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Design and Construction of Surface Drainage Systems On Agricultural Lands in Humid Areas



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Design and Construction of Surface Drainage Systems on Agricultural Lands in Humid Areas

Developed by the ASAE Surface Drainage Committee; approved by the ASAE Soil and Water Division Steering Committee; adopted by ASAE as a Recommendation December 1966; revised March 1972, March 1973; reconfirmed December 1977; reconfirmed and reclassified as an Engineering Practice December 1978; reconfirmed December 1983, December 1984, December 1985; revised December 1986; reconfirmed December 1991; revised February 1993; approved as an American National Standard August 1993; reaffirmed by ASAE December 1997, December 1999; reaffirmed by ANSI June 2000; reaffirmed by ASAE January 2001, February 2003; reaffirmed by ANSI February 2003; reaffirmed by ASABE and ANSI February 2008; reaffirmed by ASABE December 2012; reaffirmed by ANSI February 2013; reaffirmed by ASABE and ANSI November 2017.

Keywords: Drainage, Erosion, Humid, Surface

1 Purpose

1.1 This Engineering Practice is intended to improve the design, construction and maintenance of surface drainage systems which are adapted to modern farm mechanization. It is limited to agricultural or farm-size areas, 259 ha (640 ac) or less, in the humid region of the eastern USA (see Figure 1).



**Figure 1 – Key map for drainage curves
(Humid areas for eastern USA where surface drainage may be needed)**

1.2 Surface drainage is normally required for efficient crop production on slowly permeable soils with restrictive topography. It is not required when excess water is removed naturally. Typical problem areas are glaciated areas, coastal plains, bottomlands, deltas, and old lake beds. Surface drainage may eliminate the

need for subsurface drains under certain conditions. Surface drains also apply to farm mains used to collect water from field drains and subsurface drains.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Engineering Practice. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this Engineering Practice are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below. Standards organizations maintain registers of currently valid standards.

ASAE S268.4, Design, Layout, Construction and Maintenance of Terrace Systems

ASAE S526, Soil and Water Engineering Terminology

3 Definitions and terminology

3.1 The following terms used in this Engineering Practice are defined in ASAE S526:

- bedding
- berm
- crowning
- diversion
- field drain
- field lateral
- interceptor drain
- land grading
- parallel system
- reverse grade
- row drain
- row grade
- surface drainage
- water leveling

3.2 For the purpose of this Engineering Practice only, the following terms are defined herein:

3.2.1 land smoothing: The process of smoothing the land surface with a land plane or land leveler to eliminate minor depressions and irregularities without changing the general topography.

3.2.2 cross slope: The slope perpendicular to crop rows.

3.2.3 farm main: An outlet ditch serving an individual farm.

3.2.4 pipe drop: A pipe, with or without headwalls, used as an erosion control structure at a transition to drop water into a deeper drain.

3.2.5 random system: A system of meandering row drains, field drains, and/or field laterals that are located in and drain depressions in a field.

3.2.6 transition: The outlet section of a drain that discharges into a deeper drain. Transitions may be vegetated or nonvegetated sections, or erosion control structures.

4 Principles

4.1 The objectives of surface drainage are:

- a) to prevent water from ponding on land surfaces or in surface drains that are crossed by farm equipment;
- b) to remove excess water in time to prevent damage to crops;
- c) to accomplish the above without excess erosion.

4.2 Complete drainage systems shall be planned and designed with all aspects considered. The collection system, consisting of the land surface and shallow drains, removes excess surface water from individual areas within fields. The disposal system, consisting of somewhat larger ditches, receives drainage water from the collection system and removes it from the land. Transitions, including structures, that permit drains to discharge into larger or deeper drains must provide for adequate erosion control without holding water on field surfaces for excessive periods of time. The system shall be designed as an integral part of the soil and water facilities, the farm layout, and cropping plan. Farm roads shall be planned to complement the drainage system and to facilitate farming operations.

4.3 There are several methods of draining agricultural land. Land surfaces that pocket water can be drained by cutting and filling. Depressions can be drained by row drains, field drains, and field laterals. The methods can be combined, thereby reducing the number of depressions and the number of drains. A brief discussion of the principal surface drainage methods follows.

4.3.1 Land smoothing eliminates minor depressions and irregularities in a field, thereby improving surface drainage and increasing farm machinery efficiency. Frequently, this is an interim measure that will be replaced by land grading when economic conditions permit.

4.3.2 Land grading, by carefully designed cutting and filling operations, provides excellent surface drainage.

4.3.3 Water leveling was developed for fields which are to be flooded and provides adequate drainage for rice and other selected, close growing, water tolerant crops.

4.3.4 Random drainage systems provide for drainage of the low areas by row drains, field drains, and field laterals. These systems are relatively low in cost and give a high return on the investment. They require frequent maintenance and may be obstacles to farm machinery, particularly if drains are closely spaced. On severely undulating topography, random drainage may be the only economical system.

4.3.5 Parallel drainage systems facilitate mechanization by eliminating short rows and point rows. Crossable field drains or row drains are constructed between parallel field laterals. This permits farm equipment to travel greater distances without turning. Field surfaces between field laterals should be improved by land smoothing or land grading for maximum benefits.

4.3.6 Bedding, under most conditions, is not considered an acceptable drainage practice for row crops because rows adjacent to the dead furrows will not drain satisfactorily. It is an acceptable practice for hay and pasture crops in some areas. Normally there is some crop loss in and adjacent to the dead furrows.

4.3.7 Crowning was developed for sugar cane production in areas that formerly had ample hand labor; is well established in some areas and provides excellent drainage. Crowning requires more maintenance than most of the other systems. The large number of field laterals take land out of production, and they are a source of erosion and sedimentation, and weed and grass infestation. Crowning with crossable field laterals provides excellent drainage for the pasture crops commonly grown in the sugar cane areas.

4.3.8 Diversions intercept upland runoff and prevent it from overflowing bottomlands. This simplifies installation of drainage systems on bottomlands.

4.3.9 Interceptor drains intercept and remove subsurface water. They are used on long slopes with 1% or steeper grades and shallow, permeable surface soils overlying relatively impermeable subsoils.

5 Design

5.1 Surface drainage system design criteria are based on the assumption that all lands to be drained will be suitable for agricultural use after drainage. Design shall consider construction and maintenance needs and irrigation requirements where applicable. The rate of water removal, in terms of depth per unit of time to be provided by the drainage system, depends on several interrelated factors such as rainfall characteristics, soil properties, and cropping patterns. For most row crops, surface drainage systems shall complete removal of excess water from the soil surface within 24 h after rainfall ceases. More rapid removal may be necessary for high-value truck crops. A longer time is permissible for grasslands and woodlands.

5.2 The intensity of drainage desired is expressed in terms of drainage curves (see Figures 1, 2, and 3). These empirical curves were developed from a large number of field measurements of drainage flow rates and observations of the adequacy of drainage. The curves will not provide for peak flows from large storms. Excess runoff will be discharged as overland flow temporarily flooding adjacent lands. Curves with the higher coefficient values represent a larger drainage capacity.

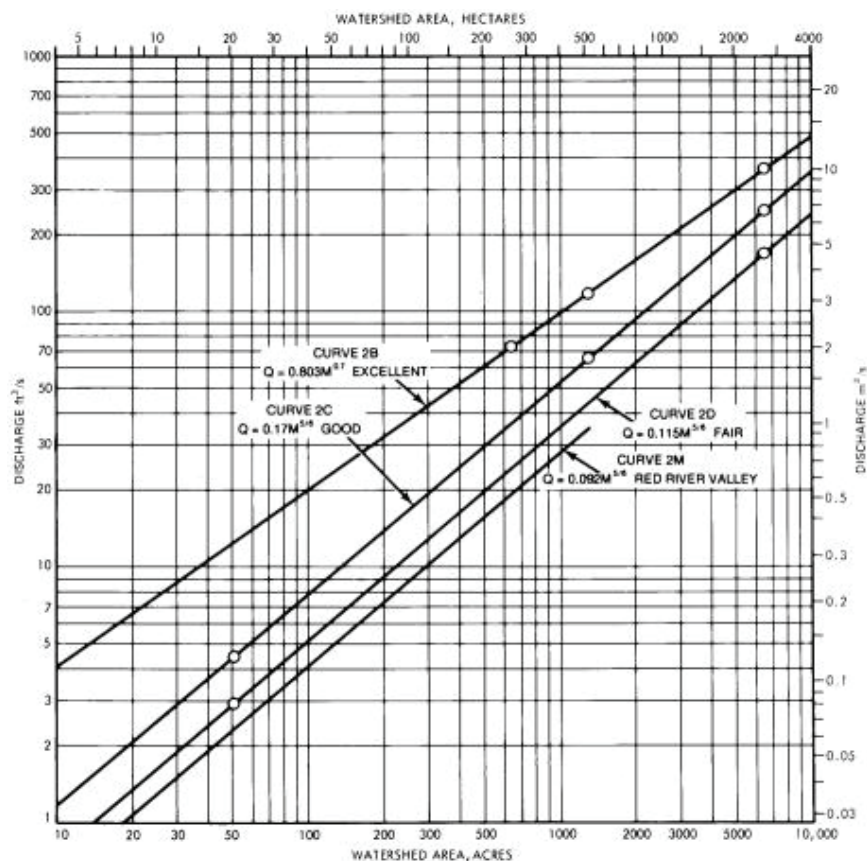


Figure 2 – Drainage curves — northern area of USA (see Figure 1).
Source based on USDA SCS National Engineering Handbook, section 16, chapter 6