Rules of
Department of Natural Resources
Division 20—Clean Water Commission
Chapter 8—Minimum Design Standards

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

10 CSR 20-8.010 Design of Municipal Waste Stabilization Lagoons in Missouri
(Rescinded August 13, 1979)

AUTHORITY: section 204.026, RSMo Supp. 1973. Original rule filed July 17, 1961, effective July 27, 1961. Amended: Filed Oct. 3, 1962, effective Oct. 13, 1962. Amended: Filed Dec. 4, 1975, effective Dec. 14, 1975. Rescinded: Filed May 4, 1979, effective Aug. 13, 1979.

10 CSR 20-8.020 Design of Small Sewage Works
(Rescinded February 28, 2019)

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10 CSR 20-8.021 Individual Sewage Treatment Systems Standards
(Rescinded March 30, 1999)

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10 CSR 20-8.030 Design of Sewage Works
(Rescinded August 13, 1979)

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***Op. Atty. Gen. No. 92, Bockenkamp (3-24-75)**. The City of Farmington may impose user charges pursuant to section 204.026(18), RSMo (Supp. 1973), to cover costs of operation and/or future expansion of a public sewer treatment facility constructed pursuant to a grant of federal funds under 33 USC, Sections 128I-1292, without the necessity of an election as provided in section 71.715, RSMo (1969).*

***Op. Atty. Gen. No. 229, Smith (8-20-73)**. Municipalities and sewer districts have authority to make the user charges to industries required by the Federal Water Pollution Control Act amendments of 1972 and to establish the reserves for future expansion or reconstruction.*

10 CSR 20-8.110 Engineering—Reports, Plans, and Specifications

PURPOSE: This rule provides the minimum criteria for the preparation of engineering reports and facility plans and specifications related to the design of wastewater systems. This rule is to be used with rules 10 CSR 20-8.110 through 10 CSR 20-8.210 for the planning and design of a wastewater treatment facility. It does not address all aspects of design, and the design engineer may refer to other appropriate reference materials so long as these minimum standards set forth in this rule are met.

(1) Applicability. Engineering reports and facility plans and specifications shall be prepared based on criteria contained in this rule, published standards, applicable federal and state requirements, standard textbooks, current technical literature, and applicable safety standards. In the event of any conflict between the above criteria, the requirement in this rule shall prevail.

(A) This rule shall not apply to treatment units covered in 10 CSR 20-8.300.

(B) This rule shall not apply to treatment units covered in 10 CSR 20-8.500.

(2) General. All documents submitted to the Missouri Department of Natural Resources (department) for the purpose of complying with this rule shall be prepared, signed, sealed, and dated by a Missouri registered professional engineer.

(A) Submittal. The design engineer must submit a project engineering report or facility plan to the department and receive department approval prior to submitting permit applications, plans, specifications, and fees.

(B) Engineering Reports or Facility Plans.

1. Engineering reports must be completed for projects involving collection systems, pumping stations, and force mains.

2. Facility plans must be completed for projects involving wastewater treatment facility projects and projects receiving department funding through the grant and loan programs under 10 CSR 20-4, Grants and Loans.

(C) Approval. Engineering report or facility plan approval does not authorize construction.

(3) Hydraulic and Organic Waste Load.

(A) Existing Systems shall—

1. Use actual flow data that accurately represent the average and peak flows to calculate projections for hydraulic capacity;

2. Include contributions from existing upstream combined sewers that will affect interceptor sewers and treatment facilities;

3. Use actual data that accurately represent organic waste load to calculate projections for organic capacity; and

4. Include documented hydraulic and organic waste load contributions of industrial sources in the calculations of projected capacity.

(B) New Collection and Wastewater Treatment Systems.

1. Hydraulic capacity for wastewater facilities and new collection systems.

A. Flow estimates for the design average flow and design peak hourly flow, including origin of the flow estimates and any assumptions, shall be identified.

B. Peaking factor. The average design flow value shall be used in conjunction with a peaking factor from the following Equation 110-1, included herein.

Equation 110-1. Ratio of peak hourly flow to design average flow.

$$\text{Peaking Factor} = \text{Q Peak Hourly} / \text{Q Design Avg} = (18 + \sqrt{P}) / (4 + \sqrt{P})$$

Where:
Q Peak Hourly = design peak hourly flow
Q Design Avg = design average flow
P = Population in thousands

C. Where the new collection system is to serve existing development, the likelihood of inflow and infiltration (I/I) contributions from existing service lines shall be evaluated.

2. Organic Waste Load. Organic waste load estimates shall be identified for all contributing parameters such as the design average five (5)-day Biochemical Oxygen Demand (BOD_5).

(C) Drinking Water Use Records. Facilities proposing drinking water usage as the basis for design average flow must provide at least one (1)-year of drinking water use records in the following form:

1. A minimum of twelve (12) continuous months of drinking water use records for facilities that discharge year-round; or

2. A minimum of continuous daily water use records during the entirety of an operating season for facilities having critical operational schedules (e.g., recreational areas, campuses, and industrial facilities).

(D) Re-Rating a Wastewater Treatment

Facility. A wastewater treatment facility owner must request department review and approval when proposing to re-rate an existing wastewater treatment facility's current design hydraulic capacity or organic waste loading. An engineering re-rating analysis must demonstrate the wastewater treatment facility can reliably operate at the proposed re-rated loading rate. The re-rating analysis shall include the following:

1. Hydraulic Capacity. Evaluate the annual average flow, the maximum monthly average flow, the maximum daily flow, and the ratio of the peak flow to annual average flow using the last five (5) years' wastewater treatment facility. Include all calculations and assumptions.

A. Calculate the design average flow using the wastewater treatment facility's average annual flow plus one (1) standard deviation for a wastewater treatment facility that will not be affected by future growth; or

B. Calculate the design average flow using the anticipated changes from the existing flow for a wastewater treatment facility that will be affected by future growth.

2. Organic Waste Load. Evaluate the design organic waste loading based on the average daily organic load.

A. Include the data from the analyses of at least three (3) twenty-four (24)-hour composite samples of the influent wastewater per week, taken during days with representative flow, for a period of at least three (3) months during both wet and dry weather conditions;

B. Include sample data of the following parameters unless monitoring of the parameter is not a requirement of the National Pollutant Discharge Elimination System (NPDES) permit: BOD_5, Total Suspended Solids (TSS), ammonia, total nitrogen, and total phosphorus;

C. Include the influence of hydraulic capacity evaluation from subparagraph (3)(D)1.A and B. of this rule; and

D. Evaluate the size of each unit process to determine if they are appropriately sized to provide adequate treatment based on the re-rated design organic waste load.

3. Existing unit processes. Evaluate each unit process for its design and peak capacity. Normally one (1) unit process will be most restrictive in terms of design capacity. Include solids processing, handling, and storage in this analysis.

4. Compliance. Evaluate the proposed change of the facility's ability to reliably and consistently comply with the NPDES permit effluent limitations and conditions.

5. Growth. Evaluate the system's anticipated rate of growth.

(4) Engineering Report. Engineering reports shall include the following:

(A) Cover Page. Include a statement identifying the owner and continuing authority (refer to 10 CSR 20-6.010(2)(A)), a contact person for each (including phone number and address), and engineer in accordance with section (2) of this rule;

(B) Problem Defined. Include a description of the existing system and an evaluation of the conditions and problems needing correction;

(C) Hydraulic Capacity and Organic Waste Load. Establish the anticipated design average and design peak flows and organic loads for the existing and ultimate conditions. Include the basis of the projection reflecting the existing or initial service area, and the anticipated future service area. More detail on flow and organic waste load information and data needed for new and existing collection systems are included in section (3) of this rule;

(D) Impact on Existing Wastewater Facilities. Evaluate the impact of the proposed project on downstream existing wastewater systems (including gravity sewers, alternative sewers, pumping stations, force mains, and treatment facilities);

(E) Project Description. Provide a written description of the project;

(F) Location Drawings. Provide drawings identifying the site of the project and anticipated location and alignment of proposed facilities;

(G) Engineering Criteria. Include design criteria for the proposed project;

(H) Site Information. Provide project site information, where applicable, including topography, soils, geologic conditions, depth to bedrock, groundwater level, distance to water supply structures, roads, residences, and other pertinent site information;

(I) Alternative Selection. Discuss the reasons for selection of the proposed alternative, including any pumping station sites, feasibility, and how the project fits into a long term plan; and

(J) For flood protection follow the provisions listed in 10 CSR 20-8.140(2)(B).

(5) Facility Plan. Facility plans shall include the following, in addition to the information in section (4) of this rule:

(A) Planning and Service Area. Include a description or drawings of the planning area, existing and potential future service areas, the site of the project, and anticipated location of the proposed facilities;

(B) Population Projection and Planning Period. Base the present and predicted population on a twenty (20)-year planning period. Consider phased construction of wastewater facilities in rapid growth areas. Design sewers and other facilities with a design life in excess of twenty (20) years for the extended period;

(C) Wastewater Treatment Facility Design Capacity. The wastewater treatment facility design capacity is the design average flow at the design average BOD_5. Establish the anticipated design average and design peak flows and waste loads for the existing period in accordance with section (3) of this rule. Include the basis of the projection of initial and future flows and waste loads;

(D) Initial Alternative Development. Discuss the process of selection of wastewater treatment alternatives for detailed evaluation. Include all wastewater management alternatives considered, including no action, and the basis for the engineering judgment for selection of the alternatives chosen for detailed evaluation;

(E) Detailed Alternative Evaluation. Include the following for the alternatives to be evaluated in detail:

1. Collection system revisions. Evaluate the proposed revisions to the existing collection system including adequacy of portions not being changed by the project;

2. Wet weather flows. Provide facilities to transport and treat wet weather flows in a manner that complies with federal, state, and local regulations;

3. Evaluate the no-discharge option and include it as an alternative in the facility plan. Also refer to 10 CSR 20-6.010(4)(A)5;

4. Evaluate the regionalization option and include it as an alternative in the facility plan;

5. Include the information outlined in 10 CSR 20-8.200(2) when the project includes wastewater irrigation or subsurface soil dispersal;

6. Site Evaluation. Consider the following criteria during site evaluation. Take appropriate measures to minimize adverse impacts when a site is critical with respect to the following items:

A. Consider compatibility of the treatment process with the present and planned future land use, including noise, potential odors, air quality, and anticipated solids processing and disposal techniques. Wastewater treatment facilities should be separate from habitation or any area likely to be built up within a reasonable future period and shall be separated in accordance with state and local requirements. Refer to 10 CSR 20-8.140(2)(C) for minimum separation distances;

B. Identify zoning and other land use restrictions;

C. Evaluate the accessibility and topography of the site;

D. Identify areas for future facility expansion;

E. For flood protection, follow the provisions listed in 10 CSR 20-8.140(2)(B);

F. Include geologic information, depth to bedrock, karst features, or other geologic considerations of significance to the project;

G. A request for a geohydrologic evaluation conducted by the department's Missouri Geological Survey is required in the following instances:

(I) All new wastewater treatment facilities to identify stream determinations (gaining or losing);

(II) All new outfalls or relocated outfalls;

(III) All new or major modifications to earthen basin structures. Earthen basin structures shall not be located in areas receiving a severe collapse potential rating. Earthen basin structures located in areas receiving a severe overall geologic limitation rating are reviewed on a case-by-case basis. Earthen basin structures located in areas receiving a moderate collapse potential rating with an appropriate engineering solution are reviewed on a case-by-case basis; and

(IV) All new features (e.g. wastewater irrigation sites, subsurface soil dispersal sites);

H. Protection of groundwater including public and private wells shall be provided. When the proposed wastewater facilities will be near a water source or other drinking water facility, as determined by the Missouri Geological Survey or by the department's Public Drinking Water Branch, include an evaluation addressing the allowable distance between these wastewater facilities and the water source. Refer to 10 CSR 20-8.140(2)(C);

I. Determine the soil type and suitability for construction and depth to normal and seasonal high groundwater;

J. Submit a soil morphology analysis conducted by a qualified soil scientist for all subsurface soil dispersal systems. Refer to section (7) of this rule;

K. Identify the location, depth, and discharge point of any field tile or curtain drain in the immediate area of the proposed site;

L. Include the present and known future effluent quality and monitoring requirements;

M. Provide a discussion of receiving waterbody access for the outfall line; and

N. Include a preliminary assessment of site availability;

7. Engineering criteria. Provide the engineering criteria and assumptions used in the design of the project. Provide the basis for unit operation and preliminary unit process sizing;

8. Location Drawings. Provide drawings identifying the site of the project and anticipated location and alignment of proposed facilities;

9. Flow diagram. Provide a preliminary flow diagram of treatment facility alternatives, including all recycle flows;

10. Removal efficiencies. Provide estimated loadings to and removal efficiencies through each unit operation in addition to total removal efficiency and effluent quality (both concentrations and mass);

11. Emergency operation. Provide a discussion of emergency operation measures as outlined in 10 CSR 20-8.140(7)(A);

12. New and innovative technology. See section (6) of this rule. Provide a contingency plan, in the event that such new technology fails to meet the expected performance;

13. Nutrient removal. Provide a discussion of nutrient removal capabilities, including the footprint available for expansion or treatment facility modifications necessary for nutrient removal for each alternative;

14. Solids. Include the solids handling and disposal alternatives considered and method selected consistant with the requirements of 10 CSR 20-8.170 and any conditions in the NPDES permit;

15. Treatment during construction. Develop a plan for the method and level of treatment (including solids processing, storage, and disposal) to be achieved during construction and include it in the facility plan. Refer to paragraph (9)(A)5. and subsection (10)(C) of this rule;

16. Cost estimates. Present cost estimates for capital construction cost, annual operation and maintenance cost (including basis), and a twenty (20)-year present worth cost for each alternative;

17. Environmental review. Include any additional environmental information meeting the criteria in 10 CSR 20-4.050, for projects receiving funding through the state grant and loan programs; and

18. Water quality reports. Submit all reviews, studies, or reports in accordance with 10 CSR 20-7, Water Quality; and

(F) Final Project Selection. Present the selected project from the alternatives considered under paragraph (5)(E) of this rule, including the financing considerations and recommendations for implementation of the plan. Provide a project implementation schedule identifying project milestones.

(6) New and Innovative Technology.

(A) Evaluation of Technology Performance. To determine if new technologies of wastewater treatment processes and equipment or applications have a reasonable and substantial chance of success, the facility plan prepared for department approval shall include the following:

1. Monitoring observations, including test results and engineering evaluations demonstrating the efficiency of processes or equipment;

2. Detailed description of the sampling protocol and test methods that are sufficiently sensitive analytical methods for detecting, identifying, and measuring the concentrations of pollutants;

3. Testing, including appropriately-composited samples, under various ranges of strength and flow rates (including diurnal variations) and waste temperatures over a sufficient length of time to demonstrate expected performance under the range of climatic and other conditions that may be encountered in the area of the proposed installations. A control group may be necessary to demonstrate effectiveness;

4. Description of manufacturer's warranty and performance warranty including all exclusions or limitations on the warranty, when available;

5. Complete design requirements, calculations, and all assumptions clearly documented and explained;

6. Documentation of how the new process or equipment functions;

7. A discussion of actual, full-scale operating experience or pilot test work. For full-scale operating experience, include the length of time that each installation has been in operation. For pilot test work, include a copy of the associated pilot test plan and final pilot test results report;

8. Discussion of known or anticipated start-up issues and operational issues that have occurred or may occur during the first year of operation;

9. A description of specific operator knowledge and skills needed to operate the proposed technology including an estimate of increased operator attention needed during start-up and the first year of operation; and

10. Other appropriate information.

(B) Pilot Test or Demonstration Plan. Proposals for pilot tests and demonstration projects shall include the following in addition to the facility plan information in section (5) of this rule:

1. Goals, objectives, and benefits with an explanation as to why a pilot study or demonstration project is necessary to obtain additional engineering data;

2. Literature identifying key design parameters and related experience;

3. A description of the proposal with schematic diagrams, pictures, drawings, or any other important information;

4. Complete design requirements, calculations, and all assumptions clearly documented and explained;

5. Identification of associated environmental impacts, both direct and indirect;

6. Detailed description of the sampling protocol and test methods that are sufficiently sensitive analytical methods for detecting, identifying, and measuring the concentrations of pollutants;

7. Complete schedule for testing and evaluation including start, completion, and submittal of the pilot test or demonstration results report; and

8. Other appropriate information.

(C) Evaluation of Collected Data. All raw testing data and the evaluation of the data and performance must be submitted for department review upon conclusion of the project demonstration. The evaluation shall identify and justify the removal of any excursions not representative of the new technology process or equipment from the data evaluation.

(7) Soils Report.

(A) Soils. Soil reports are required for all projects involving subsurface wastewater treatment and disposal. All soils investigations and resulting reports must be performed, signed, and dated by a qualified soil scientist as defined in section 701.040, RSMo. Soil observation pits (i.e., backhoe or hand dug) excavated to a depth to reveal the major soil horizons shall be utilized.

(B) Soils Report. The soils report resulting from the investigation shall include the following information:

1. A copy of each soil profile description;

2. A description of all drainage features, rock outcrops, erosion, and other natural features that may influence the soil treatment area;

3. An evaluation of any identified limiting conditions or geologic risk factors affecting the soil's ability to treat and disperse effluent, such as karst features, dense tills, clay pans, and fragipans;

4. Clear and legible scaled site plans, drawings, or maps identifying all applicable site features that could impact the soil treatment area(s). Previously prepared or otherwise available drawings or maps such as a survey prepared by a Missouri registered professional surveyor; an aerial photograph; a United States Geological Survey topographic map with the proposed soil treatment area clearly delineated; a United States Department of Agriculture Natural Resources Conservation Services county soil survey map with the proposed soil treatment area clearly delineated; or a digital orthophotograph prepared from a geographical information system may be used. The following shall be included on the drawings or maps:

A. The location of all soil observation pits with the extent of different soils clearly delineated;

B. Any existing or proposed dwellings and structures;

C. Any site disturbances such as excavated or fill areas, existing roadways, and other hardscapes and proposed hardscapes, or related site disturbances;

D. Location of all public and private wells, abandoned wells, or geothermal systems, and surface water features that could either influence or be impacted by the proposed soil treatment area. For minimum separation distances, follow the provisions listed in 10 CSR 20-8.140(2)(C);

E. North orientation arrow;

F. Identification of areas with conditions that would prohibit, limit, or adversely impact the siting of a soil treatment area including, but not limited to: sinkholes, wetland vegetation, bedrock outcrops, areas with a slope greater than fifteen percent (15%), and existing or abandoned field or drainage tiles;

G. Identification of known existing, proposed, and observed easements and right-of-ways; and

5. A discussion of the findings and conclusions must include the following:

A. Available area for the soil treatment area;

B. Depth to limiting layers (e.g., water table, fragipan, bedrock) and the source of this information;

C. Proposed application (loading) rates that take into consideration the drainage and permeability of the soils and the distance to the limiting layer.

D. The source of the application rates for each soil horizon within the specific soil description;

E. Frequency of flooding and ponding and the source of this information;

F. Relevant characteristics (e.g., bedrock outcrops, sinkholes or karst features) on the proposed site or in the surrounding area that may indicate vulnerability for surface water and groundwater contamination and the source of this information; and

G. Factors affecting the soils ability to treat and hydrologically control effluent and the source of this information.

(C) Imported Soils. When a facility is importing soils for the subsurface soil dispersal systems, the following shall be specified:

1. Physical characteristics that are uniform in texture, structure, and pore space;

2. Transportation methods that ensures uniformity and consistency of the physical characteristics as close as possible to the original state upon delivery;

3. A sandy to loamy material, with less than ten percent (10%) clay and less than fifteen percent (15%) organic debris present;

4. Methods for removal of the organic layer;

5. No compaction of imported soil;

6. Placement in small "lift" increments of four to six inches (4"–6") instead of one (1) thick layer; and

7. Native soil is to be used for the vertical separation for the subsurface soil dispersal systems with the fill for the cap being imported soils.

(8) Summary of Design. A summary of design shall accompany the plans and specifications and must include the following:

(A) Flow and waste projections including design and peak hydraulic and organic loadings for sewers, pump stations, and wastewater treatment facilities;

(B) Information to verify adequate downstream capacity of sewers, pump stations, and wastewater treatment and solids handling unit(s);

(C) Type and size of individual process units including the following: unit dimensions; rates and velocities; detention times; concentrations; recycle; chemical additive control; physical control, flexibility, and flow metering;

(D) Process diagrams, including flow diagrams with hydraulic capacity and organic waste load;

(E) Expected removal rates and concentrations of permitted effluent parameters in the discharge from the wastewater treatment facility, including a separate tabulation for each unit to handle solid and liquid fractions;

(F) Design calculations, tabulations, and assumptions clearly documented and explained from 10 CSR 20-8.120 through 10 CSR 20-8.210 used in the design of each unit process and the system(s) as a whole;

(G) The appropriate pump curve with the system curve superimposed, as applicable;

(H) Unusual specifications, construction materials, and construction methods; maps, photographs, diagrams; and other support data needed to describe the system;

(I) Architectural, structural, and mechanical component design calculations as specified in 10 CSR 20-8.120 through 10 CSR 20-8.210; and

(J) Anticipated effluent quality.

(9) Plans.

(A) General.

1. Plan components must include the following components on all plan sheets:

A. A suitable title block showing the name of the project, owner, and continuing authority (refer to 10 CSR 20-6.010(2) and 20 CSR 2030-2.050);

B. Scale ratios for mechanical drawings;

C. Bar scales for aerial maps;

D. A north arrow;

E. Datum used; and

F. Sheet numbers.

2. Plan format must include clear and legible plans drawn to a scale that allows necessary information to be seen plainly. Blueprints and hand-drafted plans are not acceptable.

3. Plan contents must include detailed plans consisting of the following:

A. Plan views, elevations, sections, and supplementary views, which together with the specifications and general layouts, provide the working information for the contract and construction of the facilities;

B. Dimensions and relative elevations of structures, the location and outline form of equipment, location and size of piping, water levels, and ground elevations;

C. All known existing structures and utilities, both above and below ground, that might interfere with the proposed construction or require isolation setback, particularly water mains and water supply structures (e.g., wells, clear wells, basins), gas mains, storm drains, and telephone, cable, and power conduits. Show the location of all existing and proposed water supply structures located within five hundred feet (500') of the proposed or existing wastewater treatment facility; and

D. Locations and logs of test borings, where applicable. Include test boring logs on the plans or in the specifications as an appendix.

4. Hydraulic profile for all wastewater treatment facilities must be included; and

5. Plan for operation during construction must specify the procedure for operation during construction that complies with the plan outlined in paragraph (5)(E)15. and subsection (10)(C) of this rule.

(B) Plans of Sewers.

1. General plans. These plans shall show the following:

A. Geographical features.

(I) Topography and elevations. Clearly show existing or proposed streets and all streams or water surfaces. Include contour lines at suitable intervals;

(II) Streams. Depict the direction of flow in all streams and high and low water elevations of all water surfaces;

(III) Boundaries. Depict the boundary lines of the continuing authority and the area to be sewered; and

B. Sewers. Show the location, size, and direction of flow of relevant existing and proposed sanitary and combined sewers draining to the treatment facility concerned.

2. Detail plans. Detail plans shall be submitted showing the following:

A. Profiles having a horizontal scale of not more than one hundred feet (100') to the inch and a vertical scale of not more than ten feet (10') to the inch;

B. Plan views drawn to a corresponding horizontal scale and shown on the same sheet;

C. Location of streets and sewers;

D. Line of ground surface; pipe size, material, and type; length between manholes; invert and surface elevation at each manhole; grade of sewer between each two (2) adjacent manholes; and any special construction features. Number all manholes on the plan and correspondingly number them on the profile;

E. Elevation and location of the basement floor on the profile of the sewer where there is any question of the sewer being sufficiently deep to serve any residence;

F. Locations of all special features, such as inverted siphons, concrete encasements, elevated sewers, etc.; and

G. Detail drawings to show the following:

(I) All stream crossings with elevations of the stream bed and ordinary high water mark, normal, and low water levels;

(II) Details of all special sewer joints and cross-sections; and

(III) Details of all sewer appurtenances such as manholes, inspection chambers, inverted siphons, regulators, tide gates, and elevated sewers.

(C) Plans of Wastewater Pumping Stations.

1. Location plans. These plans must show the following:

A. The location and extent of the tributary area;

B. Any continuing authority boundaries with the tributary area;

C. The location of the pumping station and force main; and

D. Pertinent elevations.

2. Detail plans. Detail plans shall show the following, where applicable:

A. Topography of the site;

B. Existing pumping station;

C. Proposed pumping station, including provisions for installation of future pumps;

D. Maximum elevation of wastewater in the collection system upon occasion of power failure;

E. Maximum hydraulic gradient in downstream gravity sewers when all installed pumps are in operation;

F. Test boring and groundwater elevations;

G. All pumping station appurtenances such as pumps, valves, level control switches, hatches, safety equipment, ventilation equipment, and hoisting equipment; and

H. Flood protection map. For flood protection, follow the provisions listed in 10 CSR 20-8.140(2)(B).

(D) Plans of Wastewater Treatment Facilities.

1. Location plans. Location plans shall include the following:

A. The wastewater treatment facility in relation to the remainder of the system; and

B. Sufficient topographic features to indicate its location with relation to streams and the point of discharge of treated effluent.

2. General layout. Layouts of the proposed wastewater treatment facility shall show—

A. Topography of the site;

B. Size and location of treatment facility structures;

C. Schematic flow diagram(s) showing the flow through various units and showing utility systems serving the facility processes;

D. Piping, including any arrangement for unit isolation (identify materials handled and direction of flow through pipes, including arrangements for independent operation);

E. Hydraulic profiles showing the flow of wastewater, supernatant liquor, recycle streams, and solids; and

F. Test borings and groundwater elevations.

3. Detail plans. Detail plans shall show the following, where applicable:

A. Location, dimensions, and elevations of all existing and proposed treatment facilities and solids handling facilities;

B. Elevations of high and low water level of the body of water to which the facility effluent is to be discharged;

C. Type, size, pertinent features, and operating capacity of all pumps, blowers, motors, and other mechanical devices;

D. Minimum, design average, and peak hourly hydraulic flow in hydraulic profile with wastewater, supernatant liquor, and solids flow through the treatment facility;

E. Existing and proposed solids storage volumes in plan and profile;

F. Adequate description of any features not otherwise covered by the specifications or facility plan; and

G. Flood protection map. For flood protection, follow the provisions listed in 10 CSR 20-8.140(2)(B).

(10) Specifications.

(A) Specifications shall accompany the plans. The initial page shall bear the owner and continuing authority name, and a contact person for each (including phone number and address).

(B) The technical specifications accompanying construction drawings shall include the following, but not be limited to all construction information not shown on the drawings which is necessary to inform the builder, in detail, of the design requirements for the quality of materials, workmanship, and fabrication of the project:

1. The type, size, strength, operating characteristics, and rating of equipment;

2. Allowable infiltration;

3. The complete requirements for all mechanical and electrical equipment (including machinery, valves, piping, and jointing of pipe);

4. Electrical apparatus, wiring, instrumentation, and meters;

5. Laboratory fixtures and equipment;

6. Operating tools;

7. Construction materials;

8. Special filter materials (such as stone, sand, gravel, or slag);

9. Miscellaneous appurtenances;

10. Chemicals when used;

11. Instructions for testing materials and equipment as necessary to meet design standards; and

12. Performance tests for the completed facilities and component units. It is suggested that these performance tests be conducted at design load conditions wherever practical.

(C) Operation During Construction. Specifications shall contain a program for keeping existing wastewater treatment facility units in operation during construction. Should it be necessary to take units out of operation, specifications shall include detailed construction requirements and schedules to maintain compliance with effluent limitations and the facility's NPDES permit. See paragraphs (5)(E)15. and (9)(A)5. of this rule.

(11) Revisions to Approved Plans or Specifications.

(A) General. Any revisions of approved plans or specifications affecting capacity, flow, system layout, operation of units, or point of discharge shall be approved by the department in writing, before such changes are made.

(B) Addendum. Addenda must conform to all requirements in this rule.

(C) Change Order. The owner, continuing authority, and contractor must sign and date change orders.

(D) As-Built Plans. As-built plans clearly showing the alterations must be submitted upon department request at the completion of the work.

AUTHORITY: section 644.026, RSMo 2016. Original rule filed Aug. 10, 1978, effective March 11, 1979. Amended: Filed Sept. 14, 2010, effective June 30, 2011. Amended: Filed June 15, 2018, effective Feb. 28, 2019.*

**Original authority: 644.026, RSMo 1972, amended 1973, 1987, 1993, 1995, 2000.*

10 CSR 20-8.120 Gravity Sewers

PURPOSE: This rule specifies the minimum standards for the design of gravity sewers that are part of wastewater collection and treatment systems. This rule is to be used with rules 10 CSR 20-8.110 through 10 CSR 20-8.210. It does not address all aspects of design, and the design engineer may refer to other appropriate reference materials so long as these minimum standards set forth in this rule are met.

PUBLISHER'S NOTE: The secretary of state has determined that the publication of the entire text of the material which is incorporated by reference as a portion of this rule would be unduly cumbersome or expensive. This material as incorporated by reference in this rule shall be maintained by the agency at its headquarters and shall be made available to the public for inspection and copying at no more than the actual cost of reproduction. This note applies only to the reference material. The entire text of the rule is printed here.

(1) Applicability. Wastewater systems that utilize gravity sewers 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. In the event of any conflict between the above criteria, the requirement in this rule shall prevail.

(A) This rule shall not apply to treatment units covered in 10 CSR 20-8.300.

(B) This rule shall not apply to treatment units covered in 10 CSR 20-8.500.

(2) Sanitary Sewers. Rain water from roofs, streets, and other areas and groundwater from foundation drains shall be excluded from all new sewers.

(3) Details of Design and Construction.

(A) Installation. 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.

1. Slope. All sewers shall be designed and constructed to give mean velocities, when flowing full, of not less than two feet (2') per second.

2. Depth. All sewers shall either be covered with at least thirty-six inches (36") of soil, or sufficiently insulated with other material to prevent freezing and to protect them from superimposed loads.

3. Buoyancy. Buoyancy of sewers shall be considered and flotation of the pipe shall be prevented with appropriate construction where high groundwater conditions are anticipated.

(B) Deflection test. No pipe shall exceed a deflection of five percent (5%) of the inside diameter.

(C) Joints and Infiltration.

1. Service connections. Service connections to the sewer main shall be watertight and cannot protrude into the sewer.

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.

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 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'). The exfiltration or infiltration test shall 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 shall hereby be incorporated by reference into this rule, as published by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959. This rule does not incorporate any subsequent amendments or additions.

B. Air test. The air test shall conform

to the test procedure described in 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. These standards shall hereby be incorporated by reference into this rule, as published by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959. This rule does not incorporate any subsequent amendments or additions.

(D) 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 shall hereby be incorporated by reference into 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.

(4) Manholes.

(A) Location. Manholes shall be installed—

1. At the end of each line;

2. At all changes in grade, size, or alignment;

3. At all sewer pipe intersections; and

4. At distances appropriate to allow for sufficient cleaning and maintenance of sewer lines.

(B) Drop Type.

1. A drop pipe shall be provided for a sewer entering a manhole at an elevation of twenty-four inches (24") or more above the manhole invert.

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

(C) Diameter. The minimum diameter of manholes shall be forty-two inches (42") on eight-inch (8") diameter gravity sewer lines and forty-eight inches (48") on all sewer lines larger than eight inches (8") in diameter. A minimum access diameter of twenty-two inches (22") (56 cm) shall be provided. Cleanouts shall be a minimum of eight inches (8") for pipes eight inches (8") in diameter or larger and equal to the diameter for pipes less than eight inches (8").

(D) Bench. No sewer, service connection, or drop manhole pipe shall discharge onto the surface of the bench.

(E) Watertightness. Manholes shall be watertight, constructed, and installed in accordance with the manufacturer's recommendations and procedures.

(F) Inspection and Testing.

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 shall hereby be incorporated by reference into this rule, as published by ASTM International, 100 Barr Harbor Drive, PO 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 shall hereby be incorporated by reference into this rule, as published by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959. This rule does not incorporate any subsequent amendments or additions.

(5) Protection of Water Supplies.

(A) Cross Connections. There shall be no physical connections between a public or private potable water supply system and a sewer or appurtenance that would permit the passage of any wastewater or polluted water into the potable supply.

(B) Relation to Water Works Structures. Sewers shall be laid at least fifty feet (50') in a horizontal direction from any existing or proposed public water supply well or other water supply sources or structures. Sewers must also comply with 10 CSR 23-3.010.

AUTHORITY: section 644.026, RSMo 2016. 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. Amended: Filed June 15, 2018, effective Feb. 28, 2019.*

**Original authority: 644.026, RSMo 1972, amended 1973, 1987, 1993, 1995.*

10 CSR 20-8.125 Alternative Sewer Systems

PURPOSE: This rule specifies the minimum standards for the design of alternative sewer systems that are part of wastewater collection and treatment systems. This rule is to be used with rules 10 CSR 20-8.110 through 10 CSR 20-8.210. It does not address all aspects of design, and the design engineer may refer to other appropriate reference materials so long as these minimum standards set forth in this rule are met.

(1) Applicability. Wastewater systems that utilize alternative sewer 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. In the event of any conflict between the above criteria, the requirement in this rule shall prevail.

(A) This rule shall not apply to treatment units covered in 10 CSR 20-8.300.

(B) This rule shall not apply to treatment units covered in 10 CSR 20-8.500.

(2) Approval of Sewers. For sewer approval, follow the provisions listed in 10 CSR 20-8.120(2).

(3) Supplement to the Engineering Report. Alternative sewer systems shall not to be used in lieu of conventional gravity sewers, but may be acceptable when it can be shown in the engineering report that it is not feasible to provide conventional gravity sewers. For more information, follow the provisions in 10 CSR 20-8.110(4).

(4) General.

(A) Continuing Authority. The continuing authority must be responsible for the operation and maintenance and modernization of an alternative sewer system collection system. See 10 CSR 20-6.010(2) for acceptable continuing authorities.

(B) Flooding. For flood protection, follow the provisions in 10 CSR 20-8.140(2)(B).

(C) Accessibility. For pumping station structure and septic tank accessibility, follow the provisions listed in 10 CSR 20-8.140(2)(D).

(D) Security. For fencing criteria, follow the provisions in 10 CSR 20-8.140(8)(A).

(E) Potable Water Sources. For the minimum separation distances from potable water sources, follow the provisions in 10 CSR 20-8.130(2)(D).

(F) Protection of Water Supplies. For the separation and crossings of water supplies, follow the provisions in 10 CSR 20-8.120(5).

(5) Pressure Sewers.

(A) Sewer Design.

1. Velocity. Design shall be based on the most probable number of pumping units expected to operate simultaneously or on some other acceptable method of computing the peak pumpage rate.

A. A cleansing velocity of at least two feet per second (2 ft/s), at least once and preferably several times per day, shall be achieved.

2. Minimum size. The minimum diameter sewer main pipe shall not be less than one and a half inches (1.5").

3. Installation. For sewer installation, follow the provisions in 10 CSR 20-8.120(3).

4. Hydrostatic pressure test. The applicant must comply with the manufacturer's recommended testing procedures.

5. Locator Wire. Locator wire must be utilized when sewer lines are installed within the public right-of-way in accordance with Section 319.033, RSMo.

(B) Sewer Appurtenances. Appurtenances shall be compatible with the piping system and full bore with smooth interior surfaces to eliminate obstruction and keep friction loss to a minimum.

1. Isolation valves shall be—

A. Comprised of resilient seated gate valve or ball valve with a position indicator;

B. Constructed from corrosion resistant materials; and

C. Enclosed in a watertight and lockable valve box.

2. Isolation valves shall be installed on—

A. The upstream side of major pipe intersections;

B. Both sides of stream, bridge, and railroad crossings, and unstable soil; and

C. The terminal end of the system to facilitate future extensions.

3. Proper support (e.g., crushed stone, concrete pads, or a well compacted trench bottom) shall be provided for valves so the weight of the valve is not carried by the pipe.

(C) Service Line Connection. The minimum diameter service line pipe shall be one and one quarter inches (1.25").

(D) Grinder Pump Stations.

1. Number of pumps.

A. Simplex grinder pump station shall—

(I) Not serve multiple equivalent dwelling units (EDU) if owned, operated, and maintained by individual homeowners; and

(II) Not serve commercial facilities.

B. Multiple unit grinder pump stations must be owned, operated, and maintained by an approved continuing authority. See subsection (4)(A) of this rule for more continuing authority information.

2. Grinder pump vaults shall be watertight.

3. Storage volume. A grinder pump vault shall have a storage volume of at least seventy (70) gallons.

4. Valves. The following valves must be provided in the grinder pump vaults:

A. A shutoff valve accessible from the ground surface;

B. A check valve to prevent backflow; and

C. An anti-siphon valve, where siphoning could occur.

5. Grinder pump construction. For design of pumps and motors, follow the provisions in 10 CSR 20-8.130(5).

6. Controls. For water level control design, follow the provisions in 10 CSR 20-8.130(3)(C).

7. Electrical equipment. For electrical equipment, follow the provisions in 10 CSR 20-8.130(3)(B)2.

8. Emergency operations. When the continuing authority operates and maintains the grinder pump stations, provisions must be made for periods of mechanical or power failure.

(6) Septic Tank Effluent Pumped (STEP) Sewers.

(A) Sewer Design. Follow the provisions in subsection (5)(A) of this rule.

(B) Sewer Appurtenances. Follow the provisions in subsection (5)(B) of this rule.

(C) Service Line Connection. Follow the provisions in subsection (5)(C) of this rule.

(D) Septic Tank Design. Follow the provisions in 10 CSR 20-8.180(2). Additionally, septic tank design shall:

1. Provide at least one (1) septic tank to serve each EDU;

2. Provide at least one thousand (1,000) gallons capacity; and

3. Provide twenty percent (20%) of the septic tank volume for freeboard and ventilation.

(E) Existing Septic Tanks. When existing on-site septic tanks are proposed for reuse in an alternative sewer system, they must be inspected and verified watertight prior to acceptance. Follow the provisions in subsection (6)(D) of this rule for the minimum design of acceptable existing septic tanks proposed for reuse.

(F) Pump Vault Design.

1. Number of pumps. Duplex pumps shall be provided where the design flow from the EDUs, or other, is one thousand five hundred (1,500) gallons per day or greater.

2. Pump removal. Follow the provisions in 10 CSR 20-8.130(5)(A).

3. Valves. Follow the provisions in paragraph (5)(D)4. of this rule.

4. Controls. For water level control design, follow the provisions in 10 CSR 20-8.130(3)(C).

5. Electrical equipment. Follow the provisions in 10 CSR 20-8.130(3)(B)2.

6. Emergency operations. Provisions must be made for periods of mechanical or power failure.

(7) Septic Tank Effluent Gravity (STEG) Sewers.

(A) Sewer Design.

1. Minimum size. The minimum diameter sewer main pipe shall not be less than four inches (4").

2. Installation. Follow the provisions in 10 CSR 20-8.120(3)(A).

3. Leakage tests. Follow the provisions in 10 CSR 20-8.120(3)(C)2.

(B) Sewer Appurtenances. Follow the provisions in subsection (5)(B) of this rule. When manholes are utilized at major junctions of sewer mains, follow the provisions in 10 CSR 20-8.120(4).

(C) Service Line Connection. Follow the provisions in subsection (5)(C) of this rule.

1. The diameter of service line pipe shall not be less than four inches (4").

(D) Septic Tank Design. Follow the provisions in subsections (6)(D) through (6)(E) of this rule.

(8) Combination of Sewers. A pressure sewer system discharging to a downstream STEP or STEG sewer system shall not be permitted, as effluent sewers are not designed to carry settleable solids and grease.

AUTHORITY: section 644.026, RSMo 2016. Original rule filed June 15, 2018, effective Feb. 28, 2019.*

**Original authority: 644.026, RSMo 1972, amended 1973, 1987, 1993, 1995, 2000.*

10 CSR 20-8.130 Pumping Stations

PURPOSE: This rule specifies the minimum standards for the design of pumping stations that are part of wastewater collection and treatment systems. This rule is to be used with rules 10 CSR 20-8.110 through 10 CSR 20-8.210. It does not address all aspects of design, and the design engineer may refer to other appropriate reference materials so long as these minimum standards set forth in this rule are met.

Editor's Note: The secretary of state has determined that the publication of this rule in its entirety would be unduly cumbersome or expensive. The entire text of the material referenced has been filed with the secretary of

state. This material may be found at the Office of the Secretary of State or at the headquarters of the agency and is available to any interested person at a cost established by state law.

(1) Applicability. Wastewater systems that utilize pumping stations 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. In the event of any conflict between the above criteria, the requirement in this rule shall prevail.

(A) This rule shall not apply to treatment units covered in 10 CSR 20-8.300.

(B) This rule shall not apply to treatment units covered in 10 CSR 20-8.500.

(2) General.

(A) Flood Protection. For flood protection follow the provisions in 10 CSR 20-8.140(2)(B).

(B) Access Road. For access roads to pump station sites follow the provisions in 10 CSR 20-8.140(2)(D).

(C) Safety. For safety follow the applicable portions of 10 CSR 20-8.140(8).

(D) Potable Water Sources. The distance between wastewater pumping stations and all potable water sources shall be at least fifty feet (50') in accordance with 10 CSR 23-3.010(1)(B).

(E) Housed Wet Wells. Housed wet well ventilation shall be in accordance with 10 CSR 20-8.140(8)(J).

(3) Design.

(A) Structures.

1. Separation. Dry wells, including their superstructure, shall be completely separated from the wet well with gas tight common walls.

2. Access. Suitable and safe means of access to dry wells and to wet wells shall be provided to persons wearing self-contained breathing apparatus.

(B) Pumps.

1. Multiple units. Multiple pumps shall be provided except for design average flows of less than fifteen hundred (1,500) gallons per day.

2. Electrical equipment. Electrical equipment shall be provided with the following requirements:

A. Electrical equipment must comply with 10 CSR 20-8.140(7)(B);

B. Utilize corrosive resistant equipment located in the wet well;

C. Provide a watertight seal and separate strain relief for all flexible cable;

D. Install a fused disconnect switch located above ground for the main power feed for all pumping stations.

E. When such equipment is exposed to weather, it shall comply with the requirements of weather proof equipment; enclosure NEMA 4; NEMA 4X, where necessary; and *NEMA Standard 250-2014*, published December 15, 2014. This standard shall hereby be incorporated by reference into this rule, as published by National Electrical Manufacturers Association, 1300 North 17th Street, Arlington, VA 22209. This rule does not incorporate any subsequent amendments or additions;

F. Install lightning and surge protection systems;

G. Install a one hundred ten volt (110 V) power receptacle inside the control panel located outdoors to facilitate maintenance; and

H. Provide Ground Fault Circuit Interruption (GFCI) protection for all outdoor receptacles.

(C) Controls. Water level controls must be accessible without entering the wet well.

(D) Valves. Valves shall not be located in the wet well unless integral to a pump or its housing.

(E) Wet Wells. Covered wet wells shall have provisions for air displacement to the atmosphere, such as an inverted and screened "j" tube or other means.

(F) Ventilation. Interconnection between the wet well and dry well ventilation systems is not acceptable. For ventilation follow the provisions in 10 CSR 20-8.140(8)(J).

(G) Water Supply. There shall be no physical connection between any potable water supply and a wastewater pumping station, which under any conditions, might cause contamination of the potable water supply. If a potable water supply is brought to the station, it shall comply with conditions stipulated under 10 CSR 20-8.140(7)(D).

(4) Suction Lift Pumps.

(A) Self-Priming Pumps. The combined total of dynamic suction lift at the "pump off" elevation and required net positive suction head at design operating conditions shall not exceed twenty-two feet (22').

(B) Vacuum Priming Pumps. Vacuum priming pump stations shall be equipped with dual vacuum pumps capable of automatically and completely removing air from the suction lift pump.

(C) Wet Well Access. Wet well access shall not be through the equipment compartment. Access shall be provided in accordance with paragraph (3)(A)2. of this rule.

(5) Submersible Pump Stations. Submersible pump stations shall meet the applicable requirements under section (3) of this rule, except as modified in this section.

(A) Pump Removal. Submersible pumps shall be readily removable and replaceable without personnel entering, dewatering, or disconnecting any piping in the wet well.

(B) Valve Chamber and Valves. Valves required under subsection (3)(D) of this rule shall be located in a separate valve chamber.

1. Access. A minimum access hatch dimensions of twenty-four inches by thirty-six inches (24" x 36") shall be provided. For access, follow the provisions in paragraph (3)(A)2. of this rule.

2. Portable pump connection. A portable pump connection on the discharge line with rapid connection capabilities shall be provided.

(6) Alarm Systems. Alarm systems with an uninterrupted power source shall be provided for pumping stations.

(7) Emergency Operation.

(A) In addition to the required emergency means of operation and a storage/detention basin or tank, the following minimum retention time shall be provided:

1. For facilities with a design average flow of one hundred thousand (100,000) gallons per day or greater, a storage capacity for two- (2-) hour retention of the peak hourly flow; or

2. For facilities with a design average flow of less than one hundred thousand (100,000) gallons per day, a storage capacity for four- (4-) hour retention of the peak hourly flow.

(B) Independent Utility Substations. Where independent substations are used for emergency power, each separate substation and its associated distribution lines shall be capable of starting and operating the pump station at its rated capacity.

(8) Force Mains.

(A) Design. Force main system shall be designed to withstand all pressures (including water hammer and associated cyclic reversal of stresses), and maintain a velocity of at least two feet (2') per second.

(B) Installation. For installation follow the provisions in 10 CSR 20-8.120(3)(A).

(C) Protection of Water Supplies. For separation between water mains and sanitary sewer force mains follow the provisions in 10 CSR 20-8.120(5).

(D) Locator wire. For locator wire follow the provisions in 10 CSR 20-8.125(5)(A)5.

AUTHORITY: section 644.026, RSMo 2016. Original rule filed Aug. 10, 1978, effective March 11, 1979. Amended: Filed June 15, 2018, effective Feb. 28, 2019.*

**Original authority: 644.026, RSMo 1972, amended 1973, 1987, 1993.*

10 CSR 20-8.140 Wastewater Treatment Facilities

PURPOSE: This rule contains the minimum standards for the design of systems that are part of wastewater collection and treatment systems. This rule is to be used with rules 10 CSR 20-8.110 through 10 CSR 20-8.210. It does not address all possible aspects of design, and the design engineer may refer to other appropriate reference materials so long as these minimum standards set forth in this rule are met.

PUBLISHER'S NOTE: The secretary of state has determined that the publication of the entire text of the material which is incorporated by reference as a portion of this rule would be unduly cumbersome or expensive. This material as incorporated by reference in this rule shall be maintained by the agency at its headquarters and shall be made available to the public for inspection and copying at no more than the actual cost of reproduction. This note applies only to the reference material. The entire text of the rule is printed here.

(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. In the event of any conflict between the above criteria, the requirement in this rule shall prevail.

(A) This rule shall not apply to treatment units covered in 10 CSR 20-8.300.

(B) This rule shall not apply to treatment units covered in 10 CSR 20-8.500.

(2) General.

(A) Location. Criteria to be considered when selecting a site are listed in 10 CSR 20-8.110(5)(E)6.

(B) Flood Protection. Flood protection shall apply to new construction and to existing facilities undergoing major modification. The wastewater facility structures, electrical equipment, and mechanical equipment shall be protected from physical damage by not less than the one hundred- (100-) year flood elevation.

(C) Minimum Separation Distances.

1. Potable water sources. Unless another distance is determined by the Missouri Geological Survey or by the department's Public Drinking Water Branch, the minimum distance between wastewater treatment facilities and all potable water sources shall be at least three hundred feet (300').

2. Residences. No treatment unit with a capacity of twenty-two thousand five hundred gallons per day (22,500 gpd) or less shall be located closer than the minimum distance provided in Table 140-1 below. See 10 CSR 20-2.010(68) for the definition of a residence.

Table 140-1. Minimum Separation Distance for 22,500 gal/d or less.

Type of Facility	Separation Distance
Lagoons	200' to a neighboring residence and 50' to property line
Open recirculating media filters following primary treatment	200' to a neighboring residence
All other discharging facilities	50' to a neighboring residence

3. Plant Location. The following items shall be considered when selecting a plant site: proximity to residential areas; direction of prevailing winds; accessibility by all-weather roads; area available for expansion; local zoning requirements; local soil characteristics, geology, hydrology and topography available to minimize pumping; access to receiving stream; downstream uses of the receiving stream and compatibility of the treatment process with the present and planned future land use, including noise, potential odors, air quality, and anticipated sludge processing and disposal techniques. Where a site must be used which is critical with respect to these items, appropriate measures shall be taken to minimize adverse impacts.

(D) Accessibility. Facilities shall be readily accessible by authorized personnel from a public right-of-way at all times.

(3) Quality of Effluent. The degree of wastewater treatment shall be based on 10 CSR 20-7.015, Effluent Regulations, 10 CSR 20-7.031, Water Quality Standards, and/or appropriate federal regulations including the provisions of the operating permit.

(4) Pump and Haul.

(A) General.

1. Accessibility. Conform to subsection (2)(D) of this rule.

2. Security. Follow the provisions in subsection (8)(A) of this rule for fencing.

3. Protection of water supplies. Separation and crossing of water supplies shall be in accordance with subsection (2)(C) of this rule and 10 CSR 20-8.120(5).

(B) Septic Tank Design. Conform to 10 CSR 20-8.180(2) for septic tank design.

(C) Earthen Basin Design. Follow the provisions in 10 CSR 20-8.200 for earthen basin design.

(D) Alarm system. The alarm shall be activated in cases of high water levels. Follow the provisions in subsection (7)(C) of this rule for alarm systems.

(5) Design.

(A) Type of Treatment. Items to be considered in selection of the appropriate type of treatment are presented in 10 CSR 20-8.110(5).

(B) New and Innovative Technology. Follow the provisions in 10 CSR 20-8.110(6).

(C) Design Period. Identify the design period in the facility plan per 10 CSR 20-8.110(5)(B).

(D) Design Loads.

1. Hydraulic design.

A. Identify flow conditions critical to the design of the wastewater treatment facility as described in 10 CSR 20-8.110(3).

B. The design peak hourly flows shall be used to evaluate the effect of hydraulic peaks on unit processes, pumping, piping, etc.

C. The design of treatment units that are not subject to peak hourly flow requirements shall be based on the design average flow.

2. Organic design. Base organic loadings for wastewater treatment facility design on the information given in 10 CSR 20-8.110(3). When septage is accepted at a wastewater treatment facility, the effects of septage flow shall be evaluated in the design.

(6) Outfalls.

(A) Protection and Maintenance. The outfall shall be so constructed and protected against the effects of flood water, ice, or other hazards as to reasonably ensure its structural stability and freedom from stoppage.

(B) Sampling Provisions. All sampling points shall be designed so that a representative and discrete twenty-four (24) hour automatic composite sample or grab sample of the effluent discharge can be obtained at a point after the final treatment process and before discharge to or mixing with the receiving waters.

(C) All outfalls shall be posted with a permanent sign indicating the outfall number (i.e., Outfall #001).

(7) Essential Facilities.

(A) Emergency Power Facilities.

1. General. All wastewater treatment facilities shall be provided with an alternate source of electric power or pumping capability

to allow continuity of operation during power failures.

2. Power for disinfection. Disinfection and dechlorination, when used, shall be provided during all power outages.

(B) Electrical Controls. Electrical systems and components in raw wastewater or in enclosed or partially enclosed spaces where hazardous concentrations of flammable gases or vapors that are normally present, shall comply with the NFPA 70 *National Electric Code (NEC)* (2017 Edition), as approved and published August 24, 2016, requirements for Class I, Division 1, Group D locations. This standard shall hereby be incorporated by reference in this rule, as published by National Fire Protection Association® (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471. This rule does not incorporate any subsequent amendments or additions.

(C) Alarm Systems. An audiovisual alarm or a more advanced alert system, with a self-contained power supply, capable of monitoring the condition of equipment whose failure could result in a violation of the operating permit, shall be provided for all wastewater treatment facilities.

(D) Water Supply.

1. General. No piping or other connections shall exist in any part of the wastewater treatment facility that might cause the contamination of a potable water supply.

2. Direct hot water connections. Hot water for any direct connections shall not be taken directly from a boiler used for supplying hot water to a digester heating unit or heat exchanger.

3. Indirect connections.

A. Where a potable water supply is to be used for any purpose in a wastewater treatment facility other than direct connections, a break tank, pressure pump, and pressure tank, or a reduced pressure backflow preventer consistent with the department's Public Drinking Water Branch shall be provided.

B. A sign shall be permanently posted at every hose bib, faucet, hydrant, or sill cock located on the water system beyond the break tank or backflow preventer to indicate that the water is not safe for drinking.

4. Separate non-potable water supply. Where a separate non-potable water supply is to be provided, a break tank will not be necessary, but all system outlets shall be posted with a permanent sign indicating the water is not safe for drinking.

(E) Flow Measurement. A means of flow measurement shall be provided at all wastewater treatment facilities.

(F) Sampling Equipment. Effluent twenty-four (24) hour composite automatic sampling equipment shall be provided at all mechanical wastewater treatment facilities and at other facilities where necessary under provisions of the operating permit. See 10 CSR 20-7.015.

(G) Housed Facilities. Where wastewater treatment units are in a housed facility, follow the provisions in subsection (8)(J) of this rule for ventilation.

(8) Safety. Adequate provisions shall be made to effectively protect facility personnel and visitors from hazards. The following shall be provided to fulfill the particular needs of each wastewater treatment facility:

(A) Fencing. Enclose the facility site with a fence designed to discourage the entrance of unauthorized persons and animals;

(B) Gratings over appropriate areas of treatment units where access for maintenance is necessary;

(C) First aid equipment;

(D) Posted "No Smoking" signs in hazardous areas;

(E) Appropriate personal protective equipment (PPE);

(F) Portable blower and hose sufficient to ventilate accessed confined spaces;

(G) Portable lighting equipment complying with NEC requirements. See subsection (7)(B) of this rule;

(H) Gas detectors listed and labeled for use in NEC Class I, Division 1, Group D locations. See subsection (7)(B) of this rule;

(I) Appropriately-placed warning signs for slippery areas, non-potable water fixtures (see subparagraph (7)(D)3.B. of this rule), low head clearance areas, open service manholes, hazardous chemical storage areas, flammable fuel storage areas, high noise areas, etc.;

(J) Ventilation. Ventilation shall include the following:

1. Isolate all pumping stations and wastewater treatment components installed in a building where other equipment or offices are located from the rest of the building by an air-tight partition, provide separate outside entrances, and provide separate and independent fresh air supply;

2. Force fresh air into enclosed screening device areas or open pits more than four feet (4') deep. Also see 10 CSR 20-8.130(3)(F);

3. Dampers. Dampers are not to be used on exhaust or fresh air ducts. Avoid the use of fine screens or other obstructions on exhaust or fresh air ducts to prevent clogging;

4. Continuous ventilation. Where continuous ventilation is needed (e.g., housed facilities), provide at least twelve (12) complete air changes per hour. Where continuous ventilation would cause excessive heat loss, provide intermittent ventilation of at least thirty (30) complete air changes per hour when facility personnel enter the area. Base air change demands on one hundred percent (100%) fresh air;

5. Electrical controls. Mark and conveniently locate switches for operation of ventilation equipment outside of the wet well or building. Interconnect all intermittently operated ventilation equipment with the respective wet well, dry well, or building lighting system. The manual lighting/ventilation switch is expected to override the automatic controls. For a two (2) speed ventilation system with automatic switch over where gas detection equipment is installed, increase the ventilation rate automatically in response to the detection of hazardous concentrations of gases or vapors; and

6. Fans, heating, and dehumidification. Fabricate the fan wheel from non-sparking material. Provide automatic heating and dehumidification equipment in all dry wells and buildings. Follow the provisions in subsection (7)(B) of this rule for electrical controls;

(K) Explosion-proof electrical equipment, non-sparking tools, gas detectors, and similar devices, in work areas where hazardous conditions may exist, such as digester vaults and other locations where potentially explosive atmospheres of flammable gas or vapor with air may accumulate. See subsection (7)(B) of this rule;

(L) Provisions for local lockout/tagout on stop motor controls and other devices;

(M) Provisions for an arc flash hazard analysis and determination of the flash protection boundary distance and type of PPE to reduce exposure to major electrical hazards in accordance with NFPA 70E *Standard for Electrical Safety in the Workplace* (2018 Edition), as approved and published August 21, 2017. This standard shall hereby be incorporated by reference in this rule, as published by National Fire Protection Association®, 1 Batterymarch Park, Quincy, MA 02169-7471. This rule does not incorporate any subsequent amendments or additions.

(9) Chemical Handling.

(A) General.

1. Containment materials. The materials utilized for storage, piping, valves, pumping, metering, and splash guards, etc., shall be specially selected considering the physical and chemical characteristics of each hazardous or corrosive chemical.

2. Secondary containment. Secondary containment storage areas contain the stored volume until it can be safely transferred to alternate storage or released to the wastewater treatment plant at controlled rates that will

not damage the facilities, inhibit the treatment processes, or contribute to stream pollution. Secondary containment shall be designed as follows:

A. A minimum volume of one hundred twenty-five percent (125%) of the volume of the largest storage container located within the containment area plus the space occupied by any other tanks located within the containment area when not protected from precipitation;

B. A minimum volume of one hundred ten percent (110%) of the volume of the largest storage container located within the containment area plus the space occupied by any other tanks located within the containment area when protected from precipitation; and

C. Walls and floors of the secondary containment structure constructed of suitable material that is compatible with the specifications of the product being stored.

3. Splash guards. All pumps or feeders for hazardous or corrosive chemicals shall have guards that will effectively prevent spray of chemicals into space occupied by facility personnel.

4. Piping, labeling, and coupling guard locations.

A. All piping containing or transporting corrosive or hazardous chemicals shall be identified with labels every ten feet (10') and with at least two (2) labels in each room, closet, or pipe chase.

B. All connections (flanged or other type), except those adjacent to storage or feeder areas, shall have guards that will direct any leakage away from space occupied by facility personnel.

5. Alarm system. Facilities shall be provided for automatic shutdown of pumps and sounding of alarms when failure occurs in a pressurized chemical discharge line.

6. Dust. Dust collection equipment shall be provided to protect facility personnel from dusts injurious to the lungs or skin and to prevent polymer dust from settling on walkways that become slick when wet.

(B) Chemical Housing. The following shall be provided to fulfill the particular needs of each chemical housing facility:

1. Provide storage for a minimum of thirty (30) days' supply, unless local suppliers and conditions indicate that such storage can be reduced without limiting the supply;

2. Construct the chemical storage room of fire and corrosion resistant material;

3. Equip doors with panic hardware. To prevent unauthorized access, doors lock but do not need a key to exit the locked room using the panic hardware;

4. Provide chemical storage areas with drains, sumps, finished water plumbing, and the hose bibs and hoses necessary to clean up spills and to wash equipment;

5. Construct chemical storage area floors and walls of material that is suitable to the chemicals being stored and that is capable of being cleaned;

6. Install floor surfaces to be smooth, chemical resistant, slip resistant, and well drained with three inches per ten feet (3"/10') minimum slope;

7. Provide adequate lighting;

8. Comply with the NEC recommendation for lighting and electrical equipment based on the chemicals stored. See subsection (7)(B) of this rule;

9. Store chemical containers in a cool, dry, and well-ventilated area;

10. Design vents from feeders, storage facilities, and equipment exhaust to discharge to the outside atmosphere above grade and remote from air intakes;

11. Locate storage area for chemical containers out of direct sunlight;

12. Maintain storage temperatures in accordance with relevant Material Safety Data Sheets (MSDS);

13. Control humidity as necessary when storing dry chemicals;

14. Design the storage area with designated areas for "full" and "empty" chemical containers;

15. Provide storage rooms housing flammable chemicals with an automatic sprinkler system designed for four tenths gallons per minute per square foot (0.4 gpm/ft^2) and a minimum duration of twenty (20) minutes;

16. Store incompatible chemicals separately to ensure the safety of facility personnel and the wastewater treatment system. Store any two (2) chemicals that can react to form a toxic gas in separate housing facilities;

17. Design and isolate areas intended for storage and handling of chlorine and sulfur dioxide and other hazardous gases. Follow the provisions in 10 CSR 20-8.190(3) and 10 CSR 20-8.190(4) for chlorine and dechlorination;

18. Design an isolated fireproof storage area and explosion proof electrical outlets, lights, and motors for all powdered activated carbon storage and handling areas in accordance with federal, state, and local requirements;

19. Vent acid storage tanks to the outside atmosphere, but not through vents in common with day tanks;

20. Keep concentrated acid solutions or dry powder in closed, acid-resistant shipping containers or storage units; and

21. Pump concentrated liquid acids in undiluted form from the original container to the point of treatment or to a covered storage tank. Do not handle in open vessels.

(C) Chemical Handling Design. The following shall be provided, where applicable, for the design of chemical handling:

1. Make provisions for measuring quantities of chemicals used for treatment or to prepare feed solutions over the range of design application rates;

2. Select storage tanks, piping, and equipment for liquid chemicals specific to the chemicals;

3. Install all liquid chemical mixing and feed installations on corrosion resistant pedestals;

4. Provide sufficient capacity of solution storage or day tanks feeding directly for twenty-four- (24-) hour operation at design average flow;

5. Provide a minimum of two (2) chemical feeders for continuous operability. Provide a standby unit or combination of units of sufficient capacity to replace the largest unit out-of-service;

6. Chemical feeders shall—

A. Be designed with chemical feed equipment to meet the maximum dosage requirements for the design average flow conditions;

B. Be able to supply, at all times, the necessary amounts of chemicals at an accurate rate throughout the range of feed;

C. Provide proportioning of chemical feed to the rate of flow where the flow rate is not constant;

D. Be designed to be readily accessible for servicing, repair, and observation;

E. Protect the entire feeder system against freezing;

F. Be located adjacent to points of application to minimize length of feed lines;

G. Provide for both automatic and manual operation for chemical feed control systems;

H. Utilize automatic chemical dose or residual analyzers, and where provided, include alarms for critical values and recording charts;

I. Provide screens and valves on the chemical feed pump suction lines; and

J. Provide an air break or anti-siphon device where the chemical solution enters the water stream;

7. Dry chemical feed system shall—

A. Be equipped with a dissolver capable of providing a minimum retention period of five (5) minutes at the maximum feed rate;

B. Be equipped with two (2) solution vessels and transfer piping for polyelectrolyte feed installations;

C. Have an eductor funnel or other

appropriate arrangement for wetting the polymer during the preparation of the stock feed solution on the makeup tanks;

D. Provide adequate mixing by means of a large diameter, low-speed mixer;

E. Make provisions to measure the dry chemical volumetrically or gravimetrically; and

F. Completely enclose chemicals and prevent emission of dust;

8. Provide for uniform strength of solution consistent with the nature of the chemical solution for solution tank dosing;

9. Use solution feed pumps to feed chemical slurries that are not diaphragm or piston type positive displacement types;

10. Provide continuous agitation to maintain slurries in suspension;

11. Provide a minimum of two (2) flocculation tanks or channels having a combined detention period of twenty to thirty (20 – 30) minutes. Provide independent controls for each tank or channel;

12. Insulate pipelines carrying soda ash at concentrations greater than twenty percent (20%) solution to prevent crystallization; and

13. Prohibit bagging soda ash in a damp or humid place.

(D) Chemical Safety. The following shall be provided in addition to the safety provisions in section (8) of this rule:

1. Appropriate personal protective equipment (PPE).

2. Eye wash fountains and safety showers. Eye wash fountains and safety showers utilizing potable water shall be provided in the laboratory and on each level or work location involving hazardous or corrosive chemical storage, mixing (or slaking), pumping, metering, or transportation unloading. The design of eye wash fountains and safety showers shall include the following:

A. Eye wash fountains with water of moderate temperature, fifty degrees to ninety degrees Fahrenheit (50°–90°F), suitable to provide fifteen to thirty (15–30) minutes of continuous irrigation of the eyes;

B. Emergency showers capable of discharging twenty gallons per minute (20 gpm) of water of moderate temperature, fifty degrees to ninety degrees Fahrenheit (50°–90°F), and at pressures of thirty to fifty pounds per square inch (30–50 psi);

C. Eye wash fountains and emergency showers located no more than twenty-five feet (25') from points of hazardous chemical exposure; and

D. Eye wash fountains and showers that are to be fully operable during all weather conditions; and

3. Warning signs. Warning signs requiring use of goggles shall be located near chemical stations, pumps, and other points of frequent hazard.

(E) Chemical Container Identification. The identification and hazard warning data included on shipping containers, when received, shall appear on all containers (regardless of size or type) used to store, carry, or use a hazardous substance.

AUTHORITY: section 644.026, RSMo 2016. Original rule filed Aug. 10, 1978, effective March 11, 1979. Amended: Filed June 15, 2018, effective Feb. 28, 2019.*

**Original authority: 644.026, RSMo 1972, amended 1973, 1987, 1993.*

10 CSR 20-8.150 Preliminary Treatment

PURPOSE: This rule specifies the minimum standards for the design of preliminary treatment units that are part of wastewater collection and treatment systems. This rule is to be used with rules 10 CSR 20-8.110 through 10 CSR 20-8.210. It does not address all aspects of design, and the design engineer may refer to other appropriate reference materials so long as these minimum standards set forth in this rule are met.

Editor's Note: The secretary of state has determined that the publication of this rule in its entirety would be unduly cumbersome or expensive. The entire text of the material referenced has been filed with the secretary of state. This material may be found at the Office of the Secretary of State or at the headquarters of the agency and is available to any interested person at a cost established by state law.

(1) Applicability. Wastewater systems that utilize preliminary treatment 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. In the event of any conflict between the above criteria, the requirement in this rule shall prevail.

(A) This rule shall not apply to treatment units covered in 10 CSR 20-8.300.

(B) This rule shall not apply to treatment units covered in 10 CSR 20-8.500.

(2) General. All wastewater treatment facilities must have a screening device, comminutor, or septic tank for the purpose of removing debris and nuisance materials from the influent wastewater.

(3) Grease Interceptors. Grease interceptors shall be provided on kitchen drain lines from institutions, hospitals, hotels, restaurants, schools, bars, cafeterias, clubs, and other establishments from which relatively large amounts of grease may be discharged to a wastewater treatment facility owned by the grease-producing entity. Grease interceptors are typically constructed from fiberglass reinforced polyester, high density polyethylene (HDPE), or concrete. For corrugated HDPE grease interceptors, follow *ASTM F2649 – 14 Standard Specification for Corrugated High Density Polyethylene (HDPE) Grease Interceptor Tanks*, as approved and published September 1, 2014. For precast concrete grease interceptor tanks, follow *ASTM C1613 – 17 Standard Specification for Precast Concrete Grease Interceptor Tanks*, as approved and published September 1, 2017. These standards shall hereby be incorporated by reference into this rule, as published by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959. This rule does not incorporate any subsequent amendments or additions.

(4) Screening Devices.

(A) General.

1. Freeze protection. All screening devices and screening storage areas shall be protected from freezing.

2. Provisions shall be made for isolating or removing screening devices from their location for servicing.

3. Safety.

A. Railings and gratings.

(I) Manually cleaned screen channels shall be protected by guard railings and deck gratings with adequate provisions for removal or opening to facilitate raking.

(II) Mechanically cleaned screen channels shall be protected by guard railings and deck gratings. Give consideration to temporary access arrangements to facilitate maintenance and repair.

B. Mechanical devices.

(I) Mechanical screening equipment shall have adequate removal enclosures to protect facility personnel against accidental contact with moving parts and to prevent dripping in multi-level installations.

(II) A positive means of locking out each mechanical device shall be provided.

(III) An emergency stop button with an automatic reverse function shall be located in close proximity to the mechanical device.

C. Electrical Equipment, Fixtures, and Controls. Electrical equipment, fixtures, and controls in screening area where hazardous gases may accumulate shall meet the requirements of the electrical code referenced in 10 CSR 20-8.140(7)(B).

(B) Screens. Where two (2) or more mechanically cleaned screens are used, the design shall provide for taking the largest unit out-of-service without sacrificing the capability to handle the average design flow. Where only one mechanically cleaned screen is used, it shall be sized to handle the design peak instantaneous flow.

(5) Comminutors. Provisions for location and safety shall be in accordance with screening devices, paragraph (4)(A)3. of this rule.

(6) Grit removal facilities are required for wastewater treatment facilities that—

(A) Utilize membrane bioreactors for secondary treatment;

(B) Utilize anaerobic digestion;

(C) Receive wastewater from combined sewers; or

(D) Receive wastewater from collection systems that receive substantial amounts of grit.

AUTHORITY: section 644.026, RSMo 2016. Original rule filed Aug. 10, 1978, effective March 11, 1979. Amended: Filed June 15, 2018, effective Feb. 28, 2019.*

**Original authority: 644.026, RSMo 1972, amended 1973, 1987, 1993.*

10 CSR 20-8.160 Settling

PURPOSE: This rule specifies the minimum standards for the design of settling operations that are part of wastewater collection and treatment systems. This rule is to be used with rules 10 CSR 20-8.110 through 10 CSR 20-8.210. It does not address all aspects of design, and the design engineer may refer to other appropriate reference materials so long as these minimum standards set forth in this rule are met.

Editor's Note: The secretary of state has determined that the publication of this rule in its entirety would be unduly cumbersome or expensive. The entire text of the material referenced has been filed with the secretary of state. This material may be found at the Office of the Secretary of State or at the headquarters of the agency and is available to any interested person at a cost established by state law.

(1) Applicability. Wastewater systems that utilize settling 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. In the event of any conflict between the above criteria, the requirement in this rule shall prevail.

(A) This rule shall not apply to treatment units covered in 10 CSR 20-8.300.

(B) This rule shall not apply to treatment units covered in 10 CSR 20-8.500.

(2) General Considerations.

(A) Number of Units. Multiple settling units capable of independent operation are desirable and shall be provided in all wastewater treatment facilities where design flows exceed one hundred thousand (100,000) gallons per day (gpd). Wastewater treatment facilities without multiple settling units shall be designed to include other provisions to assure continuity of treatment.

(B) Flow Distribution. Effective flow splitting devices and control appurtenances (e.g. gates and splitter boxes) shall be provided to permit proper proportioning of flow and solids loading to each settling unit, throughout the expected range of flows.

(3) Design.

(A) Side Water Depth. The minimum side water depth shall be as follows in Table 160-1 below:

Table 160-1. Minimum Side Water Depth.

Type of Settling Tank	Minimum Side Water Depth (ft)
Primary (>100,000 gpd)	10
Primary (<100,000 gpd)	7
Final following activated sludge process	12
Final following attached growth biological reactor (>100,000 gpd)	10

(B) Surface Overflow Rates.

1. Primary settling tanks. Calculate the surface overflow rates for both design average flow and design peak hourly flow from Table 160-2 below. The larger area shall determine the size of the settling tank.

Table 160-2. Maximum Primary Settling Tank Surface Overflow Rates.

Type of Primary Settling Tank	Surface Overflow Rates[1]: At Design Average Flow (gpd/ft^2)	At Design Peak Hourly Flow (gpd/ft^2)
Tanks not receiving waste activated sludge	1,000	3,000
Tanks receiving waste activated sludge	700	1,700
Chemically enhanced	1,400	1,500

[1] Calculate surface overflow rates with all flows received at the settling tanks.

2. Final settling tanks – attached growth biological reactors. Surface overflow rates for settling tanks following attached growth biological reactors shall not exceed one thousand two hundred gallons per day per square foot (1,200 gpd/ft^2) based on the design peak hourly flow.

3. Final settling tanks – activated sludge. The following design criteria in Table 160-3, included herein, shall not be exceeded:

Table 160-3. Maximum Activated Sludge Final Settling Tank Rates.

Treatment Process	Surface Overflow Rate at Design Peak Hourly Flow[1] (gpd/ft^2)	Peak Solids Loading Rate[2] (lb/day/ft^2)
With diurnal flow equalization[3]	1,000	35
Without diurnal flow equalization[3]	150 x Peaking Factor[4]	35
Conventional, Step Aeration, Complete Mix, Contact Stabilization, Carbonaceous Stage of Separate Stage Nitrification	1,200[5]	40
Extended Aeration Single-Stage Nitrification	1,000	35
Multi-Stage Nitrification	800	35
Activated Sludge with Chemical addition to Mixed Liquor for Phosphorus Removal	900	35

[1] Based on influent flow only.

[2] Calculate the peak solids loading rate based on the design maximum day flow rate plus the design maximum return sludge rate requirement and the design mixed liquor suspended solids under aeration.

[3] Applicable to wastewater treatment facilities with a design average flow of less than one hundred thousand gallons per day (100,000 gpd).

[4] To determine the peaking factor use 10 CSR 20-8.110(3) Equation 110-1.

[5] Wastewater treatment facilities needing to meet twenty milligrams per liter (20 mg/L) suspended solids or less should reduce the surface overflow rate to one thousand gallons per day per square foot (1,000 gpd/ft^2).

(C) Weirs.

1. General. Overflow weirs shall be readily adjustable over the life of the structure to correct for differential settlement of the tank.

2. Design rates. The following weir loadings in Table 160-4, below, shall not be exceeded:

Table 160-4. Maximum Weir Loading Rates.

Average Wastewater Treatment Facility Capacity (million gallons per day or MGD)	Loading Rate at Design Peak Hourly Flow (gpd/lf)
Less than 0.1	10,000
0.1 through 1.0	20,000
Greater than 1.0	30,000

(D) Submerged Surfaces. The underside and the tops of troughs, beams, and similar submerged construction elements shall have a minimum slope of one vertical to one horizontal (1:1) to prevent the accumulation of scum and solids.

(E) Freeboard. Walls of settling tanks shall extend at least six inches (6") above the surrounding ground surface and shall provide not less than twelve inches (12") of freeboard.

(4) Sludge Removal.

(A) Settling floor. The minimum slope of the settling floor shall be one vertical to

twelve horizontal (1:12) for conventional settling tanks and one vertical to one hundred ninety-two horizontal (1:192) for suction style settling tanks.

(B) Sludge hopper. The minimum slope of the sludge hopper side walls shall be one and seven tenths vertical to one horizontal (1.7:1) (i.e., sixty degrees (60°) above the horizontal).

(C) When used, dual sludge hoppers shall provide a minimum water depth of two feet (2') over the connecting wall that is between hoppers.

(5) Protective and Service Facilities.

(A) Operator Protection. Safety features shall appropriately include machinery covers, life lines, handrails on all stairways and walkways, and slip resistant surfaces. For additional safety follow the provisions listed in 10 CSR 20-8.140(8).

(B) Mechanical Maintenance Access. The design shall provide for convenient and safe access to routine maintenance items such as gear boxes, scum removal mechanism, baffles, weirs, inlet stilling baffle areas, and effluent channels.

(C) Electrical Equipment, Fixtures, and Controls. For electrical equipment, fixtures, and controls in enclosed settling basins and scum tanks, where hazardous concentrations of flammable gases or vapors may accumulate, follow the provisions in 10 CSR 20-8.140(6)(B). The fixtures and controls shall be conveniently located and safely accessible for operation and maintenance.

AUTHORITY: section 644.026, RSMo 2016. Original rule filed Aug. 10, 1978, effective March 11, 1979. Amended: Filed June 15, 2018, effective Feb. 28, 2019.*

**Original authority: 644.026, RSMo 1972, amended 1973, 1987, 1993.*

10 CSR 20-8.170 Solids Handling and Disposal

PURPOSE: This rule specifies the minimum standards for the design of solids handling and disposal operations that are part of wastewater collection and treatment systems. This rule is to be used with rules 10 CSR 20-8.110 through 10 CSR 20-8.210. It does not address all aspects of design, and the design engineer may refer to other appropriate reference materials so long as these minimum standards set forth in this rule are met.

Editor's Note: The secretary of state has determined that the publication of this rule in its entirety would be unduly cumbersome or expensive. The entire text of the material referenced has been filed with the secretary of state. This material may be found at the Office of the Secretary of State or at the headquarters of the agency and is available to any interested person at a cost established by state law.

(1) Applicability. Wastewater systems that utilize solids handling and disposal 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. In the event of any conflict between the above criteria, the requirement in this rule shall prevail.

(A) This rule shall not apply to treatment units covered in 10 CSR 20-8.300.

(B) This rule shall not apply to treatment units covered in 10 CSR 20-8.500.

(2) General Design Considerations. Systems to which this rule applies shall comply with 10 CSR 20-8.140(7) and (8).

(3) Gravity Sludge Thickeners. For the minimum side water depth, follow the provisions listed in Table 160-1 in 10 CSR 20-8.160(3)(A).

(4) Anaerobic Solids Digestion.

(A) General.

1. Safety. Gas detectors shall be provided for emergency use.

2. Alarm systems shall be provided in accordance with 10 CSR 20-8.140(7)(C) to warn of:

A. Any drop of the liquid level below minimum operating elevation; and

B. Low pressure in the space above the liquid level.

(B) High Level Emergency Overflow. An unvalved vented overflow shall be provided to prevent damage to the digestion tank and cover in case of accidental overfilling. Pipe this emergency overflow back to the treatment process or side stream treatment facility.

(C) Gas Collection, Piping, and Appurtenances.

1. Safety equipment. Where gas is produced, all necessary safety facilities shall:

A. Provide pressure and vacuum relief valves and flame traps, together with automatic safety shutoff valves and protect from freezing;

B. Not install water seal equipment; and

C. House gas safety equipment and gas compressors in a separate room with an exterior entrance.

2. Piping galleries shall be ventilated in accordance with paragraph (4)(C)4. of this rule.

3. Electrical fixtures, equipment, and controls. Electrical fixtures, equipment, and controls shall comply with the National Electrical Manufacturers Association (NEMA) 4X enclosure rating where necessary; NEMA Standard 250-2014, published December 15, 2014. This standard shall be incorporated by reference into this rule, as published by National Electrical Manufacturers Association, 1300 North 17th Street, Arlington, VA 22209. This rule does not incorporate any subsequent amendments or additions. Electrical equipment, fixtures, and controls, in places enclosing and adjacent to anaerobic digestive appurtenances where hazardous gases are included.

4. Ventilation. Any underground enclosures connecting with digestion tanks or containing solids or gas piping or equipment shall be provided with forced ventilation in accordance with 10 CSR 20-8.140(8)(J).

(D) Water Supply. Water supplies using indirect connections shall comply with 10 CSR 20-8.140(7)(D).

(5) Aerobic Solids Digestion High Level Emergency Overflow. An unvalved emergency overflow shall be provided that will convey digester overflow to the treatment plant headworks, the aeration process, or to another liquid sludge storage facility and that has an alarm for high level conditions.

(6) For solids pumping systems, audio-visual alarms shall be provided in accordance with 10 CSR 20-8.140(7)(C) for:

(A) Pump failure;

(B) Pressure loss; and

(C) High pressure.

(7) Solids Dewatering.

(A) Belt presses and conveyors shall be provided with emergency shutoff controls along the entire length of the belt presses and conveyors that will—

1. Stop the press in an emergency; and

2. Trigger an audible alarm.

(B) Alarm systems shall be provided to notify the operator(s) of conditions that could result in process equipment failure or damage, threaten operator safety, or a solids spill or overflow condition.

(8) Sludge and Biosolids Storage Lagoons. The sludge lagoon bottoms and embankments shall be sealed in accordance with 10 CSR 20-8.200(4)(C) to prevent leaching into adjacent soils or groundwater.

*AUTHORITY: section 644.026, RSMo 2016.**

Original rule filed Aug. 10, 1978, effective March 11, 1979. Amended: Filed June 15, 2018, effective Feb. 28, 2019.

**Original authority: 644.026, RSMo 1972, amended 1973, 1987, 1993.*

10 CSR 20-8.180 Biological Treatment

PURPOSE: This rule specifies the minimum standards for the design of biological treatment that is part of wastewater collection and treatment systems. This rule is to be used with rules 10 CSR 20-8.110 through 10 CSR 20-8.210. It does not address all aspects of design, and the design engineer may refer to other appropriate reference materials so long as these minimum standards set forth in this rule are met.

Editor's Note: The secretary of state has determined that the publication of this rule in its entirety would be unduly cumbersome or expensive. The entire text of the material referenced has been filed with the secretary of state. This material may be found at the Office of the Secretary of State or at the headquarters of the agency and is available to any interested person at a cost established by state law.

(1) Applicability. Wastewater systems that utilize biological treatment 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. In the event of any conflict between the above criteria, the requirement in this rule shall prevail.

(A) This rule shall not apply to treatment units covered in 10 CSR 20-8.300.

(B) This rule shall not apply to treatment units covered in 10 CSR 20-8.500.

(2) Septic Tanks.

(A) A septic tank must have a minimum capacity of at least one thousand (1,000) gallons.

(B) The septic tank shall be baffled.

(3) Recirculating Media Filters.

(A) Location. Recirculating media filters shall be located in accordance with the minimum separation distances at 10 CSR 20-8.140(2)(C)(2).

(B) Filter Bed. A minimum of two (2) filter beds and a diversion box are required for all design flows.

(C) Dosing. Both timer and float switch controls are required; timers are the primary method of operation and the float switch control is a back-up.

(D) Loading. Hydraulic loading rate shall—

1. Follow the manufacturer's recommendation for synthetic media filters; and

2. Not exceed three and one-half gallons per day per square foot (3.5 gpd/sqft) for sand or rock filters.

(E) Media Characteristics. The media is any of a number of physical structures whose sole purpose is to provide a surface to support biological growth. Commonly used media includes rock, gravel, and sand of various sizes, textile media, and peat. Finely crushed limestone, dolomite, slag, any clay, limestone, or appreciable amounts of organic material is not acceptable.

1. Rock, sand, and gravel media, when used shall–

A. Be a total of at least thirty-three inches (33") deep; and

B. Have at least twenty-four inches (24") of fine filtering media.

(4) Trickling Filters.

(A) General. Trickling filters may be used for treatment of wastewater amenable to treatment by aerobic biologic processes.

(B) Media.

1. Media depth shall—

A. Be a minimum depth of five feet (5') above the underdrains for rock filter media;

B. Be a minimum depth of ten feet (10') for manufactured filter media to provide adequate contact time with the wastewater; and

C. Be no more than ten feet (10') for rock filter media.

2. Size and grading of rock and similar media shall—

A. Contain no more than five percent (5%) by weight of pieces whose longest dimension is three (3) times the least dimension;

B. Be free from thin elongated and flat pieces, dust, clay, sand, or fine material; and

C. Conform to the following size and grading as shown in Table 180-1, included herein, when mechanically graded over vibrating screen with square openings.

Table 180-1 Particle Size Distribution:

Screen Size	Percent Passing by Weight
4.5 inches	100%
3 inches	0-95%
2 inches	0-0.2%
1 inch	0 to 0.1%

3. Manufactured and synthetic media material shall—

A. Be used in accordance with all manufacturer's recommendations;

B. Be insoluble in wastewater and resistant to flaking, spalling, ultraviolet degradation, disintegration, erosion, aging, common acids and alkalis, organic compounds, and biological attack;

C. Be evaluated to determine the suitability based on experience with an installation treating wastewater under similar hydraulic and organic loading conditions (include a relevant case history involving the use of the synthetic media);

D. Have a structure able to support the synthetic media, water flowing through or trapped in voids, and the maximum anticipated thickness of the wetted biofilm;

E. Support the maintenance activities, unless a separate provision is made for maintenance access to the entire top of the trickling filter media and to the distributor; and

F. Be placed with the edges matched as nearly as possible to provide consistent hydraulic conditions within the trickling filter.

(C) Underdrainage System.

1. Hydraulic capacity. The underdrains shall be designed with—

A. Slopes of at least one percent (1%);

B. Effluent channels that produce a minimum velocity of two feet per second (2 fps) at average daily rate of application to the filter;

C. Underdrainage system, effluent channels, and effluent pipe that permit free passage of air;

D. Drains, channels, and pipe so that not more than fifty percent (50%) of their cross section area will be submerged under the design peak hydraulic loading, including proposed or possible future or recirculated flows.

(D) Forced Ventilation.

1. Forced ventilation for a trickling filter is required when—

A. Designed for nitrification;

B. Designed with a media depth in excess of six feet (6'); or

C. Designed where seasonal or diurnal temperatures do not provide sufficient difference between the ambient air and wastewater temperatures to sustain passive ventilation.

2. Minimum design airflow rate to nitrify using a trickling filter shall be the greater of—

A. Fifty pounds (50 lbs) of oxygen provided per pound of oxygen demand at average organic loading, based on stoichiometry; or

B. Thirty pounds (30 lbs) of oxygen

provided per pound of oxygen demand at peak organic loading, based on stoichiometry.

(5) Activated Sludge.

(A) Basin lining. If using a synthetic liner, it shall be a minimum of thirty millimeters (30 mm) thick.

(B) Tank dimensions. Horizontally mixed aeration tanks shall have a depth of not less than five and a half feet (5.5').

(C) High purity oxygen, when used and enclosed. An enclosed high purity oxygen exhaust system shall be provided to collect and vent the reactor off-gases.

(6) Sequencing Batch Reactor (SBR).

(A) General. The minimum total basin volume shall be equal to the design daily influent flow volume and either upstream in-line or off-line storage is necessary to minimize influent flow during settling and decanting.

(B) Design. A minimum of two (2) reactor basins shall be installed.

(7) Membrane Bioreactor (MBR).

(A) General.

1. For wastewater treatment plants with a flow equal to or greater than one hundred thousand gallons per day (100,000 gpd), the MBR process must be designed with a minimum of two (2) membrane trains capable of treating the daily average flow with one (1) membrane cassette out of service.

2. Design flux criteria must be satisfied with one (1) membrane module out-of-service (e.g., for external clean in place, recovery cleaning, repair). For purposes of these criteria, a membrane module is the smallest membrane unit capable of separate removal from the tank while maintaining operation of other membrane units in the same tank.

3. Membranes placed in the aeration basin(s) rather than a separate membrane tank shall have—

A. Individual modules and individual diffusers that can be removed separately for maintenance and repair; and

B. Aeration basin(s) volume sized for complete nitrification.

(B) Preliminary Treatment. Each system shall—

1. Be consistent with the membrane manufacturer recommendations;

2. Comply with 10 CSR 20-8.150(6) for grit removal;

3. Provide oil and grease removal when the levels in the influent may cause damage to the membranes;

4. Provide a fine screen and high water alarm, designed to treat peak hourly flow. Coarse screens followed by fine screens may be used in larger facilities to minimize the complications of fine screening; and

5. Comply with 10 CSR 20-8.150(4)(B) for reliability.

(C) Aeration. The aeration blowers must provide adequate air for membrane scour and process demands.

(D) Redundancy. The facility shall have at least one (1) of the following:

1. The ability to run in full programmable logic control (PLC) or standby power mode in case of an automatic control failure;

2. An operational battery backup PLC if manual control is not possible; or

3. Sufficient standby power generating capabilities to provide continuous flow through the membranes during a power outage (e.g., preliminary screening, process aeration, recycle/RAS/permeate pumps, air scour, vacuum pumps) or an adequate method to handle flow for an indefinite period (e.g., private control of influent combined with contingency methods).

(E) Operations and Maintenance. The MBR design shall—

1. Include provisions to monitor membrane integrity;

2. Provide on-line continuous turbidity monitoring of filtrate or an equivalent for operational control and indirect membrane integrity monitoring for a treatment plant with design average flow greater than or equal to one hundred thousand gallons per day (100,000 gpd); and

3. Include provisions to remove membrane cassette for cleaning considering the membrane cassette wet weight plus additional weight of the solids accumulated on the membranes.

(8) Moving Bed Bioreactor (MBBR). A MBBR secondary treatment system shall provide upstream preliminary treatment units capable of—

(A) Screening to reduce pass-through and suspended solids;

(B) Grit removal; and

(C) Oil and grease removal.

AUTHORITY: section 644.026, RSMo 2016. Original rule filed Aug. 10, 1978, effective March 11, 1979. Amended: Filed June 15, 2018, effective Feb. 28, 2019.*

**Original authority: 644.026, RSMo 1972, amended 1973, 1987, 1993.*

10 CSR 20-8.190 Disinfection

PURPOSE: This rule specifies the minimum standards for the design of disinfection processes that are part of wastewater collection and treatment systems. This rule is to be used with rules 10 CSR 20-8.110 through 10 CSR 20-8.210. It does not address all aspects of design, and the design engineer may refer to other appropriate reference materials so long as these minimum standards set forth in this rule are met.

(1) Applicability. Wastewater systems that utilize disinfection 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. In the event of any conflict between the above criteria, the requirement in this rule shall prevail.

(A) This rule shall not apply to treatment units covered in 10 CSR 20-8.300.

(B) This rule shall not apply to treatment units covered in 10 CSR 20-8.500.

(2) General.

(A) Emergency Power. Disinfection and dechlorination processes, when used, shall be provided during all power outages. For additional emergency power requirements, refer to the provisions listed in 10 CSR 20-8.140(7).

(B) Secondary containment. Secondary containment shall comply with the provisions listed in 10 CSR 20-8.140(9)(A)2.

(3) Chlorine Disinfection.

(A) Contact period. A minimum contact period of fifteen (15) minutes at design peak hourly flow or maximum rate of pumpage shall be provided after thorough mixing.

(B) Gaseous Chlorine Housing.

1. Feed and storage rooms shall—

A. Have chlorine gas feed and storage rooms constructed of fire and corrosion resistant material;

B. Provide a gas-tight room to separate equipment from any other portion of the building if gas chlorination equipment or chlorine cylinders are to be in a building used for other purposes;

C. Have smooth floor surfaces that are chemical resistant, impervious, and slip resistant. Floor drains are discouraged. Design floor drains, where provided, with the ability to be plugged and sealed;

D. Have doors to this room that only open to the outside of the building, and are equipped with panic hardware. Provide door locks to prevent unauthorized access, but do

not need a key to exit the locked room using the panic hardware;

E. Be well-lit with lights that are sealed so that they will continue working during a chlorine leak. Comply with 10 CSR 20-8.140(7)(B), requirements for Class I, Division 2, Group D locations when selecting lighting and electrical equipment;

F. Be at ground level and permit easy access to all equipment;

G. Separate storage areas for one- (1-) ton cylinders from the feed area; and

H. Have designated areas for "full" and "empty" cylinder storage.

2. Heating and cooling.

A. Rooms containing disinfection equipment shall be provided with a means of heating and cooling so that a temperature of at least sixty degrees Fahrenheit (60° F) and no more than eighty-six degrees Fahrenheit (86°F) can be maintained.

B. Heating or air conditioning equipment provided for the chlorinator room shall be separate from central heating and air conditioning systems to prevent chlorine gas from entering the central system and central heating or cooling ducts are not allowed to terminate or pass through a chlorinator room.

3. Ventilation shall conform to the following:

A. Install forced mechanical ventilation to provide one (1) complete fresh air change per minute when the chlorinator room is occupied. Construct fans of chemical resistant materials and have chemical proof motors. Squirrel cage type fans located outside the chlorinator room may be approved if the fan housings and ducting are airtight and made of chlorine and corrosion resistant material;

B. Locate the entrance to the air exhaust duct from the room no more than twelve inches (12") off the floor. Locate the point of discharge as not to contaminate the air inlet to any buildings or present a hazard at the access to the chlorinator room or other inhabited areas. Utilize louvers for air exhaust to facilitate airtight closure;

C. Locate air inlets as to provide cross ventilation. Place the outside air inlet at least three feet (3') above grade. Utilize louvers for air inlets to facilitate airtight closure; and

D. Position the vent hose from the chlorinator to the outside atmosphere above grade. Provide passive vent screens.

4. Electrical controls. Switches for fans and lights shall be outside of the chlorinator room at the entrance.

5. Protective and respiratory gear. Where chlorine gas is present the applicant shall comply with 10 CSR 20-8.140(9)(D)1.

(C) Alarm System. The applicant shall conform to 10 CSR 20-8.140(7)(C) and be responsible for specifying what the alarm requirements are necessary to assure consistent disinfection in compliance with the applicable bacteria limits and the disinfection residual limit in the effluent.

(D) Sampling Equipment. Sampling equipment shall be consistent with the requirements in 10 CSR 20-8.140(7)(F).

(4) Dechlorination.

(A) Containers. Dilution tanks and mixing tanks are required when using dry compounds and may be necessary when using liquid compounds to deliver the proper dosage.

(B) Mixing and Contact Requirements.

1. Mixing requirements. Solid dechlorination systems shall not be located in the chlorine contact tank.

2. Contact time. A minimum of thirty (30) seconds for mixing and contact time shall be provided at the design peak hourly flow or maximum rate of pumpage.

(C) Housing Requirements.

1. Feed and storage rooms. The requirements for housing sulfite gas equipment shall follow the same guidelines as for chlorine gas. For specific details follow the provisions listed in subsection (3)(B).

2. Protective and respiratory gear. See paragraph (3)(B)5. of this rule.

(D) Alarm System. See subsection (3)(C) of this rule.

(E) Sampling Equipment. Sampling equipment shall be consistent with the requirements in 10 CSR 20-8.140(7)(F).

(5) Ultraviolet Disinfection.

(A) Dosage and System Sizing.

1. General. The UV dosage shall be based on the design peak hourly flow, maximum rate of pumpage, or peak batch flow.

2. Batch discharges. If no flow equalization is provided for a batch discharger, the dosage shall be based on the peak batch flow.

3. Bioassay. The UV system shall deliver the target dosage based on equipment derating factors and, if needed, have the UV equipment manufacturer verify that the scale up or scale down factor utilized in the design is appropriate for the specific application under consideration.

4. The design delivered UV dosage for a wastewater treatment facility shall be a minimum of thirty thousand microwatt seconds per centimeters squared (30,000 $\mu W \bullet s/cm^2$) based on MS-2 phage inactivation.

(B) Design.

1. Open channel systems. The combination of the total number of banks shall be capable of treating the design peak hourly flow, maximum rate of pumpage, or peak batch flow.

2. Closed vessel systems. The combination of the total number of closed vessels shall be capable of treating the design peak hourly flow, maximum rate of pumpage, or peak batch flow.

3. Cleaning. Closed vessel systems utilizing medium-pressure lamps shall be provided with an automatic cleaning system in order to prevent algae growth.

(C) Monitoring and Alarms.

1. The UV system must continuously monitor and display at the UV system control panel the following minimum conditions:

A. The relative intensity of each bank or closed vessel system;

B. The operational status and condition of each bank or closed vessel system;

C. The ON/OFF status of each lamp in the system; and

D. The total number of operating hours of each bank or each closed vessel system.

2. The UV system shall include an alarm system. Alarm systems shall comply with 10 CSR 20-8.140(7)(C).

(D) Electrical Controls. For electrical controls, follow the provisions listed in 10 CSR 20-8.140(7)(B) for electrical controls requirements.

(E) Sampling Equipment. Sampling equipment shall be consistent with the requirements in 10 CSR 20-8.140(7)(F).

AUTHORITY: section 644.026, RSMo 2016. Original rule filed Aug. 10, 1978, effective March 11, 1979. Amended: Filed June 15, 2018, effective Feb. 28, 2019.*

**Original authority: 644.026, RSMo 1972, amended 1973, 1987, 1993.*

10 CSR 20-8.200 Wastewater Treatment Lagoons and Wastewater Irrigation Alternatives

PURPOSE: This rule specifies the minimum standards for the design of lagoons and wastewater irrigation alternatives that are part of wastewater collection and treatment systems. This rule is to be used with rules 10 CSR 20-8.110 through 10 CSR 20-8.210. It does not address all aspects of design, and the design engineer may refer to other appropriate reference materials so long as these minimum standards set forth in this rule are met.

PUBLISHER'S NOTE: The secretary of state has determined that the publication of the entire text of the material which is incorporated by reference as a portion of this rule

would be unduly cumbersome or expensive. This material as incorporated by reference in this rule shall be maintained by the agency at its headquarters and shall be made available to the public for inspection and copying at no more than the actual cost of reproduction. This note applies only to the reference material. The entire text of the rule is printed here.

(1) Applicability. Wastewater systems that utilize lagoons and wastewater irrigation alternatives 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. In the event of any conflict between the above criteria, the requirement in this rule shall prevail.

(A) This rule shall not apply to treatment units covered in 10 CSR 20-8.300.

(B) This rule shall not apply to treatment units covered in 10 CSR 20-8.500.

(2) Supplementary Field Data for the Facility Plan. The facility plan shall contain pertinent information on location, geology, soil conditions, area for expansion, and any other factors that will affect the feasibility and acceptability of the proposed project, including the information required per 10 CSR 20-8.110. The following information must be submitted:

(A) Lagoons and spray irrigation fields shall be located where stormwater runoff from the watershed is minimized.

(B) Geohydrological Evaluation. A geohydrological evaluation shall be requested on all new earthen basins, earthen basin major modifications, new wastewater irrigation sites, and subsurface absorption fields.

1. Severe Collapse Potential. Earthen basins shall not be located in areas with a severe collapse potential rating.

(C) Soils investigation. Detailed soils investigations and reports shall be submitted for facilities surface irrigating more than twenty-four inches per year (24"/ yr) and for all subsurface absorption fields. Soils reports shall comply with 10 CSR 20-8.110(7).

(D) Where geosynthetic liners are used in storage or treatment basins for wastewaters of an industrial nature, the application shall:

1. Document that the liner or storage structure material is capable of containing the wastewater for at least twenty (20) years;

2. Specify repair or replacement procedures in the event of leakage or damage to the seal; and

3. Include an evaluation of secondary containment or leakage detection and collection devices for corrosive or reactive wastewaters and for toxic materials.

(3) Basis of Design.

(A) Area and Loadings for Discharging Lagoons.

1. Lagoon design for BOD_5 loadings shall not exceed thirty-four pounds per day per acre (34 lbs/day/acre) at the three-foot (3') operating depth in the primary cells.

2. Aerated Lagoons. Aeration equipment shall be capable of:

A. Maintaining the design level of dissolved oxygen within a particular cell with one (1) unit in the cell out of service;

B. Maintaining a minimum dissolved oxygen level of two milligrams per liter (2 mg/L) in the lagoon at all times;

C. Delivering one and four tenths pounds of oxygen per pound of biochemical oxygen demand removed (1.4 lbs O_2/1 lb BOD); and

D. Delivering an additional four and sixth tenths pounds of oxygen per pound of ammonia nitrogen removal (4.6 lbs O_2/1 lb NH_3).

(B) Area and Loadings for Wastewater Irrigation Storage Basins. Treatment prior to surface irrigation shall provide performance equivalent to that obtained from a primary wastewater lagoon cell designed and constructed in accordance with section (4) of this rule, except that the lagoon depth may be increased to include wastewater storage in addition to the primary volume.

(4) Lagoon Construction Details.

(A) Embankments and Berms.

1. Berms shall be constructed of relatively impervious material and compacted to at least ninety-five percent (95%) maximum dry density test method to form a stable structure.

2. The minimum berm width shall be eight feet (8') to permit access of maintenance vehicles.

3. Minimum freeboard shall be two feet (2').

4. An emergency spillway shall be provided that—

A. Prevents the overtopping and cutting of berms;

B. Is compacted and vegetated or otherwise constructed to prevent erosion; and

C. Has the ability for a representative sample to be collected, if discharging.

(B) Lagoon Bottom. Soil shall be compacted with the moisture content between two percent (2%) below and four percent (4%) above the optimum water content and compacted to at least ninety-five percent (95%) maximum dry density test method.

(C) Lagoon Seal.

1. The lagoon shall be sealed to ensure that seepage loss is as low as possible and has a design permeability not exceeding 1.0 x 10-7 cm/sec.

2. Soil Seals. The minimum thickness of the compacted clay liner must be twelve inches (12"). For permeability coefficients greater than $1.0 \times 10\text{-}7$ cm/sec or for heads over five feet (5') such as an aerated lagoon system, the following formula shall be used to determine minimum seal thickness, Equation 200-1:

Equation 200-1

$$t = \frac{H \times K}{5.4 \times 10^{-7\ cm/sec}}$$

where:

K = the permeability coefficient of the soil in question;

H = the head of water in the lagoon; and

t = the thickness of the soil seal.

3. Synthetic Liners. Synthetic seals thickness may vary due to liner material, but the liner thickness shall be no less than two-hundredths inch (.02") or twenty (20) mil and be the appropriate material to perform under existing conditions.

4. Seep collars shall be provided on drainpipes where they pass through the lagoon seal.

(D) Influent Lines.

1. Unlined corrugated metal pipe shall not be used due to corrosion problems.

2. A manhole shall be installed with its invert at least six inches (6") above the maximum operating level of the lagoon, prior to the entrance into the primary cell, and provide sufficient hydraulic head without surcharging the manhole. For manhole installation, follow the provisions listed in 10 CSR 8.120(4).

3. The influent line(s) shall be located along the bottom of the lagoon so that the top of the pipe is just below the average elevation of the lagoon seal; however, there shall be an adequate seal below the pipe.

(5) Covers for Lagoon Retrofits.

(A) Lagoon covers shall be constructed with a minimum thickness of 2 mil or meet the manufacturer's recommendations, and be ultraviolet and weather resistant.

(B) Trial seams shall be used to verify acceptable installation techniques.

(C) The cover shall include a stormwater removal system that conveys collected precipitation to sumps or includes drainage areas in the membrane within the acceptable leakage rate to allow stormwater to drain into the lagoon.

(6) Surface Irrigation of Wastewater.

(A) Site Considerations. For site considerations, follow the provision in section (2) of this rule.

(B) Wetted Application Area. The wetted application area is the land area that is normally wetted by wastewater application. The wetted application area must be:

1. Located outside of flood-prone areas having a flood frequency greater than once every ten (10) years;

2. Established—

A. At least one hundred fifty feet (150') from existing dwellings or public use areas, excluding roads or highways;

B. At least fifty feet (50') inside the property line;

C. At least three hundred feet (300') from any sinkhole, losing stream, or other structure or physiographic feature that may provide direct connection between the ground water table and the surface;

D. At least three hundred feet (300') from any existing potable water supply well not located on the property. Adequate protection shall be provided for wells located on the application site;

E. One hundred feet (100') to wetlands, ponds, gaining streams (classified or unclassified; perennial or intermittent); and

F. If an established vegetated buffer or the wastewater is disinfected, the setbacks established in subsections (A)–(E) above may be decreased if the applicant demonstrates the risk is mitigated.

3. Fenced, or if not fenced, provide in the construction permit application or the facility plan, the—

A. Method of disinfection being utilized;

B. Suitable barriers in place, or

C. Details on how public access is limited and not expected to be present.

(C) Preapplication Treatment. At a minimum, treatment prior to irrigation shall provide performance equivalent to that obtained from a primary wastewater lagoon cell designed and constructed in accordance with sections (3) and (4) of this rule, except that the lagoon depth may be increased to include wastewater storage in addition to the primary volume.

1. The size of storage basins shall be based on the design wastewater flows and net rainfall minus evaporation expected for a one (1) in ten (10) year twenty-four (24) hour return frequency for the storage period selected and shall meet the minimum storage days listed below.

A. Seventy-five (75) days for facilities located in Scott, Stoddard, Butler, Dunklin, New Madrid, Pemiscot, Mississippi, McDonald, Newton, Jasper, Lawrence, Barry, Stone, Taney, Christian, Green, Webster, Douglas, Ozark, Howell, Texas, Dent, Shannon, Oregon, Ripley, Carter, Reynolds, Iron, Madison, Wayne, Cape Girardeau, Barton, Dade, Perry, and Bollinger counties.

B. Ninety (90) days for facilities located in Vernon, Bates, Henry, St. Clair, Cedar, Dallas, Polk, Hickory, Benton, Cooper, Morgan, Moniteau, Miller, Cole, Camden, Laclede, Pulaski, Phelps, Maries, Osage, Gasconade, Franklin, Jefferson, St. Louis, Ste. Genevieve, St. Francois, St. Charles, and Crawford counties.

C. One hundred five (105) days for facilities located in Cass, Johnson, Pettis, Platte, Jackson, Clay, Ray, Lafayette, Carroll, Saline, Chariton, Randolph, Howard, Boone, Callaway, Audrain, Monroe, Ralls, Pike, Lincoln, Warren, and Montgomery counties.

D. One hundred twenty (120) days for facilities located in Atchison, Holt, Andrew, Nodaway, Worth, Gentry, DeKalb, Harrison, Daviess, Grundy, Mercer, Putnam, Sullivan, Linn, Macon, Adair, Schuyler, Scotland, Clark, Knox, Lewis, Shelby, Buchanan, Clinton, Caldwell, Livingston, and Marion counties.

E. Seasonal facilities. For facilities that operate and generate flows only from April through October season, a minimum storage capacity of forty-five (45) days shall be provided. For facilities that operate or generate flows only from November through March, the minimum storage listed in subsection (A)–(D) above is required.

(D) Application Rates and Soils Information. The application rates for each individual site shall be based on topography, soils, geology, hydrology, weather, agricultural practice, adjacent land use, and application method. Application of wastewater shall not be allowed during periods of ground frost, frozen soil, saturated conditions, or precipitation events. In design of the application rates, the following shall apply:

1. Do not exceed the hourly application rate at the design sustained permeability rate except for short periods when initial soil moisture is significantly below field capacity. Do not exceed an hourly rate of one-half (½) the design sustained permeability for slopes exceeding ten percent (10%).

2. Base the daily and weekly application rates on soil moisture holding capacity, antecedent rainfall, and depth to the most restrictive soil permeability.

A. For facilities applying at twenty-four inches per year (24"/yr), the application rate cannot exceed one inch (1") per day and three inches (3") per week.

B. For facilities applying above twenty-four inches per year (24"/yr), the application rate cannot exceed the values determined in the soils report and loading design. Follow the provisions in 10 CSR 20-8.110(7), Soils Reports for additional information.

3. Design the maximum annual application rate not to exceed ten percent (10%) of the design sustained soil permeability rate for the number of days per year when soils are not frozen.

(E) The applicant shall defer the grazing of animals or harvesting of forage crops, as listed below, following wastewater irrigation, depending upon ambient air temperature and sunlight conditions.

1. Fourteen (14) days from grazing or forage harvesting during the period from May 1 to October 31 of each year; and

2. Thirty (30) days from grazing or forage harvesting during the period from November 1 to April 30 of each year.

(F) Public Access Areas. Wastewater shall be disinfected prior to irrigation (not storage) in accordance with 10 CSR 20-8.190.

1. The wastewater shall contain as few of the indicator organisms as possible and in no case contain more than one hundred twenty-six (126) Escherichia coliform colony forming units per one hundred milliliters (126 cfu/ 100 ml);

2. The public shall not be allowed into an area when irrigation is being conducted; and

3. For golf courses utilizing wastewater, all piping and sprinklers associated with the distribution or transmission of wastewater shall be color-coded and labeled or tagged to warn against the consumptive use of contents.

(G) Alarm System. An automatic notification alarm system shall be installed on the pressure monitoring system, on each pivot and pump system, and be capable of notifying an on-call operator when a fault occurs in the system.

(7) Subsurface Absorption Systems.

(A) Site Restrictions.

1. Subsurface systems shall—

A. Exclude unstabilized fill and soils that have been highly compacted and/or disturbed, such as old road beds, foundations, or similar things;

B. Provide adequate surface drainage where slopes are less than two percent (2%);

C. Provide surface and subsurface water diversion where necessary, such as a curtain or perimeter drain; and

D. Have a ten foot (10') buffer from the property line.

2. The vertical separation between the bottom of the drip lines and/or the trench and a limiting layer, including but not limited to,

bedrock; restrictive horizon; or seasonal high water table, shall be no less than:

A. Twenty-four inches (24"); or

B. Twelve inches (12") for systems dispersing secondary or higher quality effluent; or

C. Forty-eight inches (48") where karst features are present unless the site can be reclassified.

(B) Preliminary treatment. Subsurface systems shall be, at a minimum, preceded by preliminary treatment. For design of a secondary treatment system, follow the provisions in 10 CSR 20-8.180 or section (3) of this rule.

(C) Loading rates shall not exceed the values assigned by the site and soil evaluation.

(8) Low Pressure Pipe (LPP) Subsurface Systems.

(A) Design.

1. The LPP system shall be sized in accordance with the following equations, Equation 200-2 and Equation 200-3:

Equation 200-2

$$A = \frac{Q}{LTAR}$$

and

Equation 200-3

$$L = \frac{A}{5\ ft}$$

where:

A = Minimum LPP soil treatment area (square feet (sq.ft))

L = Minimum total length of LPP trench (ft)

Q = Maximum daily wastewater flow (gallons per day (gpd))

LTAR = Long term acceptance rate (gpd/sq.ft). This is the lowest reported LPP soil loading rate between the soil surface and at least twelve inches (12") below the specified LPP trench bottom, or as approved by the Missouri Department of Natural Resources (department).

2. All network piping and low pressure distribution piping and fittings with polyvinyl chloride (PVC) shall meet ASTM Standard D 1785 *Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, or 120* as approved and published August 1, 2015, or equivalent rated to meet or exceed ASTM D2466 *Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings* as approved and published August 1, 2017. These standards shall hereby be incorporated by reference into this rule, as published by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959. This rule does not incorporate any subsequent amendments or additions.

3. Manifold design shall address freeze protection while assuring uniform distribution and to minimize drain down of laterals into other laterals at a lower elevation between dosing events.

(B) Dosage. The dosing frequency shall be based on the soils report and the dosing volume in zoned systems.

(C) Orifices and Orifice Shielding.

1. The orifice number and spacing shall be designed to provide a distribution of no more than six square feet per orifice with an orifice size of not less than one-eighth inch.

2. The distal pressure shall be designed and maintained at the end of each lateral to be no less than two feet (2 ft) (0.87 psi) when using three-sixteenth inch (3/16") or larger diameter orifices, and no less than five feet (5 ft) (2.18 psi) when using orifices smaller than three-sixteenth inch (3/16").

(9) Drip Dispersal Subsurface Systems.

(A) Design.

1. The location and size of the drains and buffers must be factored into the total area required for the drip dispersal system.

2. The drip dispersal system shall be sized with the minimum soil treatment area and total length, in accordance with the following equations, Equation 200-4 and Equation 200-5:

Equation 200-4

$$A = \frac{Q}{HLR}$$

Equation 200-5

$$L = \frac{A}{2\ feet}$$

Where:

A = Minimum soil treatment area (square feet (sq. ft))

Q = Maximum daily wastewater flow (gallons per day (gpd))

HLR= Maximum hydraulic loading rate determined in the soils report (gpd/sq.ft)

L = Minimum total length (ft)

(B) Lines.

1. The drip dispersal lines shall be placed at a minimum depth of six inches (6") below the surface.

2. Emitters and drip dispersal lines shall be placed at a minimum on a two foot (2') spacing to achieve even distribution of the wastewater and maximum utilization of the soil.

AUTHORITY: section 644.026, RSMo 2016. Original rule filed Aug. 10, 1978, effective March 11, 1979. Amended: Filed June 15, 2018, effective Feb. 28, 2019.*

**Original authority: 644.026, RSMo 1972, amended 1973, 1987, 1993.*

10 CSR 20-8.210 Supplemental Treatment

PURPOSE: This rule specifies the minimum standards for the design of supplemental treatment processes that are part of wastewater collection and treatment systems. This rule is to be used with rules 10 CSR 20-8.110 through 10 CSR 20-8.210. It does not address all aspects of design, and the design engineer may refer to other appropriate reference materials so long as these minimum standards set forth in this rule are met.

Editor's Note: The secretary of state has determined that the publication of this rule in its entirety would be unduly cumbersome or expensive. The entire text of the material referenced has been filed with the secretary of state. This material may be found at the Office of the Secretary of State or at the headquarters of the agency and is available to any interested person at a cost established by state law.

(1) Applicability. Wastewater systems that utilize supplemental treatment 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. In the event of any conflict between the above criteria, the requirement in this rule shall prevail.

(A) This rule shall not apply to treatment units covered in 10 CSR 20-8.300.

(B) This rule shall not apply to treatment units covered in 10 CSR 20-8.500.

(2) Polishing Reactors.

(A) Design. The process shall—

1. Provide a minimum hydraulic retention time of three (3) hours;

2. Be based on actual reactor influent characteristics;

3. Be based on Biochemical Oxygen Demand loading rate of forty-eight pounds per one thousand cubic feet per day (48 lbs BOD/1,000 cf/day) or less;

4. Be sized using less than two tenths a pound TKN per one thousand square feet per day (0.2 lbs TKN/1,000 ft^2/day) when nitrifying;

5. Provide sufficient alkalinity with a minimum residual of fifty milligrams per liter (50 mg/L) in the effluent or include chemical treatment;

6. Include cold weather provisions, such

as heaters, insulated covers, installation of temperature controlled enclosures for above-ground components to prevent freezing and to ensure ammonia removal; and

7. Provide a blower malfunction alarm able to notify the operator of alarm activations through audio-visual means.

(3) Filtration.

(A) Filtration systems shall be preceded with additional process, such as chemical coagulation and sedimentation or other acceptable process, when:

1. Permit requirements for total suspended solids (TSS) are less than ten milligrams per liter (10 mg/L);

2. Effluent quality is expected to fluctuate significantly;

3. Significant amounts of algae are present; or

4. The manufacturer recommends an additional process.

(B) General Design.

1. Filtration systems shall have:

A. Convenient access to all components and the media surface for inspection and maintenance without taking other units out of service;

B. Enclosed controls and heating and ventilation equipment to control humidity; and

C. The capacity to process the design average flow to the filters with the largest unit out of service utilizing a minimum of two (2) units.

2. Flocculation. For filtration systems requiring coagulation and flocculation prior to the filtration, the flocculation system shall:

A. Include chemical feed equipment to meet the system's anticipated peak design flow and the ability to proportion chemical feed rates; and

B. Ensure the rapid dispersion and mixing of chemicals throughout the wastewater by providing mechanical or in-line static mixers.

(C) Deep bed filters.

1. The design of manifold type filtrate collection or underdrain systems shall:

A. Minimize loss of head in the manifold and baffles;

B. Provide the ratio of the area of the underdrain orifices to the entire surface area of the filter media at about three one-thousandths (0.003);

C. Provide the total cross-sectional area of the laterals at about twice the area of the final openings; and

D. Provide a manifold that has a minimum cross sectional area that is one and one half (1.5) times the total area of the laterals.

2. All rotary surface wash devices shall provide adequate surface wash water to provide one half to one gallon per minute per square foot (0.5-1.0 gpm/ sq ft) of filter area.

(D) Shallow bed filters. The shallow bed filter shall:

1. Comply with the manufacturer's recommendations at average design flow;

2. Provide multiple unit operations to allow for continuous operability and operational variability;

3. Consist of a series of up to eight inch (8") filter increments having a minimum total media depth of eleven inches (11"), if using filter media except for sand media.

4. Have an effective size in the range of four-tenths millimeter to sixty-five hundredths millimeters (0.40 mm-0.65 mm) and a uniformity coefficient of one and one half (1.5) or less, if utilizing sand media;

5. Include inlet ports located throughout the length of the filter.

6. Provide an underdrainage system along the entire length of the filter so that filter effluent is uniformly withdrawn without clogging outlet openings.

7. Have a traveling bridge mechanism which—

A. Provides support and access to the backwash pumps and equipment;

B. Is constructed of corrosion resistant materials;

C. Provides for consistent tracking of the bridge;

D. Provides support of the power cords; and

E. Initiates a backwash cycle automatically when a preset head loss through the filter media occurs.

(E) Cloth/Disc Filters.

1. Media Design. The media shall:

A. Have an average pore size of no larger than thirty (30) microns;

B. Follow the manufacturer's recommendations; and

C. Be chemical-resistant if the filter will be exposed to chemicals, such as chlorine or disinfectants.

2. Filtration Rates and Hydraulics. The design shall—

A. Base the filtration rate on the effective submerged surface area of the media and provide a maximum filtration rate for peak flow of not more than six and one half gallons per minute per square foot (6.5 gpm/sq ft) of submerged cloth media; and

B. Be able to treat the design flow rate with one (1) filter unit in backwash mode.

(4) Microscreening.

(A) Screen Material. The microfabric shall be a material demonstrated to be durable through long-term performance data.

(B) Backwash. All backwash shall be recycled for treatment.

(5) In-stream Diffusers.

(A) General.

1. The mixing zone shall not encroach on a drinking water intake, recreation area, or sensitive habitat, overlap the next downstream outfall, or occlude a downstream tributary.

2. Diffuser installation requires notification and an Army Corps of Engineers permit.

(B) Diffuser Design Criteria.

1. The pipeline shall be contained within approved property boundaries or easements.

2. Maximum port velocity shall not exceed fifteen feet per second (15 fps).

AUTHORITY: section 644.026, RSMo 2016. Original rule filed Aug. 10, 1978, effective March 11, 1979. Amended: Filed June 15, 2018, effective Feb. 28, 2019.*

**Original authority: 644.026, RSMo 1972, amended 1973, 1987, 1993.*

10 CSR 20-8.220 Land Treatment

(Rescinded February 28, 2019)

AUTHORITY: section 644.026, RSMo Supp. 1988. Original rule filed Aug. 10, 1978, effective March 11, 1979. Rescinded: Filed June 15, 2018, effective Feb. 28, 2019.

10 CSR 20-8.300 Design of Concentrated Animal Feeding Operations

PURPOSE: This rule specifies the minimum standards for the design of animal waste management systems. It does not address all aspects of design, and the design engineer may refer to other appropriate reference materials so long as these minimum standards set forth in this rule are met.

PUBLISHER'S NOTE: The secretary of state has determined that the publication of the entire text of the material which is incorporated by reference as a portion of this rule would be unduly cumbersome or expensive. This material as incorporated by reference in this rule shall be maintained by the agency at its headquarters and shall be made available to the public for inspection and copying at no more than the actual cost of reproduction. This note applies only to the reference material. The entire text of the rule is printed here.

(1) Applicability. This rule applies to all new

or expanding Concentrated Animal Feeding Operations (CAFOs), however, only those applicants that are constructing earthen basins are required to obtain construction permits. The Missouri Department of Natural Resources (department) will not examine the adequacy or efficiency of the structural, mechanical, or electrical components of the concentrated animal feeding operation systems, only adherence to rules and regulations.

(2) Definitions.

(A) Definitions as set forth in the Missouri Clean Water Law, Chapter 644, Concentrated Animal Feeding Operation (Hog Bill) section 640.703, RSMo, 10 CSR 20-2.010, and 10 CSR 20-6.300 shall apply to the terms in this rule unless otherwise defined by subsection (2)(B) below.

(B) Other applicable definitions are as follows:

1. Design storage period—The calculated number of days that will fill the manure storage structure from the lower to the upper operating level for a covered storage structure or from the lower to the upper operating level for an uncovered, liquid storage structure during a period of average rainfall minus evaporation (R-E).

A. For a design storage period of fewer than three hundred sixty-five (365) days, the largest consecutive average monthly R-E, corresponding with the number of months of the storage period, shall be used.

B. For multiple storage stages, the storage period is the sum of available storage days in each stage.

C. For covered liquid manure storage structures, the upper operating level is one foot (1') below the top of the structure;

2. Freeboard—The elevation difference between the bottom of the spillway to the top of the berm for an earthen basin;

3. Groundwater table—The seasonal high water level occurring beneath the surface of the ground, including underground watercourses, artesian basins, underground reservoirs and lakes, aquifers, other bodies of water located below the surface of the ground, and water in the saturated zone. For the purposes of this rule, groundwater table does not include the perched water table;

4. Manure—The fecal and urinary excretion of animals;

5. Manure storage structure—A fabricated structure or earthen basin used to store manure, litter, and/or process wastewater;

6. Rainfall minus evaporation (R-E)—The average depth of monthly liquid precipitation minus evaporation as published in the most recent National Weather Service Climate Atlas for the geographical region of the proposed structure;

7. Safety depth—One foot (1') of liquid depth or the depth needed to hold the volume of the ten- (10-) year, ten- (10-) day storm, whichever is greater;

8. Solid manure—Manure that can be stacked without free flowing liquids;

9. Safety volume—The volume of wastewater stored between the upper pumpdown and emergency spillway crest;

10. Storage lagoon—A lagoon that does not have adequate volume to accomplish treatment;

11. Storage volume—The volume of manure, runoff, washwater, rainfall, and additional water sources between the lower and upper operating levels;

12. Ten- (10-) year, ten- (10-) day storm—The depth of rainfall occurring in a ten- (10-) day duration over a ten- (10-) year return frequency as defined by the most recent publication of the National Weather Service Climate Atlas for the geographical region of the proposed manure storage structure;

13. Total storage capacity—The combined volume of storage and safety volumes stored between the lower pumpdown level and emergency spillway crest;

14. Treatment volume—The permanent volume maintained below the lower pumpdown designed for anaerobic treatment of manure based on latitude;

15. Waste treatment lagoon—A lagoon that is sized to have three hundred sixty-five (365) days of storage volume and adequate treatment volume;

16. Wastewater—A combination of manure, washwater, runoff, rainfall, and process wastewater; and

17. Wastewater flow—The annual rate of wastewater contributed to an animal waste management system.

(3) Permit Application Documents. All engineering documents shall be prepared by, or under the direct supervision of, a registered professional engineer licensed to practice in Missouri.

(4) Location.

(A) Protection from Flooding—Manure storage structures, confinement buildings, open lots, composting pads, and other manure storage areas in the production area shall be protected from inundation or damage due to the one hundred- (100-) year flood.

(B) The minimum setback distances from manure storage structures, manure storage areas, confinement buildings, open lots, or mortality composters shall be as follows:

1. Ten feet (10') to public water supply pipelines;

2. Fifty feet (50') to property lines;

3. Fifty feet (50') to public roads;

4. One hundred feet (100') to wetlands, ponds, or lakes not used for human water supply;

5. One hundred feet (100') to gaining streams (classified or unclassified; perennial or intermittent);

6. Three hundred feet (300') to human water supply lakes or impoundments; and

7. Three hundred feet (300') to losing streams (classified or unclassified; perennial or intermittent) and sinkholes.

(C) Distances from earthen basins shall be measured from the outside edge of the top of the berm.

(5) Manure Storage Structure Sizing.

(A) No Discharge Requirement. All manure storage structures shall comply with the design standards and effluent limitations of 10 CSR 20-6.300(4).

(B) Design Storage Period. The minimum design storage period for manure storage structures shall be as follows:

1. The minimum design storage period for liquid manure, solid manure, and dry process waste to be land applied is one hundred eighty (180) days;

2. The minimum design storage period for solid manure and dry process waste to be sold or used as bedding is ninety (90) days; and

3. The minimum design storage period for waste treatment lagoons without an impermeable cover is three hundred sixty-five (365) days.

(C) New Class I swine, veal, or poultry operations shall evaluate proposed uncovered manure storage structures in accordance with applicable federal regulation as set forth in 40 CFR 412.46(a)(1), November 20, 2008, and shall hereby be incorporated by reference, without any later amendments or additions, as published by the Office of the Federal Register, National Archives and Records Administration, Superintendent of Documents, Pittsburgh, PA 15250-7954.

(D) Sizing Manure Storage Structures.

1. The structure shall be designed to hold all inputs, between the upper and lower operating levels, anticipated during the design storage period.

2. Uncovered liquid storage structures shall also include:

A. One-in-ten (1-in-10) year rainfall minus evaporation from the surface of the structure, held between the operating levels; and

B. Safety volume based on the twenty-five (25) year, twenty-four (24) hour storm event above the upper operating level.

3. Tanks and pits shall also include six inches (6") of depth below the lower operating level for incomplete removal allowance.

4. Earthen basins shall also include:

A. At least one foot (1') of freeboard or two feet (2') for structures that receive storm water from open lots larger than the surface area of the storage structure;

B. Two feet (2') of permanent liquid depth below the lower operating level. Anaerobic treatment volume greater than two feet (2') will satisfy this requirement;

C. Sludge accumulation volume; and

D. Treatment volume below the lower operating level for anaerobic treatment lagoons.

(6) Construction of Earthen basins.

(A) Geohydrologic Evaluation. A geohydrologic evaluation of the proposed earthen basin prepared by the Missouri Geological Survey shall be submitted to the department. If the geohydrologic evaluation gives a severe rating for collapse potential, an earthen basin shall not be used.

(B) Detailed Soils Investigation. A detailed soils investigation is required to substantiate feasibility and to determine the quantity and quality of soil materials on-site and from a borrow area for use in the basin and/or liner. The following information, in whole or in part, is required:

1. Atterburg limits;

2. Standard proctor density (moisture/density relationships);

3. Coefficient of permeability (undisturbed and remolded);

4. Depth to bedrock;

5. Particle size analysis; and

6. Depth to groundwater table.

(C) Shape and Location.

1. The shape of all cells shall be such that there are no narrow or elongated portions or islands, peninsulas, or coves.

2. The floor of the structure shall be a consistent elevation with finished elevations not be more than three inches (3") above or below the average elevation of the floor.

3. The floor of the basin shall be at least four feet (4') above the groundwater table or the water table as modified by subsurface drainage and at least two feet (2') above bedrock.

(D) Outer berm slopes shall not be steeper than three to one (3:1), horizontal to vertical, and inner slopes not be flatter than four to one (4:1) or steeper than three to one (3:1) for uncovered lagoons or two and one-half to one (2.5:1) for covered lagoons.

(E) Berm Construction and Width. Construction specifications shall include the following:

1. Compact soil used in constructing the basin floor (not including clay liner) and berm cores to between two percent (2%) below and four percent (4%) above the optimum water content and to at least ninety percent (90%) standard proctor density;

2. Use lifts for berm construction not exceeding twelve inches (12") with a maximum rock size not exceeding one-half (1/2) the thickness of the compacted lift; and

3. Construct the top width of the berm a minimum of eight feet (8') for fill heights from fifteen to twenty feet (15'–20'), use minimum top widths of ten feet (10') and for fill heights from twenty to twenty-five feet (20'–25'), use minimum top widths of twelve feet (12').

(F) Emergency Spillway. To prevent overtopping and cutting of berms, an emergency overflow shall be provided that—

1. Has a minimum bottom width of ten feet (10') and a minimum depth of one foot (1'); and

2. Is compacted and vegetated or otherwise constructed to prevent erosion due to possible flow.

(G) Compacted Clay Liner.

1. Liner construction. Compacted clay liners shall be constructed to—

A. Be scarified and compacted to between two percent (2%) below and four percent (4%) above the optimum water content and to at least ninety percent (90%) standard proctor density;

B. Be raised in lifts not exceeding six inches (6") with a maximum rock size not exceeding one-half (1/2) the thickness of the compacted lift;

C. Be maintained at or above the optimum water content until the basin is prefilled with water; and

D. Have a minimum thickness of twelve inches (12").

2. Permeability. All earthen basins shall be sealed so that seepage loss through the seal is minimized and to meet the following specifications:

A. Cover the floor and extend up the inner slope to where the side slope intersects with the top of the berm;

B. Have a design permeability of the basin seal not exceeding 1.0×10^{-7} centimeter per second (cm/sec). For soils which have a coefficient of permeability greater than 1.0×10^{-7} (cm/sec), unusual depth, or potable ground water contamination potential, liner thickness of more than twelve inches (12") may be required. The following equation shall be used to determine minimum seal thickness:

$$t = (H \times K) / 5.4 \times 10^{-7} \text{cm/sec}$$

where

K = permeability coefficient of the soil in question;

H = head (maximum water level depth) of water in the basin; and

t = thickness of the soil seal.

(H) Protection of Berms. Rip-rap or some other acceptable method of erosion control is required as a minimum around all piping entrances and exits, for aerated cell(s), on the slopes and floor in the areas where turbulence will occur, and for protection from wave action for basins with a surface area greater than five (5) acres.

(I) If alternative liners are used, permeability, durability, and integrity of the proposed materials must be satisfactorily demonstrated for anticipated conditions.

(J) Depth Gauges. A permanent depth measurement gauge or marker shall be installed and maintained in the basin that is easily readable at one-foot (1') or smaller increments and clearly displayed lower, upper, and emergency spillway levels.

(K) Piping. Fill around pipes installed through embankments shall be compacted to prevent seepage and pressurized piping must be valved. Valves are not required on gravity piping into the lagoon.

(L) Safety. Consideration shall be given for safety in using open storage structures including the use of prevention and recovery components.

(M) Operation and Maintenance. An operation and maintenance plan is required addressing the major components of the concentrated animal feeding operation system.

(7) Construction of Tanks and Pits. Construction of tanks and pits shall meet the following requirements:

(A) Soils and Foundation. A thorough site investigation shall be made to determine the physical characteristics and suitability of the soil and foundation for the fabricated storage structure. Position the floor of the below-ground storage tanks two feet (2') above the groundwater table;

(B) Allow one foot (1') of depth at the top of covered structures for agitation and/or ventilation;

(C) Include a permanent depth measurement gauge or marker that is easily readable at one-foot (1') or smaller increments for uncovered tanks and pits;

(D) Use perimeter tiling and granular backfill for below-ground pits;

(E) Locate tank and pit footings at or

below the maximum frost depth;

(F) Design concrete and steel features according to published guidelines; and

(G) Design and construct tanks and pits to be watertight.

(8) Construction of Solid Manure Components. The following requirements shall be met when constructing poultry buildings, open lots, stacking pads, stacksheds, and other similar structures:

(A) Divert surface water away from animal confinement areas and buildings;

(B) Floors and Pads. Construct the base of covered and uncovered lots, poultry buildings, and other solid manure storage areas of concrete or other rigid, essentially watertight materials or from a firm, compacted, earthen base of Unified Soil Classification System (USCS) class CH, MH, CL, GC, or SC soils a minimum of two feet (2') above the groundwater table and be at least two feet (2') above bedrock;

(C) Uncovered solids storage areas must also meet the following:

1. Have an overall slope between two percent (2%) and four percent (4%) for unpaved lots;

2. Be maintained in a way that prevents ponding; and

3. Have a runoff collection structure that meets the requirements of this rule.

(9) Design and Construction of Pipelines, Pump Stations, and Land Application Systems.

(A) General. Design of pipelines shall be based on the following requirements:

1. Ensure the storage/treatment facilities can be emptied within the time limits stated in the nutrient management plan;

2. Convey the required flow without plugging, based on the type of material and total solids content;

3. Install at a depth sufficient to protect against freezing;

4. Install with appropriate connection devices to prevent contamination of private or public water supply distribution systems and groundwater;

5. Size pumps to transfer material at the required system head and volume;

6. Install a minimum of three feet (3') below the natural stream floor and as nearly perpendicular to the stream flow as possible;

7. Encase when buried under public roads; and

8. Separation from potable water lines. Pipelines shall be located at least ten feet (10') horizontally from and at least eighteen inches (18") below the base of any potable water line.

9. Aerial pipeline crossings of streams shall:

A. Provide support for all joints in pipes utilized in the crossing;

B. Protect from the impact of flood waters and debris; and

C. Be constructed so that they will remain watertight and free from changes in alignment or grade.

(B) Gravity Pipelines. Design of pipelines shall be based on the following requirements:

1. Use a minimum slope of one percent (1%) for four inch (4") pipe, six-tenths percent (0.6%) for six inch (6") pipe, and four-tenths percent (0.4%) for eight inch (8") pipe;

2. Design with clean-outs at a maximum interval of three hundred feet (300') and with maximum horizontal curves of ten degrees (10°) at pipe joints; and

3. Design gravity discharge pipes used for emptying a storage/treatment structure with a minimum of two (2) valves in series.

(C) Force Mains and Pressure Pipes. Design velocities shall be between three (3) and six (6) feet per second.

(D) Testing. Hydro-pressure tests shall be made only after the completion of backfilling operations and for a minimum of one (1) hour using a minimum test pressure of the maximum system operating pressure.

(E) Pump Stations.

1. Water supply protection. Manure pump stations shall not be connected to a potable water supply and shall be located at least three hundred feet (300') from any potable water supply well.

2. Alarm systems. Alarm systems are required for pumping stations that are activated in cases of power failure, pump failure, or any cause of high water in the wet well.

(F) Land Application Systems. Land application systems shall be designed with—

1. Spray application equipment specified that minimizes the formation of aerosols;

2. The pumping system and distribution system sized for the flow and operating pressure requirements of the distribution equipment and the application restrictions of the soils and topography;

3. Provisions for draining the pipes to prevent freezing, if pipes are located above the frost line;

4. A suitable structure provided for either a portable pumping unit or a permanent pump installation, the intake to the pumping system providing the capability for varying the withdrawal depth, the intake elevation maintained twelve to twenty-four inches (12"–24") below the liquid elevation, the intake screened so as to minimize clogging of the sprinkler nozzle or distribution system orifices, and, for use of a portable pump, a stable platform and flexible intake line with flotation device to control depth of intake;

5. Thrust blocking of pressure pipes; and

6. An automatic pump or engine shut-offs in case of pressure drop.

(10) General System Details.

(A) Mechanical Equipment. Mechanical equipment shall be used and installed in accordance with manufacturers' recommendations and specifications and major mechanical units installed under the supervision of the manufacturer's representative.

(B) Potable Water Supply Protection. No piping or other connections shall exist in any part of the concentrated animal feeding operation system, which under any conditions, might cause the contamination of a potable water supply.

(11) Mortality Management. Class I operations shall not use burial as a permanent mortality management method to dispose of routine mortalities.

AUTHORITY: sections 640.710 and 644.026, RSMo 2016. Original rule filed July 14, 2011, effective April 30, 2012. Amended: Filed Jan. 26, 2016, effective Oct. 30, 2016. Amended: Filed June 15, 2018, effective Feb. 28, 2019. Emergency amendment filed Dec. 8, 2020, effective Dec. 22, 2020, expired June 19, 2021. Amended: Filed Jan. 8, 2021, effective Sept. 30, 2021.*

**Original authority: 640.710, RSMo 1996 and 644.026, RSMo 1972, amended 1973, 1987, 1993, 1995, 2000, 2012, 2014.*

10 CSR 20-8.500 Design Requirements for Agrichemical Facilities

PURPOSE: This rule specifies the minimum standards for the design of agrichemical facilities. It does not address all aspects of design, and the design engineer may refer to other appropriate reference materials so long as these minimum standards set forth in this rule are met.

PUBLISHER'S NOTE: The secretary of state has determined that the publication of the entire text of the material which is incorporated by reference as a portion of this rule would be unduly cumbersome or expensive. This material as incorporated by reference in this rule shall be maintained by the agency at its headquarters and shall be made available to the public for inspection and copying at no more than the actual cost of

reproduction. This note applies only to the reference material. The entire text of the rule is printed here.

(1) Applicability. This rule applies to all agrichemical facilities and to the construction of new secondary and operational containment of agrichemicals at existing facilities. All facilities to which this rule applies shall be designed as no-discharge systems.

(2) Exceptions.

(A) The prohibition of storing bulk liquid fertilizer in a mobile container for more than thirty (30) days shall not apply to barges and rail cars used solely for transporting liquid fertilizer from chemical production facilities to retail or wholesale facilities.

(B) The prohibition of burying pipes used for transferring full strength agrichemicals shall not apply to piping used solely for the loading and unloading of liquid fertilizer from barges and rail cars. These pipes shall be pressure tested on a yearly basis to certify the integrity of the pipes. Records of the pressure testing shall be kept on file at the facility and made available to Missouri Department of Natural Resources (department) personnel upon request.

(C) Liquid fertilizer storage tanks that were in use prior to January 13, 1992, having a storage capacity greater than forty thousand (40,000) gallons are exempt from the requirement of installing a liner underneath the tank itself. Spill containment diking is required around these tanks.

(3) Engineering Report. An engineering report is required for all facilities required by 10 CSR 20-6.010 to submit an application for a construction permit.

(4) Primary Containment for Bulk Liquid Agrichemicals for new construction. Containers and appurtenances used as the primary containment in the storage and handling of bulk agrichemicals shall be constructed, installed, and maintained to prevent a discharge and shall be of materials and construction compatible with the specifications of the product stored with:

(A) Tank anchors or raised stands;

(B) For self-supporting tanks, the ability to handle all operating stresses, hydrostatic head, pressure buildup from pumps and compressors, and any other mechanical stresses to which the containers and appurtenances may be subject to in the foreseeable course of operation;

(C) No external sight gauges used with bulk pesticide storage containers;

(D) Lockable valves for bulk liquid fertilizer containers located between the sight gauge and the storage container;

(E) A lockable main discharge valve;

(F) All appurtenances protected against damage from operating personnel and moving vehicles and located within the secondary containment or operational containment area;

(G) All storage structures for bulk liquid pesticides or bulk liquid fertilizers located above ground; and

(H) Secure transfer hose connections.

(5) Secondary Containment for Bulk Liquid Agrichemicals for new construction. Secondary containment for nonmobile bulk liquid pesticides and nonmobile bulk liquid fertilizers shall be designed to contain any spilled product to prevent a discharge with—

(A) Containment structures sized according to the Environmental Protection Agency's *Code of Federal Regulations*, 40 CFR 165.85, published July 1, 2014. This document shall hereby be incorporated by reference without any later amendments or modifications. To obtain a copy, contact the U.S. Government Printing Office at 732 North Capitol Street NW, Washington, DC, 20401, toll free at (866) 512-1800 or by visiting https://bookstore.gpo.gov;

(B) No discharge outlet or gravity drain through the wall or floor of the containment structure;

(C) The walls and floors constructed of material that is compatible with the specifications of the product being stored; resistant to penetration by moisture and agrichemicals; and designed to support the gravity load of the storage containers and any hydrostatic loads that would result from a massive spill within the containment structure;

(D) Expansion joints spaced to prevent cracks from forming; sealed with a material resistant to agrichemicals; and with water stops installed between the containment walls and floor;

(E) A collection sump, if needed, shall not be more than two feet (2') deep or larger than twenty (20) cubic feet; constructed of materials that resist penetration by moisture and agrichemicals; with a sealed connection point between the containment area floor; and at a low point in the containment area to allow for removal of accumulated liquids;

(F) No piping installed through the walls or floor except for through common, interconnecting containment walls and all piping entering and leaving the secondary containment structure shall go up and over the containment walls;

(G) No buried transfer piping;

(H) Separation of bulk liquid pesticides and bulk liquid fertilizers with a common wall and with no interconnecting piping; and

(I) All tanks for storage of rinsate or precipitation collected in the secondary or operational containment area located within a secondary containment structure.

(J) Earthen structures used for secondary containment shall be designed as follows:

1. Be constructed with a compacted soil liner or synthetic liner with a permeability rate of 1×10^{-7} cm/sec. or less.

2. Be protected against erosion with side slopes no steeper than three to one (3:1) and with a top width no less than two and one-half feet (2 1/2').

(6) Nonmobile bulk dry fertilizer storage shall be designed to—

(A) Be stored inside a sound structure to prevent contact with precipitation with all surface water runoff diverted away from the storage structure;

(B) Allow for all unloading, loading, mixing, and handling of dry bulk fertilizers to be done on an operational containment area as required in section (9) of this rule;

(C) Have an adequately sized operational containment area to hold the volume of pesticides used and impregnation equipment as required in section (9) of this rule;

(D) Allow for daily cleanup of the dry fertilizer loading, unloading, mixing, and handling areas;

(E) Prevent the downward movement of fertilizer materials and moisture through the floor with expansion joints spaced to prevent cracks from forming and sealed with a material resistant to agrichemicals; and

(F) Have a mixing and loading pad constructed under any exterior transfer area of a conveyance system.

(7) Nonmobile bulk dry pesticide storage shall be designed to—

(A) Be stored inside a sound structure to prevent contact with precipitation and with all surface water runoff diverted away from the storage structure;

(B) Allow for all loading, mixing, and handling of bulk dry pesticides to be done on an operational containment area;

(C) Allow for daily cleanup of the bulk dry pesticide loading, unloading, mixing, and handling areas;

(D) Prevent the downward movement of pesticides and moisture through the floor with expansion joints spaced to prevent cracks from forming and sealed with a material resistant to agrichemicals; and

(E) Have a mixing and loading pad under any exterior transfer area of a conveyance system.

(8) Operational containment for bulk liquid pesticides and bulk liquid fertilizers for new construction shall be designed to:

(A) Divert runoff away from the operational containment area;

(B) Contain any spilled product and any collected precipitation that comes in contact with spillage for the amount of time needed for proper cleanup and recovery;

(C) Have a minimum volume in accordance with the Environmental Protection Agency's *Code of Federal Regulations*, 40 CFR 165.85, published July 1, 2014. This document shall hereby be incorporated by reference without any later amendments or modifications. To obtain a copy, contact the U.S. Government Printing Office at 732 North Capitol Street NW, Washington, DC, 20401, toll free at (866)512-1800 or by visiting https://bookstore.gpo.gov;

(D) Have a sediment trap and sump, if needed, not more than two feet (2') deep or larger than 20 cubic feet and constructed of materials that resist penetration by moisture and agrichemicals with a sealed connection point between the operational containment area floor and the sump to prevent leakage of liquids from the containment area;

(E) Extend beneath any pump, appurtenance, or plumbing connection not located within the secondary containment area and that is used to transfer liquid fertilizer or pesticide; and

(F) Allow for bulk repackaging containment of agrichemicals.

(9) Operational Containment Area for bulk dry pesticides and bulk dry fertilizers for new construction shall be sized to—

(A) Divert runoff away from the operational containment area;

(B) Contain any spillage of dry materials that occurs from loading, unloading, or hauling; from spreading equipment; and from mixing and blending equipment. Operational containment areas must also contain precipitation that comes in contact with spillage for the amount of time needed for proper cleanup and recovery;

(C) Individual catchment basins or portable pans/containers may be used to satisfy the requirement for operational containment. The individual basins or portable containers shall be placed to catch or recover spillage and leakage from transfer connections and conveyors; and

(D) For unloading dry pesticides and dry fertilizers from rail cars, a catchment basin or concrete pad that can effectively contain the dry fertilizer or pesticide shall be used.

(10) Connection to Water Supplies. An air gap separation or reduced pressure principle backflow prevention assembly shall be installed in the water supply line that serves an agrichemical facility. The air gap or backflow prevention assembly shall be constructed, installed, and inspected in accordance with 10 CSR 60-11.010 Prevention of Backflow.

(11) Protection from Flooding. All agrichemical facilities shall be located so that the agrichemicals being stored are protected from a one hundred- (100-) year flood event.

(12) Operation and Management of Agrichemical Facilities. Field application of rinsate and collected precipitation is acceptable and recommended.

AUTHORITY: sections 644.026 and 644.036, RSMo 2016. Original rule filed July 15, 1991, effective Jan. 13, 1992. Amended: Filed Aug. 1, 2016, effective April 30, 2017. Amended: Filed June 15, 2018, effective Feb. 28, 2019.*

**Original authority: 644.026, RSMo 1972, amended 1973, 1987, 1993, 1995, 2000, 2012, 2014 and 644.036, RSMo 1972, amended 1973, 2000, 2002, 2006, 2009, 2011.*