sludge pumps. The size of valve and piping shall be at least 1½ inches.

(b) *Sludge piping.* 1. Size and head. Sludge withdrawal piping shall have a minimum diameter of 8 inches for gravity withdrawal and 6 inches for pump suction and discharge lines. Where withdrawal is by gravity, the available head on the discharge pipe shall be at least 4 feet.

2. Slope. Gravity piping shall be laid on uniform grade and alignment. Slope on gravity discharge piping shall not be less than 3%. Provisions shall be made for drainage and flushing discharge lines.

Note: The department recommends that air relief at high points in a pressure sludge line be provided.

(4) SLUDGE DEWATERING. (a) *Sludge drying beds.* 1. Area. At least one square foot of drying bed area per capita shall be provided. If necessary, wet sludge shall be hauled.

2. Percolation type. a. The lower course of gravel around the underdrains shall be properly graded and shall be at least 12 inches in depth, extending at least 6 inches above the top of the underdrains.

Note: It is desirable to place this in 2 or more layers. The top layer of at least 3 inches shall consist of gravel ⅛ inch to ¼ inch in size.

b. The top course shall consist of at least 6 to 9 inches of clean coarse sand. The finished surface shall be level.

c. Underdrains shall be at least 4 inches in diameter laid with open joints. Underdrains shall be spaced not more than 20 feet apart.

3. Impervious types. Paved surface beds may be used if adequate center or side drains are provided. Special consideration shall be given to the total bed area required.

4. Walls. Walls shall be watertight and extend 15 to 18 inches above and at least 6 inches below the surface. Outer walls shall be curbed to prevent soil from washing onto the beds.

5. Sludge removal. Not less than 2 beds shall be provided and they shall be arranged to facilitate sludge removal. Concrete truck tracks shall be provided for all percolation type sludge beds. Pairs of tracks for percolation type beds shall be on 20-foot centers.

6. Sludge influent. The sludge pipe to the beds shall terminate at least 12 inches above the surface and be so arranged that it will drain. Concrete splash plates for percolation type beds shall be provided at sludge discharge points.

(b) *Sludge lagoons.* The use of shallow sludge drying lagoons in lieu of drying beds is permissible subject to the following conditions:

1. Soil and groundwater conditions. The soil must be reasonably porous and the bottom of the lagoons must be at least 3 feet above the maximum groundwater table and at least 5 feet above bedrock. Surrounding areas shall be graded to prevent surface water entering the lagoon.

2. Depth. Lagoons shall not be more than 36 inches in depth.

3. Area. The area required will depend on design conditions. Not less than 2 lagoons shall be provided.

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

(c) *Mechanical dewatering facilities.* Provision shall be made to maintain sufficient continuity of service so that sludge may be dewatered without accumulation beyond storage capacity. Vacuum filters, sludge presses or other appropriate mechanical dewatering facilities may be approved where sufficient pilot data is presented to justify the design.

(d) *Drainage and filtrate disposal.* Drainage from beds or filtrate from dewatering units shall be returned to the raw sewage inlet to the treatment plant.

(e) *Other dewatering facilities.* If it is proposed to dewater or dispose of sludge by other methods, a detailed description of the process and design data shall accompany the plans.

(5) SLUDGE REDUCTION. (a) *Incineration.* Adequate provisions for residue disposal and air pollution control shall be provided. The appropriate requirements of Wis. Adm. Code chapter NR 154 shall be met.

(b) *Other reduction facilities.* If it is proposed to reduce the quantity of sludge by other methods, a detailed description of the process and design data shall accompany the plans.

(6) SLUDGE MANAGEMENT. (a) *General requirements.* 1. A sludge management plan shall be developed by each owner of a wastewater treatment plant and submitted to the department pursuant to conditions imposed in the WPDES permits. The department shall evaluate the plan for adequacy. If the department determines that the plan described an acceptable sludge management plan, it will issue a letter of approval to the owner.

2. If the plan as submitted is determined by the department to be unacceptable, it shall be returned to the owner of the wastewater treatment plant for revision and resubmittal. At any time after a plan has been found to be unacceptable, the department may issue an order requiring submittal of an acceptable plan.

3. The owner of the wastewater treatment plant shall be responsible for the implementation of the approved sludge management activities. An owner of a wastewater treatment plant may at any time amend the sludge management plan, subject to the approval of the department. Any proposed amendment shall contain the same type of information required in the original management plan. The amended plan may not be put into effect until it has received approval from the department.

4. The department shall evaluate the management plans on the basis of recommendations in Wisconsin department of natural resources (DNR) technical bulletin no. 88 and any other pertinent information deemed appropriate to the review of sludge management plans.

(b) *Sludge management plan requirements.* The sludge management plan shall include but not be limited to the following:

1. Provision for interim sludge storage when normal disposal sites are unavailable or inaccessible, including:

a. Type of storage

b. Location of storage

c. Capacity of facility

d. Construction details

e. Property interest or contractual agreement allowing use of the facility

f. Future use of the storage facility

g. Evaluation of environmental effects

2. Description of sludge characteristics, including:

a. The type of wastewater treatment provided resulting in sludge generation

b. The type of sludge treatment prior to disposal

c. The physical and chemical characteristics of typical sludge samples taken at intervals specified in the WPDES permit. The parameters analyzed shall include all or parts of the following:

1) Physical (solids fraction, organic fraction, others)

2) pH

3) Nutrient content (nitrogen, phosphorous, potassium, others)

4) Metals content (As, Cd, Cr, Cu, Pb, Hg, Ni, Zn, others)

5) Salt content (chlorides, fluorides, sulfates, others)

6) Biological populations (total coliform, fecal coliform, virus, others)

7) Other parameters such as oils and greases, phenolics, pesticides, toxic substances.

8) Any other parameters deemed necessary by the department on a case-by-case basis.

d. The volume or quantity of sludge generated on a daily, monthly and annual basis.

3. Proposed mode of sludge transportation, including:

a. The transporter of the sludge.

b. The method of transportation.

c. The type of vehicle used for transportation of the sludge.

4. Information about the ultimate disposal site. a. If sludge will be disposed of at one or more licensed landfill sites, the amount to be disposed of at each site, the site names and license numbers, con-

tractual agreements, and indication of approval from the solid waste management section.

b. If sludge will be disposed of on land areas (other than at licensed landfill sites) for each disposal site:

1) Soil test results at the site at intervals specified in the WPDES permits. The parameters analyzed shall include soil, pH, organic matter, available P, exchangeable K and any other parameters deemed necessary by the department on a case-by-case basis. Recommended soil additions such as lime, N, P_2O_5 and K_2O should be specified.

2) Copies of a soils map, plat map and a U.S.G.S. topographic map showing the location of the site.

3) A description of the crops to be grown or dominant vegetation on the disposal site.

4) Data on the geology, hydrology, areas for future expansion and adjacent land use.

5) The ownership of the site.

6) A description of the type of agreement covering use of land.

7) A description of the methods to be used to spread sludge on the land and incorporate it with the soil.

8) The applicator of the sludge.

9) An estimate of the total acreage to which sludge will be applied.

10) The maximum rate of application (tons/acre/year based on nitrogen or cadmium, whichever is lower) and the loading limit (tons/acre based on metal equivalents or cadmium whichever is lower).

11) The anticipated use of the site for 12 months after application of the sludge.

12) Any follow-up monitoring that is requested by the department.

c. The frequency of sludge disposal and the months in which it occurs.

d. Beginning with submission of the first plan, records shall be maintained for each site (other than at licensed landfill sites), including:

1) The amount of sludge applied (tons/acre).

2) The amount of nitrogen applied per year (lbs/acre).

3) The amount of cadmium applied per year (lbs/acre).

4) The total amount of metal equivalents applied (lbs/acre).

5) The location of the site on a plat map and the number of acres the sludge was applied to.

6) The site monitoring results.

7) A description of any adverse environmental, health or social effects that occurred due to sludge disposal.

8) A report of any action not in conformance with the approved plan.

(7) SLUDGE DISPOSAL. Sludge disposal shall be accomplished in accordance with the approved sludge management plans as specified in section NR 110.27 (6). The following items shall be considered in the development of the management plan.

(a) *Sanitary landfill.* Burial of sewage sludge in a sanitary landfill shall meet the following requirements:

1. The sludge must be capable of being mixed well with the other refuse in the compaction process.

2. The sludge must be able to support compaction equipment.

3. The sludge must be capable of permanent confinement within the earth excavation.

(b) *Surface application.* Surface application disposal of raw sludge is generally not permitted. Surface application of digested sludge will be evaluated based on the justification provided in the sludge management plan.

(c) *Transportation of sludges.* 1. Liquid. Liquid sludge shall be transported in an enclosed watertight unit from treatment plant to disposal site.

2. 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 spillage of sludge from the vehicle while in transit and to prevent an odor nuisance while in transit.

History: Cr. Register, November, 1974, No. 227, eff. 12-1-74; r. and recr. (5), cr. (6) and (7), Register, June, 1977, No. 258, eff. 7-1-77.

NR 110.28 Lagoons. (1) BASIS OF DESIGN. (a) *Stabilization ponds.* 1. Area and loadings. A minimum of 2 cells shall be provided. The primary cell shall be designed on the basis of one acre of water surface for each 100 design population or population equivalent. The secondary cell shall be ¼ to ⅓ the size of the primary cell. Where a controlled discharge is required, the secondary cell may be larger.

2. Industrial wastes. The effects of industrial wastes on the treatment process must be reflected in the design basis of the stabilization ponds. Milk wastes are not permitted in stabilization ponds.

Note: The department may waive this prohibition if adequate supporting data is presented in the plans.

(b) *Aerated lagoons.* 1. For aerated lagoons designed to treat domestic wastes only, a minimum of 2 cells shall be provided. The primary cell shall have a minimum retention time of 18 days and the secondary cell shall have a minimum retention time of 26 days. In the event a three-celled system is desired, the secondary cell shall have a minimum retention time of 18 days and the final cell shall have a minimum retention time of 6 days. Aeration equipment shall be provided in the first 2 cells of all aerated lagoons.

Note: The above detention times were based on the following formulae and assumptions:

$$T = \frac{E}{K(100-E)}$$

where T = detention time, K = reaction coefficient and E = efficiency. For domestic waste K is assumed to equal 0.5 at 20°C. To correct for anticipated wintertime temperature, the formula $KT' = K_{20}\theta^{T'-20}$ was used. In this formula, T' is the anticipated low temperature and θ is a temperature coefficient. For Wisconsin, T' is assumed to be 0° C. and θ is assumed to be 1.07. Where studies indicate a variation from the above criteria will provide an adequate degree of treatment, the department will consider such data in determining whether to waive this requirement.

2. For aerated lagoons designed to treat combined domestic and industrial wastes, laboratory or pilot studies shall be conducted to develop an appropriate reaction coefficient at both anticipated summertime and wintertime temperatures. The reaction coefficient developed shall be used to calculate the required detention time. The laboratory or pilot plant results and engineering calculations shall be submitted to justify the design. A minimum of 2 cells shall be provided with additional volume provided in the second cell to facilitate removal of solids. Provisions shall be made to recirculate final lagoon effluent to the inlet of the treatment system.

(2) POND SHAPE. The shape of all cells shall be such that there are no narrow or elongated portions. No islands, peninsulas, or coves are permitted. Dikes shall be rounded at corners to minimize accumulations of floating materials.

Note: Round, square, or rectangular ponds with a length not exceeding 3 times the width are considered most desirable.

(3) LOCATION. (a) *Distance from habitation.* The location requirements of NR 110.15 (3) shall be adhered to.

(b) *Groundwater pollution.* Lagoons shall be located to minimize the potential of groundwater pollution.

Note: The department recommends that pond bottoms be located a minimum of 3 feet above high groundwater and 5 feet above bedrock. Consideration shall be given to the nature of the subsoil and bedrock in determining the exact depth. The primary cell of a stabilization pond and the first 2 cells of an aerated lagoon shall be adequately sealed to prevent loss of liquid such that the design operating depth can be achieved and maintained.

(4) POND CONSTRUCTION DETAILS. (a) *Material.* Embankments and dikes shall be constructed of relatively impervious materials and compacted to a density of 95% as measured by the standard proctor test.

(b) *Top width.* The minimum embankment top width shall be 12 feet to permit access of maintenance vehicles.

(c) *Maximum slopes.* Embankment slopes steeper than 3 horizontal to one vertical are prohibited.

(d) *Minimum slopes.* Embankment sloped flatter than 4 horizontal to one vertical for the inner slope are prohibited.

(e) *Freeboard.* Minimum freeboard shall be 3 feet.

(f) *Minimum depth.* A minimum normal liquid depth of 2 feet for stabilization ponds and 6 feet for aerated lagoons shall be provided.

(g) *Maximum depth.* A maximum normal liquid depth of 5 feet for stabilization ponds and 14 feet for aerated lagoons shall be provided.

(h) *Seeding.* Embankments shall be seeded from the outside toe to one foot above the high water line on the dikes, measured on the slope. Additional protection for embankments, such as riprap, shall be provided where the dikes are subject to erosion.

(i) *Vegetation control.* A method to prevent vegetation growth over the bottom of the lagoon and up to one foot above the water line on the dikes shall be specified in the plans.

(5) POND BOTTOM. (a) *Uniformity.* The pond bottom shall be as level as possible at all points.

(b) *Vegetation.* The bottom shall be cleared of vegetation and debris.

(6) INFLUENT LINES. (a) *Material.* Influent lines may be constructed with any generally accepted material for underground sewer construction.

(b) *Manholes.* A manhole shall be installed at the terminus of the outfall line or the force main and shall be located as close to the dike as topography permits. Its invert shall be at least 6 inches above the maximum operating level of the pond to provide sufficient hydraulic head without surcharging the manhole.

(c) *Influent lines.* Influent lines shall be located along the bottom of the pond so that the top of the pipe is just below the average elevation of the pond bottom.

(d) *Point of discharge.* For circular or square ponds, the inlet shall be located at the center of the pond. Influent lines to rectangular ponds shall terminate at approximately the third point farthest from the outlet structure. Influent and effluent piping shall be located to minimize short-circuiting within the pond.

(e) *Inlets.* The inlet line shall discharge either horizontally onto a concrete pad or by means of an upturned elbow terminating one foot above the pond bottom.

(7) OVERFLOW STRUCTURES AND INTERCONNECTING PIPING. (a) *Material.* Interconnecting piping and overflows may be constructed of any generally accepted material for underground sewer construction.

(b) *Overflow structure.* Overflow structures shall consist of a manhole or box equipped with multiple-valved pond drawoff lines or an adjustable overflow device so that the liquid level of the pond can be adjusted to permit operation at depths of 2 to 5 feet in stabilization ponds and 6 feet to the design depth in aerated lagoons.

(8) MISCELLANEOUS. (a) *Fencing.* The pond area shall be enclosed with a suitable fence to prevent livestock movement into and discourage trespassing on the pond area. A vehicle access gate of sufficient width to accommodate mowing equipment shall be provided. All access gates shall be provided with locks.

(b) *Warning signs.* Appropriate signs shall be provided along the fence around the pond to designate the nature of the facility and the advice against trespassing.

(c) *Flow measurement.* The capability of installing flow measurement devices on the inlet and outlet of all lagoon systems shall be provided.

(9) AERATION EQUIPMENT. (a) *Air requirements.* Air shall be provided to the aerated lagoons at a rate of not less than 1.5 pounds of oxygen per pound of influent BOD_5.

(b) *Surface aeration equipment.* Surface aeration equipment shall be so designed and placed to provide optimum mixing of pond contents and dispersion of oxygen to the waste. The equipment shall be operated continuously throughout the year. Provisions must be made to prevent ice formation on the aerator during the winter season resulting in shutdown of aeration equipment. Unless sufficient justification is presented to the contrary, surface aerators shall be designed using an oxygen transfer rate of 1.5 pounds of oxygen per horsepower hour.

(c) *Subsurface aeration equipment.* 1. Flexible tubing containing air release slits shall be provided across the pond bottom in accordance with the manufacturer's recommendations. To prevent clogging of the air lines, provision must be made to accommodate cleaning at least 4 times per year or more often if necessary. Air shall be supplied to the pond system at a rate of at least 1,000 cubic feet of air per pound of design BOD, with the largest blower unit out of service.

2. Tubular aeration units shall be provided in sufficient number to supply adequate air to the pond system based on a transfer rate of 1.25 pounds of oxygen per unit per hour.

3. Where data is presented to the department to justify oxygen transfer rates varying from the above, the department may approve such design transfer rates.

(10) EFFLUENT HOLDING PONDS. (a) Effluent holding ponds shall be provided following all extended aeration activated sludge sewage treatment plants.

Note: The department may require effluent holding ponds at other locations.

(b) The detention time in the effluent pond shall be at least 30 days based on design flow.

Note: Lesser detention times may be approved by the department on a case by case basis if supported by sufficient design data.

(11) SEEPAGE PONDS.

Note: Seepage ponds should be considered where stream water quality must be maintained at a high level or where no stream exists for discharge of sewage effluent. Soil and groundwater conditions shall be thoroughly evaluated and conditions must be favorable to permit use of a seepage pond. The pond should be sized based on an evaluation of the soil's capability to accept liquid wastes.

History: Cr. Register, November, 1974. No 227, eff. 12-1-74.

NR 110.29 Land disposal of effluent. (1) GENERAL. Land disposal of secondary treated effluent may be approved by the department on a case by case basis. The effect of land disposal on groundwater is of concern; therefore the quality, direction and rate of movement and local use of the groundwater must be thoroughly analyzed in any design report submitted to the department.

(2) DESIGN REPORT. The design report shall be as comprehensive as possible and shall include all necessary maps, diagrams and additional information needed to conduct an evaluation of the proposed system. The following items must be thoroughly considered and discussed in the design report:

(a) Location;

(b) Geology;

(c) Hydrology;

(d) Soils;

(e) Agricultural practice;

(f) Adjacent land use; and

(g) Direction of groundwater movement.

History: Cr. Register, November, 1974, No. 227, eff. 12-1-74.

NR 110.30 Intermittent sand filters. (1) GENERAL. Intermittent sand filters may be used for treatment of relatively small waste streams. All such installations shall be preceded by gravity settling devices such as in conventional primary clarifiers or septic tanks. Waste from intermittent sand filters shall be disinfected and discharged to an effluent holding pond prior to discharge to a receiving water.

(2) LOADING. The loading on the sand filter shall not exceed one gallon per square foot per day for the total bed area for installations which operate with a significant rest period. The loading shall not exceed 0.5 gallon/ft²/day for the total bed area for installations used on a continuous year round basis.

(3) MEDIA. (a) *Gravel base.* Clean graded gravel placed in 3 layers around the underdrains and to a depth of at least 6 inches over the top of the underdrains shall be provided.

Note: Suggested gradings for the 3 layers are: 1½" to ¾", ¾" to ¼", ¼" to ⅛".

(b) *Sand.* At least 24 inches of clean sand above the gravel base shall be provided. The effective size of the sand shall be 0.3 to 0.6 mm, and the uniformity coefficient shall not exceed 3.5.

(4) DOSING. (a) *Duplicate units.* The filter bed shall be divided into at least 2 separate units to provide for maintenance and adequate rest periods.

(b) *Volume.* The dosing tank volume shall be such that the filter bed will be covered to a depth of 2 to 4 inches by each dose.

(c) *Siphons or pumps.* The siphons or pumps shall have a discharge capacity at minimum head of at least 100% in excess of the maximum rate of inflow to the dosing tank and at average head of at least 90 gpm/1,000 ft² of filter surface area.

(d) *Discharge lines.* Discharge lines shall have sufficient capacity to permit the full rated discharge of the siphons or pumps.

(5) DISTRIBUTION. (a) *Arrangement.* Troughs or piping used for distribution of the settled sewage over the filter surface shall be located not more than 20′ center to center.

(b) *Splash pads.* Splash pads shall be provided at each point of discharge.

(c) *Drain.* A drain opening from troughs or discharge piping shall be provided.

(6) UNDERDRAINS. Open joint or perforated clay or concrete pipe underdrains may be used. They shall be sloped to the outlet and spaced not to exceed 10 feet center to center.

(7) COVERING. All sand filter installations shall be covered with roofing paper or other suitable material and at least 3 feet of soil unless they are designed to operate only during the summer months in which case the filter may be exposed to the atmosphere.

History: Cr. Register, November, 1974, No. 227, eff. 12-1-74.