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 shall be 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 shall be adequate for the intended purpose without causing inundation damage to crops, vegetation, or works of improvements.

Underground outlet design procedure will be dependent on the following classification.

Class 1 Underground Outlet – Class 1 outlets shall be used only if sufficient storage is available for anticipated sediment and to meet proper flood routing requirements as shown in Table 1.

Table 1 – Simplified Flood Routing for Class 1 Underground Outlets

Duration of flooding (Hr. Removal Time)	Design Outflow (cfs/ac-inch of runoff)	Water Storage (Fraction of total runoff to be stored)
6	0.10	0.70
12	0.07	0.79
18	0.05	0.85
24	0.037	0.89
36	0.026	0.92
48	0.02	0.95
72	0.014	1.00

Flows into all Class 1 underground outlets shall be restricted as required to meet the designed flooding duration. Flow restriction can be accomplished with use of an orifice or properly sized reduction pipe located between the inlet and underground outlet.

The minimum duration of flooding for a Class 1 underground outlet shall be 6 hours, except LWCF minimum duration shall be 24 hours. The maximum duration of flooding shall be 24 hours on farmland to minimize potential damage to established crops. The duration of flooding may be adjusted up to 72 hours for non-farmland or LWCF applications.

Class 1 underground outlets with 2 or more inlets shall be designed for gravity flow. Pressure flow is allowed in the outlet section only.

Class 2 Underground Outlet – Class 2 outlets shall have adequate capacity to safely convey

the peak discharge from the design storm for the practice being served.

Class 3 Underground Outlet – Class 3 outlets shall be used in combination with a suitable outlet. The suitable outlet shall be designed as the principal outlet for the practice being served. The intent of the underground outlet will be to reduce the frequency and duration of flows through the suitable outlet. These flows may be the result of baseflow, outflow from small upstream structures, or irrigation tailwater.

Class 2 and 3 outlets shall have a single inlet and may be designed for either pressure or gravity flow.

If the system is designed for pressure flow, all pipe and joints must be non-perforated and able to withstand the design pressure, including surges and vacuum. 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.

Inlet. An inlet can be an open riser, a collection box, a perforated riser, or other appropriate device. Perforated risers shall be of durable, structurally sound material that is able to stand without the use of external support. It must also be a material that is resistant to damage by rodents or other animals. Use fire resistant materials for the inlet if fire is an expected hazard.

Class 1 inlets shall be a riser that is perforated with slots or holes throughout the drawdown area. Allowable materials will be metal, plastic (PVC or HDPE), or concrete. The minimum orifice diameter is 2 inches. The minimum riser diameter shall be 1.5 times the orifice diameter, but at least 6 inches. Risers shall be covered and extend at least 0.5 feet above the designed storage level, or 5 feet, whichever is less and be protected by guard posts(s). Risers are not required to extend above the constructed embankment within the storage area.

A 4 foot or longer horizontal pipe between the mainline and riser elbow (offset) is recommended for all types of pipe installation. An offset is required for inlets that are installed with solid, one piece risers that are not easily removed at approximately the channel elevation.

Open risers and collection boxes for Class 2 or 3 inlets must have an appropriate trash guard to ensure that trash or other debris entering the inlet passes through the conduit without plugging.

Collection boxes or open risers shall be large enough to allow access for required maintenance and cleaning operations.

Blind inlets may only be used in non-agricultural land applications. Blind inlets may be used where the installation of an open or above ground structure is impractical, but shall not be used for Class I outlets. Blind inlets will be placed in a graded granular filter that is designed 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 non-perforated conduits of tubing, tile or pipe. The minimum allowable conduit diameter is 4 inches. Joints shall be hydraulically smooth 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 606, Subsurface Drainage for design criteria for safe velocity.

Conduits shall be placed with at least 30 inches of cover. Maximum burial depths shall be as shown in Table 2 unless detailed engineering analysis indicates a greater depth is warranted and proper inspection can be assured.

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.

Materials. Plastic, concrete, aluminum, and steel pipe shall meet the requirements specified in the applicable ASTM standard. All materials specified in Conservation Practice Standard (606), Subsurface Drains can be used for underground outlets. Materials must meet applicable site specific design requirements for leakage, external loading, internal pressure or vacuum.

Smooth Plastic (PVC) shall meet the specifications of the following, as appropriate: ASTM D-1785, ASTM D-2241, ASTM D-3033, or ASTM D-3034.

Corrugated exterior (smooth interior) plastic pipe shall meet the specifications of the following, as appropriate: ASTM F-892, ASTM F-949, or AASHTO M-294; type S or SP.

Corrugated (exterior & interior) flexible, plastic tubing shall meet the specifications of the following, as appropriate: ASTM F-405, ASTM F-667, ASTM F-800, AASHTO M-252, or AASHTO M-294; type C or CP.

Underground outlet conduits shall be non-perforated. Protect all exposed plastic materials from degradation due to exposure to sunlight.

Outlet. The receiving channel for the outlet must be stable for anticipated design flow conditions from the underground outlet. Design the underground outlet for water surface conditions in 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.

Table 2: Maximum Fill Over Smooth (Interior & Exterior) Plastic Pipe or Corrugated Exterior (Smooth Interior) Pipe Installed in a Trench.

MAXIMUM HEIGHT OF FILL OVER CONDUIT (FT) BASED ON E=400,000						
NOMINAL DIA (inches)	*ps *PR *SDR	14 psi 80 psi 51	28 psi 100 psi 41	57 psi 125 psi 32.5	114 psi 160 psi 26	224 psi 200 psi 21
			(**)		(***)	
4 - 5		9	11	13	16	20
6		7	11	13	16	20
8		7	9	10	14	16
10		5	7	10	13	14
12		5	7	10	13	14
15 - 18		-	5	8	12	13

* Either PR (Pressure Rating) or SDR (Standard Dimension Ratio) Must be stamped on pipe as part of the manufacturer's identification. Corrugated exterior (smooth interior), plastic pipe is rated by pipe stiffness (PS) rather than pressure ratings and the PS will be stamped on the pipe or identified in the manufacturer's product literature.

** Use this column to determine allowable fill height for corrugated exterior (smooth interior) pipe stamped ASTM F-949 or AASHTO M-294.

*** Use this column to determine allowable fill height for corrugated exterior (smooth interior) pipe stamped ASTM F-892.

The Maximum fill height over corrugated (exterior & interior), flexible, plastic tubing shall be 10 feet above the top of the conduit. The minimum depth of trench is the tubing diameter plus 12 inches.

Vertical or “bubbler” outlets may be installed when site conditions prevent adequate bury depth in the outlet section. Proper drainage must be provided for the vertical component of the outlet to prevent damage from freezing. Drainage may be provided by perforations or other means.

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.

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

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.

Consider the visual quality of the riparian area when designing the underground outlet.

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.

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.