(b) *Discharge limitations for overland flow systems.* Effluent limitations are as specified in s. NR 206.08 (4) (b) and applicable surface water limitations.

History: Cr. Register, November, 1990, No. 419, eff. 12-1-90.

NR 110.26 Sludge handling, storage and disposal. (1) DESIGN REPORT. A design report shall be submitted in accordance with s. NR 110.15 (1). The report shall show calculations used to design the sludge facilities. Design of sludge handling facilities shall consider such factors as the volume of sludge generated, its percent solids and character, the degree of volatile solids reduction, sludge temperature, the degree or extent of mixing to be obtained, the sludge percent solids and characteristics after processing and the size of the installation with appropriate allowances for sludge and supernatant storage and energy requirements whenever such factors are appropriate for the design of the sludge processing facilities.

(2) GENERAL DESIGN CONSIDERATIONS. (a) *Grit removal.* When grit removal facilities are not provided, the volume of thickeners, digesters and storage facilities shall be increased to accommodate the additional solids loading.

(b) *Sludge thickening.* 1. Whenever practical, sludge thickening shall be provided.

2. Thickened sludge should have a minimum solids concentration of 5% prior to transmission to the digesters.

(c) *Multiple units.* Multiple units shall be provided. A single unit may be allowed, provided an alternate method of sludge processing, emergency storage or ultimate disposal operation exists to insure continuity of service.

(d) *Maintenance.* 1. Provisions shall be made for draining, cleaning, inspection, and maintenance of all units.

2. Tank bottoms shall be sloped to drain to a sump pump or withdrawal pipe.

3. Access manholes shall be provided. Covered tanks shall have one side wall entrance large enough to permit the use of mechanical equipment to remove grit and sand.

(e) *Storage facilities.* 1. The construction of sludge storage facilities may be required to improve sludge handling capabilities, provide flexibility in operations, and to avoid environmental or public health hazards due to improper disposal techniques.

2. Construction of these facilities will depend upon treatment plant capabilities, land availability, surface and groundwater protection, health factors, municipal sludge management capabilities and other environmental factors.

(3) GENERAL DESIGN REQUIREMENTS. (a) *Flow measurement.* Devices for measuring flow to and from sludge digestion facilities shall be provided.

(b) *Ventilation.* All enclosures which are connected with sludge digestors, or which contain sludge or gas piping or equipment shall be provided with forced ventilation in accordance with s. NR 110.14 (3) (b). The piping gallery for digesters may not be connected to other passages unless a tightly fitting self-closing door is provided at connecting passageways.

(c) *Safety.* Nonsparking tools, rubber soled shoes, safety harness, gas detectors for inflammable and toxic gases and at least 2 self-contained respiratory units should be provided for emergency use whenever inflammable and toxic gases may be present.

(d) *Supernatant withdrawal.* Sludge thickeners and aerobic digestors shall be designed for effective separation and withdrawal of supernatant and for effective collection and removal of scum and grease.

(e) *Sampling.* 1. Provisions shall be made for sampling at each supernatant draw-off level and for collecting sludge samples for analysis. Sampling pipes shall be at least 4 centimeters (1½inches) in diameter and shall terminate in a suitably-sized sink or basin.

2. Unless sampling facilities are otherwise provided, quick-closing sampling valves shall be installed at the sludge pumps. The size of valve and piping shall be at least 4 centimeters (1inches).

(f) *Chemical handling.* Chemical handling facilities shall meet the provisions of s. NR 110.22.

(4) SLUDGE PUMPS AND PIPING. (a) *Sludge pumps.* 1. Sludge pumping systems shall be designed to handle the expected range of sludge flows.

2. Multiple pumps shall be provided.

3. Pumps with demonstrated solids handling capability shall be provided for handling raw and processed sludge.

4. A minimum positive head of 60 centimeters (2 feet) shall be provided at the suction side of centrifugal-type pumps and is desirable for all types of sludge pumps. Maximum suction lifts may not exceed 3.0 meters (10 feet) for plunger pumps.

(b) *Sludge piping.* 1. Sludge withdrawal piping shall have a minimum diameter of 20 centimeters (8 inches) for gravity withdrawal and 15 centimeters (6 inches) for pump suction and discharge lines. The department may approve the use of glass lined pipe which is at least 10 centimeters (4 inches) in diameter. Where withdrawal is by gravity, the available head on the discharge pipe shall be sufficient to maintain a minimum velocity of 90 centimeters (3 feet) per second.

2. Gravity piping shall be laid on uniform grade and alignment. The slope on gravity discharge piping may not be less than 3%.

3. Provisions shall be made for draining, flushing and cleaning sludge piping.

4. Air relief valves shall be provided at high points in pressure sludge lines.

5. Special consideration shall be given to the corrosion resistance and continuing stability of pipes and supports located inside the digestion tank.

(5) ANAEROBIC DIGESTION. (a) *General.* 1. Anaerobic digesters which will also serve as supernatant separation tanks shall have a minimum side water depth of 6 meters (20 feet).

2. Multiple sludge inlets and draw-offs shall be provided. Multiple recirculation suction and discharge points to facilitate flexible operations and effective mixing of the

digester contents shall be provided unless adequate mixing facilities are provided within the digester. One sludge inlet shall discharge above the liquid level and be located at approximately the center of the tank to assist in scum breakup. Raw sludge inlet discharge points shall be so located as to minimize short circuiting to the supernatant draw-off. Sludge withdrawal for disposal shall be from the bottom of the tank. The pipe shall be interconnected with the recirculation piping to increase flexibility in mixing tank contents.

(b) *Tank capacity.* 1. The total digestion tank capacity shall be calculated based upon the factors indicated in sub. (1). If such calculations are not done, the following minimum requirements shall be met:

a. A minimum detention time of 15 days at design flows shall be provided;

b. Completely mixed digestion systems shall provide for intimate and effective mixing to prevent stratification and to assure homogeneity of digester content. The maximum system loading shall be 1.28 kilograms per cubic meter per day (80 pounds of volatile solids per 1,000 cubic feet of volume per day) in the digester;

c. The maximum system loading for moderately mixed digestion systems in which mixing is accomplished only by circulating sludge through an external heat exchanger shall be 0.64 kilograms per cubic meter per day (40 pounds of volatile solids per 1,000 cubic feet of volume per day) in the digester; and

d. The loading rates indicated in subds. 2., 3., and 4. assume that the raw sludge is derived from ordinary domestic wastewater. The loading may be modified upward or downward depending upon the degree of mixing provided. Where mixing is accomplished by other methods, loading rates may be approved on the basis of information submitted justifying the design.

(c) *Temperature.* Heating equipment shall have the ability to maintain digestion temperature in the range of 33° to 38°C (90° to 100°F).

(d) *Gas collection, piping and appurtenances.* 1. All portions of the gas system, including the space above the tank liquor, storage facilities and piping shall be so designed that under normal operating conditions, including sludge withdrawal, the gas will be maintained under positive pressure. All enclosed areas where any gas leakage might occur shall be ventilated.

2. Safety facilities shall be included where gas is produced. Pressure and vacuum relief valves and flame traps, together with automatic safety shut off valves, shall be provided. Waterseal equipment may not be installed. Gas compressors with gas safety equipment should be housed in a separate room with an exterior entrance.

3. The diameter of gas piping shall be based on the volume of gas which will be generated. Gas piping shall slope to condensate traps. The use of float-controlled condensate traps is prohibited.

4. Gas burning boilers, engines and other units using gas as a fuel shall be located in ventilated rooms, preferably at ground level and shall be isolated in accordance with the provisions of s. ILHR 54.14. Gas lines to these units shall be provided with suitable flame traps.

5. Electrical fixtures and controls in enclosed places where gas may accumulate shall comply with the national electrical code requirements for class 1, group D, division 2 locations.

6. Waste gas burners shall be readily accessible and shall be located at least 7.6 meters (25 feet) away from any plant structure if placed at ground level. Waste gas burners may be located on the roof of the control building if sufficiently removed from the tank. All waste gas burners shall be equipped with automatic ignition, such as a pilot light or a device using a photoelectric cell sensor. Consideration should be given to the use of natural or propane gas to insure reliability of the pilot light. If the waste gas burner is in a remote location, the department may approve the discharge of gas to the atmosphere through a return-bend screened vent terminating at least 3 meters (10 feet) above the walking surface, provided the assembly incorporates a flame trap.

7. A gas meter with by-pass shall be provided to meter total gas production. Additional gas meters may be required to measure gas usage.

(e) *Digestion tank heating.* 1. Whenever possible, digestion tanks shall be constructed above groundwater level. Digestion tanks shall be insulated to minimize heat loss.

2. Piping shall be designed to provide for the heating of feed sludge before introduction to the digesters. Heat exchanger sludge piping shall be sized for heat transfer requirements.

3. Sufficient heating capacity shall be provided to consistently maintain the design sludge temperature. Where digestion tank gas is used for other purposes, an auxiliary fuel supply shall be provided.

4. Consideration should be given to equipping hot water internal heating controls with an automatic mixing valve to temper the boiler water with return water so that the inlet water to the heat jacket can be maintained between 49° to 55°C (120° to 130°F) to prevent excessive caking or encrustation of sludge on the heat jacket. Manual controls shall also be provided.

5. The boiler shall be provided with automatic controls to maintain the boiler temperature at approximately 82°C (180°F). Automatic controls shall also be provided to shut off the main gas supply in the event of pilot burner or electrical failure, low boiler water level or excessive temperature.

6. Thermometers shall be provided to show temperatures of the sludge, hot water feed, hot water return and boiler water.

(f) *Supernatant withdrawal.* 1. Supernatant piping shall be 15 centimeters (6 inches) in diameter, or larger.

2. Piping shall be arranged so that withdrawal can be made from 3 or more levels in the tank. A positive unvalved vented overflow shall be provided.

3. If a supernatant selector is provided, provisions shall be made for at least one other draw-off level located in the supernatant zone of the tank in addition to a positive unvalved vented overflow pipe. High pressure backwash facilities shall be provided.

(6) AEROBIC SLUDGE DIGESTION. (a) *General.* 1. Aerobic digesters shall be designed to provide effective air mixing, reduction of organic matter, supernatant separation and sludge concentration.

2. The digester detention time may be calculated based upon the factors indicated in subd. 1. If such calculations are not done, the following minimum requirements shall be met:

a. A minimum of 15 days detention time shall be provided for waste activated sludge and 20 days for primary sludge or a combination of primary and waste activated sludge. Where sludge temperature is lower than 10°C (50°F), additional time shall be provided; and

b. The volatile suspended solids loading may not exceed 1.60 kilograms per cubic meter per day (100 pounds per 1,000 cubic feet per day) in the digestion unit. Lower loading rates may be necessary depending on temperature, type of sludge and other factors.

3. The aeration system for aerobic digesters shall be capable of meeting the oxygen requirements of par. (b), or the mixing requirements of par. (c), whichever is greater.

(b) *Oxygen demand.* 1. Aeration systems shall be capable of maintaining a minimum digester dissolved oxygen concentration of one milligram per liter.

2. In the absence of experimentally determined values, the design oxygen requirements for aerobic digesters shall be 2.0 kilograms oxygen per kilogram (2.0 pounds oxygen per pound) anticipated volatile suspended solids reduction. An additional 1.8 kilograms oxygen per kilogram (1.8 pounds oxygen per pound) of BOD_5 applied to the digester by primary sludge shall be supplied.

3. The design of the aeration system to meet the digester oxygen requirements shall comply with the provisions of s. NR 110.21 (5) (c).

(c) *Mixing requirements.* 1. Digestion tanks shall be designed for effective mixing.

2. Diffused aeration systems shall be capable of delivering a minimum air flow rate of 30 cubic meters per minute per 1,000 cubic meters (30 cubic feet per minute per 1,000 cubic feet) of digester volume.

3. Mechanical aerators shall deliver 26.3 kilowatts per 1000 cubic meters (1.0 horsepower per 1,000 cubic feet) of digester volume.

(d) *Aeration equipment.* Aeration equipment needed to meet the requirements of pars. (b) and (c) shall comply with the provisions of s. NR 110.21 (6).

(e) *Supernatant withdrawal.* Aerobic digesters shall be equipped for supernatant draw-off. It is recommended that multi-level draw-off be provided.

(7) OTHER SLUDGE STABILIZATION PROCESSES. (a) *Lime stabilization.* Sufficient lime shall be added to produce a pH of 12 after 2 hours of contact.

(b) *Composting.* Static aerated pile, within vessel, or windrow composting methods shall be maintained at a minimum operating temperature of 40°C (104°F) for at least 5 days. For 4 hours during this period the temperature must exceed 70°C (158°F). Composting design, siting and operation shall be done in accordance with chs. NR 500 to 520.

(c) *Other methods.* Other methods or operating conditions may be acceptable for sludge stabilization if pathogens and volatile solids are reduced to an extent equivalent to anaerobic digestion.

(8) SLUDGE DEWATERING. (a) *Sludge drying beds.* 1. The drying bed area shall be calculated based upon such factors as climatic conditions, character and volume of sludge to be dewatered, the method and character of sludge removal and other methods of sludge disposal. At least 0.19 square meters (2 square feet) of drying bed area per capita population equivalent shall be provided when the drying bed is the primary method of dewatering, and 0.09 square meters (1 square foot) per capita population equivalent if it is to be used as a back-up dewatering unit. The bed area shall be increased by 25% if the beds are paved.

2. At least 2 drying beds shall be provided.

3. Percolation type drying beds shall meet the following conditions:

a. The lower course of gravel around the underdrains shall be properly graded and shall be at least 30 centimeters (one foot) in depth, extending at least 15 centimeters (6 inches) above the top of the underdrains. It is desirable to place this in 2 or more layers. At least 8 centimeters (3 inches) of the top layer shall consist of gravel 3 to 6 millimeters (⅛ to ¼ inches) in size.

b. The top course shall consist of at least 15 to 23 centimeters (6 to 9 inches) of clean, medium to coarse, sand with a grain size of 1 to 3 millimeters in diameter. The finished sand surface shall be level.

c. Underdrains shall be clay pipe or concrete drain tile at least 10 centimeters (4 inches) in diameter laid with open joints. Underdrains shall be spaced not more than 6 meters (20 feet) apart.

d. An impervious layer shall be provided immediately beneath the lower course to prevent the downward movement of filtrate into the groundwater.

4. Paved surface drying beds may be used if adequate center or side drains are provided. If partially paved drying beds are used, they shall be designed with consideration for space requirement to operate mechanical equipment for removing the dried sludge.

5. Sludge influent piping to the beds shall terminate at least 30 centimeters (one foot) above the surface and be so arranged that the beds will drain. Concrete splash plates for percolation type beds shall be provided at sludge discharge points.

6. Walls shall be watertight and extend 38 to 46 centimeters (15 to 18 inches) above and at least 15 centimeters (6 inches) below the surface of the beds. Outer walls shall be curbed to prevent soil from washing onto the beds.

7. Drying beds shall be arranged to facilitate sludge removal. Concrete truck tracks shall be provided for all sludge beds. Pairs of tracks shall be on 6 meter (20-foot) centers.

(b) *Sludge drying lagoons.* The bottom of the lagoons must be at least 1.25 meters (4 feet) above the maximum

seasonal high groundwater level and at least 3 meters (10 feet) above bedrock. The bottom of the lagoons shall be constructed in accordance with s. NR 110.28.

2. Lagoons may not be more than one meter (39 inches) in depth.

3. The area required will depend on design conditions. At least 2 lagoons shall be provided.

4. Lagoons shall be adequately isolated to avoid creating nuisances.

(c) *Mechanical dewatering facilities.* 1. General. Provision shall be made to maintain sufficient continuity of service so that sludge may be dewatered without accumulation beyond storage capacity. Design calculations or pilot plant data shall be submitted to justify the basis of design and equipment.

2. The capacity of vacuum filters, centrifuges, filter presses, belt filters or other mechanical dewatering facilities shall be sufficient to dewater the sludge produced with the largest unit out of service.

3. There shall be provided at least one back-up vacuum pump and one back-up filtrate pump for each vacuum filter installation. The vacuum filter shall be designed to allow for the easy removal and replacement of the vacuum pump and filtrate pump.

4. The dewatering area shall be ventilated.

(d) *Drainage and filtrate disposal.* The drainage from drying beds or shallow lagoons and the filtrate from dewatering units shall be returned to the sewage treatment process at appropriate points.

(e) *Other dewatering facilities.* If other methods of reducing the quantity of sludge are proposed, a detailed description of the process and design data shall accompany the plans.

(9) SLUDGE REDUCTION. (a) *Incineration.* Adequate provisions for residue disposal and air pollution control shall be provided. The appropriate requirements of chs. NR 415 and 500 to 520 shall be met.

(b) *Other reduction facilities.* If other methods of reducing the quantity of sludge are proposed, a detailed description of the process and design data shall accompany the plans.

(10) SLUDGE STORAGE FACILITIES. (a) *General.* A detailed description of the wastewater treatment process and design data shall accompany plans for the proposed storage facility. Sludge storage facilities shall be designed and operated to maintain compliance with the groundwater quality standards in ch. NR 140.

(b) *Separation distances.* 1. Sludge storage facilities may not be located within the following distances of a water supply well.

a. 1000 feet from a community public water supply well;

b. 250 feet from a private water supply well;

2. Separation distances from residential and commercial buildings shall be maintained as required in s. NR 110.15 (3) (d).

3. A minimum separation distance of 1.25 meters (4 feet) shall be maintained between the bottom of storage lagoons and the highest recorded or indicated seasonal groundwater table elevation.

4. A minimum separation distance of 3 meters (10 feet) shall be maintained between the bottom of storage lagoons and bedrock.

(c) *Liquid sludge storage facilities.* 1. Liquid sludge storage facilities shall be designed to facilitate easy addition and removal of sludge without causing damage to the facility.

2. Liquid sludge storage lagoons and pits shall be designed and constructed in accordance with s. NR 110.24.

3. The maximum lagoon depth shall be 6 meters (20 feet). The depth may be increased by the department on a case-by-case basis.

4. Storage tanks shall be designed, installed and maintained to prevent leaks due to corrosion or structural failure.

5. In the event a sludge storage facility is temporary, it shall be abandoned in such a manner so as to prevent safety, environmental and aesthetic problems from occurring. The department shall be notified in writing if the storage facility is to be abandoned and how abandonment will be accomplished.

(d) *Cake storage facilities.* 1. Permanent and temporary cake storage facilities shall be designed to minimize odors and to protect surface waters, groundwaters and soil.

2. Surface runoff shall be diverted away from the storage location.

3. Cake storage facilities designed as pits shall provide a method of draining-off and collecting precipitation.

4. All sludge stored at an intermediate term cake storage facility shall be covered with a temporary cover. At a minimum, the cover shall be a 4 mil polyethylene cover or equivalent. The cover shall be anchored or otherwise secured.

5. All sludge stored at a long term cake storage facility shall be covered with a permanent cover.

6. Abandonment shall be accomplished in accordance with s. NR 110.26 (10) (g).

(e) *Monitoring wells.* Monitoring wells may be required on a case-by-case basis. Construction of monitoring wells shall comply with the requirements of s. NR 110.25 (5) and ch. NR 141.

(f) *Amount of storage.* Appropriate sludge storage and length of storage shall be evaluated according to the following priority:

1. POTW's that produce sludge and are in the process of upgrading their wastewater treatment facilities and are proposing to or are currently landspreading sludge will be required to provide adequate storage capacity for the 20 year design life as required under facilities planning. Long term sludge storage facilities for liquid or cake sludge shall be designed to provide capacity for 180 days of storage. Lesser storage capacity, but in no case less that 150 days, may be approved upon evaluation of the local

soil and climatic conditions, the availability of suitable winter sludge disposal sites or other pertinent considerations. This storage capacity may not include storage in clarifiers, oxidation ditches or aeration basins. However, extra digester capacity that is greater than the digestive requirements can be considered as storage and can be used in calculating the 150 or 180 days of storage. The department may determine leasing to be an acceptable alternative to construction if the lease is for a minimum of 5 years with an option for another 5 years if the WPDES permit is reissued.

2. For those POTW's not upgrading their facilities, and who have 5 or more years of remaining design life of POTW but need additional sludge storage, an engineering report shall be submitted regarding the upgrading of the sludge storage capacity. POTW's that are not upgrading their facilities but are having sludge management problems due to lack of storage will be required to either: a) build 150 to 180 days of storage or b) lease for 150 to 180 days of storage covering the facilities' projected 5 to 10 year sludge production needs. The storage requirement will be based on the projected remaining design life left in the POTW and would be as follows:

Remaining Design life of POTW	DESIGN YEAR STORAGE REQUIREMENTS
0 to 5 years	Take action to address immediate needs and start facility planning
5 to 10 years	10 years
10 to 15 years	15 years
15 to 20 years	20 years

3. Facilities that are not in the process of upgrading their wastewater treatment facility and are not encountering sludge land disposal problems even though the facility has less than 150 or 180 day storage capacity are not required to expand their sludge storage capacity. If necessary, the department may require additional storage at such time as federal sludge regulations require.

(11) TRANSPORTATION OF SLUDGES. (a) *Liquid.* 1. Liquid sludge shall be transported in an enclosed watertight unit from treatment plant to disposal site.

2. The department recommends that all sludge field spreading equipment be provided with a control so that the discharge valve can be opened and closed by the driver while the vehicle is in motion.

(b) *Semi-solid cake.* Sludge cake shall be transported in a covered watertight unit to prevent leakage of sludge moisture released in transit. Provision shall be taken to prevent the spilling of sludge from the vehicle while in transit and to prevent an odor nuisance while in transit.

(12) ULTIMATE DISPOSAL. (a) *Sludge management.* 1. The owner of a municipal wastewater treatment plant shall be responsible for compliance with WPDES permit sludge management reporting requirements.

2. The owner of the municipal wastewater treatment plant shall be responsible for the implementation of the sludge management plan in accordance with WPDES permit requirements.

3. The department shall evaluate sludge management plans and reports according to the requirements of ch. NR 204 and any other pertinent information deemed appropriate to the review of sludge management plans and reports.

4. Sludge management program requirements shall include the submission of the following reports if required by the WPDES permit plus any additional information which the department may require:

a. General sludge management information;

b. Sludge characteristics;

c. Landfilling and public use;

d. Agricultural site characteristics and operations; and,

e. Sludge disposal records.

(b) *Landspreading.* Landspreading and storage of sludge from municipal wastewater treatment facilities shall be done in accordance with WPDES permit requirements and subs. (10) and (11).

(c) *Landfilling.* Landfilling of sludge from municipal wastewater treatment facilities shall comply with the requirements of chs. NR 500 to 520.

(d) *Other disposal.* All other disposal options shall be carried out in compliance with all applicable state and federal regulations.

History: Cr. Register, November, 1974, No. 227, eff. 12-1-74; r. and recr. Register, February, 1983, No. 326, eff. 3-1-83, am. (9), (12) (a) 3. and (c), r. and recr. (10) and cr. (12) (d), Register, November, 1990, No. 419, eff. 12-1-90; **correction in (7) (b) made under s. 13.93 (2m) (b) 7., Stats., Register, September, 1995, No. 477.**

NR 110.27 Requirements for certified or registered laboratory. Bacteriological analyses of groundwater samples, and all radiological analyses, shall be performed by the state laboratory of hygiene or a laboratory certified or approved by the department of health and social services. Other laboratory test results for those pollutants which are required by the WPDES permit to be monitored and which are submitted to the department in support of facility plans or plans and specifications under this chapter shall be performed by a laboratory certified or registered under ch. NR 149. The department may require, on a case-by-case basis, that certain other laboratory test results submitted to the department be performed by a certified or registered laboratory. The following tests are excluded from this requirement:

(1) Temperature,

(2) Turbidity,

(3) Bacteria tests in wastewater effluent,

(4) pH,

(5) Chlorine residual,

(6) Specific conductance,

(7) Physical properties of soils and sludges,

(8) Nutrient tests of soils and sludges,

(9) Flow measurements.

Note: The requirement in this section to submit data from a certified or registered laboratory is effective on August 28, 1986.

History: Cr. Register, April, 1986, No. 364, eff. 8-28-86.