



**MISSOURI**  
DEPARTMENT OF  
NATURAL RESOURCES

**Title 10—DEPARTMENT OF NATURAL RESOURCES**  
**Division 20—Clean Water Commission**  
**Chapter 8—Minimum Design Standards**

**WORKING DOCUMENT**  
**Strawman**

**The Department presents these draft materials for  
stakeholder review and discussion only.  
Subject to the Red Tape Reduction review.**

The Missouri Department of Natural Resources has identified 10 CSR 20-8, Minimum Design Standards, as a potential rulemaking amendment. This workgroup has been convened for the purpose of informal and voluntary public participation and discussions regarding the development of this rule prior to initiating formal rulemaking.

Under Governor Greitens' leadership, all state agencies are working to reduce regulations and other government processes that unnecessarily burden individuals and businesses while doing little to protect or improve public health, safety, and our natural resources. The Missouri Department of Natural Resources is committed to limiting regulation to what is necessary to protect Missouri's environment, implementing statutory mandates, and maintaining state control of programs. Any further proposed changes to rules discussed on this page are being developed with these goals in mind. We welcome your comments to help ensure that our regulations provide required protections but do not add unnecessary costs.

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**Title 10—DEPARTMENT OF NATURAL RESOURCES**  
**Division 20—Clean Water Commission**  
**Chapter 8—*[Design Guides]* Minimum Design Standards**

**10 CSR 20-8.120 *[Design of]* Gravity Sewers**

*[PURPOSE: The following criteria have been prepared as a guide for the design of sewers. This rule is to be used with rules 10 CSR 20-8.110 through 10 CSR 20-8.220 for the planning and design of the complete treatment facility. This rule reflects the minimum requirements of the Missouri Clean Water Commission in regard to adequacy of design, submission of plans, approval of plans, and approval of completed wastewater treatment facilities and collection systems. It is not reasonable or practical to include all aspects of design in these standards. The design engineer should obtain appropriate reference materials which include but are not limited to: copies of all ASTM International standards pertaining to sewers and appurtenances, design manuals such as Water Environment Federation’s Manuals of Practice, and other sewer design manuals containing principles of accepted engineering practice. Deviation from these minimum requirements will be allowed where sufficient documentation is presented to justify the deviation. These criteria are taken largely from the 2004 edition of the Great Lakes-Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers’ Recommended Standards for Wastewater Facilities and are based on the best information presently available. These criteria were originally filed as 10 CSR 20-8.030. It is anticipated that they will be subject to review and revision periodically as additional information and methods appear.]*

***PURPOSE: The following minimum criteria have been prepared as a standard for the design of wastewater systems. This rule is to be used with rules 10 CSR 20-8.110 through 10 CSR 20-8.500 for the planning and design of a treatment facility. It is not reasonable or practical to include all aspects of design in these standards. The design engineer may use other appropriate reference materials for these design aspects not addressed in this rule, which include but are not limited to: copies of all ASTM International and American Water Works Association (AWWA) standards pertaining to wastewater systems and appurtenances, design manuals such as Water Environment Federation’s Manuals of Practice, Department prepared guides and other wastewater design manuals containing principles of accepted engineering practice. This rule specifies minimum standards for the design and construction of wastewater systems, in addition to engineering experience and judgement in accordance with standards of practice.***

*[(1) Definitions. Definitions as set forth in the Clean Water Law and 10 CSR 20-2.010 shall apply to those terms when used in this rule, unless the context clearly requires otherwise.*

*Where the terms “shall” and “must” are used, they are to mean a mandatory requirement insofar as approval by the Missouri Department of Natural Resources (department) is concerned, unless justification is presented for deviation from the requirements. Other terms, such as “should,” “recommend,” “preferred,” and the like, indicate the preference of the department for consideration by the design engineer.*

*(A) Deviations. Deviations from these rules may be approved by the department when engineering justification satisfactory to the department is provided. Justification must substantially demonstrate in writing and through calculations that a variation(s) from the*

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*design rules will result in either at least equivalent or improved effectiveness. Deviations are subject to case-by-case review with individual project consideration.]*

*[(2) Applicability. This rule shall apply to all facilities with a design flow of one hundred thousand (100,000) gallons (378.5 m<sup>3</sup>) per day or greater. This rule shall also apply to all facilities with a design flow of twenty-two thousand five hundred (22,500) gallons (85.2 m<sup>3</sup>) per day or greater until such time as 10 CSR 20-8.020 is amended.]*

**(1) Applicability. Wastewater systems shall be designed based on criteria contained in this rule, published standards, applicable federal and state requirements, standard textbooks, current technical literature and applicable safety standards. To the extent of any conflict between the above criteria, the requirement in this rule shall prevail.**

**(A) This rule shall not apply to animal waste management systems. Regulations for these facilities are found in 10 CSR 20-8.300.**

**(B) This rule shall not apply to agrichemical facilities. Regulations for these facilities are found in 10 CSR 20-8.500.**

*[(3) Approval of Sewers. The department will approve plans for new systems, extensions to new areas, or replacement sanitary sewers only when designed upon the separate basis, in which rain water from roofs, streets, and other areas and groundwater from foundation drains are excluded.]*

**(2) Approval of Sewers. Rain water from roofs, streets, and other areas and groundwater from foundation drains shall be excluded from sewers**

*[(4) Design Capacity and Design Flow.*

*(A) Sewer capacities shall be designed for the estimated ultimate tributary population, except in considering parts of the systems that can be readily increased in capacity. Similarly, consideration must be given to the maximum anticipated capacity of institutions, industrial parks, etc. An economic analysis of alternatives must be included in the engineering report or facility plan where future relief sewers are planned.*

*1. The following factors must be considered in determining the required capacities of sanitary sewers:*

*A. Design peak hourly flow;*

*B. Additional maximum wastewater or waste flow from industrial plants;*

*C. Inflow and infiltration (I/I);*

*D. Topography of area;*

*E. Location of wastewater treatment facilities;*

*F. Depth of excavation; and*

*G. Pumping requirements.*

*2. The basis of design for all sewer projects shall be included in the engineering report or facility plan. More detailed computations may be required by the department for critical projects.*

*(B) Sewer flows shall be based on the design peak hourly flow in accordance with 10 CSR 20-8.110(4)(C)4. and must be designed to prevent or eliminate sanitary sewer overflows (SSOs).]*

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**(15)3** Details of Design and Construction.

*[(A) Minimum Size. Gravity sewers conveying raw wastewater shall be no less than eight inches (8") (20 cm) in diameter, except in circumstances where smaller diameter pipe can be justified.*

*[(B) Depth. All sewers shall be sufficiently deep so as to receive wastewater from basements and shall be covered with at least thirty-six inches (36") (91 cm) of soil, other insulation, or material to prevent freezing and to protect them from superimposed loads.*

*[(C) Buoyancy. Buoyancy of sewers shall be considered and flotation of the pipe shall be prevented with appropriate construction where high groundwater conditions are anticipated.]*

**[(D)A) Slope. The continuing authority of the sanitary sewer system shall give written assurance to the Department that any additional sewer maintenance necessary for reduced slopes will be provided.**

*[1. All sewers shall be designed and constructed to give mean velocities, when flowing full, of not less than two feet (2') per second (0.6 m/s). The following are the minimum slopes which should be provided for sewers forty-two inches (42") (107 cm) or less; however, slopes greater than these may be desirable for construction, to control sewer gases, or to maintain self-cleansing velocities at all rates of flow within the design limits:*

<i>Nominal Sewer Size</i>	<i>Minimum Slope in Feet Per 100 Feet (m/100 m)</i>
<i>8 inch (20 cm)</i>	<i>0.40</i>
<i>10 inch (25 cm)</i>	<i>0.28</i>
<i>12 inch (30 cm)</i>	<i>0.22</i>
<i>14 inch (36 cm)</i>	<i>0.17</i>
<i>15 inch (38 cm)</i>	<i>0.15</i>
<i>16 inch (41 cm)</i>	<i>0.14</i>
<i>18 inch (46 cm)</i>	<i>0.12</i>
<i>21 inch (53 cm)</i>	<i>0.10</i>
<i>24 inch (61 cm)</i>	<i>0.08</i>
<i>27 inch (69 cm)</i>	<i>0.067</i>
<i>30 inch (76 cm)</i>	<i>0.058</i>

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<i>33 inch (84 cm)</i>	<i>0.052</i>
<i>36 inch (91 cm)</i>	<i>0.046</i>
<i>39 inch (99 cm)</i>	<i>0.041</i>
<i>42 inch (107 cm)</i>	<i>0.037</i>

- A. Sewer sizes not included in the above table should be designed and constructed to give mean velocities, when flowing full, of not less than three feet (3') per second (0.9 m/s), based on Manning's formula using an "n" value of 0.013.*
- 2. Minimum flow depths. Slopes which are slightly less than the recommended minimum slopes may be permitted. Such decreased slopes may be considered where the depth of flow will be one-third (1/3) of the diameter or greater for design average flow. Whenever decreased slopes are selected, the design engineer must furnish with his/her engineering report or facility plan computations of the anticipated flow velocities of average daily and peak hourly flow rates. The operating authority of the sewer system will give written assurance to the department that any additional sewer maintenance required by reduced slopes will be provided.*
- 3. Minimize solids deposition. The pipe diameter and slope shall be selected to obtain the greatest practical velocities to minimize settling problems. Oversize sewers will not be approved to justify using flatter slopes. If the proposed slope is less than the minimum slope of the smallest pipe, which can accommodate the design peak hourly flow, the actual depths and velocities at minimum, average, and design maximum day and peak hourly flow for each design section of the sewer shall be calculated by the design engineer and be included with the plans.*
- 4. Slope between manholes. Sewers shall be laid with uniform slope between manholes.*
- 5. High velocity protection. Where velocities greater than fifteen feet (15') per second (4.6 m/s) are attained, special provision shall be made to protect against displacement by erosion and impact.*
- 6. Steep slope protection. Sewers on twenty percent (20%) slope or greater shall be anchored securely with concrete anchors or equal, spaced as follows:*
- A. Not over thirty-six feet (36') (11 m) center-to-center on grades twenty percent (20%) and up to thirty-five percent (35%);*
  - B. Not over twenty-four feet (24') (7.3 m) center-to-center on grades thirty-five percent (35%) and up to fifty percent (50%); and*
  - C. Not over sixteen feet (16') (4.9 m) center-to-center on grades fifty percent (50%) and over.]*

**[(E) Alignment.**

- 1. Sewers twenty-four inches (24") (61 cm) or less shall be laid with straight alignment between manholes. Straight alignment shall be checked by either using a laser beam or lamping.*
- 2. Curvilinear alignment of sewers larger than twenty-four inches (24") (61 cm) may be considered on a case-by-case basis provided compression joints are specified and ASTM or specific pipe manufacturers' maximum allowable pipe joint deflection limits are not*

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*exceeded. Curvilinear sewers shall be limited to simple curves which start and end at manholes. When curvilinear sewers are proposed, the recommended minimum slopes indicated in paragraph (5)(D)1. of this rule must be increased accordingly to provide a minimum velocity of two feet (2') per second (0.6 m/s) when flowing full.*

**(F) Changes in Pipe Size.**

*1. When a smaller sewer joins a larger one, a manhole is required according to subparagraph (6)(A)1.B. of this rule. The invert of the larger sewer should be lowered sufficiently to maintain the same energy gradient. An approximate method for securing these results is to place the 0.8 depth point of both sewers at the same elevation.*

*2. Sewer extensions should be designed for projected flows. When the diameter of the receiving sewer is less than the diameter of the proposed extension at a manhole, the manhole shall be constructed with special consideration of an appropriate flow channel to minimize turbulence. The department may require a schedule for construction of future downstream sewer relief.*

**(G) Materials.** *Any generally accepted material for sewers will be given consideration, but the material selected should be adapted to local conditions, such as character of industrial wastes, possibility of septicity, soil characteristics, exceptionally heavy external loadings, abrasion, corrosion, and similar problems.*

*1. All sewer pipe and joint materials shall conform to the appropriate ASTM specifications.*

*2. Suitable couplings complying with ASTM specifications shall be used for joining dissimilar materials. The leakage limitations on these joints shall be in accordance with paragraph (5)(I)4. or (5)(I)5. of this rule.*

*3. All sewers shall be designed to prevent damage from superimposed live, dead, and frost-induced loads. Proper allowance for loads on the sewer shall be made because of soil and potential groundwater conditions, as well as the width and depth of the trench. Where necessary, special bedding, haunching, initial backfill, concrete cradle, or other special construction shall be used to withstand anticipated potential superimposed loading or loss of trench wall stability. See ASTM D2321 or ASTM C12 when appropriate.*

*4. For new pipe or joint materials for which ASTM standards have not been established, the design engineer shall provide complete material and installation specifications developed on the basis of criteria adequately documented and certified in writing by the pipe manufacturer to be satisfactory for the specific detailed plans for approval by the department.]*

**([H]B) Installation.**

*[1. Standards. Installation specifications shall contain appropriate requirements based on the criteria, standards, and requirements established by industry in its technical publications. Requirements shall be set forth in the specifications for the pipe and methods of bedding and backfilling thereof so as not to damage the pipe or its joints, impede cleaning operations, and future tapping, nor create excessive side fill pressures and ovalation of the pipe, nor seriously impair flow capacity.*

**2. Trenching.**

*A. The width of the trench shall be ample to allow the pipe to be laid and jointed properly and to allow the bedding and haunching to be placed and compacted to adequately support the pipe. The trench sides shall be kept as nearly vertical as*

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*possible. When wider trenches are specified, appropriate bedding class and pipe strength shall be used.*

*B. In unsupported and unstable soil, the size and stiffness of the pipe, stiffness of the embedment, insitu soil, and depth of cover shall be considered in determining the minimum trench width necessary to adequately support the pipe.*

*C. Ledge rock, boulders, and large stones shall be removed to provide a minimum clearance of four inches (4") (10 cm) below and on each side of all pipe(s).*

*D. Dewatering. All water entering the excavations or other parts of the work shall be removed until all the work has been completed. No sanitary sewer that ultimately arrives at existing pumping stations or wastewater treatment facilities shall be used for the disposal of trench water.*

**3 Bedding, haunching, and initial backfill.**

*A. Rigid pipe. Bedding Classes A, B, C, or crushed stone, as described in ASTM C12, shall be used and carefully compacted for all rigid pipe provided the proper strength pipe is used with the specified bedding to support the anticipated load, based on the type of soil encountered and potential groundwater conditions.]*

**[B]1. Ductile iron pipe. Embedment materials for bedding and initial backfill, as described in ASTM A746 – 09(2014) Standard Specification for Ductile Iron Gravity Sewer Pipe, as approved and published October 1, 2014, shall be used for ductile iron pipe provided the proper strength pipe is used with the specified bedding to support the anticipated load based on the type of soil encountered and potential groundwater conditions. This standard is incorporated by reference in this rule, as published by ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959. This rule does not incorporate any subsequent amendments or additions.**

**[C]2. Plastic pipe. Embedment materials for bedding, haunching, and initial backfill, Classes I, II, or III, as described in ASTM D2321 – 14e1 Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications, as approved and published August 1, 2014, shall be used [and carefully compacted for all flexible pipe] provided the proper strength pipe is used with the specified bedding to support the anticipated load, based on the type of soil encountered and potential groundwater conditions. This standard is incorporated by reference in this rule, as published by ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959. This rule does not incorporate any subsequent amendments or additions.**

**[D]3. Composite pipe. Except as described in ASTM D2680 – 01(2014) Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping, as approved and published August 1, 2014, the bedding, haunching, and initial backfill requirements for composite pipe shall be the same as for plastic pipe. This standard is incorporated by reference in this rule, as published by ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959. This rule does not incorporate any subsequent amendments or additions.**

**[4. Final backfill.**

*A. Final backfill shall be of a suitable material removed from excavation except where other material is specified. Debris, frozen material, large clods, stones,*

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*organic matter, or other unstable materials shall not be used for final backfill within two feet (2') (0.6 m) of the top of the pipe.*

*B. Final backfill shall be placed in such a manner so as not to disturb the alignment of the pipe.]*

[5.](C) Deflection test. No pipe **shall** exceed a deflection of five percent (5%) of the inside diameter.

*[A. Deflection tests shall be performed on all flexible pipe. The test shall be conducted after the final backfill has been in place at least thirty (30) days to permit stabilization of the soil-pipe system.*

*B. No pipe shall extend a deflection of five percent (5%). If the deflection exceeds five percent (5%), the pipe shall be excavated. Replacement or correction shall be accomplished in accordance with requirements in the department-approved specifications.*

*C. The rigid ball or mandrel used for the deflection test shall have a diameter not less than ninety-five percent (95%) of the base inside diameter or average inside diameter of the pipe depending on which is specified in the ASTM specification, including the appendix, to which the pipe is manufactured. The test shall be performed without mechanical pulling devices. A mandrel must have nine (9) or more odd number of flutes or points.]*

[6. Video inspection. Video inspection of all new and rehabilitated sewers after installation is recommended.]

([I]D) Joints and Infiltration.

[1. Joints. The installation of joints and the materials used shall be included in the specifications. Sewer joints shall be designed to minimize infiltration and to prevent the entrance of roots throughout the life of the system.]

[2]1. Service connections. Service connections to the sewer main **shall** be watertight and **cannot** protrude into the sewer. *[If a saddle-type connection is used, it shall be a device designed to join with the types of pipe which are to be connected. All materials used to make service connections shall be compatible with each other and with the pipe materials to be joined and shall be corrosion proof.]*

[3]2. Leakage tests. Leakage tests **shall** be specified **for gravity sewers except polyvinyl chloride (PVC) pipe with a diameter of twenty-seven inches (27") or less.** *[This may include appropriate water or low pressure air testing. The testing selected should take into consideration the range in groundwater elevations during the test and anticipated during the design life of the sewer.]*

[4.]A. Water (hydrostatic) test. The leakage exfiltration or infiltration **shall** not exceed one hundred (100) gallons per inch of pipe diameter per mile per day *[(0.38 m<sup>3</sup>/cm of pipe diameter/km/day)]* for any section between manholes of the system. An exfiltration or infiltration test **shall** be performed with a minimum positive head of two feet (2') *[(0.6 m)]*. **The exfiltration or infiltration test shall, as a minimum, conform to the test procedure described in ASTM C969 – 17 Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines, as approved and published April 1, 2017, for precast concrete pipe. This standard is incorporated by reference in this rule, as published by ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West**



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**Conshohocken, PA 19428-2959. This rule does not incorporate any subsequent amendments or additions.**

[5.]**B.** Air test. The air test **shall**, as a minimum, conform to the test procedure described in *[ASTM C828 for clay pipe, ASTM C924 for concrete pipe twenty-four inches (24") or less in diameter,]* **ASTM C1103 – 14 Standard Practice for Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines, as approved and published November 1, 2014,** for concrete pipe twenty-seven inches (27") or greater in diameter, and **ASTM F1417 – 11a(2015) Standard Practice for Installation Acceptance of Plastic Non-pressure Sewer Lines Using Low-Pressure Air, as approved and published August 1, 2015,** for plastic, composite, and ductile iron pipe. *[All other materials shall have test procedures approved by the department.]* **These standards are incorporated by reference in this rule, as published by ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959. This rule does not incorporate any subsequent amendments or additions.**

*[(J) Alternative Installation Methods (Trenchless Technologies). Trenchless technologies shall be evaluated by the department on a case-by-case basis.]*

**(E) Bore or Tunnel. Where casing pipe is utilized it shall be constructed of steel with welded joints conforming to AWWA C200-17 Steel Water Pipe, 6 In. (150 mm) and Larger, as approved and published August 1, 2017, or ductile iron pipe with mechanical joints. This standard is incorporated by reference in this rule, as published by American Water Works Association (AWWA), 6666 West Quincy Avenue, Denver, CO 80235-3098. This rule does not incorporate any subsequent amendments or additions;**

*[(6)4] Manholes.*

**(A) Location.**

*[1.]* Manholes **shall** be installed—

*[A]1.* At the end of each line;

*[B]2.* At all changes in grade, size, or alignment; **and**

*[C]3.* At all sewer pipe intersections[;].

*[D. At distances not greater than four hundred feet (400') (120 m) for sewers fifteen inches (15") [(38 cm)] or less; and*

*E. At distances not greater than five hundred feet (500') (150 m) for sewers sixteen inches to thirty inches (16"–30") (46 cm–76 cm).]*

*[2. Spacing of manholes greater than five hundred feet (500') (150 m) may be approved by the department in cases where adequate cleaning equipment can justify such spacing.*

*3. Greater spacing may be permitted in larger sewers.*

*4. Cleanouts may be used only for special conditions and shall not be substituted for manholes nor installed at the end of laterals greater than one hundred fifty feet (150') (46 m) in length.]*

**(B) Drop Type. When using precast manholes, drop connections must not enter the manhole at a joint.**

*[1. A drop pipe shall be provided for a sewer entering a manhole at an elevation of twenty-four inches (24") (61 cm) or more above the manhole invert. Where the difference in elevation between the incoming sewer and the manhole invert is less than twenty-four inches (24") (61 cm), the invert shall be filleted to prevent solids deposition.*

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2. *Drop manholes should be constructed with outside drop connection. Inside drop connections can be used when the manhole diameter is sufficient to secure the drop pipe to the interior wall of the manhole and provide adequate access for cleaning.*

3. *When using precast manholes, drop connections must not enter the manhole at a joint.*

4. *Due to the unequal earth pressures that would result from the backfilling operation in the vicinity of the manhole, the entire outside drop connection shall be encased in concrete.]*

(C) Diameter. *[The minimum diameter of manholes shall be forty-two inches (42") (107 cm) on eight-inch (8") (20 cm) diameter gravity sewer lines and forty-eight inches (48") (122 cm) on all sewer lines larger than eight inches (8") (20 cm) in diameter. Larger diameter manholes are necessary for large diameter sewers in order to maintain structural integrity. A minimum access diameter of twenty-two inches (22") (56 cm) shall be provided.]* **Cleanouts shall be a minimum of eight inches (8") in diameter.**

*[(D) Flow Channel.*

1. *The flow channel straight through a manhole should be made to conform as closely as possible in shape and slope to that of the connecting sewers, without obstructing maintenance, inspection, or flow in the sewers.*

2. *When curved flow channels are specified in manholes, including branch inlets, minimum slopes indicated in paragraph (5)(D)1. of this rule should be increased to maintain acceptable velocities.]*

*[(E)D) Bench. [A bench shall be provided on each side of any manhole channel when the pipe diameter(s) are less than the manhole diameter. The bench should be sloped no less than a one-half inch per foot (0.5 in/ft) (12.7 mm/m).] No sewer, service connection, or drop manhole pipe shall discharge onto the surface of the bench.*

*[(F)E) Watertightness.*

*[1.] Manholes shall be watertight[. Manholes shall be] and constructed of [the] precast concrete or poured-in-place concrete [type]. Precast manholes shall conform to the design and test methods specified in ASTM C478 – 15a Standard Specification for Circular Precast Reinforced Concrete Manhole Sections, as approved and published October 1, 2015, and C497 – 17 Standard Test Methods for Concrete Pipe, Manhole Sections or Tile, as approved and published April 1, 2017. These standards are incorporated by reference in this rule, as published by ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959. This rule does not incorporate any subsequent amendments or additions.*

*[2. Manhole lift holes, grade adjustment rings, precast section joints, and any additional areas potentially subject to infiltration shall be sealed watertight.*

*3. Inlet and outlet pipes shall be joined to the manhole with a gasketed flexible watertight connection or any watertight connection arrangement that allows differential settlement of the pipe and manhole wall to take place.*

*4. Watertight manhole covers are to be used wherever the manhole tops may be flooded by street runoff or high water. Bolt-down cover assemblies may be needed on manholes subject to displacement by sewer surcharging. Locked manhole covers may be desirable in isolated easement locations or where vandalism may be a problem.]*

*[(G)F) Inspection and Testing. [The specifications shall include a requirement for inspection and testing for watertightness or damage prior to placing into service.]*

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1. Vacuum testing, if specified for concrete sewer manholes, **shall** conform to the test procedures in **ASTM C1244 – 11(2017) Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill, as approved and published April 1, 2017**, or the manufacturer's recommendation. **This standard is incorporated by reference in this rule, as published by ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959. This rule does not incorporate any subsequent amendments or additions.**

2. Exfiltration testing, if specified for concrete sewer manholes, **shall** conform to the test procedures in **ASTM C969 – 17 Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines, as approved and published April 1, 2017**. **This standard is incorporated by reference in this rule, as published by ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959. This rule does not incorporate any subsequent amendments or additions.**

*[(H) Corrosion Protection for Manholes. Where corrosive conditions due to septicity or other causes are anticipated, corrosion protection on the interior of the manholes shall be provided.]*

*(I) Electrical. Electrical equipment installed or used in manholes shall conform to 10 CSR 20-8.130(4)(C)5.]*

*[(7) Inverted Siphons. Inverted siphons shall have not less than two (2) barrels, with a minimum pipe size of six inches (6") (15 cm). They shall be provided with necessary appurtenances for maintenance, convenient flushing, and cleaning equipment. The inlet and discharge structures shall have adequate clearances for cleaning equipment, inspection, and flushing. Design shall provide sufficient head and appropriate pipe sizes to secure velocities of at least three feet (3') per second (0.9 m/s) for design average flows. The inlet and outlet details shall be arranged so that the design average flow is diverted to one (1) barrel and so that either barrel may be cut out-of-service for cleaning. The vertical alignment should permit cleaning and maintenance.]*

*[(8) Sewers in Relation to Streams.*

*(A) Location of Sewers in Streams.*

*1. Cover depth. The top of all sewers entering or crossing streams shall be at a sufficient depth below the natural bottom of the stream bed to protect the sewer line. In general, the following cover requirements must be met:*

*A. One foot (1') (0.3 m) of cover is required where the sewer is located in rock;*

*B. Three feet (3') (0.9 m) of cover is required in other material. In major streams, more than three feet (3') (0.9 m) of cover may be required;*

*C. In paved stream channels, the top of the sewer line should be placed below the bottom of the channel pavement; and*

*D. Less cover will be approved only if the proposed sewer crossing will not interfere with future modifications to the stream channel. Justification for requesting less cover shall be provided to the department.*

*2. Horizontal location. Sewers along streams shall be located sufficiently outside the stream bed to prevent pollution by siltation during construction and to minimize possible exposure due to erosion.*

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3. *Structures. The sewer outfalls, headwalls, manholes, gateboxes, or other structures shall be located so they do not interfere with the free discharge of flood flows of the stream.*

4. *Alignment. Sewers crossing streams should be designed to cross the stream as nearly perpendicular to the stream flow as possible and shall be free from change in grade.*

5. *Sewer systems shall be designed to minimize the number of stream crossings.*

*(B) Construction.*

1. *Materials. Sewers entering or crossing streams shall be constructed of ductile-iron pipe with mechanical joints; otherwise, they shall be constructed so they will remain watertight and free from changes in alignment or grade. Material used to backfill the trench shall be stone, coarse aggregate, washed gravel, or other materials which will not readily erode, cause siltation, damage pipe during placement, or corrode the pipe.*

2. *Siltation and erosion. Construction methods that will minimize siltation and erosion shall be employed. The design engineer shall include in the project specifications the method(s) to be employed in the construction of sewers in or near streams. Such methods shall provide adequate control of siltation and erosion by limiting unnecessary excavation, disturbing or uprooting trees and vegetation, dumping of soil or debris, or pumping silt-laden water into the stream. Specifications shall require that clean-up, grading, seeding, planting, or restoration of all work areas shall begin immediately. Exposed areas shall not remain unprotected for more than seven (7) days.]*

*[(9) Aerial Crossings.*

*(A) Support shall be provided for all joints in pipes utilized for aerial crossings. The supports shall be designed to prevent frost heave, overturning, and settlement.*

*(B) Precautions against freezing, such as insulation and increased slope, shall be provided. Expansion jointing shall be provided between above-ground and below-ground sewers. Where buried sewers change to aerial sewers, special construction techniques shall be used to minimize frost heaving.*

*(C) For aerial stream crossings, the impact of flood waters and debris shall be considered. The bottom of the pipe should be placed no lower than the elevation of the fifty (50)-year flood.*

*(D) Aerial crossings shall be constructed of ductile-iron pipe with mechanical joints; otherwise, they shall be constructed so that they will remain watertight and free from changes in alignment or grade.]*

*[(10)5] Protection of Water Supplies.*

*(A) Cross Connections [Prohibited]. There shall be no physical connections between a public or private potable water supply system and a sewer[,] or appurtenance [thereto] which would permit the passage of any wastewater or polluted water into the potable supply. [No water pipe shall pass through or come in contact with any part of a sewer manhole.]*

*(B) Relation to Water Works Structures. Sewers shall be laid at least fifty feet (50') horizontally from any existing or proposed public water supply well or other water supply sources or structures. Refer to 10 CSR 23-3.010.*

*[1. While no general statement can be made to cover all conditions, it is recognized that sewers shall meet the requirements of 10 CSR 23-3.010 with respect to minimum distances from public water supply wells or other water supply sources and structures.*

**LEGEND:**

Text to be *[deleted]* is in italics and bracketed.

Added text is **bolded**.

2. *All existing water works units, such as basins, wells, or other treatment units, within two hundred feet (200') (60 m) of the proposed sewer shall be shown on the engineering plans.]*

(C) Relation to Water Mains.

1. Horizontal and vertical separation.

*[A. Sewer mains shall be laid at least ten feet (10') (3.0 m) horizontally from any existing or proposed water main. The distances shall be measured edge-to-edge. In cases where it is not practical to maintain a ten-foot (10') (3.0 m) separation, the department may allow deviation on a case-by-case basis, if supported by data from the design engineer. Such a deviation may allow installation of the sewer closer to a water main, provided that the water main is in a separate trench or on an undisturbed earth shelf located on one (1) side of the sewer and at an elevation so the bottom of the water main is at least eighteen inches (18") (46 cm) above the top of the sewer.]*

*[B]A. [If] **When** it is impossible to obtain proper horizontal and vertical separation [as described above for sewers,] the sewer **must** be constructed of slip-on or **ductile iron** mechanical joint pipe or continuously encased and be pressure *[tested]* **rated** to **at least** one hundred fifty pounds per square inch (150 psi) *[(1,034 kPa)]* **and pressure tested** to *[assure]* **ensure** watertightness.*

*[C]B. Manholes [should] **shall** be located at least ten feet (10') *[(3.0 m)]* horizontally from any existing or proposed water main.*

**C. When it is impossible to obtain proper horizontal separation as described above for manholes, the manhole shall be located at least ten feet (10') from a water main joint or centered on a twenty foot (20') length of water main pipe.**

2. Crossings.

A. Sewers crossing water mains **shall** be laid to provide a minimum vertical distance of eighteen inches (18") *[(46 cm)]* between the outside of the water main and the outside of the sewer. *[This shall be the case where] **whether** the water main is [either] above or below the sewer. The crossing **shall** be arranged so that the sewer joints will be equidistant and as far as possible from the water main joints. Where a water main crosses under a sewer, adequate structural support **shall** be provided for the sewer to maintain line and grade.*

B. When it is impossible to obtain proper vertical separation as stipulated above, one (1) of the following methods *[must]* **shall** be specified:

(I) *[The sewer shall be d]Design[ed] and construct[ed] equal to water pipe [and shall be pressure tested to assure watertightness prior to backfilling] **as described in subparagraph (5)(C)1.A. of this rule;** or*

(II) **Encase** *[E]either the water main or sewer line [may be] continuously [encased or enclosed] in a watertight carrier pipe which extends ten feet (10') *[(3.0 m)]* on both sides of the crossing, measured perpendicular to the water main. [The carrier pipe shall be of materials approved by the department for use in water main construction.]*

*AUTHORITY: section 644.026, RSMo 2000.\* Original rule filed Aug. 10, 1978, effective March 11, 1979. Amended: Filed May 17, 1994, effective Dec. 30, 1994. Amended: Filed June 28, 2011, effective Feb. 29, 2012.*

*\*Original authority 1972, amended 1973, 1987, 1993, 1995.*