

Chapter NR 504

**LANDFILL LOCATION, PERFORMANCE,
DESIGN AND CONSTRUCTION CRITERIA**

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NR 504.07	Minimum design and construction criteria for final cover systems.		

Note: Corrections made under s. 13.93 (2m) (b) 7., Register, August, 1997, No. 500.

NR 504.01 Purpose. The purpose of this chapter is to help ensure that efficient, nuisance-free and environmentally acceptable solid waste management procedures are practiced in this state and to provide information on locational criteria, performance standards and the minimum design and construction requirements for landfills. This chapter is adopted under ch. 289 and s. 227.11, Stats.

History: Cr. Register, January, 1988, No. 385, eff. 2-6-88; am., Register, June, 1996, No. 486, eff. 7-1-96.

NR 504.02 Applicability. (1) Except as otherwise provided, this chapter governs all landfills as defined in s. 289.01 (20), Stats., except landspreading facilities regulated under ch. NR 518, small demolition waste landfills regulated under ch. NR 503, hazardous waste facilities as defined in s. 291.01 (8), Stats., and regulated under chs. NR 600 to 690 and metallic mining waste facilities regulated under ch. NR 182.

(2) This chapter does not apply to the design, construction or operation of industrial wastewater facilities, sewerage systems and waterworks treating liquid wastes approved under s. 281.41, Stats., or permitted under ch. 283, Stats., nor to facilities used solely for the disposal of liquid municipal or industrial wastes which have been approved under s. 281.04, Stats., or permitted under ch. 283, Stats., except for facilities used for the disposal of solid waste.

Note: Owners or operators proposing to site a new or expand an existing municipal solid waste landfill within a 5 mile radius of any airport runway end used by turbojet or piston type aircraft must notify the owner or operator of the affected airport and the federal aviation administration (FAA).

History: Cr. Register, January, 1988, No. 385, eff. 2-6-88; correction in (1) made under s. 13.93 (2m) (b) 7., Stats., Register, May, 1995, No. 473; am. (1), Register, June, 1996, No. 486, eff. 7-1-96; am. (1), Register, August, 1997, No. 500, eff. 9-1-97.

NR 504.03 Definitions. The terms in this chapter are defined in s. NR 500.03.

History: Cr. Register, January, 1988, No. 385, eff. 2-6-88.

NR 504.04 Landfill locational criteria and performance standards. (1) **GENERAL.** As part of the feasibility report required under ch. NR 512 an applicant shall demonstrate to the department that the proposed landfill will comply with all of the locational criteria and performance standards of this section unless an exemption is granted.

(2) **EXEMPTIONS.** (a) Exemptions from compliance with subs. (3) (a), (b), (d), (e), (f), (g), (h), (i) and (4) (b), (e) and (f) may be granted by the department only upon demonstration by the applicant of circumstances which warrant such an exemption. Exemptions from compliance with sub. (4) (a) may be granted only in accordance with the standards set forth in ch. NR 103. Exemptions from compliance with subs. (3) (c) and (4) (c) may not be granted. Exemptions from compliance with sub. (4) (d) may be granted only according to the procedures set forth in chs. NR 507 and 140. Exemptions from compliance with sub. (3) (f) will be based on an

evaluation of the information contained in par. (b). However, no exemptions from sub. (3) (f) may be granted unless information on the well location, former and present well owner, well driller, well log and construction details and the general hydrogeologic setting is submitted to the department. Exemptions from sub. (3) (i) may be granted only if the applicant demonstrates that engineering measures have been incorporated into the landfill's design to ensure that the integrity of the structural components of the landfill will not be disrupted.

(b) Additional factors which may be considered by the department in determining whether or not to grant exemptions under this section include waste types, characteristics and quantities; the geology and hydrogeology of the landfill; the proposed landfill design and operation; the availability of other environmentally suitable alternatives; compliance with other state and federal regulations and the health, safety and welfare of the public. Requests for exemptions and information needed to demonstrate the circumstances that warrant such exemptions shall be addressed by the applicant in the feasibility report.

(3) **LOCATIONAL CRITERIA.** No person may establish, construct, operate, maintain or permit the use of property for a landfill where the limits of filling are or would be within the following areas:

(a) Within 1,000 feet of any navigable lake, pond or flowage not including landfill drainage or sedimentation control structures.

(b) Within 300 feet of any navigable river or stream.

(c) Within a floodplain.

(d) Within 1,000 feet of the nearest edge of the right-of-way of any state trunk highway, interstate or federal aid primary highway or the boundary of any public park, unless the landfill is screened by natural objects, plantings, fences or other appropriate means so that it is not visible from the highway or park.

(e) Within an area where the design or operation of the landfill would pose a significant bird hazard to aircraft.

1. A landfill which is proposed to be located within 10,000 feet of any airport runway end designed or planned to be designed and used by turbojet aircraft or within 5,000 feet of any airport runway end designed for and used only by piston type aircraft and which is proposed to be used for the disposal of putrescible waste shall be presumed to pose a significant bird hazard to aircraft unless the applicant can demonstrate to the satisfaction of the department that the landfill will not pose a significant bird hazard to aircraft.

2. A landfill used for the disposal of putrescible waste which is in existence on July 1, 1996, and which is located within 10,000 feet of any airport runway end used or planned to be used by turbojet aircraft or within 5,000 feet of any runway end used by only piston-type aircraft shall be closed by October 9, 1996 unless the owner or operator of the landfill demonstrates to the satisfaction of the department that the landfill will not pose a significant hazard to aircraft. The deadline for closure may be extended by the

department by up to 2 years if the owner or operator demonstrates that there is no available alternative disposal capacity and there is no immediate threat to human health and the environment.

Note: Owners or operators proposing to site a new or expand an existing municipal solid waste landfill within a 5 mile radius of any airport runway end used by turbojet or piston type aircraft must notify the owner or operator of the affected airport and the federal aviation administration (FAA).

(f) Within 1,200 feet of any public or private water supply well.

(g) Within 200 feet of a fault that has had displacement in Holocene time.

(h) Within seismic impact zones.

(i) Within unstable areas.

(4) **PERFORMANCE STANDARDS.** No person may establish, construct, operate, maintain or permit the use of property for a landfill if there is a reasonable probability that the landfill will cause:

(a) A significant adverse impact on wetlands as provided in ch. NR 103.

(b) A significant adverse impact on critical habitat areas.

(c) A detrimental effect on any surface water.

(d) A detrimental effect on groundwater quality or will cause or exacerbate an attainment or exceedance of any preventive action limit or enforcement standard at a point of standards application as defined in ch. NR 140. For the purposes of design the point of standards application is defined by s. NR 140.22 (1).

(e) The migration and concentration of explosive gases in any landfill structures excluding the leachate collection system or gas control or recovery system components in excess of 25% of the lower explosive limit for such gases at any time. The migration and concentration of explosive gases in the soils outside of the limits of filling within 200 feet of the landfill property boundary or beyond the landfill property boundary in excess of the lower explosive limit for such gases at any time. The migration and concentration of explosive gases in the air outside of the limits of filling within 200 feet of the landfill boundary or beyond the landfill property boundary in excess of the lower explosive limit for such gases at any time.

(f) The emission of any hazardous air contaminant exceeding the limitations for those substances contained in s. NR 445.03.

History: Cr. January, 1988, No. 385, eff. 2-6-88; am. (1), (2) (a), (b), (3) (intro.), (a), (d), (4) (intro.), (a) (e), r. and recr. (3) (e), cr. (3) (g) to (i), Register, June, 1996, No. 486, eff. 7-1-96.

NR 504.05 General design and construction criteria. (1) Unless otherwise specified in this chapter, the minimum design criteria in ss. NR 504.06 to 504.09 apply to all new landfills and to the expansion of existing landfills for which the plan of operation was approved after July 1, 1996, as well as to proposed design changes for all landfills which are submitted after July 1, 1996. Landfills designed in substantial conformance with these design criteria are presumed to be capable of meeting the performance standards of s. NR 504.04(4)(d) regarding groundwater quality.

(2) If the proposed design differs from the requirements in ss. NR 504.06 to 504.09, the applicant shall provide supporting justification for any differences.

(3) The design capacity of all proposed landfills, except landfills that are exempted in s. 289.28 (2), Stats., shall be determined such that the projected operating life of the landfill is not less than 10 years nor more than 15 years. Expansions of existing landfills are not subject to the 10-year minimum design capacity requirement. Waste approved for use in construction of landfill components is not considered part of the design capacity.

History: Cr. Register, January, 1988, No. 385, eff. 2-6-88; r. and recr., Register, June, 1996, No. 486, eff. 7-1-96.

NR 504.06 Minimum design and construction criteria for landfill liners and leachate collection systems.

(1) **GENERAL.** (a) All major phases of landfills initially accepting

municipal solid waste after July 1, 1996, shall be designed with a composite liner and a leachate collection system capable of limiting the average leachate head level on the composite liner to one foot or less during operation and after closure of the landfill, except as provided in s. NR 504.10 (1) (c). The composite liner shall consist of 2 components; the upper component shall consist of a nominal 60-mil or thicker geomembrane liner with no thickness measurements falling below the minimum industry accepted manufacturing tolerances, and the lower component shall consist of a minimum 4 foot thick layer of compacted clay meeting the specifications of s. NR 504.06 (2) (a). The geomembrane component shall be installed in direct and uniform contact with the compacted clay soil component, and the landfill shall meet or exceed the standards in the applicable portions of subs. (2), (3) and (4). All other landfills shall be designed to contain and collect leachate to the maximum practical extent. This shall be accomplished by designing the landfill to meet the standards contained in the applicable portions of subs. (2), (3) and (4), unless the department approves the applicant's alternative design as per s. NR 504.10, which provides an equivalent or better level of performance than the standards contained in this chapter.

(b) If the applicant does not complete construction of the first major phase of the landfill within 2 years from the date of the plan of operation approval, the applicant shall reapply to the department for approval to construct the landfill. This application does not constitute a feasibility report as defined in s. 289.24, Stats. The department may require additional conditions of approval and require redesign of the landfill in accordance with state-of-the-art design criteria.

(2) **COMPOSITE OR CLAY LINED LANDFILLS.** All landfills designed with a composite liner or a clay liner shall meet the following requirements:

(a) All clay used in liner construction shall meet the following specifications:

1. A minimum of 50% by weight which passes the 200 sieve.
2. A saturated hydraulic conductivity of 1×10^{-7} cm/sec or less, when compacted to required moisture contents and densities based on the modified Proctor method, standard Proctor method, or a line of optimums method approved by the department.
3. An average liquid limit of 25 or greater with no values less than 20.
4. An average plasticity index of 12 or greater with no values less than 10.

(b) The separation distance between the seasonal high groundwater table and the bottom of the clay component of a composite liner or a clay liner shall be at least 10 feet except for zone-of-saturation landfills.

(c) The separation distance between the top of the bedrock surface and the bottom of the clay component of a composite liner or a clay liner shall be at least 10 feet.

(d) The slope of the liner surface toward the leachate collection lines shall be at least 2%.

(e) The minimum thickness of the clay component of a composite liner at all locations shall be at least 4 feet. The minimum thickness of a clay liner at all locations shall be at least 5 feet.

(f) The clay component of a composite liner or a clay liner shall be constructed in the following manner:

1. All clay layers in the liner shall be constructed in lift heights no greater than 6 inches after compaction using footed compaction equipment having feet at least as long as the loose lift height. As needed, clay shall be disked or otherwise mechanically processed prior to compaction to break up clods and allow for moisture content adjustment. Clod size shall be no greater than 4 inches. All compaction equipment utilized shall have a minimum static weight of 30,000 pounds. Lighter equipment may be used in small areas where it is not possible to use full size equipment.

Alternative procedures or equipment may be proposed for approval by the department.

2. A sufficient number of passes of the compaction equipment shall be made over each lift of clay to ensure complete remolding of the clay.

3. All clay shall be compacted to 90% modified or 95% standard Proctor density at a moisture content at least 2% wet of optimum if using the modified Proctor method and wet of optimum if using the standard Proctor method, based on the characteristics of the appropriate Proctor curve for the clay being placed. As clay placement proceeds, the minimum density and moisture content targets shall be adjusted as necessary. The department recommends use of an alternate method of determining adequate density and moisture content based on a line of optimums method. However, this method may not be used unless it has been previously detailed in a landfill's plan of operation or a proposed plan modification and approved in writing by the department. At a minimum, any such proposal shall address how the line of optimums would be defined, as well as how the minimum dry unit weight needed to ensure adequate shear strength of the clay soils proposed would be determined.

(g) The slope of the interior sidewalls of a landfill may not exceed 3 horizontal to one vertical nor be less than 5 horizontal to one vertical.

(h) The clay component of a liner in adjacent phases shall be keyed together to form a continuous clay seal. This shall be accomplished by excavating steps along the edge of the existing lined phase and overlapping them with the lifts of clay being placed for the liner of the new phase. A minimum of 4 steps shall be included, with the total width of the spliced area measuring a minimum of 15 feet.

(3) COMPOSITE-LINED LANDFILLS. All landfills designed with a composite liner shall meet the following additional requirements for the geomembrane component of the liner:

(a) All geomembranes shall be fabricated from resins specifically formulated for waste containment purposes. Nominal geomembrane thickness shall be 60 mils or greater with no thickness measurements falling below the minimum industry accepted manufacturing tolerances.

(b) Additional protection shall be provided for the geomembrane component of the composite liner along areas subject to traffic or other concentrated activity during construction or operation. This shall include sumps, sideslope risers and entry ramps.

(c) For slopes in excess of 10%, geomembrane panels shall be installed such that all seams run perpendicular to the contour lines of the slope to the extent possible.

(d) Prior to geomembrane placement, the clay surface shall be rolled and graded so it is free of irregularities, protrusions, loose soil and abrupt changes in grade. The surface shall also be free of stones, grade stakes and construction debris which may be damaging to the geomembrane and shall contain no areas excessively softened by high water content. The clay surface shall be sufficiently dry and dense such that the construction equipment used to place the geomembrane panels do not rut the clay surface. All depressions and large cracks shall be filled in with tamped clay.

(e) Geomembrane panels made of polyethylene resins shall be welded by double-tracked, fusion welding machines for all linear seams. Corners, butt seams and long repairs shall be fusion welded where possible. Extrusion or fusion welding shall be used for all other repairs, detail work and patches. Department approval shall be obtained prior to use of any other welding method for either panel seaming, repairs or construction of details.

(f) The geomembrane component of a composite liner constructed in phases adjacent to each other shall be welded together to form a continuous membrane surface. The liner extending beyond the proposed edge of waste at a phase junction shall be protected from traffic and weather.

(g) Wrinkles in the geomembrane component which are higher than they are wide, shall be smoothed or cut out and repaired prior to covering with soil. Guidance to machine operators placing soil on the geomembrane component shall be provided by the use of an observer with an unobstructed view of the advancing lift of soil.

(h) The minimum thickness of soil which must be present over the geomembrane component before vehicular traffic may occur shall be one foot for vehicles with ground pressure less than 5 pounds per square inch and 2 feet for all other tracked vehicles and flotation tire equipped vehicles. Trucks and other wheeled hauling equipment shall be confined to corridors or locations with a soil thickness of 3 or more feet over the geomembrane component.

(i) In order to lessen desiccation effects, the base of the landfill and the lower 10 vertical feet of the sideslope shall be covered with a drainage blanket within 30 days after completing quality control and quality assurance testing of the installation. The remaining sideslope shall be covered with either drainage material or a geotextile to prevent damage to the geomembrane.

(j) To prevent movement and folding of wrinkles, placement of soil over the membrane shall be performed during cooler temperature periods to the extent possible using methods of placement which minimize wrinkling.

(k) Anchor trenches shall be designed and constructed around the perimeter of the landfill to secure the permanent edges of the geomembrane. The geomembrane shall be seamed completely to the ends of all panels to minimize the potential of tear propagation along the seam.

(4) ZONE-OF-SATURATION LANDFILLS. All landfills proposed with base grades beneath the groundwater table shall meet the following requirements:

(a) The landfill shall be located in a fine-grained soil environment.

Note: Fine-grained soil environment is defined in s. NR 500.03(86).

(b) The landfill shall meet the requirements in sub. (2)(a), (d), (e), (f), (g) and (h), and if the landfill will accept municipal solid waste, sub. (3).

(c) An analysis shall be performed of the effect which groundwater flow may have on uplift of the liner and the short and long-term stability of the geomembrane component of the composite liner. The analysis shall evaluate the effect of an underdrain or other dewatering system.

(d) Borings, backhoe pits or other means of exposing subsoils shall be performed on a 100-foot grid to a minimum depth of 5 feet below the gradient control layer, if part of the design, or a minimum depth of 5 feet below the subbase grades of the liner. All detected granular or silty soils within this 5 foot depth shall be removed and replaced with compacted, fine-grained soils.

(5) LEACHATE COLLECTION SYSTEMS. All leachate collection systems shall incorporate the following design features:

(a) A leachate collection system shall be included in each horizontal phase of the landfill. This system shall be designed to route leachate to the perimeter of the landfill in the most direct manner possible and limit the average leachate head level on the liner to one foot or less. The piping layout shall be such that leachate flows no more than 130 feet across the base of the liner before encountering a perforated leachate collection pipe. The department will consider greater flow distances for well designed composite landfills.

(b) The minimum slope on all leachate collection pipes at the base of the landfill shall be a constant 0.5%. The department recommends that greater pipe slopes be utilized whenever possible.

(c) The minimum diameter of all leachate collection or transfer pipes shall be 6 inches. Schedule 80 PVC pipe or an approved substitute shall be used.

(d) Leachate collection trenches for clay liners shall be designed as rectangular trenches. Leachate collection trenches for

composite liners shall be designed as vee-trenches, with a minimum depth of 18 inches and with sideslopes no steeper than 3 horizontal to one vertical. The clay component of vee-trenches shall be smooth-drum rolled such that the clay in the trenches is smooth prior to placement of the membrane. A geotextile shall be used to line the base and sidewalls of all leachate collection trenches and shall be placed directly over the geomembrane component of a composite liner or the clay component of a clay liner. The geotextile shall have a minimum weight of 12 oz/yd², and may not be overlapped over the top of the trench.

(e) The bedding material utilized in backfilling the leachate collection pipe trenches shall have a uniformity coefficient of less than 4, a maximum particle diameter of 1½ inches, a maximum of 5% of the material which passes the number 4 sieve and consist of rounded to subangular gravel. A minimum depth of 4 inches of gravel shall be placed in the trenches prior to installation of the leachate pipes. The backfill shall also be placed such that a minimum of 6 inches of material exists above the top of the pipe and within the trenches. An additional 6 inches of material shall be mounded above the trench. In cases where the particle size of the drainage blanket is significantly less than the collection trench bedding, a properly designed graded soil filter or geotextile shall be utilized to minimize the migration of the drainage blanket material into the collection trenches. Limestone and dolomite may not be used in the leachate collection system unless no other suitable material is reasonably available.

(f) The sizing of sand, gravel, geotextiles and pipe openings shall be analyzed for control of piping of soil materials. The gradation of sand and gravel, the apparent opening size of geotextiles, and the pipe opening sizes shall be selected to achieve a stable and self-filtering structure under all conditions of leachate flow.

(g) All leachate collection lines shall have cleanout access points installed on both ends of each line and may not exceed 1,200 feet from the end of one cleanout to the toe of the opposite slope.

(h) Leachate lines, manholes and other engineering structures may not penetrate the liner in the vertical direction. For clay lined landfills, leachate transfer lines may penetrate the liner in the horizontal direction only. The number of liner penetrations shall be kept to a minimum. Composite lined landfills shall be designed without any perforations in the liner and in accordance with par. (j).

(i) Any leachate line that penetrates a clay liner shall have a 4 foot by 4 foot anti-seep collar placed around it. A minimum of 5 feet of compacted clay, as measured from the pipe, shall be placed around the collar in all directions.

(j) All composite lined landfills shall be designed and constructed with sumps and sideslope risers as part of their leachate removal system rather than utilizing systems which penetrate the composite liner sidewall. The leachate removal system shall meet the following requirements:

1. The volume of the sump and the capacity of the pump shall be sized so that accumulation of leachate outside the sump does not occur based on an assumed annual leachate collection rate of 6 inches. The volume of the sump shall take into account the potential buildup of solids over time.

2. The base of the leachate collection sumps shall be protected by the use of a thick polyethylene plate or other means acceptable to the department which is placed prior to the installation of the sideslope riser and backfill.

3. The leachate discharge pipes between the sideslope risers and collection tank shall be equipped with valves to prevent backflow into the waste disposal area.

(k) All leachate lines transporting leachate out of the landfill by gravity shall be constructed with valves so the flow of leachate can be controlled. The valves shall be compatible with the leachate and be capable of being operated from the ground surface.

(L) All leachate transfer lines located outside of the composite lined or clay lined area shall be designed to assure groundwater protection through the use of double-cased pipe or by using another approved secondary containment method. All leachate transfer line piping shall be pressure tested prior to use. Unless otherwise approved by the department, the upslope end of the secondary pipe shall be sealed and the downslope end shall be open to allow any collected liquid to flow into the manhole.

(m) All leachate transfer lines, manholes, lift stations and other structures which transfer or store leachate outside the limits of waste shall be designed as shallow as practical and located far enough from the limits of filling so that excavations associated with repair of these devices would not infringe on the landfill cover system or sidewall liner. Each of these devices shall be constructed above the seasonal high groundwater table unless it is not technically feasible to do so and the design meets the requirements of par. (L).

(n) Leachate collection tanks and manholes shall be designed with a secondary containment system to prevent the discharge of leachate to ground and surface waters in the event of a leak or spill. Means shall be provided to monitor the tank and manholes within the secondary containment system unless other means for leak detection are approved by the department.

(o) All leachate collection tanks shall be designed to contain the volume of leachate which is generated by the landfill over a 4 day period and to withstand the soil and liquid loads that will be encountered during installation and use. The installation of the tanks shall follow the recommendations of the consultant and manufacturer.

(p) Measures shall be proposed to prevent accidental discharges at the leachate loadout station from entering groundwater or surface water. Unless an alternate method is approved by the department, the leachate loading station shall be paved with a concrete or asphalt pad and sloped to a catch basin to direct all spills back into the leachate holding tank.

(q) All manholes and enclosed structures for leachate and gas control systems shall be designed to allow for proper venting and access control. For landfills designed with active gas recovery systems, these devices shall be designed to minimize air intrusion into the landfill.

(r) All control systems such as pumps, valves and meters shall be designed to be operated from the ground surface.

(s) All leachate and groundwater collection systems shall be designed to accurately monitor the volume of liquid removed by the system.

(t) A minimum one foot thick granular drainage blanket shall be placed on top of the geomembrane component of a composite liner and on top of the clay component of a clay liner. For composite lined landfills, if the drainage blanket contains gravel greater than 1/4 inch, then a nonwoven geotextile shall be installed below the drainage blanket. The geotextile shall have a minimum weight of 12 oz/yd². The granular drainage blanket shall contain no more than 5% material by weight which passes the number 200 sieve, have a uniformity coefficient of less than 4 for gravel soils and less than 6 for sandy soils, and a hydraulic conductivity which is greater than or equal to 1×10^{-2} cm/sec at the anticipated field density.

(u) All major horizontal clay lined phases above the saturated zone shall be designed with a collection basin lysimeter to monitor the unsaturated zone except for composite lined landfills.

History: Cr. Register, January, 1988, No. 385, eff. 2-6-88; r. and recr., Register, June, 1996, No. 486, eff. 7-1-96; am. (5) (e) and (t), Register, August, 1997, No. 500.

NR 504.07 Minimum design and construction criteria for final cover systems. (1) GENERAL. (a) All final cover systems shall be designed to minimize leachate generation by limiting the amount of percolation through the cap system, reduce landfill maintenance by stabilizing the final surface through

design of compatible slopes and establishment of vegetation, account for differential settlement and other stresses on the capping layer, minimize the climatic effects of freeze-thaw and desiccation on the clay capping layer of the final cover system, and provide removal of leachate and venting of gas from those landfills which accept wastes with a high moisture content or which readily biodegrade.

(b) All new landfills and expansions of existing landfills shall be designed with a final cover system meeting the requirements in subs. (2) to (9) unless it is established to the satisfaction of the department that portions of the final cover system are not needed based on the proposed waste types and the proposed design. The geomembrane component in sub. (5) does not apply to landfills designed exclusively for the disposal of high volume industrial waste, or to other landfills which are not designed to accept municipal solid waste unless the landfill is composite lined.

(c) Any phases of an existing landfill which have been designed and constructed with a composite liner shall be designed and constructed with a final cover system meeting the requirements in subs. (2) to (9), except that the requirement for the geomembrane layer in sub. (5) does not apply to composite lined phases of existing landfills which have completed final cover placement by July 1, 1996.

(d) Landfills which accept papermill sludges or other industrial solid wastes with high water contents and low strength may propose alternate final cover systems if the strength of the waste mass will not allow for the construction of the cover system required in this section.

(2) **GRADING LAYER.** A minimum 6 inch thick grading layer shall be designed over the final waste elevation of landfills proposing to accept municipal solid waste to attain the required slope and provide for a stable base for subsequent system components. Daily and intermediate cover may be used for this purpose.

(3) **SUPPORT LAYER FOR LOW-STRENGTH WASTES.** A support layer shall be designed for stabilization, reinforcement and removal of leachate and gas over the final waste elevations for landfills which accept industrial solid wastes with high water contents and low strength.

(4) **CLAY CAPPING LAYER.** A minimum 2 foot thick clay cap shall be designed to provide a low hydraulic conductivity barrier to percolation. Clay used for this layer shall meet the specifications in s. NR 504.06(2)(a). The clay capping layer shall be constructed according to s. NR 504.06(2)(f).

(5) **GEOMEMBRANE LAYER.** A geomembrane layer shall be designed to provide a low hydraulic conductivity barrier to percolation. The design and construction of the geomembrane component of the final cover system shall meet the requirements of s. NR 504.06(3)(c) to (j) and the following:

(a) The nominal geomembrane thickness shall be 40 mils or greater, with no thickness measurements falling below industry accepted manufacturing tolerances.

(b) The geomembrane shall be installed in direct contact with the clay capping layer.

(c) Penetrations of the geomembrane, such as gas extraction wells, shall be fitted with prefabricated collars of pipe and membrane or plate and welded at the same angles which the penetrations make with the final cover slope. Methods of fixing membrane boots to vertical pipes extending above the geomembrane shall allow for differential settlement of the waste with respect to the piping without damage to the membrane seal.

(6) **DRAINAGE AND ROOTING ZONE LAYER.** A minimum 2.5 foot thick drainage and rooting zone layer shall be designed above the geomembrane layer or clay capping layer. This layer shall include a rooting zone to provide additional rooting depth for vegetation and to protect the geomembrane layer or the clay capping layer from freeze-thaw damage and other environmental effects. It shall also include a drainage layer to allow for the drainage of liquid infiltrating through the cap. Soils available on or near the pro-

posed landfill property may be proposed for the rooting zone portion of this layer. This layer may not be densely compacted.

(a) For all landfills, a drainage layer shall be designed immediately above the capping layer. The drainage layer shall consist of a minimum of one foot of sand with a minimum hydraulic conductivity of 1×10^{-3} cm/sec or a geosynthetic drain layer of equivalent or greater transmissivity.

(b) A perimeter drain pipe shall be placed at the low end of all final cover sideslopes. The drain pipe shall be surrounded by a minimum of 6 inches of gravel or sand with a minimum hydraulic conductivity of 1×10^{-2} cm/sec. The drain pipe shall be sloped to a series of outlets at spacings no further than every 200 feet. Modeling may be submitted to the department which supports the proposal of a different spacing.

(7) **TOPSOIL.** A minimum of 6 inches of topsoil shall be designed over the cover layer to support the proposed vegetation. Fertilizer and lime shall be added in accordance with section 630, Wisconsin department of transportation standard specifications for road and bridge construction or other appropriate specifications in order to establish a thick vegetative growth.

(8) **REVEGETATION.** The seed type and amount of fertilizer applied shall be proposed depending on the type and quality of topsoil and compatibility with both native vegetation and the final use. Unless otherwise approved by the department in writing, seed mixtures and application rates shall be in accordance with section 630, Wisconsin department of transportation standard specifications for road and bridge construction. Application rates for fertilizer and mulch shall also be specified.

Note: Copies of Wisconsin department of transportation standard specifications for road and bridge construction can be obtained from the department of natural resources, bureau of waste management, 101 s. webster street, Madison, Wisconsin, 53707. Copies are also available for inspection at the offices of the revisor of statutes and the secretary of state.

(9) **FINAL USE.** The proposed final use shall be compatible with the final cover system. The following activities are prohibited at solid waste disposal landfills which are no longer in operation unless specifically approved by the department in writing.

(a) Use of the waste disposal area for agricultural purposes.

(b) Establishment or construction of any buildings over the waste disposal area.

(c) Excavation of the final cover or any waste materials.

History: Cr. Register, January, 1988, No. 385, eff. 2-6-88; am. (1) (a), (b), (2), cr. (1) (c), (d), (5), (6) (a), (b), r. and recr. (3), (4), r. (5) (a) to (c), renum. (5) to (8) to be (6) to (9) and am. (6) (intro.), (7), (9) (intro.), (a), (b), Register, June, 1996, No. 486, eff. 7-1-96.

NR 504.08 Minimum design and construction criteria for landfill gas extraction systems. (1) GENERAL. All landfills accepting wastes with the potential to generate gas shall be designed to prevent the migration of explosive gases generated by the waste fill.

(2) **ACTIVE GAS EXTRACTION AND TREATMENT.** In order to efficiently collect and combust hazardous air contaminants, all landfills which accept municipal solid waste shall be designed with an active gas recovery system. All gas recovery systems shall include the following design features, unless otherwise approved by the department:

(a) Vertical gas extraction wells shall be proposed throughout the entire landfill with a maximum radius of influence of 150 feet per well and lesser radii proposed for wells located near the perimeter of the landfill. The radii of influence of adjacent wells shall overlap. Alternate well spacings may be proposed if site specific data is obtained through performance of pump tests.

(b) All vertical gas extraction wells shall extend to 10 feet above the leachate collection system and shall be placed in 36 inch diameter boreholes. An exemption may be proposed to allow for placement of gas extraction wells closer to the leachate collection system.

(c) The pipe in the borehole shall be a minimum 6 inch diameter, Schedule 80 polyvinylchloride or an approved alternate.

(d) The lower 2/3 to 3/4 of the pipe in the borehole shall be slotted or perforated pipe.

(e) The backfill around the slotted or perforated pipe in the borehole shall be one to 1/2 inch washed stone. The top 10 feet of the borehole shall be sealed.

(f) Each gas extraction well shall have a flow control valve and sampling access port.

(g) The gas header system shall be looped to allow alternative flow paths for the gas.

(h) The minimum slope on the header pipe shall be 2% for pipes over the waste mass.

(i) Polyethylene pipe shall be used for header and lateral pipes.

(j) The sizing of the blower, header and laterals shall ensure that a minimum vacuum of 10 inches water column is available in the header adjacent to those wells located furthest from the blower.

(k) A drip leg or equivalent shall be installed immediately before the blower to separate condensate from gas while preserving the suction at the wells while under maximum operating vacuum.

(l) All condensate transfer piping and gas transfer piping located outside of the limits of waste shall be designed to be fully encased in at least 2 feet of clay, double-cased pipe or by using another approved secondary containment method except for systems with multiple drip legs within the landfill where the bulk of the condensate has been removed.

(m) The system shall be designed to have the ability to collect and treat all condensate, measure volumes and collect samples.

(n) A flare shall be designed to meet the requirements of ch. NR 445.

(3) **GAS MONITORING WELLS.** A minimum of one gas monitoring well shall be located on each side of the landfill. The wells shall be constructed according to s. NR 507.11.

(4) **PASSIVE GAS EXTRACTION SYSTEMS.** Landfills which accept only industrial waste or other nonmunicipal solid waste with the potential to generate gas and which do not utilize an active gas extraction system shall be designed with a system which allows gas venting from the entire landfill surface. An analysis shall be performed to determine the spacing needed between gas venting trenches for an effective system and also to ensure that ch. NR 445 limits for hazardous air contaminants will not be exceeded. The system shall be designed with a continuous layer below the capping layer which allows surficial venting from the waste final surface. This layer may be part of the support layer required in s. NR 504.07 (3). This layer shall consist of a minimum of one foot of granular soil with a minimum hydraulic conductivity of 1×10^{-3} cm/sec and a series of flexible, perforated pipes connected to a series of outlets.

History: Cr. Register, May, 1992, No. 437, eff. 6-1-92, r. and recr., Register, June, 1996, No. 486, eff. 7-1-96.

NR 504.09 Storm water management and miscellaneous design and construction criteria for landfills.

(1) **STORM WATER MANAGEMENT.** (a) Storm water drainage ditches, structures and sedimentation basins shall be designed such that the construction of these items shall occur during the initial stage of construction to control rainfall runoff and limit entrained sediment from reaching surface water bodies.

(b) All landfills shall incorporate the following concepts in the design of both temporary and permanent erosion and sediment control measures:

1. Grading and construction shall be scheduled to minimize soil exposure.
2. Existing vegetation shall be retained whenever feasible.
3. Disturbed areas shall be vegetated and mulched.
4. Runoff shall be diverted away from disturbed areas and active fill areas.

5. Runoff velocities shall be minimized.

6. Drainageways and outlets shall be prepared to handle concentrated or increased runoff.

7. Sediment shall be trapped on site.

8. Runoff control structures shall be inspected and maintained.

(c) The design calculations required in pars. (d), (e) and (f) shall each be performed for the period in the landfill's development where the combination of surface conditions and contributing acreage would result in the greatest runoff volume.

(d) All temporary and permanent storm water drainage ditches, swales, conveyance channels, channel linings, outlet protection, culverts and other storm water control structures handling flow onto or off the landfill shall be designed to accommodate peak flow rates from a 25 year, time of concentration storm event.

(e) Temporary and permanent sediment control measures shall be designed to settle 0.015 mm size particles for all storms up to and including the 25 year, 6 hour storm. The surface area for sediment basins shall be calculated using the average rainfall intensity over the 25 year, 6-hour storm event for the landfill. Principal spillway, emergency spillway and outlet protection for sediment basins shall be designed to pass a 25 year, time of concentration storm event. Emergency spillways for sedimentation basins shall be designed to pass a 100 year, time of concentration storm event. The design of the dewatering structures for sediment basins shall be selected such that the basin is dewatered in no less than 3 days. An analysis shall be performed to document compliance with this requirement.

(f) Storm water shall be diverted away from the active fill area of the landfill and any borrow areas to a sedimentation control structure.

(g) Containment berms placed around active fill areas shall be designed to control and collect the liquid volume resulting from the 25 year, 24-hour storm event. The design shall consider the volume of liquid generated from active fill areas which shall include areas with exposed solid waste or areas with waste covered by daily cover. Storm water in contact with active fill areas shall be handled and treated as leachate in accordance with ch. NR 506.

(h) Storm water drainage ditches, structures and sedimentation basins shall discharge along existing drainage patterns capable of accepting the anticipated flow volume. An analysis shall be performed to determine the amount and velocity of runoff prior to landfill development and to document compliance with this requirement.

(i) Storm water diversion and construction at a landfill shall be designed to minimize impacts on adjacent property, such as erosion, sedimentation and flooding.

(j) Design of all storm water management features shall comply with other applicable requirements of the department. Such requirements include, but are not limited to, ch. NR 103, and permits required by ch. 30, Stats.

(2) **MISCELLANEOUS.** All landfills shall be designed to meet the following requirements:

(a) A method of controlling any dust or windblown debris shall be included in the landfill design. The factors which will be considered by the department when evaluating alternative provisions for controlling dust and windblown debris includes the remoteness of the landfill, natural screening, windbreaks and waste types.

(b) Access to the landfill shall be restricted through the use of fencing, natural barriers or other methods approved in writing by the department.

(c) All access roads for the landfill, including those leading to the active area, shall be designed for all weather operation.

(d) All access roads which are used by over the highway vehicles shall be designed with a maximum grade no greater than 10%. The intersection of the landfill access road with an existing highway shall be designed to provide sufficient sight distance and minimum interference with traffic on the highway.

(e) Unless otherwise approved by the department, all borrow areas shall be abandoned in accordance with s. 208.3, Wisconsin department of transportation standard specifications for road and bridge construction. Pre-existing commercial borrow sources are exempt from this requirement.

Note: Copies of Wisconsin department of transportation standard specifications for road and bridge construction can be obtained from the department of natural resources, bureau of waste management, 101 s. webster street, Madison, Wisconsin 53707. Copies are also available for inspection at the offices of the revisor of statutes and the secretary of state.

(f) A minimum separation distance of 100 feet shall be maintained between the limits of filling and adjacent property line. A minimum distance of 50 feet shall be maintained between any permanent berms or excavations associated with the landfill, excluding storm water diversion structures and the adjacent property line.

(g) The landfill shall be designed so that final grades in each phase are reached as soon as possible, and the open area used for refuse filling is minimized.

(h) The final slopes of all landfills shall be equal to or greater than 5%, but may not exceed 4 horizontal to one vertical. Landfills primarily designed for the acceptance of papermill or wastewater treatment plant sludge shall have final slopes no greater than 6 horizontal to one vertical.

(i) A minimum of 2 leachate head wells shall be proposed for each major horizontal phase of the landfill unless otherwise approved by the department.

(j) All landfills which accept municipal solid waste shall be supplied with a weight scale.

(k) All landfills shall be designed with properly protected permanent benchmarks for horizontal and vertical control. Elevations shall be tied to USGS datum and horizontal control shall be referenced to the property boundary.

History: Cr., Register, June, 1996, No. 486, eff. 7-1-96.

NR 504.10 Alternative design criteria for landfills accepting high volume industrial wastes. This section applies to landfills designed principally for high volume industrial waste, wood residue and minor amounts of other wastes as approved by the department. This section applies to all new landfills and to the expansion of existing landfills for which the plan of operation was approved after February 1, 1988.

(1) GENERAL. (a) An applicant may design a high volume industrial waste landfill to meet the standards contained in ss. NR 504.05 to 504.09 or may propose an alternative design in accordance with the provisions of this section.

(b) If the applicant does not complete construction of the first major phase of the landfill within 2 years from the date of the plan of operation approval, the applicant shall reapply to the department for approval to construct the landfill. This application does not constitute a feasibility report as defined in s. 289.24, Stats. The department may require additional conditions of approval and require redesign of the landfill in accordance with state-of-the-art design criteria.

(c) An owner or operator of a landfill which is designed primarily for disposal of high volume industrial waste may accept up to 10% by weight of municipal waste such as packaging which is generated in conjunction with the manufacturing process, and not be subject to the design requirements of s. NR 504.05(1). Household and plant waste not generated as a direct result of the manufacturing process such as office and cafeteria waste, may not be disposed of in a landfill which does not meet the requirements of s. NR 504.05(1).

(2) DESIGN CAPACITY. Design capacity shall be in accordance with s. NR 504.05(3).

(3) DESIGN CRITERIA. An applicant seeking approval of an alternative design under this section shall demonstrate in the feasibility report required in ch. NR 512 that the alternative design adequately protects public health, welfare and the environment and meets or exceeds the location and performance standards of s. NR 504.04. The applicant may include the following types of information as a part of such a demonstration:

(a) Landfill characteristics including regional and specific information on land use, geology, hydrology, hydrogeology and soils.

(b) Waste characteristics including quantity and physical and chemical analyses of the waste and its leachate.

(c) An analysis of any design to control geologic or hydrogeologic conditions of the site.

(d) Field demonstration data.

(e) Design and performance data for other similarly designed and constructed landfills.

(f) Accepted scientific or engineering analyses or field studies, field plots, research, manufacturer's data or demonstrations.

(4) APPROVAL CRITERIA. The department shall approve the alternative design proposed by the applicant if the department determines to a reasonable degree of certainty that the alternative design adequately protects public health, welfare and the environment and meets or exceeds the location and performance standards of s. NR 504.04.

History: Cr., Register, June, 1996, No. 486, eff. 7-1-96.

NR 504.11 Minimum design and construction criteria for landfills accepting residue produced by burning municipal solid waste. (1) APPLICABILITY. This section applies to landfills designed for residue produced by the burning of municipal solid waste as approved by the department. This section applies to all new and existing landfills.

(2) LANDFILL DESIGN CRITERIA FOR RESIDUE PRODUCED BY BURNING MUNICIPAL SOLID WASTE. (a) All landfills that accept municipal solid waste combustor residue that tests below the limits specified in s. NR 502.13(6)(g) shall be designed as composite lined monofill cells according to the following criteria:

1. The composite liner shall consist of a minimum 60 mil geomembrane overlying a minimum thickness of 4 feet of compacted clay meeting the specifications of s. NR 504.06.

2. The leachate collection system shall be designed such that the leachate from the residue monofill cell can be sampled and collected separately from non-residue disposal areas.

3. The department may approve alternate designs such as double liners if it finds that the design provides equivalent protection.

(b) All landfills that accept municipal solid waste combustor residue that exceeds the limits specified in s. NR 502.13(6)(g) shall be designed as a double composite lined monofill cell according to the following criteria. The department may approve alternate designs if it finds that the design provides equivalent protection.

1. The double composite liner shall be designed with 2 separate composite liners with each liner consisting of a minimum 60 mil geomembrane overlying a minimum thickness of 4 feet of compacted clay meeting the specifications of s. NR 504.06.

2. The composite liners shall be separated by a leachate detection layer consisting of a minimum one foot layer of granular material.

3. Separate leachate collection systems shall be designed above and between the composite liners. The leachate collection system shall be designed such that the leachate from the leachate detection layer can be sampled and collected separately from the

upper leachate collection system and from the non-residue disposal areas.

(c) All landfills which accept municipal solid waste combustor residue shall be approved by the department in accordance with s. NR 514.07(5) prior to accepting each specific residue waste stream.

History: Cr., Register, June, 1996, No. 486, eff. 7-1-96.