Engineering Department

Drainage Report Standards

2021

Enid Drainage Criteria

4/15/2021

1. Hydrology
    a. Use ODOT Roadway Design Manual[1] for Rational Method up to 10 minutes time of concentration.
    b. Use ODOT Roadway Design Manual[1] for Hydrographs – NRCS Unit Hydrograph Method 10-minte Tc and up.
    c. Use NOAA Atlas 14[2] balanced storm for Rainfall for hydrographs
2. Roadway Hydraulics
    a. The 10% (10-year) storm fully urbanized Q must be contained at curb depth with a combination of gutter flow and storm sewer flow.
    b. The 2% (50-year) storm fully urbanized Q must be contained within the right of way with a combination of street flow up to the right of way limit and storm sewer flow.
    c. The 1% (100-year) storm fully urbanized Q must be shown to have a water surface elevation at least one foot below all finished pad elevations.
3. Storm Sewer Hydraulics
    a. Storm sewer design shall be designed and analyzed using HEC-22, Urban Drainage Design Manual, Current Edition[3]. This reference details the methods for evaluation of head losses in storm sewer systems.
4. Primary Channels
    a. Definition: All FEMA designated streams and those with more than 640 acres of drainage area.
    b. Primary channels shall be enclosed within an easement encompassing the flow from a 2% (50-year) storm considering full upstream development.
    c. Channels shall have one foot of freeboard for a 2% (50-year) storm considering full upstream development.
    d. Channels shall be design and constructed to flow subcritically, unless special design considerations are approved.
    e. Shall be analyzed using HEC-RAS[4], current version.
        i. If the channel has a FEMA-mapped floodplain the hydraulic model shall be obtained from FEMA, or a duplicate effective model must be prepared.
        ii. A revised existing model must be prepared with current topography to update the current BFEs or to generate BFEs if this is a Zone A floodplain.
        iii. If a channel or floodplain modification is a part of the project, a proposed HEC-RAS model must be prepared, modelling proposed ground and complying with above.

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[1] ODOT Roadway Drainage Manual, November 2014, https://www.ok.gov/odot/Doing_Business/Pre-Construction_Design/Roadway_Design/Support_Units/Oklahoma_Roadway_Drainage_Manual.html
[2] https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=ok
[3] Urban Drainage Design Manual, HEC-22, Third Edition, USDOT, FHWA, September 2009 (Revised August 2013) https://www.fhwa.dot.gov/engineering/hydraulics/pubs/10009/10009.pdf
[4] Hydrologic Engineering Center's (CEIWR-HEC) River Analysis System (HEC-RAS) website, USACE; https://www.hec.usace.army.mil/software/hec-ras/

5. Secondary Channels
    a. Definition: All streams with drainage areas between 160 and 640 acres
    b. Shall be improved with a pilot channel designed and constructed to contain low stream flows and to provide protection from low flow erosion.
    c. Existing secondary channels shall be enclosed within an easement encompassing the flow from a 2% (50-year) storm considering full upstream development.
    d. Proposed channels will flow subcritically and have one foot of freeboard during the 50-year storm considering full upstream development.
    e. Shall be analyzed using HEC-RAS[4], current version.
6. Small drainage channels
    a. Definitions: Streams with less than 160 acres and more than 0.5 acres of drainage area.
    b. Shall be paved or improved to be highly erosion resistant, will maintain the flow line and size of drainage and will be highly resistant to damage from cleaning operations.
    c. Shall be enclosed within an easement encompassing the flow from a 2% (50-year) storm considering full upstream development.
    d. Proposed small channels will either:
        i. flow subcritically with one foot of freeboard, or
        ii. flow supercritically with a freeboard equal to or great than 2.5 times the velocity head at the 50-year storm.
        iii. The Froude number for proposed, concrete-lined channels shall be less than 0.85 or greater than 1.20.
7. Flumes
    a. Definition: small concrete lined channels that collect water from roadways and carry it from streets to small, secondary or primary channels.
    b. Flumes will be designed using Manning's formula:

    $$Q = \left(\frac{1.49}{n}\right) A R^{\frac{2}{3}} S^{\frac{1}{2}}$$

    Where
    Q = Discharge in cfs
    n = Roughness coefficient (Table 7-2)
    A = Area in square feet
    R = Hydraulic radius, A/P, feet
    P = Wetted perimeter, feet

    S = Slope of the energy grade line (EGL) in ft/ft
    c. Flumes shall be designed so that the 100-year water surface elevation is one foot or more below the finished pad elevation of all buildings in the drainage basin.
8. Allowable storm sewer pipe – for material specifications refer to ODOT 2009 (or most recent) Standard Specifications Chapter 700 – Materials.
    a. Reinforced concrete pipe, class appropriate to structural requirements
    b. Corrugated polypropylene pipe in areas with at least 2 feet of cover.
    c. Corrugated metal pipe in areas with at least 2 feet of cover.
9. Stormwater Detention
    a. For project areas of 2.0 acres or less, use the Unit Volume Detention Method (see Figure 1):

i. The required pond storage is calculated based on the post-development “C” value for the 20% (5-year) storm and for the 1% (100-year) storm by selecting the storage volumes in acre-feet per acre of drainage basin and multiplying those values times the drainage basin size.
ii. The maximum outflow is calculated based on the pre-development “C” value for the 20% (5-year) storm and for the 1% (100-year) storm by interpolating the values given in the table below for outflow per acre of drainage basin and multiplying those values times the drainage basin size.
iii. The maximum allowable design depth of the ponding is 18-inches for the 1% (100-year) flood and 9-inches for the 20% (5-year) flood to minimize the probability of significant vehicular damage.
iv. Where a weir or a small dimension outlet through a curb is used, the size and shape are designed based on the discharge/storage requirements.
v. For the 2-stage weir configuration, the 20% (5-year) storm must completely fill the bottom 9-inches up to the weir and release the pre-project 20% (5-year) flow rate. The 1% (100-year) volume must fill the entire 18-inch depth of water and release the pre-project 1% (100-year).
vi. To assure that the detention facility performs as designed, maintenance access shall be provided. The outlet shall be designed to minimize unauthorized modifications which effect function. Any change within the detention area affecting storage or discharge shall require a permit from the Office of City Engineer or the department assigned these duties.
vii. All parking lot detention areas shall have a minimum of two signs posted identifying the detention pond area. The signs shall have a minimum area of 1.5 square feet and contain the following message:

"WARNING"

"This area is a stormwater detention pond and is subject to periodic flooding to a depth of (“x” during a 1% (100-year) storm)."
viii. Any suitable materials and geometry of the sign are permissible, subject to approval by the CITY ENGINEER.

b. For project areas greater than 2.0 acres, the following requirements apply:
i. Design is based on a 24-hour, fully developed hydrograph routed through the stormwater detention facility.
ii. Outflow from the facility must not exceed the existing flow rates for the 50% (2-year) storm, the 10% (10-year) storm, the 4% (25-year) storm, the 20% (50-year) storm, or the 1% (100-year) storm.
iii. For embankment-type control structures, the 0.2%(500-year) storm under full development must pass through the emergency spillway with one-foot of freeboard unless OWRB has more strict requirements.

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DRAINAGE REPORT REVEW FORM

File No:
Date:
Location-
Address:
Legal:
Applicant:
Engineer:
Checklist

- Existing contours
- Proposed contours
- Drainage basin boundaries
- For Developments 2 acres or smaller:
  - Pre-development
    - Impervious & Pervious Drainage area
    - Rational Method C Value
    - Flow arrows
  - Post -development
    - Impervious & Pervious Drainage area
    - Rational Method C Value
    - Flow arrows
    - Required and Actual Detention Storage 20% (5-year) Storm Frequency
    - Required and Actual Detention Storage 1% (100-year) Storm Frequency
    - Outlet structure configuration.
- For Developments larger than 2 acres On site drainage
  - Drainage area to site
  - Onsite drainage areas to structures
  - 50% (2-year), 20% (5-year), 10% (10-year), 4% (25-year), 2% (50-year) and 1% (100-year) storm Qs at each structure and points leaving the site
  - Minimum paved slopes of .3 %
  - Note any division and how mitigated
  - 10% (10-year) storm Qdoes not exceed curb height
  - 1% (100-year) storm is minimum 1 foot lower than any finished floor
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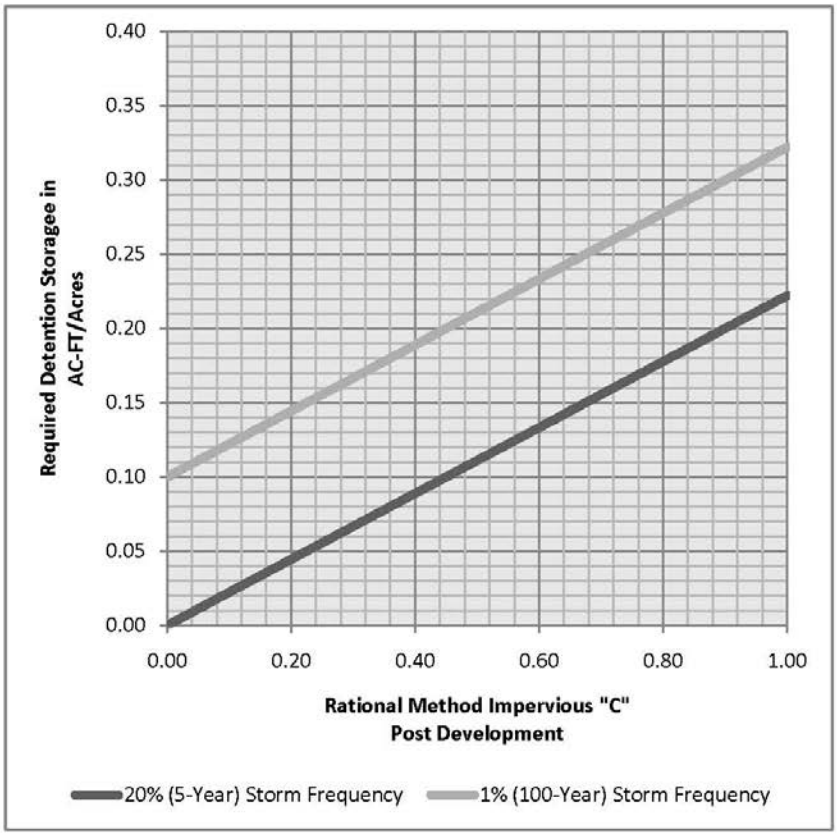
- Detention plan (If used in place off site modeling or to mitigate impacts for areas greater than 2 acres in size)
  - NRCS hydrograph parameters
    - Drainage Areas
    - Lag computation
    - Impervious Area calculation
  - Pre-detention and Post detention Q's for the 50% (2-year), 20% (5-year), 10% (10-year), 4% (25-year), 2% (50-year) and 1% (100-year) storm Qs

    - Pre-detention and post detention Hydrographs for Q for the 50% (2-year), 20% (5-year), 10% (10-year), 4% (25-year), 2% (50-year) and 1% (100-year) storm.
    - 0.2% (500-year) storm Q and routing showing applicable design elevations for dam safety
    - Storage volume required
    - Storage volume provided
    - Discharge rating curve
    - Discharge structure matching rating curve
    - Digital copies of Final computer models.

- Off site drainage
    - Critical section between site and Master Plan main channel showing channel capacity and % (100-year) storm and 2% (50-year) elevations (post development).
    - Profile of channel from site to Master Plan main channel with ground, 100 yr. post-development water surface and structure elevations including site.
    - All appropriate FEMA (Federal Emergency Management Agency) submittal data to achieve a Letter of Map Revision (LOMR)
    - Digital copies of Final computer models.

STORAGE



Pre-Developed 1% (100-Year) Rational Method "C"	Outflow Rate for Drainage CFS/AC	
	20% (5-Year)	1% (100-Year)
0.1	0.0	0.6
0.2	0.1	1.3
0.3	0.2	2.0
0.4	0.6	2.9
0.5	1.8	4.9
0.6	3.6	7.5