MISSOURI
DEPARTMENT OF
NATURAL RESOURCES

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

WORKING DOCUMENT
Strawman

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

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

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

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

10 CSR 20-8.200 Wastewater Treatment *[Ponds (Lagoons)]* Lagoons and Wastewater Irrigation Alternatives

PURPOSE: [The following criteria have been prepared as a guide for the design of waste-water treatment ponds (lagoons). This rule is to be used with rules 10 CSR 20-8.110–10 CSR 20-8.220 for the planning and design of the complete treatment facility. This rule reflects the minimum requirements of the Missouri Clean Water Commission as regards adequacy of design, submission of plans, approval of plans and approval of completed sewage works. Deviation from these minimum requirements will be allowed where sufficient documentation is presented to justify the deviation. These criteria are taken largely from Great Lakes-Upper Mississippi River Board of State Sanitary Engineers Recommended Standards for Sewage Works and are based on the best information presently available. These criteria were originally filed as 10 CSR 20-8.030. It is anticipated that they will be subject to review and revision periodically as additional information and methods appear. Addenda or supplements to this publication will be furnished to consulting engineers and city engineers. If others desire to receive addenda or supplements, please advise the Clean Water Commission so that names can be added to the mailing list.]

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

[(1) Definitions. Definitions as set forth in the Clean Water Law and 10 CSR 20-2.010 shall apply to those terms when used in this rule, unless the context clearly requires otherwise. Where the terms shall and must are used, they are to mean a mandatory requirement insofar as approval by the agency is concerned, unless justification is presented for deviation from the requirements. Other terms, such as should, recommend, preferred and the like, indicate discretionary requirements on the part of the agency and deviations are subject to individual consideration.

(2) Exceptions. This rule shall not apply to facilities designed for twenty-two thousand five hundred (22,500) gallons per day (85.4 m^3) or less (see 10 CSR 20-8.020 for the requirements for those facilities).]

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

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

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

[(3) General. This rule deals with generally used variations of treatment ponds to achieve secondary treatment including controlled discharge pond systems, flow-through pond systems and aerate pond systems. Ponds utilized for equalization, percolation, evaporation and sludge storage will not be discussed in this rule.]

(*[4]***2**) Supplement**ary** *[to Engineer's Report]* **Field Data for the Facility Plan**. The *[engineer's report]* **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 in addition to that required in 10 CSR 20-8.110.*

(A) Supplementary Field Survey Data.

1. The location and direction of all residences, commercial developments, parks, recreational areas and water supplies, including a log of each well if available within one-half (1/2) mile (0.8 km) of the proposed pond shall be included in the engineer's report.

2. Land use zoning adjacent to the proposed pond site shall be included.

3. A description, including maps showing elevations and contours, of the site and adjacent area shall be provided. Due consideration shall be given to additional treatment units and/or increased waste loadings in determining land requirements. Current United States Geological Survey and Soil Conservation Service maps may be considered adequate for preliminary evaluation of the proposed site.

4. The location, depth and discharge point(s) of any field tile in the immediate area of the proposed site shall be identified.

5. A geological evaluation of the proposed lagoon site prepared by the Division of Geology and Land Survey (DGLS) shall be submitted. To obtain this geological evaluation of the proposed site, the engineer shall submit the following information to the Department of Natural Resources, Division of Geology and Land Survey, P.O. Box 250, Rolla, MO 65401:

A. A layout sheet showing the proposed location. The layout shall include the legal description, property boundaries, roads, streams and other geographical landmarks which will assist in locating the site;

B. Size of the lagoon and/or approximate volume of waste to be treated;

C. Maximum cuts to be made in the construction of the lagoon; and

D. Location and depth of cut for borrow area, if any.

6. Sulfate content of the primary water supply shall be determined.

7. Data from all soil borings conducted by a professional soil testing laboratory to determine subsurface soil characteristics and groundwater characteristics, including elevation, at the proposed site and their effect on the construction and operation of a pond shall also be provided. All boring holes shall be filled and sealed. The permeability characteristics of the pond bottom and pond seal material shall also be studied. At the facility plan stage particle size analysis, Atterburg limits, standard Procter density (moisture-density relations) or permeability coefficient may be required on a case-by-case basis to reflect soil characteristics. At the twenty percent (20%) design stage, soil analysis of each representative soil material including particle size analysis, Atterburg limits, standard Procter density (moisture-density relations) and permeability coefficient of the compacted soil as measured in a falling head permeameter or other test procedure acceptable to the agency may be required. Soil borings may be required in each geological area to determine depth to piezometric surface and to bedrock. Recommendations of the DGLS will be used to establish the required tests at the facility plan and twenty percent (20%) design stages.

(B) Site Information.

1. Distance from habitation. Lagoon sites should be as far as practicable from habitation or any area which may be built up within a reasonable future period. The agency does not attempt to set any minimum distance from habitation since each case must be judged upon its own merits.

2. Prevailing winds. If practicable, ponds should be located so that local prevailing winds will be in the direction of uninhabited areas.

3. Surface runoff. Location of ponds in watersheds receiving significant amounts of stormwater runoff is discouraged. Adequate provisions must be made to divert stormwater runoff around the ponds and protect embankments from erosion.

4. Hydrology. Construction of ponds in close proximity to water supplies and other facilities subject to contamination should be avoided. A minimum separation of four feet (4') (1.2 m) between the bottom of the pond and the maximum groundwater elevation should be maintained where feasible.

5. Groundwater pollution. Proximity of lagoons to water supply located in areas of porous soils and fissured rock formation shall be elevated to avoid creation of health hazards or other undesirable conditions. If the geological report from DGLS makes suggestions for remedial treatment of the site, the engineer shall comply with the suggestions. In some cases, the engineering geologist requests to visit the site during or after construction. When a request is made, the consulting engineer shall comply with the request.]

(A). Locate lagoons and spray irrigation where stormwater runoff from the watershed shall be minimized.

(B) Geohydrological Evaluation. A geohydrological evaluation shall be conducted on all new lagoons, new wastewater irrigation sites, and subsurface adsorption fields.

1. High Collapse Potential. Lagoons shall not be located in areas with a high collapse potential due to bedrock and soil conditions.

(C) Soils investigation. Detailed soils investigations and reports shall be submitted for facilities irrigating more than twenty four inches per year (24"/ yr) and for all subsurface adsorption fields. See 10 CSR 20-8.110(8).

(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.

(*[5]***3**) Basis of Design.

(A) *[Quality of Effluent. A controlled discharge stabilization pond (four (4)-cell) will be considered capable of meeting effluent limitations of thirty (30) mg/l biochemical oxygen demand (BOD_5) and thirty (30) mg/l suspended solids. Flow-through stabilization ponds (three (3)-cell), and aerated lagoon systems will be considered capable of meeting effluent limitations of thirty (30) mg/l BOD_5 and eighty (80) mg/l suspended solids. Flow-through lagoon systems and aerated lagoon systems followed by submerged sand filters will be considered capable of meeting effluent limitations of twenty (20) mg/l BOD_5 and twenty (20) mg/l suspended solids. Lagoons may be incorporated into irrigation systems or systems utilizing chemical coagulation and filtration to meet the requirements of 10 CSR 20-7.015(3)(A)3. Please refer to 10 CSR 20-7.015 Effluent Regulation for discharge requirements.*

(B) Area and Loadings for Controlled Discharge Stabilization Ponds (four (4)-cell).] **Area and Loadings for Discharging Lagoons.**

1. *[Pond]* **Lagoon** design for BOD_5 loadings shall not exceed thirty-four pounds **per day per acre (34 lbs/day/acre)** *[(34) lbs./acre/day (38 km per hectare per day)]* at the three-foot (3') *[(1.9 m)]* operating depth in the primary cells. *[The primary cell shall be followed by a secondary cell having 0.3 the area of the primary cell and by two (2) storage cells. The two (2) storage cells shall have a volume above the two-foot (2') (0.6 m) level for one (1) month's storage of average daily flow in each cell. At least one hundred twenty (120) days' detention time between the two-foot (2') level [(0.6 m)] and the maximum operating depth shall be provided in the entire pond system. [Flow can be based on one hundred (100) gallons per capita per day (38 m^3/cap/d) or other values if data is presented to justify the rate. Primary and secondary cells shall be designed for water depths up to a maximum of five feet (5') (1.5 m). The storage cell should be made as deep as possible up to a maximum depth of eight feet (8') (2.4 m).*

(C) Area and Loadings for Flow-through Stabilization Ponds (three (3)-cell). Pond design for BOD_5 loadings shall not exceed thirty-four (34) pounds per acre per day (38 km per hectare per day). The second cell must be at least 0.3 the area of the first cell and the third cell 0.1 the area of the first cell. The first and second cells must have a variable operating level of between two feet (2') (0.6 m) and five feet (5') (1.5 m). The third cell must have a variable operating level of between two feet (2') (0.6 m) and eight feet (8') (2.4 m).Detention time of at least one hundred twenty (120) days must be provided. Flows of less than one hundred (100) gallons per capita per day (.38 m^3/cap/d) may be used if data is presented to justify the lower rate.

(*D*) *Aerated Lagoons. For the development of final design parameters it is recommended that actual experimental data be developed; however, the aerated lagoon design for minimum detention time may be estimated using the following formula:*

$$t = \frac{E}{2.3\ K_1 \times (100\text{-}E)}$$

where:

t = detention time in the aeration cell in days;
E = percent of BOD_5 to be removed in an aerated pond; and
K_1 = reaction coefficient aerated lagoon, base 10.
For normal domestic sewage the K_1 value may be assumed to be .15 per day for Missouri conditions. The reaction rate coefficient for domestic sewage which includes some industrial waste, other waste or partially treated sewage must be determined experimentally for various conditions which might be encountered in the aerated ponds. Conversion of the reaction coefficient at other temperatures shall be based on experimental data. Raw sewage strength should also consider the effect of any return sludges. Also, additional storage volume should be considered for sludge and in northern climates, ice cover. Oxygen requirements generally will depend on the BOD_5 loading, the degree of treatment and the concentration of suspended solids to be maintained. Aeration equipment shall be capable of maintaining a minimum dissolved oxygen level of two (2) mg/l in the ponds at all times. Suitable protection from weather shall be provided for electrical controls. The aeration equipment shall be capable of providing 1.3 pounds of oxygen per pound of BOD_5 (1.3 kg/kg BOD_5) removed. BOD_5 removal shall be based on warm weather rates. Aerated cells shall be followed by a polishing cell with a volume of 0.3 of the volume of the aerated cell (see 10 CSR 20-8.180 for details on aeration equipment).]

2. Aerated Lagoons. The **aeration equipment shall be capable of:**

A. Maintaining the design level of dissolved oxygen within a particular cell with the one 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 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.

[(E) Multiple Units. Parallel cells should be considered for large installations. The maximum size of any cell should be forty (40) acres (16 ha). The system should be designed to permit isolation of any cell without disrupting service of the other cells.

(F) Pond Shape. The shape of all cells should be so that there are no narrow or elongated portions. Round, square or rectangular ponds with a length not exceeding three (3) times the width are considered most desirable. No islands, peninsulas or coves shall be permitted. Dikes should be rounded at corners to minimize accumulation of floating materials. Common dike construction, wherever possible, is strongly encouraged.

(G) Industrial Wastes. Consideration shall be given to the type and effects of industrial wastes on the treatment process. In some cases it may be necessary to pretreat industrial or other discharges. Industrial wastes shall not be discharged to ponds without assessment of the effects the substances may have upon the treatment processor discharge requirements in accordance with state and federal laws.

(H) Additional Treatment. Consideration should be given in the design stage to the utilization of additional treatment units as may be necessary to meet applicable discharge standards (see paragraph (4)(A)3. of this rule).]

(*[6]***4**) *[Pond]* **Lagoon** Construction Details.

(A) Embankments and *[Dikes.]* **Berms.**

1. [Material. Dikes] **Berms** shall be constructed of relatively impervious material and compacted to at least ninety-five percent (95%) standard *[Procter]* density **method** to form a stable structure. *[Vegetation and other unsuitable materials shall be removed from the area where the embankment is to be placed.]*

2. *[Top width.]* The minimum *[dike]* **berm** width shall be eight feet (8') *[(2.4 m)]* to permit access of maintenance vehicles.

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

4. Provide an emergency spillway, which shall prevent overtopping and cutting of berms, and

A. Be compacted and vegetated or otherwise constructed to prevent erosion; and

B. Have the ability to be collect a representative sample if discharging, including flow.

[3. Maximum slopes. Inner and outer dike slopes shall not be steeper than three horizontal to one vertical (3:1).

4. Minimum slopes. Inner slopes should not be flatter than four horizontal to one vertical (4:1). Flatter slopes can be specified for larger installations because of wave action but have the disadvantage of added shallow areas being conducive to emergent vegetation. Outer slopes shall be sufficient to prevent surface runoff from entering the ponds.

*5. Freeboard. Minimum freeboard shall be two feet (*2'**).** *(0.6 m). For very large cells, three feet (3') (1.0 m) should be considered.*

6. Design depth. The minimum operating depth should be sufficient to prevent growth of aquatic plants and damage to the dikes, bottom, control structures, aeration equipment and other appurtenances. In no case should pond depths be less than two feet (2') (0.6 m). The design water depth for aerated lagoons should be ten to fifteen feet (10–15') (3–4.5 m). This depth limitation may be altered depending on the aeration equipment, waste strength, climatic conditions and geologic conditions.

7. Erosion control. A justification and detailed discussion of the method of erosion control which encompasses all relative factors such as pond location and size, variations in operating depths, seal material, topography, prevailing winds, cost breakdown, application procedures, etc., shall be provided.

A. Seeding. The dikes shall have a cover layer of fertile topsoil with a minimum thickness of four inches (4") (10 cm) to promote establishment of an adequate vegetative cover wherever riprap is not utilized. Prior to prefilling (in accordance with paragraph (6)(C)3. of this rule), adequate vegetation shall be established on dikes from the outside toe to one foot (1') above the water line measured on the slope. Perennial-type, low growing, spreading grasses that minimize erosion and can be mowed are most satisfactory for seeding of dikes. In general, alfalfa and other long-rooted crops should not be used for seeding since the roots of this type are apt to impair the water holding efficiency of the dikes. Alternate dike stabilization practices may be considered if vegetative cover cannot be established prior to prefilling.

B. Additional erosion protection. Riprap or some other acceptable method of erosion control is required as a minimum around all piping entrances and exits. For aerated cell(s) design should ensure erosion protection on the slopes and bottoms in the areas where turbulence will occur. Additional erosion control may also be necessary on the exterior dike slope(s) to protect the embankment(s) from erosion due to severe flooding of a water course.

C. Alternate erosion protection. Alternate erosion control on the interior dike slopes may be necessary for ponds which are subject to severe wave action. In these cases riprap or an acceptable equal shall be placed from one foot (1') (.3 m) above the high water mark to two feet (2') (0.6 m) below the low water mark (measured on the vertical). This protection should also be provided in the storage cells of a controlled discharge (four (4)-cell) pond and the third cell of a flow-through pond (three (3)-cell) where large fluctuations in operating depths will occur.]

(B) *[Pond]* **Lagoon** Bottom.

[1. Soil. Soil used in constructing the pond bottom (not including the seal) and dike cores shall be selected to avoid settlement.] Soil shall be compacted with the moisture content between two percent (2%) below and four percent (4%) above the optimum water content and to the specified standard *[Procter]* density **method** but no less than ninety-five percent (95%) standard *[Procter]* density **method**.

(C) **Lagoon** Seal.

1. *[Design. Ponds shall be sealed so that seepage loss through the seal is as low as practicably possible. Seals consisting of soils or synthetic liners may be used provided the permeability, durability, integrity and cost effectiveness of the proposed materials can be satisfactorily demonstrated for anticipated conditions. Bentonite, soda ash or other sealing aids may be used to achieve an adequate seal in systems using soil. Results of a testing program which substantiates the adequacy of the proposed seal must be incorporated into and/or accompany the engineering report. Standard ASTM procedures or other acceptable methods shall be used for all tests.]* **Seal all lagoons to ensure that seepage loss shall be as low as possible and not to exceed the maximum allowable percolation losses in Table 200-1.**

Table 200-1 Maximum Allowable Percolation Losses

Lagoon Seal	**3500 g/acre/day**
Lagoon Seals located in areas with potential groundwater contamination	**1700 g/acre/day**

2. *[Soils having a permeability coefficient of 10- cm/sec or less with a compacted thickness of twelve inches (12") (30.5 cm) will be acceptable as a lagoon seal for water depths up to five feet (5') (1.5 m).]* **Soil Seals. The minimum thickness of the compacted clay liner must be twelve inches (12").** For permeability coefficients greater than 10^{-7} cm/sec or for heads over five feet (5') *[(1.5 m)]* such as an aerated lagoon system, the following formula shall be used to determine minimum seal thickness**, Equation 200-1:**

Equation 200-1

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

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.
[Units for H and t may be English or metric; however, they must be the same. For a seal consisting of an artificial liner, seepage loss shall not exceed the equivalent of the rate expressed in this paragraph.]

[2. Normal construction methods will include over-excavation below grade level of twelve inches (12") (30.5 cm), scarification and compaction of base material to ninety-five percent (95%) standard Procter density at moisture content between two percent (2%) below and four percent (4%) above optimum, and compaction of lifts generally not exceeding six inches (6") (15.2 cm) to ninety-five percent (95%) standard Procter density at moisture content between two percent (2%) below and four percent (4%) above optimum. Maximum rock size should not exceed one-half (1/2) of the thickness of the compacted lift. The cut face of dikes must also be over-excavated and compacted in lifts not to exceed six inches (6") (15.2 cm) per lift. Soils containing plastic clay may be excluded from this construction requirement on a case-by-case basis based on particle size analysis and Atterburg limits. In fact, with some clay soils, satisfactory construction cannot be obtained by over-excavation and recompaction. Construction control must include field density. A minimum of two (2) density tests per acre or not less than three (3) tests must be performed for the base and each lift. Permeability tests of field compacted material may be performed at the option of the consulting engineer.

3. Prefilling. The pond shall be prefilled in order to protect the liner, to prevent weed growth, to reduce odor, to allow measurement of percolation losses and to maintain moisture content of the seal. However, the dikes must be completely prepared as described in subparagraphs (6)(A)7.A. and/or B. of this rule before the introduction of water. If the lagoon bottom is allowed to dry, the seal must be recompacted as required in paragraph (6)(C)2.

4. Percolation losses. Measurement of percolation losses shall consider flow into and out of the lagoon, rainfall and evaporation, and changes in water level. Measured percolation losses in excess of one-sixteenth inch (1/16") (1.6 mm) per day will be considered excessive.]

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 drain pipes where they pass through the lagoon seal.

(D) Influent Lines.

1. [*Material. Cast- or ductile-iron pipe should be used for the influent line to the pond.]* Unlined corrugated metal pipe *[should be avoided]* **shall not be used** due to corrosion problems. *[Other materials selected shall be suited to local conditions. In material selection, consideration must be given to the quality of the wastes, exceptionally heavy external loadings, abrasion, soft foundations and similar problems.]*

2. *[Manhole. A manhole shall be installed prior to entrance of the influent line into the primary cell(s) and shall be located as close to the dike as topography permits. Its invert shall be at least six inches (6") (15 cm) above the maximum operating level of the pond and provide sufficient hydraulic head without surcharging the manhole.]* **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. Install manholes per 10 CSR 8.120(6).**

[3. Flow distribution. Flow distribution structures shall be designed to effectively split hydraulic and organic loads equally to the primary cells.]

[*4. Influent line(s).]* **3.** The influent line(s) shall be located along the bottom of the *[pond]* **lagoon** so that the top of the pipe is just below the average elevation of the *[pond]* **lagoon** seal; however, the pipe shall have adequate seal below it.

[5. Point of discharge. All primary cells shall have individual influent line(s) which terminate at approximately the center of the cell so as to minimize short-circuiting. Consideration should be given to multi-influent discharge points for primary cells of twenty (20) acres (8 hectares) or larger to enhance distribution of the waste load on the cell. All aerated cells shall have influent lines which distribute the load within the mixing zone of the aeration equipment. Consideration of multi-inlets should be closely evaluated for any diffused aeration systems.

6. Influent discharge apron. The influent line(s) shall discharge horizontally into the shallow saucer-shaped depression. The end of the discharge line(s) shall rest on a suitable concrete apron large enough so that the terminal influent velocity at the end of the apron does not cause soil erosion. A minimum size apron of two feet (2') (0.6 m) square shall be provided.

(E) Control Structures and Interconnecting Piping.

1. Structure. Facilities design shall consider the use of multipurpose control structures, where possible, to facilitate normal operational functions such as drawdown and flow distribution, flow and depth measurement, sampling, pumps for recirculation, chemical additions and mixing and to minimize the number of construction sites within the dikes. As a minimum, control structures shall be accessible for maintenance and adjustment of controls; adequately ventilated for safety and to minimize corrosion; locked to discourage vandalism; contain controls to allow water level and flow rate control, complete shut off and complete draining; constructed of noncorrosive materials (metal on metal contact in controls should be of like alloys to discourage electrochemical reactions); and located to minimize short-circuiting within the cell and avoid freezing and ice damage. Recommended devices to regulate the water level are valves, slide tubes or dual slide gates. Regulators should be designed so that they can be preset to stop flows at any pond elevation.

2. Piping. All piping shall be of cast-iron or other acceptable materials. The piping should not be located within the seal. Seep collars shall be provided on drain pipes where they pass through the pond seal. Backfill around the drain pipe shall be placed and compacted in the same manner as the pond seal. Pipes should be anchored with adequate erosion control.

A. Drawdown structure piping.

(I) Multilevel outlets. The outlet structure on each pond cell, except aerated cells, shall be designed to permit overflow at one-foot (1') (30.5 cm) increments between the two foot (2') (61 cm) level and the maximum operating level. Suitable baffling shall be provided to prevent discharge of scum or other floating materials. Means must be provided to prevent unauthorized variance of the lagoon depth. A flap valve shall be provided at the outlet end of the final cell overflow or drain pipe to prevent entrance of animals or backwater from flooding.

(II) Pond drain. All ponds shall have emergency drawdown piping to allow complete draining for maintenance. These should be incorporated into the previously described structures. Sufficient pumps and appurtenances shall be made available to facilitate draining of individual ponds if ponds cannot be drained by gravity.

(III) Emergency overflow. To prevent overtopping of dikes, emergency overflow should be provided.

B. Hydraulic Capacity. The hydraulic capacity for constant discharge structures and piping shall allow for a minimum of two hundred fifty percent (250%) of the design flow of the system. The hydraulic capacity for controlled discharge systems shall permit transfer of water at a minimum rate of six inches (6") (15.2 cm) of pond water depth per day at the available head.

(7) Submerged Sand Filters.

(A) Applications. Submerged sand filters may be used for solids and BOD_5 removal following waste stabilization ponds and are considered to be both a third lagoon cell and solids removal facility when designed according to the parameters in subsection (7)(B) of this rule.

(B) Design Details.

1. Following nonaerated waste stabilization ponds, the loading shall not exceed five (5) gallons per day per square foot (.2 m^3/m^2/day) of sand. Following aerated waste stabilization ponds, the loading shall not exceed fifteen (15) gallons per day per square foot (.6 m^3/m^2/day) of sand.

2. Clean graded gravel, preferably placed in at least three (3) layers should be placed around the underdrains and to a depth of at least six inches (6") (15 cm) over the top of the underdrains. Suggested gradings for the three (3) layers are: one and one-half inches to three-fourths inch (1 1/2"–3/4") (3.8 cm–1.9 cm), three-fourths inch to one-fourth inch (3/4"–1/4") (1.9 cm–.6 cm) and one-fourth inch to one-eighth inch (1/4"–1/8") (.6 cm–.3 cm).

3. At least twenty-four inches (24") (0.6 m) of clean washed sand should be provided. The sand should have an effective size of 0.3–1.0 mm and a uniformity coefficient of 3.5 or less.

4. Open-joint or perforated pipe underdrains may be used. They should be spaced not to exceed ten-foot (10') (3.0 m) center-to-center.

5. The earth base of the filters should be sloped to the underdrains or the underdrains may simply be placed in the gravel base on the flat bottom of the basin.

6. The depth of liquid above the sand must be adjustable from one to five feet (1–5') (.3 m–1.5 m).

7. At least two (2) cells must be provided with the combined capacity equal to that necessary for the design loading.

8. A vehicle access ramp from the top of the embankment down to the sand surface and running along one (1) side of the filter is a desirable feature for periodic maintenance of the filter.

(8) Miscellaneous.

(A) Fencing. The pond area shall be enclosed with an adequate fence to discourage trespassing and prevent entering of livestock. Minimum fence height shall be five feet (5') (1.5 m). The fence may be of the chain link or woven type. Fencing shall not obstruct vehicle traffic or mowing operations on the dike. A vehicle access gate of sufficient width to accommodate mowing equipment shall be provided. All access gates shall be provided with locks.

(B) Access. An all-weather access road shall be provided to the pond site to allow year-round maintenance of the facility.

(C) Warning Signs. Appropriate permanent signs shall be provided along the fence around the pond to designate the nature of the facility and advise against trespassing. At least one (1) sign shall be provided on each side of the site and one (1) for every five hundred feet (500') (150 m) of its perimeter.

(D) Flow Measurement. Refer to 10 CSR 20-8.140(8)(G).

(E) Groundwater Monitoring. An approved system of groundwater monitoring wells or lysimeters may be required around the perimeter of the pond site to facilitate groundwater monitoring. The use of wells and/or lysimeters will be determined on a case-by-case basis.

(F) Laboratory Equipment. Refer to 10 CSR 20-8.140(8)(D).

(G) Pond Level Gauges. Pond level gauges shall be provided.

(H) Service Building. Consideration in design should be given to a service building for laboratory and maintenance equipment.]

(5) Lagoon Retrofits

(A) Covers.

1. Lagoon covers shall be constructed of either permeable or impermeable, with a minimum thickness of 2 mil or meet the manufacturer's recommendations, and be ultraviolet and weather resistant.

2. Trial seams shall be used to verify acceptable installation techniques.

3. 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. See Section (2) of this rule.

(B) Wetted Application Area. The wetted application area is the land area which is normally wetted by wastewater application. The wetted application area must conform to the following criteria:

1. Flood-prone areas which flood at a frequency greater than once every ten (10) years should not only application area;

2. The wetted application area shall be 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. Fencing. If not proposing fencing, the construction permit application or the facility plan must provide the method of disinfection being utilized, the suitable barriers in place, or 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 return frequency for the storage period selected and meets the minimum storage days listed below.

A. A minimum total days' storage of 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. A minimum total days' storage of 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. A minimum total days' storage of 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. A minimum total days' storage of 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. The following shall apply to design application rates:

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

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. See 10 CSR 20-8.110(8), 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 grazing of animals or harvesting of forage crops shall be deferred, 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. Disinfect wastewater prior to irrigation (not storage) in accordance with section (3) of this rule.

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 Dispersal Systems.

(A) Site Restrictions.

1. Subsurface systems shall not be constructed in unstabilized fill and exclude soils that have been highly compacted and/or disturbed, such as old road beds, foundations, etc..

2. The vertical separation between the bottom of the trench and a limiting layer, including but not limited to, bedrock; restrictive horizon; or seasonal high water table, shall be:

A. No less than twenty-four inches (24”) or

B. No less than twelve inches (12”) for systems dispersing secondary or higher quality effluent; or

C. No less than forty-eight inches (48”) where karst features are present unless the site can be reclassified.

3. Adequate surface drainage shall be provided where slopes are less than two percent (2%); and

4. Surface and subsurface water diversion is required where necessary, such as a curtain or perimeter drain.

(B) Preliminary treatment. Subsurface systems shall be preceded by preliminary treatment; however secondary treatment is recommended. For design of a secondary treatment system, see 10 CSR 20-8.180 or 8.200(3).

(C) Loading rates shall not to 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 department.

2. All network piping and low pressure distribution piping and fittings with polyvinyl chloride (PVC) shall meet ASTM Standard D 1785 Schedule 40, 80, or 120 or equivalent rated to meet or exceed ASTM D2466. Supply watertight, rigid solid wall network piping including the main, sub-mains, and manifold.

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 and Trenches.

1. **The drip dispersal lines shall be placed at depths of six to ten (6-10") inches below the surface.**
2. **Emitters and drip dispersal lines shall be placed on a two foot (2') spacing to achieve even distribution of the wastewater and maximum utilization of the soil.**

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