

Chapter 4 - BEST MANAGEMENT PRACTICE STANDARDS

SUBSURFACE DRAIN

(Permanent Practice)

Definition

A perforated conduit, such as corrugated plastic tubing, tile, or pipe, installed beneath the ground surface to collect and/or convey drainage water to an outlet.

Purpose

To improve the soil environment for vegetative growth, reduce erosion, and improve water quality by:

1. regulating the water table and ground water flows,
2. intercepting and preventing water movement into a wet area around buildings, roads, and play areas,
3. relieving artesian pressures,
4. removing surface runoff and discharge from detention structures.

Conditions Where Practice Applies

This practice applies to areas having a high water table where the benefits of lowering the water table or controlling ground water or surface runoff justify installing such a system.

This standard applies to areas suitable for the intended use after installation of required drainage and other conservation practices. The soil shall have enough depth and permeability to permit installation of an effective and economically feasible system.

In areas where an outlet is available, either by gravity flow or by pumping, the outlet shall be adequate for the quantity and quality of effluent to be discharged. Consideration shall be given to possible damages above or below the point of discharge that might involve legal actions under state or local laws. Consideration shall be given to maintaining or enhancing environmental values.

Planning Considerations

Subsurface drainage systems are of two types: relief drains and interceptor drains. Relief drains are used either to lower the water table in order to improve the growth of vegetation, or to remove surface water. They are installed along a slope and drain in the direction of the slope. They can be installed in a gridiron pattern, a herringbone pattern, or a random pattern.

Interceptor drains are used to remove water as it seeps down a slope or to prevent the soil from becoming saturated and subject to slippage. They are

installed across a slope and drain to the side of the slope. They usually consist of a single pipe or series of single pipes instead of a patterned layout.

Soil Conservation Service Practice Standard "Subsurface Drains Code 606" provides additional guidance and design criteria.

Design Criteria

The design and installation shall be based on adequate surveys and site and soil investigations.

1. Capacity. The required capacity shall be determined by one or more of the following:
 - a. Application of a locally tried and proven drainage coefficient to the acreage drained, including added capacity required to dispose of surface water entering through inlets.
 - b. Comparison of the site with other similar sites where subsurface drain yields have been measured.
 - c. Measurement of the rate of subsurface flow or intercept flow at the site during a period of adverse weather and ground water conditions.
 - d. Application of Darcy's law to lateral or artesian subsurface flow.
2. Size. The size of subsurface drains shall be computed by applying Manning's formula and shall not be less than 3 inches in diameter. The size shall be based on the required capacity and computed by using one of the following assumptions:
 - a. The hydraulic gradeline is parallel to the bottom grade of the subsurface drain with the conduit flowing full at design flow.
 - b. The conduit flowing partly full where a steep grade or other conditions require excess capacity.
 - c. Conduit flowing under pressure with hydraulic gradeline set by site conditions on a grade that differs from that of the subsurface drain. This procedure shall be used only if surface water inlets or nearness of the conduit to outlets with fixed water elevations permit satisfactory estimates of hydraulic pressure and flows under design conditions.
3. Depth, spacing, and location. The depth, spacing, and location of the subsurface drain shall be based on site conditions, including soils, topography, ground water conditions, site use, outlets, and be at least 50 feet from trees.

The minimum depth of cover over subsurface drains 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 or sections laid through minor depressions where the conduit is not subject to damage by frost action or equipment travel.

The maximum depth of cover for standard duty corrugated plastic tubing shall be 10 feet. Manufacturer's recommendations for loading and backfilling should be followed for corrugated plastic tubing and other materials.

4. Minimum velocity and grade. 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 ft/sec. If a hazard exists, a velocity of not less than 1.4 ft/sec. 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 cleaning solutions.
5. Maximum velocity without protection. Excessive flow velocity in the drain may induce piping of soil material into the drain line. Maximum 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

6. Maximum grade and protection. On sites where topographic conditions require that drain lines be placed on steep grades and design velocities will be greater than indicated under "Maximum velocity without protection," special measures shall be used to protect the conduit or surrounding soil. The protective measures shall include one or more of the following:
 - a. Enclose continuous perforated pipe or tubing with fabric-type filter material or properly graded sand and gravel.
 - b. Use nonperforated continuous tubing, a watertight pipe, or seal joints.
 - c. Place the conduit in a sand and gravel envelope or blinding with the least erodible soil available.
 - d. Select rigid butt end pipe or tile with straight smooth sections and square ends to obtain tight fitting joints.
 - e. Install open air risers for air release or entry.

7. Protection against root clogging. Problems may occur where it is necessary to place drains in close proximity to perennial vegetation. Roots of water-loving trees, such as willow, cottonwood, elm, and soft maple, or some shrubs and grasses growing near sub-surface drains may enter and obstruct the flow.

The first consideration is to use nonperforated tubing or closed joints through the root zone area. Where this is not possible, water-loving trees should be removed from a distance of at least 100 feet on each side of the drain. A distance of 50 feet should be maintained from other species of trees except for fruit trees. Orchards can often be drained by drains located close to the fruit trees.

8. Materials. Subsurface drains include conduits of plastic, clay, concrete, bituminized fiber, metal, or other materials of acceptable quality. The conduit shall meet strength and durability requirements of the site.
9. Foundations. If soft or yielding foundations are encountered, the lines shall be stabilized and protected from settlement by adding gravel or other suitable materials to the trench, by placing the conduit on a treated plank that will not readily decompose or on other rigid supports, or by using long sections of perforated or watertight pipe having adequate strength to insure satisfactory subsurface drain performance. The use of a flat treated plank is not recommended for corrugated plastic tubing.
10. 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:
 - a. local experience indicates a need,
 - b. soil materials surrounding the conduit are dispersed clays, low plasticity silts, or fine sands (ML or SM with P.I. less than 7), or
 - c. where deep soil cracking is expected.

When a sand-gravel filter is specified, the filter gradation will be based on the gradation of the base material surrounding the conduit.

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.

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.

11. 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.

12. Placement and bedding. The conduit should not be placed on exposed rock or stones more than 1.5 inch in diameter. Where such conditions are present the trench must be overexcavated 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. 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. The upper end of the drain shall be capped.

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 a compacted bedding is not specified, the conduit should be blinded with selected material containing no hard objects larger than 1.5 inches in diameter. Blinder material should be carried to a minimum of 3 inches above the conduit.

13. Auxiliary structures and protection. Structures installed in drain lines must not unduly impede the flow of water in the system. Their capacity must be no less than that of the line or lines feeding into or through them. The use of internal couplers for corrugated plastic tubing will be allowed.

If the drain system is to carry surface water flow, the capacity of the surface water inlet shall not be greater than the maximum design flow in the drain line or lines. Covers, orifice plates, and/or trash racks should be used to ensure that no foreign materials are allowed in the drain lines.

Junction boxes, manholes, catch basins, and sand traps must be accessible for maintenance. A clear opening of not less than 2 feet will be provided in either circular or rectangular structures.

Junction boxes shall be installed where three or more lines join or if two lines join at different elevations. In some locations it may be desirable to bury junction boxes. A solid cover should be used, and the junction box should have a minimum of 1 1/2 feet of soil cover.

The outlet must be protected against erosion and undermining of the conduit, entry of tree roots, damaging periods of submergence, and entry of rodents or other animals into the subsurface drain. A continuous section of rigid pipe without open joints or perforations will be used at the outlet end of the line and must discharge above the normal elevation of low flow in the outlet ditch. Corrugated plastic tubing is not suitable for the outlet section. Minimize the visual impact of projecting outlets. If burning vegetation on the outlet ditch bank is likely to create a fire hazard, the material from which the outlet pipe is fabricated must be fire resistant. If the likelihood is great, the outlet pipe must be fireproof.

Plans and Specifications

Plans for installing subsurface drains shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

Specifications for construction and installing a subsurface drain shall use or be in conformance with the following. Any variation from these specifications shall be approved by an engineer.

1. **General.** All conduits shall be laid to line and-grade in such a way that the side walls are continuously and uniformly supported with suitable bedding material. Such material shall be properly placed and compacted to provide lateral restraint against deflection and to protect the conduit against collapse during backfilling.
2. **Installation.** Inspecting and handling materials. Material for subsurface drains shall be carefully inspected before the drains are installed. Plastic pipe and tubing shall be protected from hazard-causing deformation or warping. Plastic pipe and tubing with physical imperfections shall not be installed. A damaged section shall be removed and a suitable joint made connecting the retained sections. Clay and concrete tile shall be checked for damage from freezing and thawing before it is installed. All material shall be satisfactory for its intended use and shall meet manufacturer's specifications and requirements.
3. **Conduit Perforations Special Requirements.** Where perforated conduit is required, the water inlet area shall be at least 1 in²/ft of conduit length. Round perforations shall not exceed 3/16-inch diameter except where filters, envelopes, or other protection are provided or for organic soils, where a maximum hole diameter of 1/2 inch may be used. Slotted perforations shall not exceed 1/8 inch in width.
4. **Trenching.** Trench widths must be adequate for proper installation of the conduit, allow proper joining of sections, and allow proper

placement of filter, envelope, or blinding materials. The trench bottom shall be constructed to proper grade before placement of the conduit.

Where rock is encountered the trench will be overexcavated a minimum of 6 inches and refilled to proper grade with a suitable bedding material.

Provisions for safety during trenching operations shall be in compliance with the applicable safety and health regulations for construction.

5. Bedding. The trench bottom shall be smooth and free of clods and loose or exposed rock. Where a gravel envelope is not specified, the bottom of the trench shall be shaped to conform to the pipe. The groove may be semi-circular, trapezoidal, or a 90 degree "V"-shape.

In unstable soils, a firm foundation shall be provided by overexcavation and backfilling with processed stone or gravel, suitably graded so as to act as a mat into which unstable soil will not penetrate.

6. Filters and envelopes. If a sand-gravel filter is specified, it shall be clean, hard, durable material and of the gradation specified.

When sand-gravel envelopes are used, they will be of clean, hard, durable material with less than 5 percent passing the No. 200 sieve, not more than 30 percent passing the No. 60 sieve, and with a maximum size of 1 1/2 inches. Geotextile filter fabrics may also be used to prevent soil movement into drains.

7. Placement. Conduit will be placed in such a way that maximum stretch of plastic pipe does not exceed 5 percent.

Fittings shall be installed in accordance with instructions furnished by the manufacturers. Couplers are recommended at all joints and fittings, at all changes in direction (where the centerline radius is less than three times tubing diameter), at changes in diameter, and at junction with another line.

Caps are needed at the upper end of lines. All fittings shall be compatible with the tubing. Where certain fittings are not available, handcut holes are acceptable provided care is taken when making the connection not to create a means of obstructing flow, catching debris, or allowing soil to enter the line. Place selected bedding material, containing no hard object larger than 1 1/2 inches in diameter in the trench to a minimum depth of 6 inches over the conduit. The conduit will be held in place mechanically until secured by blinding.

8. Backfilling. Place backfill material so that displacement or deflection of the conduit will not occur. This is preferably on an angle, so the material flows down the front slope. Avoid large stones, frozen material, and dry clods that cause concentrated point loads on the tubing. The trench should be backfilled as soon as practical. When installing the tubing on a hot day, backfilling should be delayed until tubing temperature cools to the soil temperature.

Subsurface Drain Design Form

Project Location: City _____, County _____,

Section _____, Range _____, Township _____

Planned Construction Date: _____, Ending Date _____

Structural Data: Required Flow Capacity _____ cfs

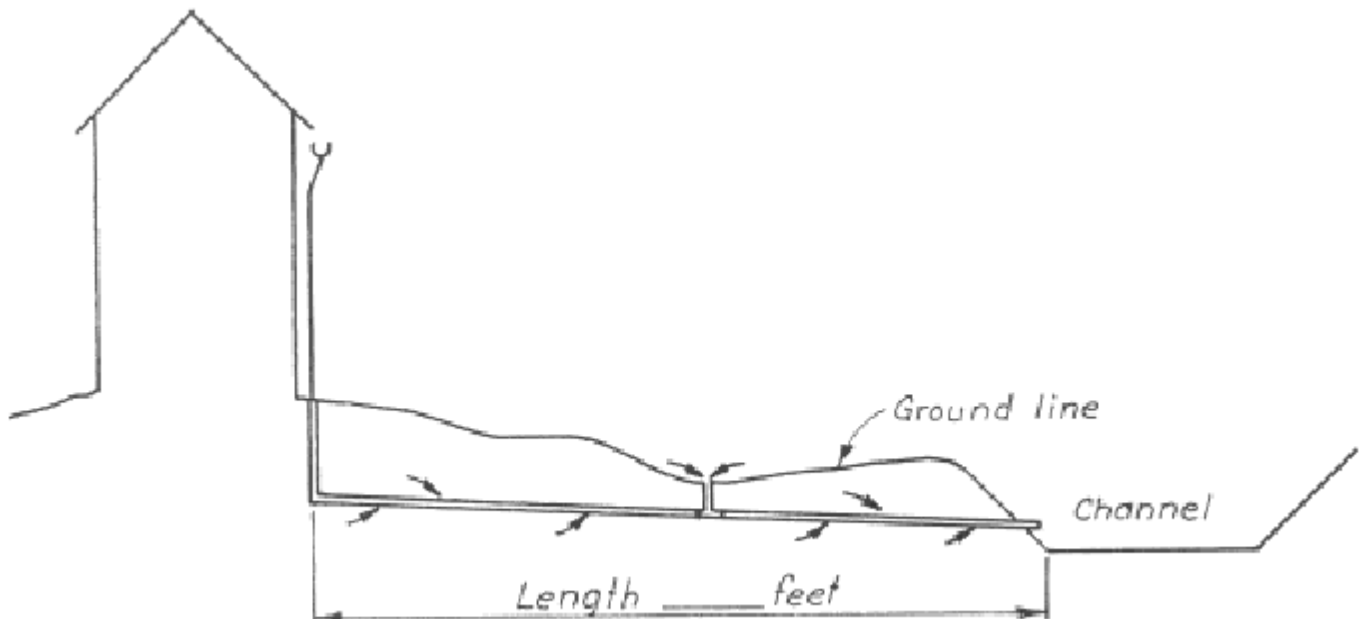
Water Source: Roof Drain _____, Parking Area _____, Retention Basin _____,
Ground Water _____, Surface Water _____

Drain Size: Diameter _____ inches, Length _____ Feet

Drain Outlet: Structure _____, Channel _____, Road Ditch _____

Entrance Protection: Surface Grating _____, Filter Bed _____, Roof _____

Project/Developer Representative: _____
Name _____ Date _____



Note: Alter Diagram As Required To Show Additions Or Omissions