

DRAINAGE CRITERIA MANUAL

JEFFERSON COUNTY DRAINAGE DISTRICT NO. 3



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Adopted December 17, 2025

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FOREWORD

Jefferson County Drainage District No. 3's ("District") Drainage Criteria Manual was prepared pursuant to House Bill 919, which authorizes drainage districts to review and approve drainage plans for proposed development.

The District's Board of Commissioners adopted this manual on August 20, 2025. The drainage regulations and the Drainage Criteria Manual are available online at <https://www.jcdd3.org>.

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1. General Provisions

1.1. Authority and Purpose

This Drainage Criteria Manual is adopted by Jefferson County Drainage District No. 3 pursuant to the authority set forth in Texas Water Code § 49.211. The regulations are accessible online at www.jcdd3.org.

The express intent of the Drainage Regulation is that the 10-year, 25-year, 50-year, and 100-year peak flow runoff within the boundaries of subdivisions and developments, and the 10-year, 25-year, 50-year, and 100-year peak flow discharge that flows from subdivisions and developments, be conveyed safely, that these flows have flow paths to the most appropriate District outfall, that along the flow paths property is not adversely impacted by these flows, and that it be demonstrated that the receiving District outfalls and ditches have the capacity to convey the additional flows without increasing downstream flooding.

The manual is for users with knowledge and experience in applications of standard engineering principles and practices of drainage design and management. It is the purpose of this Drainage Criteria Manual to outline criteria and guidance to be used by developers, engineers, and land surveyors in the design of drainage measures to manage rainfall runoff. These criteria shall be used unless otherwise approved by the District Engineer.

1.2. Interpretation

The responsibility for interpretation of the criteria and guidance contained in this manual rests solely with the District Engineer, who shall construe them in the best interests of the District. The criteria and guidance shall be considered the minimum necessary for the promotion of the public health, safety, and welfare with respect to stormwater runoff and drainage and the reduction of flood hazards.

1.3. Conflict

This manual is not intended to interfere with, abrogate, or annul any other ordinance, rule, regulation, statute, or other provision of law. Where any provision imposes restrictions different from those imposed by Jefferson County, Texas Department of Transportation (TxDOT), or an incorporated municipality within the boundaries of the District, whichever provisions are more restrictive or impose higher standards shall control.

1.4. Interpretation

Terms used in these regulations may be defined in the Drainage Regulations. Terms that are not specifically defined shall have the meanings commonly used by engineers and others engaged in managing stormwater.

1.5. Pipelines and Utility Permits

These regulations do not address pipelines and utilities. The District has administrative procedures for applications for the construction, maintenance, and repair of pipelines and utilities that are proposed within the District's facilities and easements. Contact the District's office to obtain the Pipeline/Utility Permit Application packet.

2. Approval Process

2.1. Overview of Approval Process

The District's procedures are described in the Drainage Regulations. The following is an overview of the review and approval process (Exhibit 2A). In the event of a conflict, the regulations shall prevail.

A pre-submission conference is required. The District acknowledges that drainage concerns, the adequacy of the existing drainage system and access for maintenance, and solutions to address inadequacies and flooding that may be exacerbated by new development vary from location to location to location. The purpose of the pre-submission conference is to improve understanding of the existing drainage system in the vicinity of and downstream of the proposed subdivision or development site and to discuss measures that are necessary and appropriate to address drainage and flooding. The District Engineer may provide information, data, and computer models from the District's engineering studies, and evidence of drainage and flooding concerns based on observations and data collected from past storm and flood events.

To schedule a pre-submission conference, the Applicant/Owner submits a Concept Approval form to the District (available at <https://www.jcdd3.org/departments/engineering>). For this purpose, the information requested includes:

- A. The current Landowner(s) and the Applicant(s), if different from the Owner(s), and their addresses, telephone numbers, and e-mail addresses.
- B. Designation of the Applicant/Owner's authorized representative, if any, who is authorized explicitly to act on the Applicant/Owner's behalf to obtain the District's approval, and the authorized representative's address, telephone number, facsimile number, and e-mail address.
- C. The location of the proposed subdivision or development and the legal description, the tax tract number assigned by the Jefferson Central Appraisal District, or the subdivision lot and block numbers.
- D. A general description of the proposed subdivision or development.

The District will participate in these meetings and advise applicants regarding drainage. Depending on the site conditions and drainage needs in the vicinity of any given proposed development site, the District reserves the right to require a pre-submission conference.

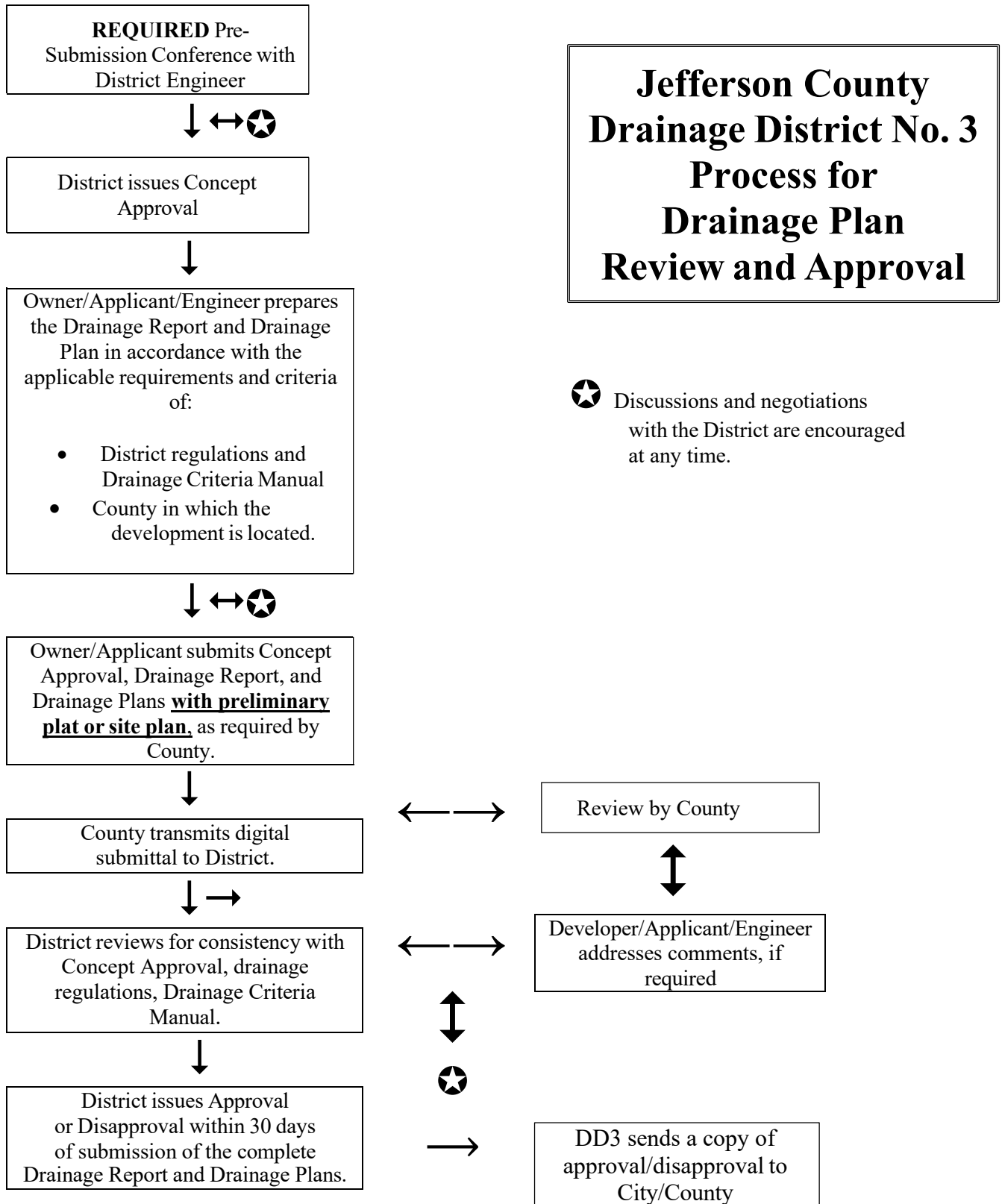
The District will issue a Concept Approval after the pre-submission conference. The Concept approval will summarize the concepts, proposals, and agreements discussed at the pre-submission conference. The Concept Approval is not the District's final approval.

The Applicant/Owner will submit to the applicable local jurisdiction the Concept Approval and a digital copy of the drainage report and drainage plans that are prepared in accordance with the District's Drainage Regulations and this manual. Addressing the District's requirements does not relieve the Applicant/Owner of the responsibility to fulfill the requirements of the applicable local jurisdiction.

The District will review the drainage report and drainage plans for consistency with the Concept Approval, the District's Drainage Regulations, and this manual. Additional information may be requested if necessary to perform the District's review.

At any time, Applicants/Owners and designated representatives are encouraged to contact the District, especially if it is determined that the provisions of a Concept Approval are no longer applicable due to differing conditions.

EXHIBIT 2A



★ Discussions and negotiations with the District are encouraged at any time.

3. Advisories

3.1. Engineering Judgment

The Drainage requirements, criteria, and schematics included in this manual establish uniform practices for the design of drainage associated with subdivisions and developments. However, the requirements of this manual neither replace the need for engineering judgment on behalf of designers, nor does it preclude the use of methods not presented. Other accepted methods and procedures may be used with prior approval of the District Engineer.

3.2. Deviations

Deviations from the District's drainage regulations and this manual, if known or anticipated, shall be identified and discussed at the pre-submission conference. Deviations are to be identified in the drainage report, and the technical justification for such deviations, including computations as appropriate, shall be provided. The acceptability of the deviations shall be determined by the District Engineer.

3.3. Requirements of Other Jurisdictions

It is the responsibility of the Applicant/Owner to obtain any and all approvals required by Jefferson County, TxDOT, or the other municipalities, or any other agency of the State of Texas or the United States of America. Evidence that such approvals have been applied for or obtained may be required by the District prior to issuance of an Approval.

4. Hydrologic Design Criteria

4.1. Acceptable Methods

Estimating peak flow discharges and routing flow hydrographs for the pre-development and post-development conditions is necessary for the planning, analysis, and design of drainage improvements and drainage facilities. The following hydrologic methods and models are accepted by the District:

- A. **HEC-RAS:** developed by the U.S. Army Corps of Engineers' Hydrologic Engineering Center. Specific parameters that shall be used are described in Section 3.1.
- B. **HEC-HMS, Hydrologic Modeling System:** developed by the U.S. Army Corps of Engineers' Hydrologic Engineering Center. Specific parameters that shall be used are described in Section 4.1.
- C. **Rational Method:** used for peak flow discharge estimation for small rural drainage basins and is the most widely used method for urban drainage design for small drainage areas. The Rational Method equation is given below:

$$Q = CIA$$

where:

Q = peak flow (cfs)

C = dimensionless runoff coefficient

I = rainfall intensity (in/hr)

A = drainage area (acres)

4.2. Specific Design Parameters for HEC Models

Sound engineering judgment shall be used to select the parameters required and in the construction of HEC-RAS and HEC-HMS models. Unless approved by the District Engineer, the following design parameters shall be used:

- A. **Soil Coefficient:** The exponential loss rate function using parameters in Table 4-1 or USDA Soil Conservation Service runoff curve numbers (Appendix A) may be used.

Table 4-1. Exponential Loss Rate Parameters for Jefferson County

| | |
|------------------------------------|-----|
| Initial Storage (STRKK) | 0.3 |
| Initial Accumulation (DLRK) | 0.0 |
| Rate of Change (RTIOL) | 0.7 |
| Amount of Impervious Cover (RTIMP) | * |

* To be calculated carefully, based on evaluation of drainage area.

-
- B. **Precipitation Distribution:** The hypothetical 24-hr, 10-year, 25-year, 50-year, and 100-year storm rainfall distribution based on the Atlas 14 report shall be used to calculate flow rates.

The rainfall distribution changes based on location, even within Jefferson County. With that in mind, please use the following link to access NOAA’s website and enter the address at which the development is taking place to obtain the data:

https://hdsc.nws.noaa.gov/pfds/pfds_map_cont.html?bkmrk=tx

For the **Data Type**, either “Precipitation Depth” or “Precipitation Intensity” can be selected to gather the data needed for the specific design methodology. For the **Time Series Type**, “Annual Maximum” needs to be used.

NOTE: The District will make updates when new data is available, but the design engineer will need to use the latest available rainfall data for the analysis of the development.

- C. **Storage Coefficient (R):** Clark’s storage coefficient shall be determined by the following formula (or other methods approved by the District Engineer):

$$R = 1.6T_c$$

where:

R = Clark’s storage coefficient (hrs)

T_c = time of concentration (hrs)

- D. **Time of Concentration (T_c):** The time of concentration for a drainage area is a function of characteristics that can be estimated from available maps, topographic data, and hydrologic modeling software by analyzing the length and type of flow path that is taken by runoff. Time of concentration typically has three components: overland flow, ditch flow, and storm sewer flow.

Basin Characteristics

where:

L_o = length of overland flow patch (ft)

L_d = length of ditch flow patch (ft)

L_s = length of storm sewer flow patch (ft)

S_o = slope overland flow path (ft/ft)

S_d = slope of ditch flow path (ft/ft)

S_s = slope of storm sewer flow path (ft/ft)

V_d = velocity of ditch flow (ft/sec)

V_s = velocity of storm sewer flow (ft/sec)

H_r = hydraulic radius of ditch flow calculated
by area divided by wetted perimeter (ft)

D = diameter of storm sewer pipe (ft)

It is assumed that the time of concentration is the time necessary for runoff to travel from the most hydraulically distant point to the outlet of the drainage area. The total travel time is the combination of travel through all flow paths: Overland flow, ditch flow, and storm sewer flow. Using the basin characteristics, the formulas to calculate time of concentration are as follows:

$$T_c = T_o + T_d + T_s$$

where:

- T_c = time of concentration (hrs)
- T_o = overland flow travel time (hrs)
- T_d = ditch flow travel time (hrs)
- T_s = storm sewer flow travel time (hrs)

where:

$$T_o = 0.00013 \left[\frac{L}{S^{0.5}} \right]^{0.77}$$

o

$$T_d = \frac{L}{3600V_d}$$

$$V_d = \frac{1.49}{n} H_r^{\frac{2}{3}} S_d^{\frac{1}{2}}$$

$$T_s = \frac{L}{3600V_s}$$

$$V_s = \frac{1.49}{n} \left[\frac{D}{4} \right]^{\frac{2}{3}} S_s^{\frac{1}{2}}$$

4.3. Specific Design Parameters for Rational Method

Unless approved by the District Engineer, the following design parameters shall be used in the Rational Method equation.

- A. **Runoff Coefficient “C”:** The runoff coefficient “C” represents the combined effects of infiltration, surface detention, and other rainfall losses. Values of the runoff coefficient shall be as shown in Table 4-2. For drainage areas within the Extra-Territorial Jurisdictional area, runoff coefficients shall be the smaller of the values shown in Table 4-2 or the values required by other jurisdictions.

Table 4-2: Runoff Coefficient “C”

| DESCRIPTION OF AREA | “C” |
|--------------------------------------|------|
| Residential Districts | |
| Lots larger than ¾ acre | 0.35 |
| Lots between ¼ and ¾ acre | 0.45 |
| Lots smaller than ¼ acre | 0.55 |
| Multi-Family Areas | |
| Fewer than 20 dwelling units/acre | 0.65 |
| 20 or more dwelling units/acre | 0.80 |
| Business/Industrial Districts | |
| Business | 0.80 |
| Light Industrial | 0.65 |
| Heavy Industrial | 0.75 |
| Railroad Yard | 0.30 |
| Other | |
| Parks, open areas | 0.18 |

- B. **Time of concentration (T_c):** See Section 4.1(D)
- C. **Intensity “I”:** Rainfall intensity is a measure of the rate of rainfall over a drainage area and is expressed as a uniform rate for a period equal to the time of concentration of the drainage area. Intensity values are a function of the time of concentration, variable runoff coefficients, and the storm frequency investigated. Intensity values shall be determined by the following formula, using the coefficient values shown in Table 4-3.

$$I = \frac{b}{(T_c + d)^e}$$

where:

I = rainfall intensity

T_c = time of concentration

e, b, and d = runoff coefficients

Table 4-3: Atlas 14 Rainfall Intensity Coefficients*

| Frequency | 2-Year | 5-Year | 10-Year | 25-Year | 50-Year | 100-Year |
|---------------------|---------|---------|---------|---------|----------|----------|
| Runoff Coefficients | | | | | | |
| e | .7862 | .7691 | .7505 | .7266 | .7065 | .6872 |
| b | 69.0281 | 81.5214 | 88.8360 | 97.4049 | 101.4198 | 105.5701 |
| d (min) | 13.2179 | 13.4732 | 13.4254 | 13.3288 | 13.0449 | 12.9873 |

*NOAA Atlas 14, "Precipitation-Frequency Atlas of the United States" (Volume 11 Version 2.0: Texas, September 2018) & https://hdsc.nws.noaa.gov/pfds/pfds_map_cont.html?bkmrk=tx

NOTE: The rainfall coefficients presented above from Atlas 14 are the latest available at the date of issuance for this manual. The District will make updates when new data is available, but the design engineer will need to use the latest available rainfall data for the analysis of the development.

4.4. Offsite Flows

Offsite drainage patterns, either through surface runoff or channel flow (natural or manmade), and their effects on site development need to be analyzed to ensure that no adverse impact is placed on surrounding properties (upstream or downstream).

If offsite flows need to be conveyed through the site looking to be developed (due to terrain, existing channels, etc.), consideration needs to be taken on the method in which that is accomplished to avoid negatively impacting onsite detention, if detention is required.

5. Hydraulic Design Criteria

5.1. General

Determination of the water surface profile and the hydraulic gradeline is essential to the design and analysis of existing or proposed channels, detention basins, and closed conduits. Analyses involve calculating energy losses due to friction, obstructions, transitions, bends, and confluences. When calculating water surface profiles either by hand or with a computer program, all relevant sources of head loss are to be included. Design of channels and closed conduits generally focuses on minimizing energy losses (results in a smaller channel/conduit) and controlling dissipation of excessive energy (reduces erosion problems).

Design of proposed drainage improvements shall ensure that the 10-year, 25-year, 50-year, and 100-year peak flow runoff within the boundaries of subdivisions and developments, and the same flow rates that discharge from subdivisions and developments, are conveyed safely, and that these flows have flow paths to the most appropriate District outfalls.

Hydraulic designs are based on Manning's Equation, expressed as follows:

$$Q = \frac{1.486}{n} (A) (R^2) (S_f^{1/2})$$

where:

Q = flow (cu ft/sec)

n = roughness coefficient (Manning's "n")

A = cross-sectional area (sq ft)

R = hydraulic radius (wetted perimeter)

S_f = slope of the hydraulic gradient

5.2. Acceptable Models

The following hydraulic models are accepted by the District:

- A. **HEC-RAS, River Analysis System:** Developed by the U.S. Army Corps of Engineers' Hydrologic Engineering Center. Specific parameters that shall be used are described in Section 5.1.
- B. **Other Hydraulic Models:** With approval from the District Engineer.

5.3. Specific Design Parameters

- A. **Manning’s “n” for Open Channels and Overbanks:** Values of Manning’s “n” for open channels and overbank areas are selected based on engineering judgment. The selected values shall be the higher of the value required by DD3, the County, or TxDOT, as applicable, or the values in Table 5-1.

Table 5-1: Manning’s “n” for Open Channels and Overbanks

| Type of Channel, Natural Stream or Floodplain | Description | Minimum | Normal | Maximum |
|--|----------------------------------|---------|--------|---------|
| Cement: | Neat, surface | 0.010 | 0.011 | 0.013 |
| | Mortar | 0.011 | 0.013 | 0.015 |
| Concrete: | Trowel finish | 0.011 | 0.013 | 0.015 |
| | Float finish | 0.013 | 0.015 | 0.016 |
| | Finished, gravel bottom | 0.015 | 0.017 | 0.020 |
| | Unfinished | 0.014 | 0.017 | 0.020 |
| | Gunite, good section | 0.016 | 0.019 | 0.023 |
| | Gunite, wavy section | 0.018 | 0.022 | 0.025 |
| | On good excavated rock | 0.017 | 0.020 | -- |
| | On irregular excavated rock | 0.022 | 0.027 | -- |
| Concrete bottom float finished with sides of: | Dressed stone in mortar | 0.015 | 0.017 | 0.020 |
| | Random stone in mortar | 0.017 | 0.020 | 0.024 |
| | Cement rubble masonry, plastered | 0.016 | 0.020 | 0.024 |
| | Cement rubble masonry | 0.020 | 0.025 | 0.030 |
| | Dry rubble or riprap | 0.020 | 0.030 | 0.035 |
| Gravel bottom with sides of: | Formed concrete | 0.017 | 0.020 | 0.025 |
| | Random stone in mortar | 0.020 | 0.023 | 0.026 |
| | Dry rubble or riprap | 0.023 | 0.033 | 0.036 |
| Brick: | Glazed | 0.011 | 0.013 | 0.015 |
| | In cement mortar | 0.012 | 0.015 | 0.018 |
| Masonry: | Cemented rubble | 0.017 | 0.025 | 0.030 |
| | Dry rubble | 0.023 | 0.032 | 0.035 |
| Asphalt: | Smooth | 0.013 | 0.013 | -- |
| | Rough | 0.016 | 0.016 | -- |
| Vegetal lining: | | 0.030 | -- | 0.500 |
| Excavated or dredged earth (straight and uniform): | Clean, recently completed | 0.016 | 0.018 | 0.020 |
| | Clean, after weathering | 0.018 | 0.022 | 0.025 |
| | Gravel, uniform section, clean | 0.022 | 0.025 | 0.030 |
| | With short grass, few weeds | 0.022 | 0.027 | 0.033 |

| Type of Channel, Natural Stream or Floodplain | Description | Minimum | Normal | Maximum |
|--|--|----------------|---------------|----------------|
| Excavated or dredged earth (winding and sluggish): | No vegetation | 0.023 | 0.025 | 0.030 |
| | Grass, some weeds | 0.025 | 0.030 | 0.033 |
| | Dense weeds or aquatic plants in deep channels | 0.030 | 0.035 | 0.040 |
| | Earth bottom and rubble sides | 0.028 | 0.030 | 0.035 |
| | Stony bottom and weedy banks | 0.025 | 0.035 | 0.040 |
| | Cobble bottom and clean sides | 0.030 | 0.040 | 0.050 |
| Dragline excavated or dredged: | No vegetation | 0.025 | 0.028 | 0.033 |
| | Light brush on banks | 0.035 | 0.050 | 0.060 |
| Rock cuts: | Smooth and uniform | 0.025 | 0.035 | 0.040 |
| | Jagged and irregular | 0.035 | 0.040 | 0.050 |
| Channels not maintained, weeds, and brush uncut: | Dense weeds, high as flow depth | 0.050 | 0.080 | 0.120 |
| | Clean bottom, brush on sides | 0.040 | 0.050 | 0.080 |
| | Same, highest state of flow | 0.045 | 0.070 | 0.110 |
| | Dense brush, high stage | 0.080 | 0.100 | 0.140 |
| Minor natural streams (top width at flood stage < 100 feet); low slope topography: | Clean, straight, full stage, no rifts or deep pools | 0.025 | 0.030 | 0.033 |
| | Same as above, but with more stones and weeds | 0.030 | 0.035 | 0.040 |
| | Clean, winding, some pools and shoals | 0.033 | 0.040 | 0.045 |
| | Same as above, but some weeds and stones | 0.035 | 0.045 | 0.050 |
| | Same as above, lower stages, more ineffective slopes and sections | 0.040 | 0.048 | 0.055 |
| | Same as above, but with some weeds and more stones | 0.045 | 0.050 | 0.060 |
| | Sluggish reaches, weedy, deep pools | 0.050 | 0.070 | 0.080 |
| | Very weedy reaches, deep pools, or floodways with a heavy stand of timber and underbrush | 0.075 | 0.100 | 0.150 |

| Type of Channel, Natural Stream or Floodplain | Description | Minimum | Normal | Maximum |
|--|---|----------------|---------------|----------------|
| Natural mountain streams, no vegetation in channels, banks usually steep, tree and brush along banks submerged at high stages: | Bottom: gravels, cobbles, and a few boulders | 0.030 | 0.040 | 0.050 |
| | Bottom: cobbles with large boulders | 0.040 | 0.050 | 0.070 |
| Floodplains, pasture, no brush: | Short grass | 0.025 | 0.030 | 0.035 |
| | High grass | 0.030 | 0.035 | 0.050 |
| Floodplains, cultivated areas: | No crop | 0.020 | 0.030 | 0.040 |
| | Mature row crops | 0.025 | 0.035 | 0.045 |
| | Mature field crops | 0.030 | 0.040 | 0.050 |
| Floodplains, brush: | Scattered brush, heavy weeds | 0.035 | 0.050 | 0.070 |
| | Light brush and trees, in winter | 0.035 | 0.050 | 0.060 |
| | Light brush and trees, in summer | 0.040 | 0.060 | 0.080 |
| | Medium to dense brush, in winter | 0.045 | 0.070 | 0.110 |
| | Medium to dense brush, in summer | 0.070 | 0.100 | 0.160 |
| Floodplains, trees: | Dense willows, summer, straight | 0.110 | 0.150 | 0.200 |
| | Cleared land with tree stumps, no sprouts | 0.030 | 0.040 | 0.050 |
| | Same as above, but with heavy growth of sprouts | 0.050 | 0.060 | 0.080 |
| | Heavy stand of timber, few trees down, little undergrowth, flood stage below branches | 0.080 | 0.100 | 0.120 |
| | Same as above, but with flood stage reaching branches | 0.100 | 0.120 | 0.160 |
| Major streams (top width at flood stage > 100 feet) | Regular section with no boulders or brush | 0.025 | -- | 0.060 |
| | Irregular and rough section | 0.035 | -- | 0.100 |

Source: "Open-Channel Hydraulics" by V.T. Chow, 1959

- B. **Manning’s “n” for Closed Conduits:** Values of Manning’s “n” for closed conduits (pipes and culverts) are selected based on the type of material and engineering judgment. The selected values shall be the higher of the value required by DD3, the County, or TxDOT, as applicable, or the values in Table 5-1.

Table 5-2: Manning’s “n” for Closed Conduits

| | |
|-------------------------------------|--------------------|
| Reinforced Concrete Pipe | 0.012 |
| Reinforced Concrete Box | 0.012 |
| Smooth Flow Metal Pipe ¹ | |
| Asphaltic Lining | 0.012 |
| Double Wall | 0.012 |
| Concrete Lining | 0.012 |
| Ultra Flow | 0.012 |
| Corrugated Metal Pipe ² | 0.024 |
| Structural Plate Pipe ³ | 0.027-0.036 |
| Long Span Structural Pipe | 0.031 ¹ |

¹ For composite perimeters (e.g., partial smooth flow), a weighted roughness coefficient based upon relative perimeters must be calculated.

² For helically-corrugated metal pipe of diameters less than 36-inch, an improved roughness coefficient is possible. Consult the Texas Department of Transportation’s Hydraulic Manual, “Hydraulic Flow Resistance Factors for Corrugated Metal Conduits,” FHWA.

³ Due to the number of variations in structural plate pipe, there are many possibilities for roughness coefficient.

Source: City of Beaumont, Public Works Department, Procedure manual, Specifications and Details.

- C. **Starting Water Surface Elevation:** For drainageways that directly discharge to a District outfall, the starting water surface elevation (tailwater condition) will be provided by the District Engineer at the pre-submission conference. For other drainageways, the design shall assume that the receiving ditch is flowing full (top of bank).

6. Design Criteria for Channels

6.1. General

The requirements of this section apply to drainageways and channels that are designed to convey drainage. Acceptable designs will provide for adequate conveyance of design discharges, incorporate measures to address potential erosion, and be designed to allow for access and maintenance.

Earthen, grass-lined channels generally produce lower flow velocities and more channel storage; they generally require more right-of-way, are more vulnerable to erosion, and require periodic mowing and maintenance. Concrete-lined channels generally convey flows at higher velocities with less storage, which may increase downstream peak flows and discharges; they generally require less right-of-way and are more stable under higher flow velocities.

6.2. Channels to be Conveyed to the District

Unless otherwise approved by the District Engineer, the following design criteria apply to channels to be conveyed to the District.

- A. **General Performance Requirement:** Open channels shall be designed to convey the design discharge such that the water surface elevation is a minimum of one (1) foot below the top of the channel section. This provides a minimum margin of safety in the event of channel obstructions or sedimentation, unaccounted changes in upland drainage, and for flows that exceed the design discharge.
- B. **Maximum Velocity in Open Channels:** Open channels shall be designed such that velocities during the 100-year peak flow discharge will not cause erosion at any point along the channel. (See Page 185, Table 7-6 of “Open-Channel Hydraulics” by Ven Te Chow, 1959 as reference)
- C. **Maximum Velocity in Conduits and Pipes:** Conduits and pipes shall be designed to convey the 100-year peak flow discharge at velocities that do not exceed 7 feet per second.
- D. **Channel Alignment and Transitions:** Changes in horizontal channel alignment (bends and curves), transitions in cross-section size, geometry, and changes in channel type are to be gradual to minimize head losses, changes in flow regime, deposition of sediment, and potential for erosion.

-
- E. **Erosion Protection:** Earthen, grassed channels and transitions from earthen, grassed channels to lined channels shall have erosion protection if the velocities associated with the design discharge indicate the potential for erosion. Erosion protection may be appropriate along curved channel sections at bridge and culvert transitions, at confluences where side ditches outfall into the channel in areas with erodible soils, and other locations based on a review of site conditions and flow velocities.
- F. **Minimum Channel Dimensions - Earthen, Grassed Channels:** Unless site constraints or other conditions warrant other dimensions, the minimum dimensions are:
- Bottom width: 10 feet
 - Side slopes: 4 horizontal to 1 vertical
- G. **Minimum Channel Dimensions - Concrete-Lined Channels:** The minimum dimensions are:
- Bottom width: 8 feet
 - Side Slopes: 2 horizontal to 1 vertical
 - Width and depth of low flow section formed in bottom: to be determined on a case-by-case basis.

6.3. Channels Not to be Conveyed to the District

For channels not conveyed to the District, the minimum dimensions shall be those required by the applicable local jurisdiction.

7. Design Criteria for District Outfalls

7.1. General

The requirements of this section apply to the District's outfalls. Outfalls are defined in the District's drainage regulations to include the receiving District ditch, the point at which a contributory open drainage ditch discharges into the District's ditch, and/or the end of a drainage pipe that discharges into a District ditch. The term includes slope paving or other means to control erosion if provided or required at the outfall.

7.2. General

Unless otherwise approved by the District, proposed work that affects or modifies District outfalls shall be demonstrated to meet the following requirements:

- A. Improvements to outfalls shall be designed to convey the 100-year peak flow discharge.
- B. Receiving outfalls shall be demonstrated to convey additional flows without increasing downstream flooding associated with the 100-year peak flow discharge.
- C. Where new drainageways confluence with District outfall channels, the angle of intersection between the channels shall be between 15 degrees and 45 degrees, to provide for smooth transitions and reduce the potential for scour.
- D. Expansions and contractions are to be designed to minimize energy losses.
- E. Erosion protection shall be used where engineering judgment and experience suggest it is appropriate to protect the District's drainage facilities.
- F. Erosion protection shall be used on all outfall connections.

7.3. Design Schematics

For guidance, the District provides the sample schematics shown in Appendix B to illustrate designs that have been effective:

- A. Pipe tie-in at low-flow lined ditch.
- B. Pipe tie-in at concrete-lined ditch.
- C. Pipe tie-in at earthen ditch.
- D. 100-year peak flow discharge overflow at District right-of-way.
- E. Curb cut overflow and swale overflow.
- F. Typical earthen ditch section.
- G. Typical concrete ditch section.
- H. Typical box culvert transition to earthen or concrete channel.

The requirements of this section apply to new, replacement or modified bridges and culverts that cross the District's drainage facilities.

8. Design Criteria for Roadways Crossing District Facilities

8.1. Performance Expectations and Design Requirements for New Crossings

Unless otherwise approved by the District, new bridges and new culverts that are proposed for roadways that will cross the District's drainage facilities shall: .

- A. Be designed to maintain the direction of flow in the District's drainage facility.
- B. Be designed so as not to encroach into the District's drainage facility nor to impede the flow of water in the District's drainage facilities under normal flow conditions and under flood conditions.
- C. Be designed so as not to impede the flow of drainage to the District's drainage facilities.
- D. Convey the 100-year peak flow discharge with no increase in base flood elevation that increases flooding on any property upstream or downstream.
- E. Be designed to convey the 100-year peak flow with a maximum flow velocity of 7 feet per second.
- F. Be designed to span completely the District's drainage facility; if not feasible, the design of bridge piers or separation between multiple culverts shall minimize the potential for debris blockage; additional freeboard between the base flood elevation and the low chord of the bridge or top of the culvert may be required.
- G. For bridges, they should be designed with the lowest chord at least one foot above the higher of the base flood elevation or the top of the bank of the channel.
- H. For culverts, they could be designed to convey the 100-year peak flow discharge with 6-inch total head loss (for flowing full condition).
- I. Be designed to minimize transitions and head losses associated with expansions and contractions (see Schematic 9 in Appendix B).
- J. Not encroach on the FEMA-designated floodway unless such encroachment is approved by FEMA through issuance of a Conditional Letter of Map Revision. It is the Applicant/Owner's responsibility to submit the required documentation to FEMA. The District will not review a submittal that proposes a floodway encroachment unless the Conditional Letter of Map Revision is included.
- K. Be designed to protect against erosion during passage of the 100-year peak flow discharge.

-
- L. Be designed to adequate bottom width and side slopes to allow for maintenance by the District.
 - M. Not be designed to involve alteration of the District's facility as a means to compensate for loss of cross-sectional area.

8.2. Performance Expectations and Design Requirements for Replacement or Modified Crossings

Unless otherwise approved by the District, replacement bridges, replacement culverts, or modifications of existing bridges and culverts shall:

- A. Match the roadway approach and alignment, unless otherwise required by the owner or the applicable local jurisdiction; if changes are required, the crossing shall, to the extent practical, conform to the performance expectations and design requirements for new crossings in Section 8(A).
- B. Improve transitions to minimize expansion and contraction losses.
- C. Be designed to reduce obstructions, especially if the District has evidence that the existing crossing is subject to blockage by debris or sedimentation.
- D. Be designated to address known erosion problems at the crossing.

8.3. Design Schematics

For guidance, the District provides Schematic 8, shown in Appendix B, to illustrate configurations that minimize transitions and head losses associated with expansions and contractions.

9. Drainage and Flood Hazard Reduction Criteria

9.1. General

Drainage reports and drainage plans for subdivisions and developments shall demonstrate that the design of the proposed drainage system will manage increases in runoff in ways that are consistent with the District's drainage regulations and this manual.

If drainage designs developed in accordance with the District's drainage regulations and this manual are determined to be inadequate to address increases in runoff, specific drainage and flood hazard reduction measures will be discussed at the pre-submission conference. The effectiveness of alternatives will be determined based on the adequacy of existing drainage capacity and existing flooding problems.

10. On-Site Detention and Retention Criteria

10.1. General

Within the whole of the District's jurisdiction, a policy of a net-zero increase in runoff between existing site conditions and proposed site conditions will be used to mitigate the effect of new development, redevelopment, or site modifications that are adding impervious surfaces greater than 0.25 Acres.

A detention facility is designed to store the increased runoff while releasing discharges continuously at acceptable rates through flow-limiting outlet structures, thus controlling downstream peak flows. A retention facility, often designed to have a permanent pool, is designed to store runoff and release it after the passage of peak flows. In some cases, if the availability of land is limited, underground storage can be utilized by storing the runoff below the facility using methods such as an oversized storm pipe network and storage chambers, and controlling the discharge rate by orifices within a larger pipe, a reduced pipe size, etc.

10.2. State Jurisdiction

The District's requirements are independent of any requirements that may be imposed by the State. Detention and retention facilities for which the height of the dam (embankments) is greater than six (6) feet are subject to Title 31 of the Texas Administrative Code, Chapter 200 (sub-chapters A through E), and all subsequent changes. For the purpose of this determination, the height of the dam is defined as the distance from the lowest point on the crest of the dam, excluding spillways, to the lowest elevation on the centerline or downstream toe of the dam, including the natural stream channel.

10.3. District Approval

The District may withhold approval of a facility that is subject to State jurisdiction unless provided evidence that an application has been submitted to the State or a permit or approval has been received from the State.

10.4. Performance Expectations and Design Requirements

Unless otherwise approved by the District, proposed on-site detention and retention facilities shall be demonstrated to meet the following requirements:

- A. Commercial computer programs are available for designing detention and retention facilities and their associated inflow and outflow structures; early coordination with the District Engineer is recommended to ensure the proposed program is acceptable.

-
- B. A detailed soils investigation by a geotechnical engineer shall be undertaken and included in the Drainage Report.
 - C. The maximum post-development discharge for the 10-year, 25-year, 50-year, and 100-year peak flow, measured where drainage leaves the Applicant/Owner's property, shall not exceed the pre-development aforementioned peak flow discharges at that location.
 - D. Drainage of the detention facility shall be free drainage only (gravity drainage); pumped detention facilities shall not be approved unless it is demonstrated to the satisfaction of the District Engineer that other methods are infeasible or do not provide the necessary management of drainage.
 - E. Erosion protection shall be provided at the discharge point and downstream to where it is determined that the drainage path will be stable during the 100-year peak flow discharge.
 - F. The facility shall be sized such that the water surface resulting from the inflowing 100-year peak discharge will be one foot below the top of the embankment.
 - G. An emergency spillway or overflow structure shall be provided to handle discharges that exceed the 100-year peak flow discharge.
 - H. Adequate access for inspection and maintenance shall be provided.
 - I. Detention may not be required by the District if the proposed development will outfall into a District controlled regional detention facility that has capacity.
 - J. Development sites that discharge directly into the Jefferson County, TxDOT, or other jurisdictions' systems will require their review and approval. The District will still perform a review of the development and correspond with the necessary jurisdiction as needed.
 - K. If the detention criteria set forth in this manual conflicts with those regulations being used by the Jefferson County, TxDOT, or other jurisdictions, the more restrictive criteria shall govern.

-
- L. A master drainage plan for the purpose of grandfathering projects regarding a drainage and detention plan is as follows:

A master drainage plan establishes the current and future drainage plan for a developmental site and generally consists of drainage, grading, detention, and other applicable site requirements. These site plans contain detailed calculations for impervious areas, detention, restrictors, flow rate, etc. For any master drainage plan with provided detention that is based on the Atlas 14 rainfall data, the District shall allow the developer to proceed under the approved master drainage for up to five years. If the master drainage plan for provided detention is not based on Atlas 14 rainfall data or the master drainage plan does not contain detention, then the delta of the detention requirement must be provided by the property owner. If Jefferson County or TxDOT has a more restrictive time frame (less than five years) in which a master drainage plan can be followed, the more restrictive time frame shall govern.

- M. Plat, replat, change use of, or subdividing any tract to reduce stormwater detention requirements will not be permitted. Original tract size on plat or replat, change the use of, subdividing, and survey will be used to determine the detention requirements.

10.5. Inspection and Maintenance Agreement

Applicant/Owners will be required to execute an agreement that addresses inspection and maintenance, in addition to any provision required by the State or the applicable local jurisdiction. The agreement shall:

- A. Address routine and periodic inspection and maintenance to provide for the designed detention or retention function.
- B. Address inspection after floods and maintenance and repairs that may be required to restore the designed function.
- C. Clearly identify the property owner as responsible for inspection and maintenance, and shall provide for action by the property owner upon notification by the District that maintenance or repairs may be required.
- D. Be recorded with deed and shall convey the inspection and maintenance responsibilities to future owners and assigns.

APPENDIX A. - SCS RUNOFF CURVE NUMBER TABLES

Table 2-2a: Runoff curve numbers for urban areas.

Table 2-2b: Runoff curve numbers for cultivated agricultural lands.

Table 2-2c: Runoff curve numbers for other agricultural lands.

Table 2-2d: Runoff curve numbers for arid and semiarid rangelands.

Source: U.S.D.A. Soil Conservation Service, Urban Hydrology for Small Watersheds, Technical Release No. 55 (2nd Edition, June 1986). Accessible online at: <ftp://ftp.wcc.nrcs.usda.gov/downloads>.

Table 2-2a Runoff curve numbers for urban areas ^{1/}

| Cover description Cover type and hydrologic condition | Average percent impervious area ^{2/} | Curve numbers for hydrologic soil group ⁻⁻⁻ | | | |
|--|--|---|----|----|----|
| | | A | B | C | D |
| <i>Fully developed urban areas (vegetation established)</i> | | | | | |
| Open space (lawns, parks, golf courses, cemeteries, etc.): ^{1/} | | | | | |
| Poor condition (grass cover < 50%) | | 68 | 79 | 86 | 89 |
| Fair condition (grass cover 50% to 75%) | | 79 | 69 | 79 | 84 |
| Good condition (grass cover > 75%) | | 39 | 61 | 74 | 80 |
| Impervious areas: | | | | | |
| Paved parking lots, roofs, driveways, etc. (excluding right-of-way) | | 98 | 98 | 98 | 98 |
| Streets and roads: | | | | | |
| Paved; curbs and storm sewers (excluding right-of-way) | | 98 | 98 | 98 | 98 |
| Paved; open ditches (including right-of-way) | | 83 | 89 | 92 | 93 |
| Gravel (including right-of-way) | | 76 | 85 | 89 | 91 |
| Dirt (including right-of-way) | | 72 | 82 | 87 | 89 |
| Western desert urban areas: | | | | | |
| Natural desert landscaping (impervious areas only) | | 63 | 77 | 85 | 88 |
| Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders) | | 96 | 96 | 96 | 96 |
| Urban districts: | | | | | |
| Commercial and business | 85 | 89 | 92 | 94 | 95 |
| Industrial | 72 | 81 | 88 | 91 | 93 |
| Residential districts by average lot size: | | | | | |
| 1/8 acre or less (town houses) | 65 | 77 | 85 | 90 | 92 |
| 1/4 acre | 38 | 61 | 75 | 83 | 87 |
| 1/3 acre | 30 | 57 | 72 | 81 | 86 |
| 1/2 acre | 25 | 54 | 70 | 80 | 85 |
| 1 acre | 20 | 51 | 68 | 79 | 84 |
| 2 acres | 12 | 46 | 65 | 77 | 82 |
| <i>Developing urban areas</i> | | | | | |
| Newly graded areas (impervious areas only, no vegetation) ^{3/} | | 77 | 86 | 91 | 94 |
| Idle lands (CN's are determined using cover types similar to those in table 2-2c). | | | | | |

^{1/} Average runoff condition, and $I_a = 0.2S$.

^{2/} The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

^{3/} CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

^{4/} Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

^{5/} Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Table 2-2b Runoff curve numbers for cultivated agricultural lands¹¹

| Cover type | Cover description Treatment ¹¹ | Hydrologic condition □ | Curve numbers for hydrologic soil group | | | |
|--|--|---------------------------|--|----|----|----|
| | | | A | B | C | D |
| Fallow | Bare soil | | 77 | 86 | 91 | 94 |
| | Crop residue cover (CR) | Poor | 76 | 85 | 90 | 93 |
| | | Good | 74 | 83 | 88 | 90 |
| Row crops | Straight row (SR) | Poor | 72 | 81 | 88 | 91 |
| | | Good | 67 | 78 | 85 | 89 |
| | SR+ CR | Poor | 71 | 80 | 87 | 90 |
| | | Good | 64 | 75 | 82 | 85 |
| | Contoured (C) | Poor | 70 | 79 | 84 | 88 |
| | | Good | 65 | 75 | 82 | 86 |
| | C + CR | Poor | 69 | 78 | 83 | 87 |
| | | Good | 64 | 74 | 81 | 85 |
| | Contoured & terraced (C&T) | Poor | 66 | 74 | 80 | 82 |
| | | Good | 62 | 71 | 78 | 81 |
| | C&T+CR | Poor | 65 | 73 | 79 | 81 |
| | | Good | 61 | 70 | 77 | 80 |
| Small grain | SR | Poor | 65 | 76 | 84 | 88 |
| | | Good | 63 | 75 | 83 | 87 |
| | SR+CR | Poor | 64 | 75 | 83 | 86 |
| | | Good | 60 | 72 | 80 | 84 |
| | C | Poor | 63 | 74 | 82 | 85 |
| | | Good | 61 | 73 | 81 | 84 |
| | C + CR | Poor | 62 | 73 | 81 | 84 |
| | | Good | 60 | 72 | 80 | 83 |
| | C&T | Poor | 61 | 72 | 79 | 82 |
| | | Good | 59 | 70 | 78 | 81 |
| | C&T+CR | Poor | 60 | 71 | 78 | 81 |
| | | Good | 58 | 69 | 77 | 80 |
| Close-seeded or broadcast legumes or rotation meadow | SR | Poor | 66 | 77 | 85 | 89 |
| | | Good | 58 | 72 | 81 | 85 |
| | C | Poor | 64 | 75 | 83 | 85 |
| | | Good | 55 | 69 | 78 | 83 |
| | C&T | Poor | 63 | 73 | 80 | 83 |
| | | Good | 51 | 67 | 76 | 80 |

¹¹ Average runoff condition, and Ja;0.2S

□ Crop residue cover applies only if residue is on at least 5% of the surface throughout the year.

¹¹ Hydraulic condition is based on combination factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes, (d) percent of residue cover on the land surface (good □ 20%), and (e) degree of surface roughness.

Poor: Factors impair infiltration and tend to increase runoff.

Good: Factors encourage average and better than average infiltration and tend to decrease runoff.

Table 2-2c Runoff curve numbers for other agricultural lands *JJ*

| Cover description | Hydrologic condition | Curve numbers for hydrologic soil group | | | |
|--|----------------------|---|----|----|----|
| | | A | B | C | D |
| Pasture, grassland, or range-continuous forage for grazing. ¹ | Poor | 68 | 79 | 86 | 89 |
| | Fair | 49 | 69 | 79 | 84 |
| | Good | 39 | 61 | 74 | 80 |
| Meadow-continuous grass, protected from grazing and generally mowed for hay. | | 30 | 58 | 71 | 78 |
| Bmsh-bmsh-weed-grass mixture with brush the major element. ² | Poor | 48 | 67 | 77 | 83 |
| | Fair | 35 | 56 | 70 | 77 |
| | Good | 30 | 48 | 65 | 73 |
| Woods-grass combination (orchard or tree farm). & | Poor | 57 | 73 | 82 | 86 |
| | Fair | 43 | 65 | 76 | 82 |
| | Good | 32 | 58 | 72 | 79 |
| Woods. ³ | Poor | 45 | 66 | 77 | 83 |
| | Fair | 36 | 60 | 73 | 79 |
| | Good | 30 | 55 | 70 | 77 |
| Farmsteads-buildings, Janes, chiveways, and surrounding lots. | | 59 | 74 | 82 | 86 |

¹ Average runoff condition, and $la = 0.2S$.

Poor: <50% ground cover or heavily grazed with no mulch.

Fair: 50 to 75% ground cover and not heavily grazed.

Good: > 75% ground cover and lightly or only occasionally grazed.

² *Poor:* <50% ground cover.

Fair: 50 to 75% ground cover.

Good: >75% ground cover.

³ Actual curve number is less than 30; use CN = 30 for runoff computations.

CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

Poor: Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.

Fair: Woods are grazed but not burned, and some forest litter covers the soil.

Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

Table 2-2d Runoff curve numbers for arid and semiarid rangelands ^{1/}

| Cover description | | Curve numbers for hydrologic soil group --- | | | |
|--|------------------------------------|---|----|----|----|
| Cover type | Hydrologic condition ^{2/} | A | B | C | D |
| Herbaceous-mixture of grass, weeds, and low-growing brush, with brush the minor element | Poor | | 80 | 87 | 93 |
| | Fair | | 71 | 81 | 89 |
| | Good | | 62 | 74 | 85 |
| Oak-aspen-mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush. | Poor | | 66 | 74 | 79 |
| | Fair | | 48 | 57 | 63 |
| | Good | | 30 | 41 | 48 |
| Pinyon-juniper-pinyon, juniper, or both; grass understory. | Poor | | 75 | 85 | 89 |
| | Fair | | 58 | 73 | 80 |
| | Good | | 41 | 61 | 71 |
| Sagebrush with grass understory. | Poor | | 67 | 80 | 85 |
| | Fair | | 51 | 63 | 70 |
| | Good | | 35 | 47 | 55 |
| Desert shrub-major plants include saltbush, greasewood, creosotebush, blackbrush, bursage, palo verde, mesquite, and cactus. | Poor | 63 | 77 | 85 | 88 |
| | Fair | 55 | 72 | 81 | 86 |
| | Good | 49 | 68 | 79 | 84 |

^{1/} Average runoff condition, and $la_1 = 0.2S$. For range in humid regions, use table 2-2c.

Poor: <30% ground cover (litter, grass, and brush overstory).

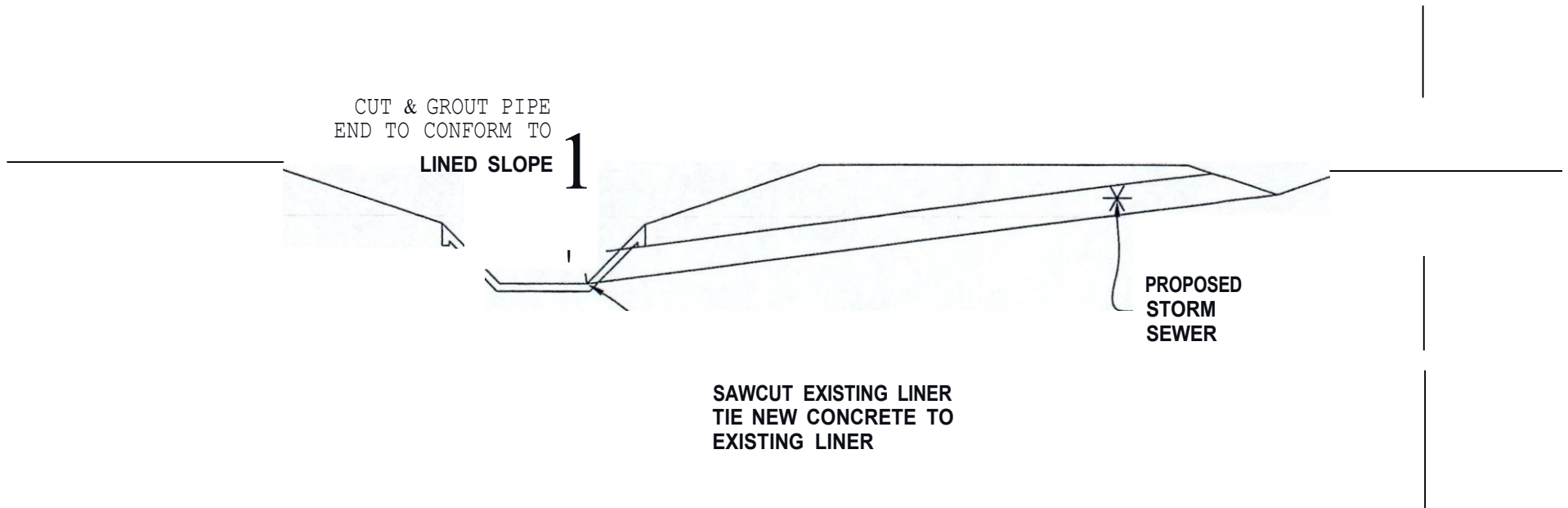
Fair: 30 to 70% ground cover.

Good: > 70% ground cover.

^{2/} Curve numbers for group A have been developed only for desert shrub.

APPENDIX B - SAMPLE DESIGN SCHEMATICS

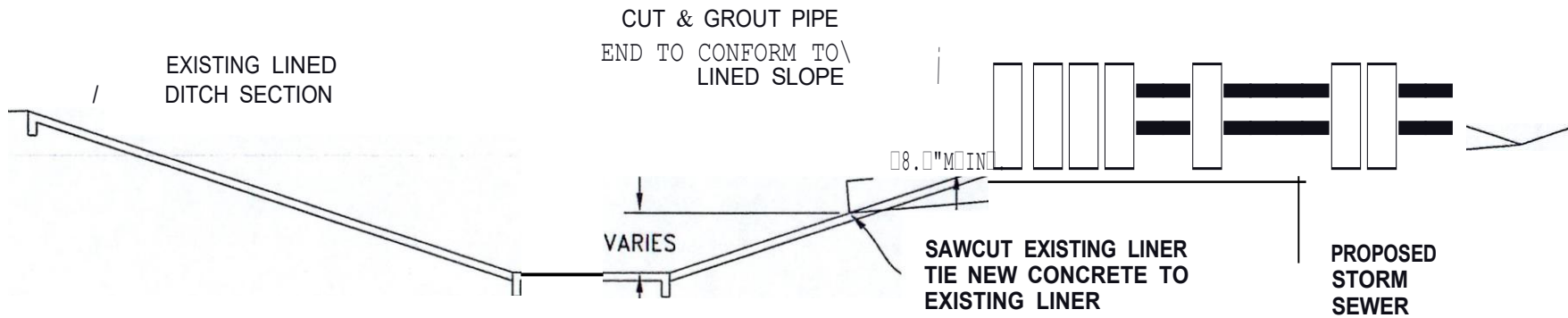
JEFFERSON COUNTY
DRAINAGE DISTRICT
NO. 3



TYPICAL DITCH CROSS SECTION
NEW STORM SEWER TIE-IN
LOW FLOW LINED SECTION

ALL STORM SEWERS ENTERING
A 0D6 OUTFALL WITH CONCRETE
LINING ARE REQUIRED TO ENTER
THROUGH LINING WHERE PRACTICAL.
IF NOT PRACTICAL, AN ALTERNATIVE
WILL BE DESIGNED AND DETAILED
BY APPLICANT AND APPROVED BY 006.

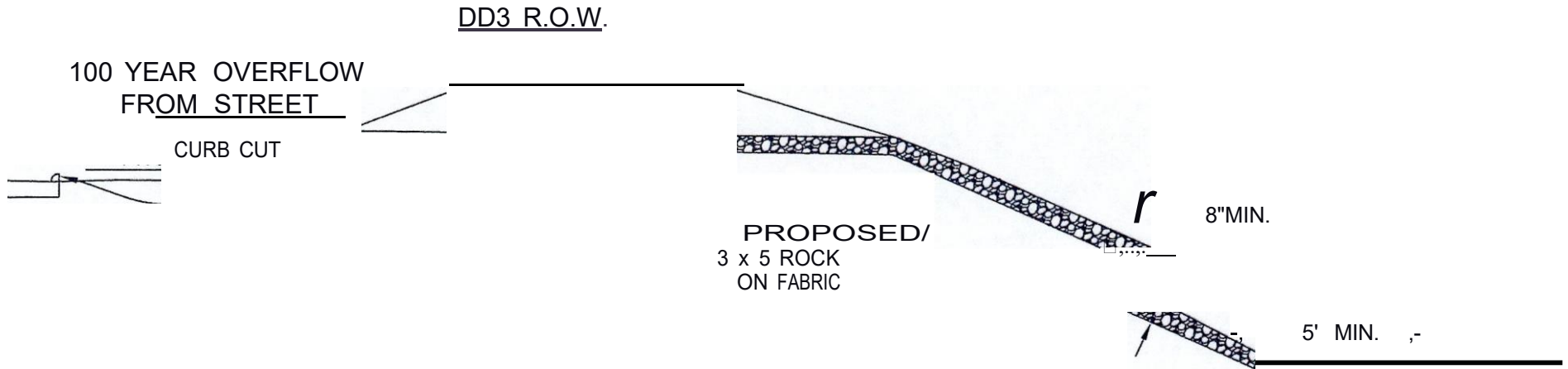
JEFFERSON COUNTY DRAINAGE DISTRICT NO. 3



TYPICAL DITCH CROSS SECTION NEW STORM SEWER TIE-IN AT CONCRETE LINED DITCH

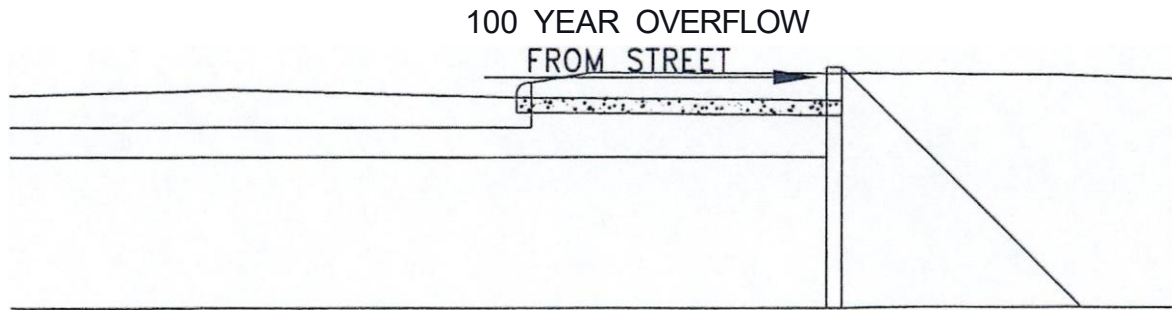
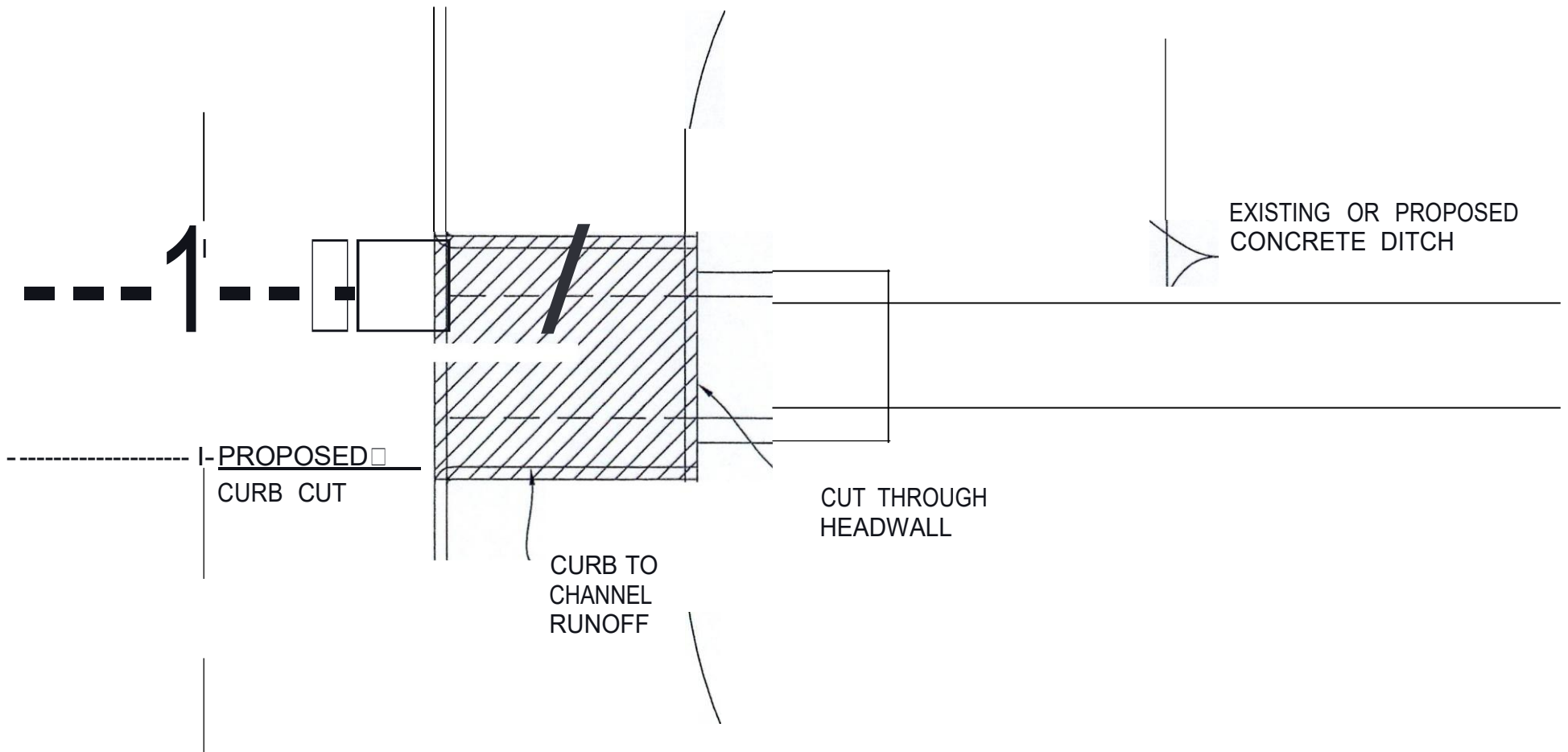
ALL STORM SEWERS ENTERING
A DD3 OUTFALL WITH CONCRETE
LINING ARE REQUIRED TO ENTER
THROUGH LINING WHERE PRACTICAL.
IF NOT PRACTICAL, AN ALTERNATIVE
WILL BE DESIGNED AND DETAILED

BY APPLICANT AND APPROVED BY 006.



PROPOSED/
3 x 5 ROCK
ON FABRIC

100 YEAR OVERFLOW AT
DISTRICT RIGHT-OF-WAY

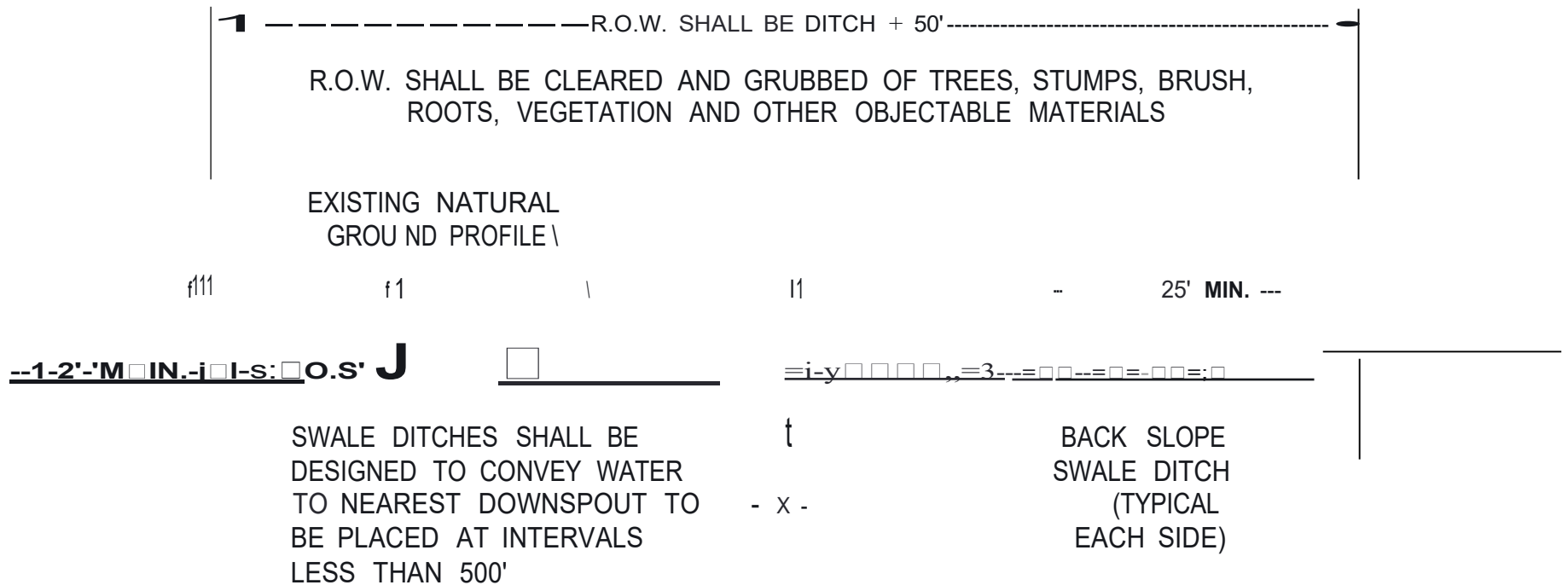


CURB CUT SECTION

OVERFLOW SHALL BE PROVIDED TO RELIEF STREET FLOODING WHEN THE UNDERGROUND SYSTEM CAPACITY IS EXCEEDED. THE OVERFLOW MAY BE AT DITCH CROSSINGS OR SWALES PROVIDED TO DELIVER RUNOFF TO NEAREST OUTFALLS.

AS A MINIMUM, R.O.W. SHALL BE SEEDED AS FOLLOWS: APRIL - SEPTEMBER 20 lbs PER ACRE BERMUDA
 40 lbs PER ACRE MILLETT
 OCTOBER - MARCH 20 lbs PER ACRE HOLLAND BERMUDA
 20 lbs PER ACRE UNHOLLANO BERMUDA
 40 lbs PER ACRE ANNUAL RYEGRASS

AS A MINIMUM, R.O.W. SHALL BE FERTILIZED WITH 600 lbs PER ACRE 13-13-13 GRANULATED OR PERLATED FERTILIZER.
 R.O.W. WILL NOT BE ACCEPTED UNTIL GERMINATION AND A GOOD STRAND OF GRASS IS ESTABLISHED.

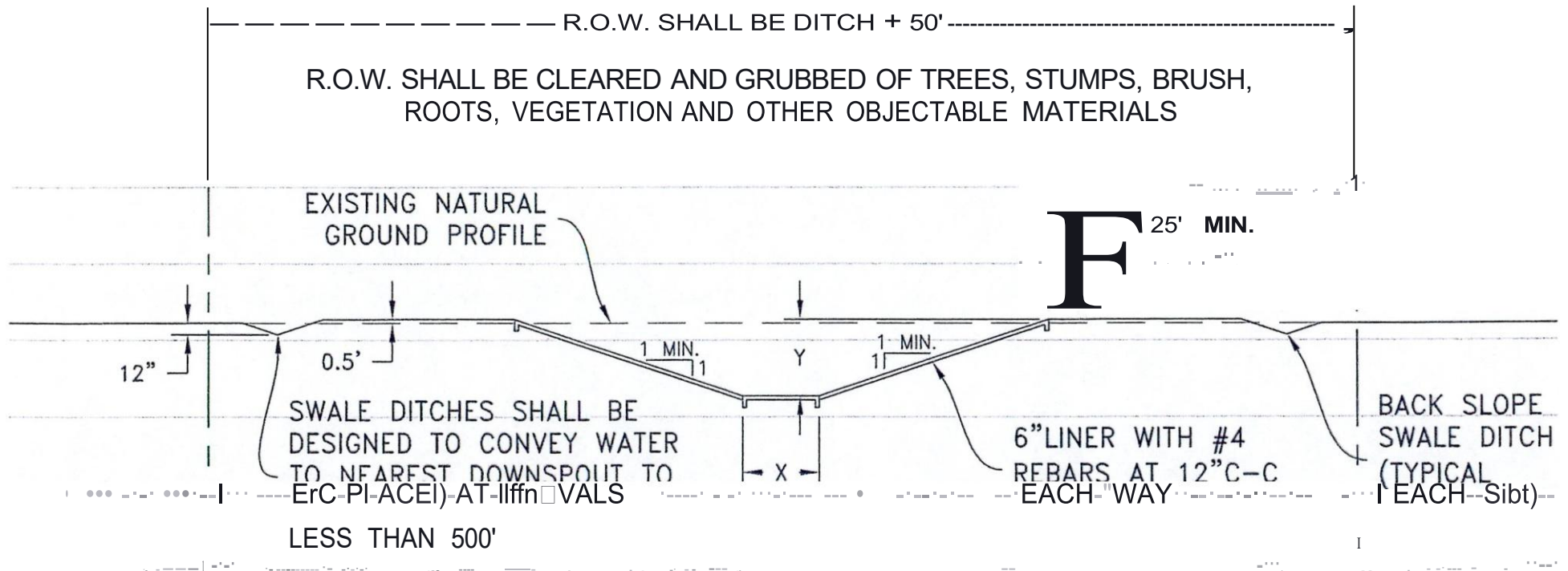


TYPICAL EARTHEN DITCH CROSS SECTION

NOTES:
 X = DITCH BOTTOM WIDTH
 Y = DITCH DEPTH

AS A MINIMUM, R.O.W. SHALL BE SEEDED AS FOLLOWS: APRIL - SEPTEMBER 20 lbs PER ACRE BERMUDA
 40 lbs PER ACRE MILLffii
 OCTOBER - MARCH 20 lbs PER ACRE HOLLAND BERMUDA
 20 lbs PER ACRE UNHOLLAND BERMUDA
 40 lbs PER ACRE ANNUAL RYEGRASS

AS A MINIMUM, R.O.W. SHALL BE FERTILIZED WITH 600 lbs PER ACRE 13-13-13 GRANULATED OR PERLATED FERTILIZER.
 R.O.W. WILL NOT BE ACCEPTED UNTIL GERMINATION AND A GOOD STRAND OF GRASS IS ESTABLISHED.

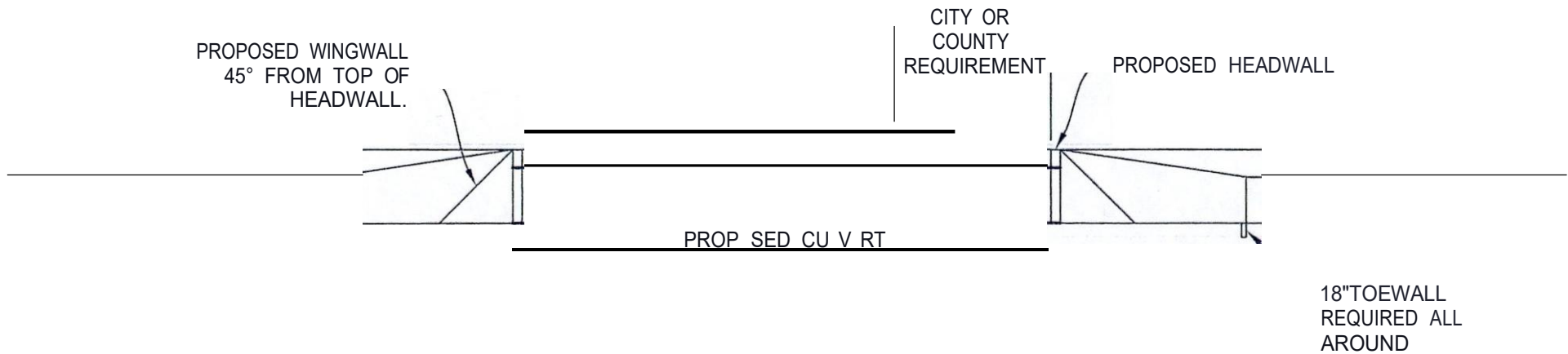
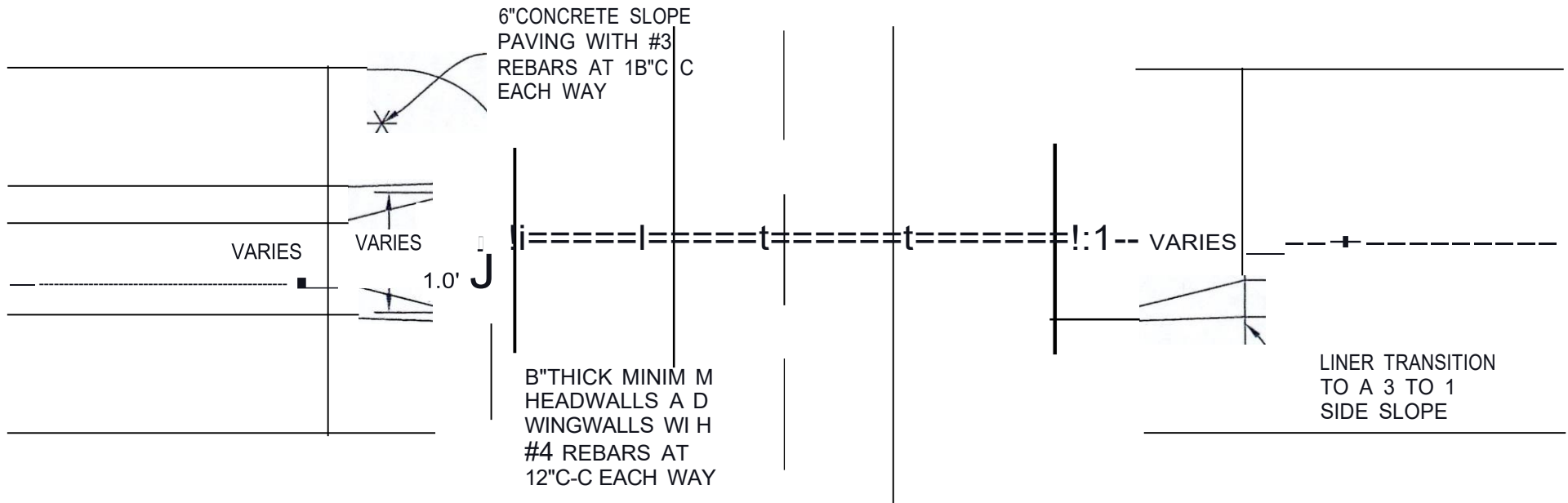


TYPICAL LINED DITCH CROSS SECTION

NOTES:

X - DITCH BOTTOM WIDTH
 Y = DITCH DEPTH

JEFFERSON COUNTY
 DRAINAGE DISTRICT No. 3



TYPICAL BOX CULVERT TRANSITION
TO EARTHEN OR CONCRETE
CHANNEL