

Chapter NR 213

LINING OF INDUSTRIAL LAGOONS

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NR 213.01 Purpose. The purpose of this chapter is to establish minimum design standards, material requirements and performance criteria for the construction and lining of new or modified lagoons which will receive industrial wastewaters or sludges for treatment or storage. It is the intent of the department through this chapter to restore, protect and maintain the physical, chemical and biological integrity of the groundwaters of the state and to preclude detrimental effects to this resource.

Histry: Cr. Register, July, 1984, No. 343, eff. 8-1-84.

NR 213.02 Applicability. (1) This chapter is applicable to all new or modified lagoons for the storage or treatment of raw or pretreated wastewater and associated sludges from industrial facilities for which a plan approval under s. 144.04, Stats., and ch. NR 108 is required, except those lagoons listed in sub. (2).

(2) This chapter is not applicable to:

(a) New or existing lagoons licensed under ch. NR 180, 181, 182 or 132.

(b) New lagoons used solely for research purposes under the direction of a Wisconsin registered professional engineer, soil scientist, geologist or a scientist employed by a university located within this state, if approved by the department and provided the following requirements are met:

1. The size of the lagoon does not exceed one acre.
2. The lagoon is developed, operated and maintained in a safe, nuisance-free manner so that no pollutants enter waters of the state.
3. Copies of the research proposal are submitted to the department prior to initiating construction and any resulting reports or publications on the research are provided to the department.

(c) Lagoons designed, constructed and used for the storage of animal wastes.

(3) The department may, on a case-by-case basis, allow less stringent standards than those described in this chapter if it can be demonstrated to the department's satisfaction that the requirements of this chapter are more stringent than necessary to preclude detrimental effects to the groundwaters of the state.

(4) Variances to any requirement in this chapter shall be requested in writing and submitted pursuant to s. NR 213.06 (1). The request shall include all supporting documentation for the variance.

(5) This chapter sets forth specific requirements and specifications for the sampling, testing and construction required for the lining of industrial lagoons. The department's intent in this regard is to match the liner requirements and specifications to the characteristics of the wastewater.

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NR 213.03 Definitions. The following definitions apply to the terms used in this chapter. Definitions of other terms and meanings of abbreviations are set forth in ch. NR 205.

(1) "ASTM" means the American Society for Testing and Materials. Copies of ASTM standards referenced in this chapter are available for inspection at the offices of the department of natural resources, the secretary of state's office and the office of the revisor of statutes. ASTM standards may be obtained from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

(2) "Bedrock" means the rocks that underlie soil material or are at the earth's surface which are encountered when the weathered in-place consolidated material, larger than 2 mm in size, is greater than 50% by volume.

(3) "Coefficient of permeability" means the rate of discharge of water under laminar flow conditions, through a unit cross-sectional area of a porous medium, under a unit hydraulic gradient and standard temperature.

(4) "Detrimental effect" means having a significant damaging impact on groundwater for any present or future consumptive or nonconsumptive uses.

(5) "Groundwater monitoring" means measuring the groundwater level and analyzing samples of water taken from the ground.

(6) "High groundwater level" means either the elevation to which the soil is saturated as observed as a free water surface in an unlined hole, or the elevation to which the soil has been seasonally or periodically saturated as indicated by soil color patterns throughout the soil profile, whichever is higher.

(7) "Lagoon" means a natural or man-made containment structure, constructed primarily of earthen materials and used for the treatment or storage of industrial wastewater.

(8) "Modified lagoon" means any existing lagoon for which a submittal of plans and specifications to the department for the upgrading of that lagoon is required under s. 144.04, Stats., and ch. NR 108.

(9) "Wetlands" has the meaning specified under s. 23.32, Stats.

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NR 213.04 Severability. Should any section, paragraph, phrase, sentence, clause or word of this chapter be declared invalid or unconstitutional for any reason, the remainder of this chapter shall not be affected thereby.

History: Cr. Register, July, 1984, No. 343, eff. 8-1-84.

NR 213.05 General design requirements. (1) LOCATION. (a) Lagoons may not be located closer than:

1. 1,000 feet from a public water supply well.
2. 250 feet from a private water supply well.
3. 500 feet from an inhabited dwelling except that this distance may be reduced with the written consent of the affected property owner.

(b) All lagoons shall conform with the requirements of ch. NR 116.

(c) A lagoon may not be located within wetlands.

(2) BASIC CONSTRUCTION DESIGN. (a) Effective erosion protection of exterior slopes shall be provided by appropriate means, such as riprap or seeding with grass.

(b) Liquid depths shall be maintained as necessary to prevent scouring of the liner and liner cover, discourage vegetative growth, and avoid desiccation and cracking of the liner.

(c) A minimum separation of 5 feet shall be maintained between the bottom of the liner and either bedrock or the high groundwater level, whichever is higher.

(3) GROUNDWATER MONITORING. (a) A groundwater monitoring system designed and constructed in accordance with s. NR 214.12 (2) (d) to (o) and (3) (a), (b), (d) and (e) may be required to provide information on the long term effects of a lagoon on groundwater.

(b) When a groundwater monitoring system is required, the monitoring frequency will be established on a case-by-case basis.

(4) ADDITIONAL REQUIREMENTS. In cases where critical groundwater, geologic or construction conditions warrant, the department may require construction specifications or testing requirements more stringent than those described in this chapter if necessary to preclude detrimental effects to the groundwaters of the state.

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NR 213.06 General submittal requirements. (1) GENERAL. An engineering report and plans and specifications shall be submitted to the department for approval in accordance with s. 144.04, Stats., prior to initiating construction.

(a) It is recommended that whenever possible, a preliminary engineering report outlining the project and including any available information required under par. (b) be made prior to submittal of final plans.

(b) The engineering report shall outline the entire project and include, at a minimum, the following information: subsurface site conditions, waste sources, waste analysis and waste volume; materials and specifications of the proposed liner required under ss. NR 213.07 and 213.08; com-

patibility of the waste and proposed liner and estimated life of the liner required under sub. (4); the proposed method of installation, and the equipment and testing methods to be used for quality control both during and after construction.

(c) The plans and specifications shall include the existing and finished elevations and adequate details to fully illustrate the proposed installation.

(d) When a groundwater monitoring system is required under s. NR 213.05 (3), an engineering report and plans and specifications shall be submitted and shall include: a discussion of the installation, the proposed materials to be used, and the method of construction and location of all proposed wells.

(2) **SUBSURFACE INVESTIGATION.** (a) Reports on subsurface site conditions shall include boring logs, particle size distribution and soil classifications for each major lithologic unit and the depths to groundwater and bedrock when encountered. When on-site soil is proposed as the lining material, compaction curves, permeabilities and Atterberg limits shall be established for the soil proposed for the lining material.

(b) Sufficient soil borings shall be performed at each proposed lagoon site to adequately define the subsurface soil conditions and depth to groundwater and bedrock at the site. A minimum of 3 borings for the first acre and one boring for each additional acre or portion of an acre shall be performed. The borings should be distributed in a grid pattern over the entire site. In no case may less than 3 borings be performed. The department may require additional borings depending upon the size of the lagoon, proposed liner, waste material, or known or anticipated critical hydrogeologic conditions at the site.

(c) All soil borings shall extend a minimum of 10 feet below the proposed base grade of the lagoon, or to groundwater or bedrock, whichever is less.

(d) Soil borings shall be performed by or under the supervision of a qualified soil testing laboratory, engineering firm, or other individual or firm which has demonstrated the capability to perform such work.

(e) Measurement of the resistance of the soil to penetration and the collection of soil samples shall be performed every 5 feet and at all significant changes in soil type or lithology in each soil boring.

(f) All soil samples shall be analyzed for particle size distribution and classified texturally.

(g) When required under s. NR 213.05 (3), groundwater monitoring wells may be installed in the soil boring holes provided these holes are located adequately to assure representative monitoring of both up-gradient and down-gradient groundwater conditions.

(3) **WASTE ANALYSIS.** (a) Representative samples of all wastewater or sludge to be placed in the lagoon shall be analyzed to determine the composition of the samples. Past analyses may be used, provided they are representative of the wastewater to be discharged to the lagoon.

(b) Sludge shall be analyzed on both a total solids and an extracted pore water basis.

(c) The parameters analyzed for may include BOD₅, COD, pH, alkalinity, specific conductance, chloride, sulfate, sodium, calcium, magnesium, total dissolved solids, hardness, or any other constituents or properties known or suspected to be detrimental to the integrity of the proposed liner.

(d) For new facilities, estimated wastewater characterization shall be provided, along with the basis for the estimates.

(4) WASTE AND LINER COMPATIBILITY. (a) Compatibility between the waste and the proposed liner shall be addressed and documented. Prior research or data from similar existing sites shall be included when available. If specific testing is performed, all test procedures used shall be detailed and the results provided.

(b) For synthetic and soil-bentonite liners, written confirmation of compatibility, as well as the estimated design life of the liner against the waste in question, shall be provided by the manufacturer of the synthetic liner or bentonite.

(c) The department may require controlled long term compatibility testing such as column studies, permeability or immersion tests to determine long-term changes in permeability, soil structure or physical properties of the liner.

(5) SAMPLING AND TESTING STANDARDS. (a) Soil samples taken to determine soil classification, particle size distribution or permeability shall be taken in accordance with ASTM D1586 (1974), ASTM D1587 (1974) or ASTM D3550 (1977).

(b) Coefficient of permeability of the constructed soil or soil-bentonite liner shall be determined using a laboratory permeability test on hydrated and saturated specimens of the liner material, compacted at the same approximate density as exists in the in-field condition. Tests may be performed on remolded or core samples. The permeability shall be based on stabilized inflow and outflow rates during the test. Separate tests shall be performed using tap water and the wastewater or sludge extract, and the results compared. All preparation work and information detailing the test apparatus shall be submitted along with all results obtained.

(c) Particle size analyses to determine particle size distribution of soil samples shall be performed in accordance with ASTM D422 (1972).

(d) Plasticity index shall be determined in accordance with ASTM D424 (1971).

(e) Measurement of the resistance of soil to penetration shall be determined in accordance with ASTM D1558 (1977) or ASTM D1586 (1974).

(f) Standard proctor densities shall be determined in accordance with ASTM D698 (1978).

(g) Soils shall be classified texturally according to the Unified Classification System.

(h) In-place density may be determined in accordance with ASTM D2922 (1978) or ASTM D2937 (1976).

(i) Other methods of sampling and testing may be approved by the department on a case-by-case basis.

History: Cr. Register, July, 1984, No. 343, eff. 8-1-84.

NR 213.07 General liner specifications. (1) **GENERAL.** (a) All lagoons shall be sealed to prevent excessive exfiltration.

1. Natural soil materials, soil-bentonite mixtures or synthetic liners approved by the department may be used as lagoon liners.

2. All liners shall be constructed with materials compatible with the wastewater to be contained by the lagoon.

3. Prior to installation of any type of liner, the lagoon bottom shall be compacted to a depth of 6 inches, at a minimum to 95% of the maximum standard proctor dry density, at or above optimum moisture.

4. All liners shall be constructed to provide a uniform barrier to exfiltration across the lagoon bottom, interior dike walls and extending up the dike wall to the berm.

5. The department may require a liner to be protected by an inorganic layer of soil or crushed stone if necessary to protect against such things as photochemical reaction, ice or wave action, freeze-thaw action, liner floatation or vehicular traffic on the liner. This layer shall have a minimum thickness of one foot and be uniformly graded and free from large rocks, soil clumps and sticks. If a granular noncohesive soil is used, the department may require that a soil fabric securely attached to the berm be placed between the liner and the cover material to prevent slumping of the cover material.

6. Riprap may be required along the air-water interface if necessary to minimize rodent activity or exposure and erosion of the liner or subgrade.

7. For lagoons which will be empty for extended periods of time, a synthetic lining material shall be used to prevent liner degradation as a result of desiccation.

(b) Soil or soil-bentonite liners. 1. The design standard for the coefficient of permeability of soil or soil-bentonite liners may not exceed 1×10^{-7} cm/sec.

2. The thickness of soil or soil-bentonite liners shall be determined according to Darcy's equation and shall include an appropriate safety factor for construction variability. See Table 1 below.

Table 1

MINIMUM REQUIRED LINER THICKNESS (INCHES)
FOR NATURAL SOIL AND SOIL-BENTONITE LINERS

Coefficient of Permeability of the Liner cm/sec (ft./day)	Wastewater Depth (ft.)							
		4	6	8	10	12	14	16
1×10^{-7} (2.82×10^{-4})		12	16	20	25	29	34	38
5×10^{-8} (1.41×10^{-4})		12	12	12	13	16	18	20

For all permeabilities less than those shown above, regardless of the wastewater depth, the minimum liner thickness shall be 12 inches.

3. To a depth of 6 inches, a minimum of 15% of the unmodified soil upon which a soil or soil-bentonite liner is to be constructed shall pass a No. 200 sieve. If this requirement cannot be met, a soil filter fabric designed to retain those particles passing a No. 200 sieve shall be placed between the liner and the existing soil.

4. Soil or soil-bentonite liners shall be compacted at or above optimum moisture.

5. A means shall be provided to prevent soil or soil-bentonite liners from disiccating after completion of construction and prior to placing the lagoon into operation.

(2) EXFILTRATION RATE. (a) The design loss of wastewater or sludge from any lined lagoon may not exceed 500 gallons per acre per day.

(b) In circumstances where soil characteristics, groundwater quality, waste characteristics or concern with the liner-waste compatibility warrant, the department may require that more stringent exfiltration rates be met.

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NR 213.08 Specific liner specifications. (1) NATURAL SOIL LINER SPECIFICATIONS. (a) Natural soil liners shall consist of soils of which a minimum of 50% of the soil particles pass a No. 200 sieve.

(b) Natural soil to be used as a liner shall contain less than 2% organic material, and less than 5% by weight of the natural soil to be used shall be retained on a No. 4 sieve.

(c) Natural soil to be used as a liner shall have a plasticity index of at least 15.

(d) Natural soil liners shall be compacted to at least 95% of the maximum standard proctor dry density.

(e) Natural soil liners shall be constructed and compacted in lifts. A lift may not exceed a compacted thickness of 6 inches.

(f) Frost susceptible soils may not be used to construct a natural soil liner. Silts and silty sands shall be considered frost susceptible.

(g) When constructing natural soil liners with native in-place soils, the subbase shall be scarified prior to compaction. Subsequently, the existing base shall be scarified prior to placement of each successive lift.

(h) Natural soil liners shall be constructed under the direct supervision of a qualified soils technician or engineer, or geotechnical engineer.

(2) SOIL-BENTONITE LINERS. (a) The soil to be mixed with the bentonite shall have a plasticity index of at least 12, a minimum of 30% of the soil by weight shall pass a No. 200 sieve, and less than 5% by weight shall be retained on a No. 4 sieve.

(b) Bentonite shall be applied at a rate recommended by the manufacturer or an independent soil expert. Completed soil-bentonite liners shall contain a minimum of 5% bentonite by dry weight.

(c) Ninety percent of the bentonite by weight shall pass a No. 80 sieve.

(d) Bentonite shall be thoroughly admixed with the soil throughout the entire thickness of each lift.

(e) Soil-bentonite liners shall be compacted to at least 85% of the maximum standard proctor dry density.

(f) Soil-bentonite liners shall be constructed under the direct supervision of a qualified representative of the bentonite manufacturer, soil technician or engineer, or geotechnical engineer.

(3) SYNTHETIC LINERS. (a) Synthetic liners shall have a minimum thickness of 30 mils.

(b) Synthetic liners shall be installed under the direct supervision of a qualified manufacturer's representative.

(c) To a depth of 6 inches below the bottom of synthetic liners, the soil shall be free from large rocks, angular stones, soil clumps, sticks or other material which may puncture the liner.

(d) Synthetic liners shall be securely anchored into the dike berm.

(e) Venting shall be provided beneath synthetic liners to prevent failure as a result of backpressure from gas accumulation or fluctuations in the watertable elevation. If a liner cover is provided, this requirement may be waived.

(f) Prior to constructing synthetic liners, the underlying soils shall be treated with an herbicide in accordance with the manufacturer's recommendations.

History: Cr. Register, July, 1984, eff. 8-1-84.

NR 213.09 Quality assurance and testing requirements. (1) GENERAL. (a) All liners shall be tested before the lagoons are put into operation to ensure that all performance standards and design specifications as approved have been met. A post-construction report shall be submitted to the department for approval prior to discharging any wastes into the lagoons. The report shall include: all material test results required under sub. (2) or (3); plan sheets illustrating final elevations, slopes and test locations; a discussion of weather conditions and any unexpected conditions encountered during construction.

(b) Testing shall be performed in accordance with sub. (2) or (3), or any other method approved by the department.

(c) All tests shall be performed under the direct supervision of the design engineer except for tests on synthetic or soil-bentonite liners, which shall be performed under the direct supervision of a representative of the manufacturer unless otherwise specified by the department in the plan approval.

(2) SOIL OR SOIL-BENTONITE LINERS. (a) Following completion of construction and prior to being put into use, core samples of soil or soil-bentonite liners shall be taken in accordance with ASTM D1587 (1974). A minimum of 5 samples per acre of liner surface shall be taken. The samples shall be split proportionately between the wetted areas of the bottom and interior walls of the dikes relative to the total area of each and spaced to provide representative samples of the liner. For lagoons less than one acre in size, a minimum of 5 samples shall be taken.

(b) The core samples shall be tested by a soil testing laboratory or engineering firm for the following parameters: dry unit weight density, moisture content, degree of compaction, liner thickness, particle size distribution and Atterberg limits. Additionally, permeability tests shall be performed on a minimum of 3 of every 5 core samples. The design standards for liner thickness and permeability shall be considered met if:

1. The average thickness of soil or soil-bentonite liners and cover samples, analyzed separately, are equal to or greater than the specified design thickness; and

2. An individual sample does not have a thickness which is less than the design thickness by more than 0.1 foot; and

3. The permeability of at least 60% of the liner samples tested are equal to or less than the design permeability; and

4. An individual sample does not have a permeability more than one order of magnitude greater than the design permeability.

(c) All test holes shall be backfilled using materials identical to the liner design materials and compacted.

(3) SYNTHETIC LINERS. (a) Subsequent to installation of synthetic liners and prior to placement of the liner cover, all field constructed seams shall be tested in accordance with the manufacturer's recommendations to insure the integrity of the liner. All faulty seams shall be repaired and retested until a proper seal is obtained.

History: Cr. Register, July, 1984, No. 343, eff. 8-1-84.