

GENERAL:

1. To provide minimum standards for Storm Drainage Systems. See Section [22 0100](#) for more information.

DESIGN GUIDELINES:

1. This section applies to stormwater conveyance systems outside the footprint of buildings. Building systems are covered in Section 22 0100.
2. Trunk storm sewers are defined as the primary spine(s) of the piping system and generally carry the flow from more than one site.
3. Stormwater systems shall be designed using the actual time of concentration. The worst case of complete development, per the current Master Plan, or current conditions shall be used for calculation of offsite flow.
4. Generally, the Rational Formula shall be used for areas under 200-acres. Runoff coefficients shall consider percentage of impervious area and average site grade (slope).
5. Return periods will be 25 years with actual time of concentration (duration) for all building sites, pedestrian malls, streets, quadrangles, and Trunk Storm Sewers.
6. Return periods will be ten (10) years with actual time of concentration (duration) for parking lots, park space, and open areas.
7. Project Manager (PM) will establish "return periods" for all other areas.
 - 7.1. Return period must satisfy governing municipality's regulations.
8. No ponding is allowed on paved areas. Detention basins shall be labeled on the drawings.
9. Designer will compare above return periods with those required by the local municipality. Coordination with municipality may be required and should be reviewed with the PM. Any discrepancies will be discussed with the project manager.
10. All buildings and structures will be developed such that no entry of water through entrances, window wells, area ways, basements, drains, etc. will occur during a minimum hundred-year storm. Design should maintain positive drainage away from building entrances.
 - 10.1. Connections to building drains shall be designed to prevent surcharge from the storm sewer for the 100-year storm.

- 10.1.1. Sidewalk grade shall be set to prevent surface from collecting and channeling surface drainage.
11. Particular attention will be paid to bicycle and wheelchair safety in the design of storm drainage systems. Grate bars will be placed perpendicular to direction of traffic flow. Grates in pedestrian areas should be sized to avoid catching heels of shoes.
12. At MU, a modified version of the City of Columbia standard curb inlet is used for all work not in the public right-of-way.
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13. At MU only, storm drains less than 36" in diameter shall run on a straight line and grade between structures. Horizontal and vertical bends are permitted in 8" and 10" lines provided a cleanout is included. The deflection should utilize a wye with the cleanout as an upstream extension of the downstream line's alignment.
14. Consultants shall use the Missouri Department of Natural Resources document "Protecting Water Quality – A field guide to erosion, sediment and storm water best management practices for development sites in Missouri and Kansas" and the EPA guidance "Storm Water Management for Construction Activities" as Best Management Practice guidelines for the preparation of site plans and construction details relative to erosion control on construction sites.
15. The state of Missouri HB 1867 requires tracer wire for all new or fully replaced sewer installations in public right of way. New provisions for sewer installations on University of Missouri projects are included within.

SPECIFICATION REQUIREMENTS:

1. Storm sewer pipe shall be:
- 1.1 Reinforced Concrete Pipe (RCP) conforming to ASTM C76 or AASHTO M170, Class 3 minimum, and asbestos-free.
- 1.1a. Joints shall be flexible rubber gasket conforming to ASTM C443 or ASTM C361.
- 1.1b. The minimum pipe size for storm drains is 12".
- 1.2. High Density Poly Ethylene Pipe (HDPE) up to 48" in diameter, can be used in all areas, except easements and roadways, conforming to AASHTO M294 and ASTM F2306. HDPE pipe to be ADS N-12 WT IB, smooth interior, dual wall or approved equal.
- 1.3 High Performance Polypropylene Pipe (HPP) having a smooth interior and an annular corrugated exterior. HPP pipe shall meet or exceed ASTM F2736 where up

to 30 inches in diameter, and ASTM F2881 where diameter is 36 to 60 inches. AASHTO loading requirements shall be met.

- 1.4 Minimum gage of HDPE or HPP piping shall be per manufacturers recommendations. Backfill applications, and minimum and maximum pipe backfill coverage limits for HDPE and HPP piping shall be per manufacturers installation requirements, except maximum depth of fill above pipe shall not exceed 9 feet. Backfill methods that vary from the manufacturer's installation requirements shall be approved by the Engineer of Record".
2. Area drain piping shall be 8" or larger. Pipe shall be:
 - 2.1. Ductile iron conforming to ASTM A746 with cement lining conforming to ANSI/AWWA C104/A21.4, and asphaltic coating on the interior and exterior conforming to ANSI/AWWA C110/A21.10, and asbestos-free.
 - 2.2. Polyvinyl chloride (PVC) conforming to ASTM D2241, PVC 1120, DR 21, PR 200 (SDR-21).
3. Perforated pipe for subgrade drains shall be SDR-35 or Schedule 40 PVC. Pipe shall be installed in a geotextile envelope with clean rock. Perforated pipe in a 'sock' is not acceptable.
4. Drain tiles are to be installed at footings and tied to sanitary or storm sewer system as allowed by local municipalities. Down spouts will be tied into storm sewers (in lieu of foundation drain tiles) and will not discharge on grade
5. Inlets and junction boxes may be cast-in-place or precast conforming to ASTM C478.
 - 5.1. Storm manholes (junction boxes) shall use a Deeter 1247, Neenah R-1642, or exact equal frame and lid. The lid shall be lettered with the words 'Storm Sewer' or 'Storm Drain'.
 - 5.2. Structures over 3-feet from lid to lowest flow line shall include steps. Steps shall be Neenah 1980-J, Deeter 1606, M.A. Industries PS2-PF, or equal.
6. Trace Wire & Test Stations
 - 6.1. **MU:** Tracer Wire shall be #14 AWG solid, steel core soft drawn high strength tracer wire, 250# average tensile break load, 30 mil High Molecular Weight (HMWPE) or High Density (HDPE) polyethylene jacket complying with ASTM-D-1248, 30 volt rating. Jacket color shall be green. No THHN insulated wire shall be allowed. Tracer wire shall be Copperhead Industries HS-CCS or approved equal. The tracer wire shall be taped to the pipe at the three o'clock position every 5 feet. The tracer wire ends will terminate at a tracer wire test station.
 - 6.2. **MS&T:** Tracer wire shall be #12 THHN attached to top of pipe at 5' intervals. Tracer wire ends to terminate in manhole near the lid with 5' coil of wire.

- 6.3. **MU:** Tracer wire shall have moisture resistant splices for direct bury applications. Splices shall be Copperhead Industries Snakebit or 3M DBR or approved equal.
- 6.4. **MU:** Tracer Wire test stations shall be installed 2 feet of the manhole or structure in the flow line of the pipe. These test stations shall be designed to be easily detected by magnetic and electronic locators. A magnet shall be securely attached at the top of the upper tube of the box for locating purposes. Lid shall be green and have a brass terminal for attaching locating equipment and a brass 5 sided nut for removing cap. Tracer wire test station shall be Copperhead Industries Snake Pit or approved equal.

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7. Warning Tape

- 7.1. Install warning tape at least 12" above the top of pipe.