface and subsurface waters from flowing into and adjacent to the pipe. Particular locations of weakness are below inlets, bends, transitions and areas where compaction is difficult. They should be placed on a maximum spacing of 100 feet.

Anti-seep collars of concrete, sheet metal, or rubber can be used. The collars are to extend

beyond the pipe on all sides at least 1 foot or the diameter of the pipe whichever is greater.

Compaction around the anti-seep collars must be equal to or greater than the adjacent in-place material.

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.

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, if not properly covered, can present a safe 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.

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.

Cultural Resources and Endangered Species

This practice is likely to occur in areas where Cultural Resources or Endangered Species

habitat may be found. Follow NRCS Planning Policy to address these concerns.

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. 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.