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Agricultural Drainage Outlets — Open Channels

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Developed by the ASAE Surface Drainage Committee; approved by the ASAE Soil and Water Division Standards Committee; adopted by ASAE January 1982; reconfirmed December 1986, December 1987; revised March 1990; reaffirmed December 1994, December 1995, December 1996, December 1998, December 1999, February 2003, February 2008; editorial revision February 2008; reaffirmed December 2012; revised September 2014, reaffirmed November 2018.

Keywords: Channels, Drainage

1 Purpose and Scope

1.1 The purpose of this Engineering Practice is to provide planning, design, construction and maintenance information and criteria for agricultural drainage outlets by means of open channels. Drainage, so provided, will enhance agricultural production and protect environmental resources. This Engineering Practice is compatible with ASAE EP302, Design and Construction of Surface Drainage Systems on Agricultural Lands in Humid Areas, ASAE EP480 Design of Subsurface Drains in Humid Areas, and ASAE EP481, Construction of Subsurface Drains in Humid Areas.

1.2 This Engineering Practice covers all engineering phases of open-channel planning, design, construction, and maintenance for projects within the following limits:

1.2.1 Watersheds larger than 2.6 km^2 (1 $mile^2$) and smaller than 260 km^2 (100 $mile^2$) with average slopes generally less than 4.7 m/km (25 ft/mile).

1.2.2 Channels excavated in earthen material, to convey design flows within banks and to be stable and maintainable.

1.2.3 Channel work that will not have a serious impact on significant environmental resources and adverse effects will be minimized.

1.2.4 Project development that will be physically and economically sound, environmentally and socially acceptable and compatible with long-term use of natural resources.

2 Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies unless noted. For undated references, the latest approved edition of the referenced document (including any amendments) applies.

ANSI/ASAE EP302.3, Design and Construction of Surface Drainage Systems on Agricultural Lands in Humid Areas

ANSI/ASAE S318, Safety for Agricultural Field Equipment

ASAE EP480 Design of Subsurface Drains in Humid Areas*

ASAE EP481, Construction of Subsurface Drains in Humid Areas*

*Merge in progress to become ASAE EP260, Design and Construction of Subsurface Drains in Humid Areas

King and Brater, Handbook of Hydraulics

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Geological survey water-supply. Paper #1849

Supplement B to US Soil Conservation Service, National Engineering Handbook, Section 5

USDA, Soil Conservation Service. 1977. Technical Release No. 25. Design of open channels

USDA, Soil Conservation Service. National Engineering Handbook. Section 16

USDA, Soil Conservation Service. National Handbook of Conservation Practices. Practice 582. Open channels

National Academy of Sciences, Highway Research Board. National Cooperative Highway Research Program. Report 108. Tentative design procedures for riprap lined channels

2 Resource Development

2.1 The efficient removal of excess water from land used for agricultural production is essential for optimum crop qualities and yields. Drainage is required for irrigated land in arid areas to prevent or reduce salinity problems.

2.2 Land resources have a wide variety of values that satisfy many objectives and needs of people. Use of these resources for agricultural production may have impact on other values. To reduce this impact, drainage development should focus primarily on existing pasture and cropland or land suitable for agricultural production. Objectives should be evaluated for maximizing economic returns while minimizing adverse environmental impacts, and for providing maximum beneficial use of water, land and natural resources.

3 Site Investigations

3.1 Reconnaissance and preliminary investigations should consist of the following:

3.1.1 A field reconnaissance, by an interdisciplinary team, to establish the scope and objectives and probable conflicts of resource usages. The watersheds above and downstream from the problem area should be included to determine possible detrimental effects. Discussions with landowners and others will provide information on local support for the project, types of improvements needed, and an indication of their priorities.

3.1.2 An investigation to establish physical and economic feasibility. This investigation is an extension of the field reconnaissance survey. It should include (a) a working map of the project and watershed showing the pertinent physical features; (b) a generalized soil and land use map; (c) an environmental evaluation; (d) a preliminary plan for each objective; (e) an estimate of project costs and benefits; and (f) an assessment of impacts. Existing data such as aerial photographs, topographic maps, property ownership, previous project plans, local surveys, detailed soil maps, and legal requirements should be used.

3.2 Adequacy of an outlet for a proposed channel should be examined to insure that it will safely carry the discharge from the project and not cause damage downstream.

3.3 All local, state and federal laws should be strictly observed.

3.4 Engineering field surveys shall utilize an established system of horizontal and vertical controls to define channel alignment, channel bank and bottom profiles, and topography of adjacent land. Sufficient cross sections shall be obtained to accurately identify channel excavation and hydraulic conditions. Whenever possible mean sea level datum using third order vertical control, or better, should be used. Drawings and maps should be prepared displaying survey data, topography, drainage patterns, soils, land use, land capacity, drainage area, benefited areas, and ownership.

3.5 Subsurface investigations should be made to obtain information on the soils, geology, and water table elevations. Soil borings should be made to obtain information on soil conditions to a depth below planned excavation of about one-half the proposed depth of channel. Data is needed on soil materials in order to determine soil stability, permeability, and barriers which could affect channel construction. Piezometers and observation wells may be useful for determining groundwater elevations and movement.

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3.5.1 Information from each boring should be located on a plan view and plotted on the profile. Logs should be plotted using the Unified Soil Classification System.

3.5.2 Laboratory tests should be made for mechanical analysis, plasticity indices, and dispersion. Sheer strength, hydraulic conductivity, moisture aeration curves, and drainable pore space data may be required for final design.

4 Design Discharges

4.1 The design discharge of the channel or system of channels is the discharge that provides for the most economical level of agricultural production. Experience has shown that the most economical level of production results when the following criteria are met.

4.1.1 The design discharge should remove excess water from the watershed in 24 hours for most agricultural crops. A longer time period may be appropriate for woodland, pasture and some crops, while a shorter time period may be necessary for other crops.

4.1.2 The effects of outflow from floodwater retarding structures discharging into the channel or system of channels, should be considered when selecting a design discharge.

4.2 Drainage coefficient is defined as that discharge capacity which removes a specified depth (volume) of water from the watershed in a 24 hour period. The drainage coefficient includes the capacity for direct runoff and base flow from the watershed. In some instances, especially larger watersheds fed by many subsurface drains or seeps and springs and in irrigation areas, separation of flow sources may be desirable for design purposes. The accretion discharge from subsurface drains or seeps and springs may be a significant portion of the channel flow in humid areas. In arid regions the flow from irrigated lands may be the only inflow to some channel systems.

4.2.1 Where applicable, ASAE EP480 Design of Subsurface Drains in Humid Areas, and ASAE EP481, Construction of Subsurface Drains in Humid Areas, should be used to determine subsurface drainage discharge for channel design capacities. Seepage and discharge from springs should be considered, and where the flow is continuous and generally uniform for extended periods, it should be added as a base flow in computing the required capacity of the channel.

4.2.2 For arid areas, drainage and seepage discharge from irrigated lands may be a large portion of the required collection channel capacities. Experience in similar watersheds will provide the best estimate of discharges. Measured discharges have ranged from 0.0018 to 0.70 $m^3/s \cdot km$ (0.10 to 40.0 $ft^3/s \cdot mile$) of channel. The discharge may also be rationalized from the amount of irrigation water that is applied.

$$q = \frac{i[(P + L)/100]}{T}$$

where:

q = drainage coefficient, mm/day (in./day)

P = deep percolation from irrigation and leaching, percent

L = field canal losses, percent

i = irrigation application, mm (in.)

T = time between irrigations, days

4.2.3 Drainage coefficients for collection channel systems for irrigated areas are usually in the range of 3 to 6 mm/24 h (0.12 to 0.24 in./24 h). The disposal system for several irrigated tracts usually has a smaller combined coefficient than the sum of the collection system components. This combined coefficient may be in the range of 2 to 4 mm/24 h (0.08 to 0.15 in./24 h). Deep percolation, consumptive use by trees and phreatophyes and land temporarily not irrigated, along with cultural practices, account for the reduction in combined flow to the disposal system.

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