



CHECKLIST FOR STREETS, INLETS, AND STORM SEWER DESIGN

Yes No N/A Design Requirements

I. STREET CLASSIFICATION AND DESIGN CRITERIA

			A. Determine drainage classification for the roadway section using Table 7-1 or Table 7-2.
			B. Determine the allowable flow depth and roadway encroachment for the minor storm using Table 7-3.
			C. Determine the allowable flow depth and roadway encroachment for the major storm using Table 7-4.
			D. Determine the allowable cross-street flow due to spread over the street crown for the minor and major storm using Table 7-5.

II. HYDRAULIC EVALUATION OF STREET CAPACITY

			A. Minor Storm Capacity Evaluation
			1. Determine/verify capacity of street section in minor storm using Figures 7-1 through 7-19. All County standard street parameters must apply in order to use these figures.
			2. If the County standard street parameters do NOT apply, use the UD-Inlet spreadsheet to determine/verify the capacity of the street section in the minor storm.
			B. Major Storm Capacity Evaluation
			1. Determine/verify capacity of street section in major storm using Figures 7-1 through 7-19. All County standard street parameters must apply in order to use these figures. Criteria listed in Section 7.5.4 must also apply in order to use the 12-inch depth curve for the major storm event.
			2. If the County standard street parameters or the criteria listed in Section 7.5.4 do NOT apply, use the UD-Inlet spreadsheet to determine/verify the capacity of the street section in the major storm.
			C. Cross Street Flow
			1. Verify that the maximum allowable cross-street flow is not exceeded per Table 7-5.
			2. If cross-street flow is occurring, inlets and storm sewers on the upstream side of the street shall be designed to fully convey design flows, assuming no cross-street flow; inlets and storm sewers on the downstream side of the street shall be increased in capacity by 1.5 times the estimated cross-flow.
			3. If crossspans are being used, calculations shall be completed to evaluate the capacity of the roadway and any side streets impacted by the crossspan.
			D. Rural Roadside Ditches
			1. Verify capacity of roadside ditch for minor and major storm event



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			based on Criteria in Tables 7-3 and 7-4.
			2. Spread of flow shall not extend outside of the street right-of-way.
			3. Provide a minimum of 12-inches of freeboard from the major storm water surface elevation to the lowest point of water entry at any adjacent structure.
			4. Design ditch in accordance with the criteria for grass-lined minor drainageways as described in Chapter 12. Check ditch velocities and provide adequate protection (if necessary) in accordance with the Major Drainage section of the UDFCD Manual.
			5. Design ditch section for maintenance access, including 4 to 1 side slopes.

III. INLET DESIGN AND ANALYSIS

			A. Inlet Selection
			1. Review Section 8.1.3, General Design Guidelines for Inlets.
			2. Determine appropriate inlet to use for the given site conditions, using Table 8-1.
			3. Obtain approval from the County if a standard County inlet is NOT being used.
			C. Inlets on Continuous Grade - Minor Storm
			1. <u>Preliminary Design.</u> Determine rough inlet placement and capacity of curb opening inlet (Type R) in minor storm using Figures 8-1 through 8-20. These Figures are based on maximum allowable flow in street section (See Section 8.4.1). All County standard street sections and inlet parameters must apply in order to use these figures.
			2. <u>Preliminary Design.</u> If the County standard street parameters or standard curb opening inlet does NOT apply, use the UD-Inlet spreadsheet to determine/verify the capacity of the curb opening inlet in the minor storm.
			3. <u>Final Design.</u> Use the UD-Inlet spreadsheet to determine final placement and to verify the capacity of the curb opening inlet in the minor storm. (Figures 8-1 through 8-20 can be used to determine capacity only if the flow in the street is at the maximum allowable AND the standard street section and curb opening inlet parameters apply.)
			D. Inlets on Continuous Grade - Major Storm
			1. <u>Preliminary Design.</u> Determine rough inlet placement and capacity of curb opening inlet (Type R) in major storm using Figures 8-1 through 8-20. These Figures are based on maximum allowable flow in street section (See Section 8.4.1). All County standard street sections and inlet parameters must apply in order to use these figures.
			2. <u>Preliminary Design.</u> If the County standard street parameters or



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			standard curb opening inlet does NOT apply, use the UD-Inlet spreadsheet to determine/verify the capacity of the curb opening inlet in the major storm.
			3. <u>Final Design.</u> Use the UD-Inlet spreadsheet to determine final placement and to verify the capacity of the curb opening inlet in the major storm. (Figures 8-1 through 8-20 can be used to determine capacity only if the flow in the street is at the maximum allowable AND the standard street section and curb opening inlet parameters apply.)
			E. Inlet in Sump Conditions
			1. Determine capacity of inlets in sump condition using Figures 8-21 and 8-22. The County standard inlet parameters must apply to use these figures.
			2. If the County standard inlet parameters do NOT apply, use UD-Inlet spreadsheet to evaluate inlet capacity.
			3. Provide a surface flow path at all sump inlets for emergency overflows if the inlet becomes clogged. The emergency overflow path shall convey the major storm discharge within a drainage tract or easement. See Section 8.5.3.
			F. Other Design Considerations
			1. Curb chase drains shall NOT be used in place of a standard inlet.
			2. Review Figure 8-1 for conceptual placement of median inlets.
			3. Maximum length of an inlet shall not exceed the length of a triple unit.
V. STORM SEWER DESIGN AND ANALYSIS			
			A. Storm Sewer Design Storm
			1. Design storm sewer to convey the minor storm runoff that exceeds the minor storm capacity of the street or roadside swale. The storm sewer shall convey the minor storm in a "just full" condition, without surcharging the system. See Section 9.8.2.
			2. Design storm sewer to convey a storm greater than the minor event when the conditions listed in Section 9.1.2 apply.
			B. Storm Sewer Pipe Material
			1. Design storm sewers located within County rights-of-way, public easements or in private streets with reinforced concrete pipe (RCP).
			2. Private storm sewers (parking lots, individual site, etc.) may be designed with alternate materials, only if approved by the County. See Section 9.2.1.
			3. Design storm sewer with minimum pipe diameters per Table 9-1.
			4. Provide trench installation details as shown in SD-5. Evaluate whether project specific conditions, material or loading require a modified trench detail.



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			4. Provide water tight joints, with rubber gaskets, for all storm sewer pipe joints and structure connections.
			C. Storm Sewer Easements and Maintenance
			1. Provide easement to ensure adequate space for access, construction, and maintenance of the storm sewer pipe. Use Table 9-2 for guidance.
			2. Paving, landscaping, and other surface treatment along easements shall allow maintenance access to pipe. See section 9.4.3.
			D. Storm Sewer Vertical Alignment
			1. Construct pipe to withstand AASHTO HS-20 loading.
			2. Minimum cover over pipe shall be 12-inches to finished grade. Pipe under roadways shall be constructed with a minimum cover of 30-inches to finished grade.
			3. Contact specific agency/owner of utility to determine the agency's vertical clearance requirements at utility crossings.
			4. Verify that County's minimum vertical clearance of 18-inches between storm sewer and water line or sanitary sewer is provided.
			5. Provide encasement around sanitary sewer when storm sewer crosses below a sanitary line. See Section 9.5.3.
			E. Storm Sewer Horizontal Alignment
			1. Alignment between drainage structures shall be straight.
			2. Contact specific agency/owner of utility to determine the agency's horizontal clearance requirements at utility crossings.
			3. Verify that County's minimum horizontal clearance of 10-feet (outer diameter to outer diameter) between storm sewer and water line or sanitary sewer line is provided.
			F. Manholes
			1. Construct manhole when there is a change in size, direction, or grade of a storm sewer pipe.
			2. Construct manholes at maximum spacing provided in Table 9-3.
			3. Use Table 9-4 as guidance to determine appropriate manhole type for site conditions.
			4. Verify that 12-inches of clearance is provided along the inside wall of the manholes between the outside walls of storm sewer pipes.
			5. If a special manhole structure is required, use Section 9.7.3 for guidance.
			6. Include steps in manholes exceeding 3.5-feet in height in accordance with AASHTO M 199. Construct cages and/or landing platforms in deep manholes to comply with the Occupational Health and Safety Administration standards.
			7. Design manholes with drops no greater than 1-foot between the upstream and downstream pipe inverts (unless designing a small storm drainage outfall for energy dissipation, see Section 9.7.6).



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			Drops greater than 1-foot may require additional analysis, at the County's request.
			8. Manholes used for energy dissipation in small storm drainage outfalls (30-inch pipe or smaller) shall be constructed per Section 9.7.6 and Figure 9-1.
			9. Construct manholes with channelization/shaping per the details provided on SD-6.
			10. Design manholes in accordance with design considerations provided in Section 9.7.8.
			G. Hydraulic Design of Storm Sewers
			1. Maximum velocity in pipe shall not exceed 18 feet per second. See Section 9.8.1 for additional information.
			2. Minimum velocity in pipe shall be 4 feet per second. See Section 9.8.1 for additional information.
			3. Minimum slope for pipes less than 30-inches is 0.01 ft/ft. Minimum slope for pipes with diameters of 30-inches and greater is 0.005 ft/ft.
			4. Complete hydrologic evaluation of storm sewer system for minor and major storm events. See Step 1 in Sections 9.8.2 and 9.8.3.
			5. Determine pipe capacity of storm sewer system for minor and major storm events. See Step 2 in sections 9.8.2 and 9.8.3. Verify storm sewer is NOT surcharged in the minor storm event.
			6. Calculate hydraulic grade line of storm sewer system for minor and major storm events. See Step 3 in sections 9.8.2 and 9.8.3. Verify storm sewer is NOT surcharged in the minor storm event. Verify hydraulic grade line is located a minimum 1-foot below finished grade at all storm sewer structures.
			7. Complete a "check" of the storm sewer system using NeoUDSewer. If other software program is used, complete calibration model per Section 9.8.4.



CHECKLIST FOR STORM SEWER CONSTRUCTION PLANS

Yes No N/A Design Requirements

I. STORM SEWER PLAN VIEW, the following information shall be shown:

			A. Title block with project information, including a list of sheet revisions and an approval block
			B. Boundaries of project and plan sheet layout (key map)
			C. Existing and proposed roadways, sidewalks, and other surface features.
			D. Existing and proposed drainageways, irrigation ditches and culverts/storm sewer pipes
			E. Existing and proposed utilities (overhead and underground)
			F. Existing and proposed storm sewer structures (manholes, inlets, pipes, etc.)
			G. Existing and proposed contours
			H. Stationing along project control line
			I. Right-of-way and easement lines
			J. North arrow and scale bar
			K. Label size (diameter) of proposed storm sewer pipes
			L. Label storm sewer structures/pipes to be removed or plugged.

II. STORM SEWER PROFILE, the following information shall be shown:

			A. Title block with project information, including a list of sheet revisions
			B. Horizontal and vertical scale bars
			C. Labels for pipe length, slope, diameter and material (from inside wall of structure to inside wall of structure)
			D. Existing and proposed ground along storm sewer alignment
			E. Existing and proposed utilities along storm sewer alignment
			F. Hydraulic grade line of storm sewer for major storm event
			G. Label the following at storm sewer structures (inlets, manholes, flared end sections, etc.):
			1. Type of structure including diameter and/or length
			2. Height of structure
			3. Finished grade rim and/or grate elevation
			4. Station and offset from project control line
			5. Storm sewer pipes entering and exiting the structure, including invert elevations

III. STORM SEWER DETAILS, the following information shall be shown:

			A. Include any structure details or special connections that are not Arapahoe County Standard details or Colorado Department of Transportation M & S Standard Plans