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

Underground outlets shall be planned, designed, and constructed to comply with all federal, state, tribal, and local laws and regulations.

Utilities and Permits. The landowner and/or contractor shall be responsible for locating all buried utilities in the project area, including drainage tile and other structural measures.

The landowner shall obtain all necessary permissions from regulatory agencies, including but not limited to the Illinois Department of Agriculture, US Army Corps of Engineers, US Environmental Protection Agency, Illinois Environmental Protection Agency and Illinois Department of Natural Resources – Office of Water Resources, or document that no permits are required.

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 ground 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. For relief wells used as outlets, the underground outlet system shall have a positive hydraulic grade line to the relief well. Inline relief wells shall have a positive hydraulic grade line from the relief well to the outlet of the system. If junction boxes or other structures are needed, they shall be designed and installed in a manner that facilitates cleaning and other maintenance activities.

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. The perforated riser shall have adequate capacity to prevent the riser from becoming a controlling restriction to flow in the underground outlet system.

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.

Maximum Velocity. The maximum velocity must not exceed the safe velocity for the conduit materials and installation (Table 1).

Maximum Velocity for non-perforated Dual Wall Polyethylene pipe and joints is 20 ft/s. All joints and fittings shall be watertight, capable of withstanding 10.8 psi internal pressure.

Table 1. Corrugated Plastic Tubing Velocity, ft/s

Soil Texture	Perforated	Non-Perforated
Sand and sandy loam	3.5	8.0
Silt and silt loam	5.0	10.0
Silty clay loam	6.0	12.0
Clay and clay loam	7.0	12.0
Coarse sand or gravel	9.0	12.0

Non-perforated Polyvinyl Chloride (PVC), Smooth Steel or Corrugated Metal Pipe have no velocity restrictions if joints are watertight and pipe is aligned to prevent cavitation and water hammer.

Minimum Velocity. In areas where sedimentation is not a hazard, the minimum grades shall be based on site conditions and a velocity of not less than 0.5 feet per second (ft/s). If a sedimentation hazard exists, a velocity of not less than 1.4 ft/s shall be used to establish the minimum grades if site conditions permit. 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 clearing solutions.

Materials. Plastic, concrete, aluminum, and steel pipe shall meet or exceed the requirements specified in the applicable ASTM standard. All materials specified in Illinois Conservation Practice Standard IL 606, Subsurface Drain can be used for underground outlets. Materials must meet or exceed 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. Refer to Illinois Conservation Practice IL 606, Subsurface Drain for criteria for the design of filter media. Protect all exposed plastic materials from degradation due to exposure to sunlight.

Depth. The minimum depth of cover over conduits in mineral soils shall be 2 feet. This minimum depth shall apply to normal field levels and may exclude sections of line near the outlet sections laid through minor depressions where the conduit is not subject to damage by frost action or equipment travel.

The minimum depth of cover in organic soils shall be 2.5 feet for normal field levels, as defined above, after initial subsidence. Structural measures shall be installed if it is feasible to control the water table level in organic soils within the optimum range of depths.

The maximum depth of cover for standard duty corrugated plastic tubing shall be 10 feet for trench widths of 2 feet or less (measured at tubing and to 1 foot above top of tubing). Heavy-duty tubing shall be specified for depths greater than 10 feet, trench widths more than 2 feet, or in rocky soils.

For computation of maximum allowable loads on conduits, use the trench and bedding conditions specified and the crushing strength of the kind and class of drain. The design load on the conduit shall be based on a combination of equipment loads and trench loads. Equipment loads are 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 are 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. NEH, Part 636, Chapter 52 “Structural Design of Flexible Conduits” may be used for the design.

Placement and Bedding. The conduit should not be placed on exposed rock or stones more than 1.5 inches in diameter for 6 inch or larger tile and stones no more than ¾ inch diameter for tile less than 6 inches. Where such conditions are present, the trench must be over-excavated, a minimum of 6 inches and refilled to grade with a suitable bedding material.

The conduit must be placed on a firm foundation to ensure proper alignment. Prevent runoff and surface water from entering the trench.

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 such materials as quicksand or a silt slurry.

For trench installations of corrugated plastic tubing 8 inches or less in diameter, one of the following bedding methods will be specified:

1. A shaped groove or 90° V-notch 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 soil bedding material beside and to 3 inches above the tubing.

For trench installations of corrugated plastic tubing larger than 8 inches, the same bedding requirements will be met except that a semi-circular or trapezoidal groove shaped to fit the conduit will be used rather than a V-shaped groove.

For rigid conduits installed in a trench, the same requirements will be met except that a groove or notch is not required.

All trench installations should be made when the soil profile is in its driest possible condition in order to minimize problems of trench stability, conduit alignment, and soil movement into the drain.

For trench installations where a sand-gravel or compacted bedding is not specified, the conduit should be blinded with selected material containing no hard objects larger than 1.5 inches in diameter. Blinding should be

carried to a minimum of 3 inches above the conduit.

All installations shall meet the minimum requirements of the appropriate ASTM specification.

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.

Existing subsurface main(s) in good working condition may be used as outlets for new subsurface laterals if the in situ main line is positioned such that newly installed laterals meet all applicable criteria found within this standard. An existing subsurface main to be utilized as an outlet shall have adequate capacity for the purposes of both the new subsurface lateral and the existing tile drainage system, including any surface intakes. A pressure relief well may be used to provide additional capacity for the outlet, provided that the criteria in the "Auxiliary Structures and Protection" section are met.

A free 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. If the outlet is directed to a ditch or channel, at least two-thirds of the continuous section of closed conduit shall be buried in the ditch bank, and the cantilever section must extend to the toe of the ditch.

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 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.

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 Illinois Conservation Practice Standard IL 646 - Shallow Water Development and Management and Illinois Conservation Practice Standard IL 554 – Drainage Water 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.

Consider the existence of cultural resources in the project area and any project impacts on such resources.

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 keep inlets, trash guards, 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.
- 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 (NEH), Part 650, Engineering Field Handbook, Chapters 3, 6, 8, 14.

USDA-NRCS. National Engineering Handbook (NEH), Part 636, Chapter 52, “Structural Design of Flexible Conduits.”

NATURAL RESOURCES CONSERVATION SERVICE
ILLINOIS CONSTRUCTION SPECIFICATION
UNDERGROUND OUTLET

Scope
The work shall consist of furnishing and installing conduits, inlets and appurtenances for the underground outlet system as shown on the drawings and specified herein.

Utilities
The landowner and/or contractor shall be responsible for locating all buried utilities in the project area, including drainage tile and other structural measures.

Inspection and Handling of Materials
Conduit and inlet materials shall be carefully inspected before installation. Where applicable, clay and concrete tile shall be checked for damage from freezing and thawing prior to installation. Bituminized fiber and plastic pipe and tubing shall be protected from hazards causing deformation or warping. Materials with physical imperfections shall not be installed. All material shall be satisfactory for its intended used and shall meet applicable specifications and requirements.

Materials
Materials for underground outlets shall meet the requirements as shown in the plans and specifications. They shall be field inspected for any deficiencies, such as thin spots or cracking, prior to installation.

Where perforated conduit is required, the water inlet area shall be at least 1 $in.^2$/ft of conduit length. Round perforations shall not exceed 3/16-in. in diameter except where filters, envelopes, or other protection is provided or for organic soils, where a maximum hole diameter of ½ in. may be used. Slotted perforations shall not exceed 1/8 in. in width.

The following reference specifications pertain to products currently acceptable for use as underground outlets:

REFERENCE SPECIFICATIONS FOR UNDERGROUND OUTLET MATERIALS

Description	ASTM
Plastic	
Corrugated Polyethylene (PE) Pipe and Fittings	F405 F667
Poly Vinyl Chloride (PVC) Pipe and Fittings	F949 D1785 D2241
Styrene-Rubber (SR) Plastic Drain Pipe and Fittings	D2852
Dual Wall Polyethylene Pipe	
Corrugated Polyethylene (PE) Pipe and Fittings	F2306 F2648 F405 F667
Elastomeric Seals and Joints (Gaskets)	F477 D3212
Clay	
Clay Drain Tile and Pipe	C4 C700 C301
Concrete	
Concrete Drain Tile and Pipe	C412 C118 C14 C76 C444
Test Methods for Concrete Pipe	C497
Portland Cement	C150
Metal	
Corrugated Aluminum Pipe	B745
Corrugated Steel Pipe	A760

Placement
All underground outlets shall be laid to line and grade and covered with approved blinding, envelope, or filter material to a depth of not less than 3 inches over the top of the drain. No reversals in grade of the conduit shall be permitted. Material used for blinding shall contain no rocks greater than 1½ inches in diameter. The cover over all buried conduit lines shall be at least 2 feet deep.

All conduits shall be installed in accordance with the appropriate ASTM specification.

Rigid conduits, such as clay or concrete tile, will not need the 90º V groove, but all other applicable placement and bedding requirements will be adhered to. Joints between drain tiles shall have the closest possible fit.

Backfill
Earth backfill material shall be placed in the trench in such a manner that displacement of the conduit will not occur and so that the filter and bedding material, after backfilling, will meet the requirements of the drawings and specifications. Backfill within 2 feet of conduit shall have no rock particles larger than 2 inches in diameter.

Backfill Under Ridge Area
When conduits are installed two or more seasons prior to construction of terrace, basin or diversion ridges, backfilling operations should be performed at an angle to the trench so that loose backfill material flows down the advancing frontslope. In all other cases the conduit under the ridge area shall receive special backfilling as shown in Figure 1.

Backfill shall have adequate moisture for compaction. The moisture content can generally be considered as satisfactory if the fill material can be molded into a round ball between the hands without readily separating or squeezing out free water. Backfill within 6 inches of conduit shall be hand-compacted. Subsequent layers of backfill shall be placed in 6 inch lifts and mechanically compacted.

Water packing may be used as an alternative to mechanical compaction. If the conduit is non-perforated, it shall be filled with water during the water packing procedure. The initial backfill, before wetting, shall be of sufficient depth to ensure complete coverage of the pipe after consolidation has taken place. Water packing is accomplished by adding water in such quantity as to thoroughly saturate the initial backfill without inundation. The wetted fill shall be allowed to dry until firm before final backfill is begun.

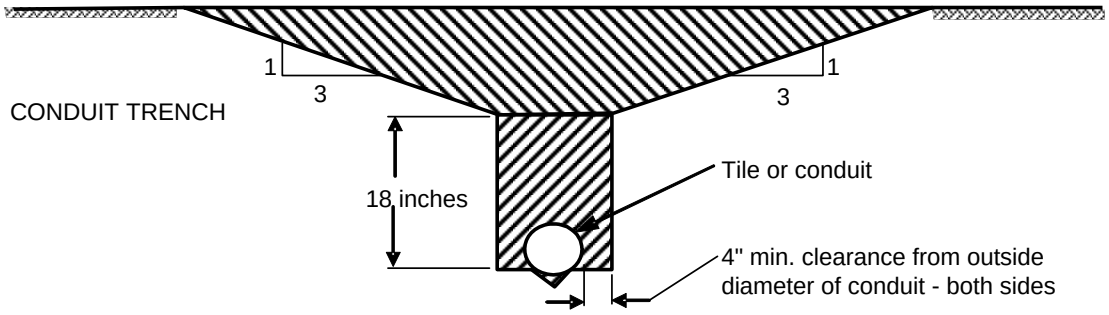

Figure 1.

Inlets for Underground Outlets
Inlets for underground outlets shall be installed in accordance with IL NRCS standard drawings, or approved equivalent.

Outlet
A continuous section of non-perforated conduit shall be used at the outlet, unless a headwall is used. All outlets shall have an animal guard, hinged to allow passage of debris.

The continuous section of non-perforated conduit shall be long enough to satisfy all requirements of the standard:

- At least two-thirds of the pipe shall be buried in the ditch bank.
- The cantilever section must extend to the toe of the ditch side slope or to the side slope protected from erosion.
- The continuous section must be at least 10 feet long.

Acceptable materials for use at the outlet include the following:

- Corrugated metal pipe, galvanized or aluminum, 16-gauge, minimum thickness,
- Smooth steel pipe with 3/16 of an inch minimum thickness,
- Smooth plastic pipe, polyvinyl chloride (PVC), with a SDR of 35 or less or schedule 40 or heavier, and
- Dual wall corrugated polyethylene pipe.

All plastic and polyethylene pipe outlets shall include an ultra-violet stabilizer. Conduit ends shall be protected from sun damage during installation.

NATURAL RESOURCES CONSERVATION SERVICE

ILLINOIS OPERATION AND MAINTENANCE

UNDERGROUND OUTLET

Follow the operation and maintenance plan below to keep your underground outlet system functioning as intended:

- Inspect site after significant storm events and at least annually to identify repair and maintenance needs.
- Keep inlets, trash guards, relief wells, collection boxes and structures clean and free of materials that can reduce the flow.
- Ensure orifice plates are installed and working properly.
- Repair leaks and broken or crushed pipe to ensure proper functioning.
- Repair any settlement or erosion that occurs around the pipe with soil and reseed as needed. If this problem persists, evaluate the pipe for leakage and erosion of the fill material into or along the pipe.
- Maintain design depth of cover on all pipelines and structures.
- Limit traffic over pipeline to designated sections that were designed for traffic loads.
- Check outlet pipe and animal guard to ensure proper functioning.
- Maintain erosion protection at outlets; repair any eroded areas at the outlet.
- Promptly repair or replace damaged or inoperable components.
- Protect the components from damage by farm equipment and livestock. Avoid damage to riser inlets and relief wells by farm equipment. Mark risers so they are visible to prevent damage by equipment.
- Follow OSHA trench safety requirements during repairs of the underground outlet.

Additional Details:

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Illinois, NRCS

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