Chapter NR 811

REQUIREMENTS FOR THE OPERATION AND DESIGN OF COMMUNITY WATER SYSTEMS

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Note: Chapter NR 111 as it existed on April 30, 1992 was repealed and a new chapter NR 811 was created effective May 1, 1992.

NR 811.01 Applicability. This chapter governs the general operation, design and construction of community water systems. The standards for design and construction shall be considered minimum standards for new facilities and the minimum standards to which existing facilities shall be upgraded when improvements are undertaken at those facilities. These standards may be imposed on a case–by–case basis to existing facilities when the department determines that a potential health risk exists.

Note: The authority to promulgate and enforce these rules is contained in chs. 280 and 281, Stats. Pursuant to s. 299.97, Stats., any person who violates this chapter shall forfeit not less than $10 nor more than $5,000 for each violation. Each day of continued violation is a separate offense.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.02 Definitions. In this chapter:

(1) "A.N.S.I." means the American National Standards Institute, 1430 Broadway, New York, NY 10018.

(2) "A.P.I." means the American Petroleum Institute, 211 N. Ervay, Suite 1700, Dallas, Texas 72501.

(3) "Approval" means the written approval of the department for any project requiring approval pursuant to s. 144.04, Stats., and s. NR 108.03.

(4) "A.S.T.M." means the American Society for Testing and Material, 1916 Race Street, Philadelphia, Pennsylvania 19103.

(5) "A.W.W.A." means the American Water Works Association, 6666 West Quincy Avenue, Denver, Colorado 80235.

(6) "Boil water notice" means a special type of public notice that informs consumers that the water is bacteriologically unsafe and must be boiled prior to consumption. A boil water notice includes the following information:

(a) The water has tested bacteriologically unsafe for drinking;

(b) All water used for washing of eating utensils, drinking or cooking must be boiled at a rolling boil for at least 5 minutes;

(c) Ice and any beverages prepared with unboiled water must be discarded; and

(d) The above precautions are in effect until further notice.

(7) "Community water system" means a public water system which serves at least 15 service connections used by year–round residents or regularly serves at least 25 year–round residents. Any water system serving 7 or more homes, 10 or more mobile homes, 10 or more apartment units or 10 or more condominium units shall be considered a community water system unless information is provided by the owners indicating that 25 year–round residents will not be served.

(8) "Cross connection" means any connection between 2 otherwise separate systems, one of which contains potable water from a public water system and the other water from a private source, water of unknown or questionable safety or steam, gases or chemicals, whereby there may be a flow from one system to the other, the direction of flow depending on the pressure differential between the 2 systems.

(9) "CT" or "CT calc" is the product of the "residual disinfectant concentration" (C) in mg/l determined before or at the first customer, and the corresponding "disinfectant contact time" (T) in minutes, i.e., "C" x "T".

(10) "Department" means the department of natural resources.

(11) "Distribution system" means all pipes or conduits by which water is delivered to consumers except piping inside buildings served and service pipes from a building to a distribution main or pipe.

(12) "Groundwater" means that part of the subsurface water which is in the zone of saturation.

(13) "Groundwater source" means all groundwater obtained from horizontal collectors, infiltration lines, springs, and dug, drilled or other types of wells.

(14) "I.S.O." means the Insurance Services Office, 6550 York Avenue South, #600, Minneapolis, Minnesota 55435.

(15) "Living unit" means a residence, apartment unit, condominium unit or other domicile.

(16) "Municipal water system" means a community water system owned by a city, village, county, town, town sanitary district, utility district, public inland lake and rehabilitation district, municipal water district or a federal, state, county or municipal owned institution for congregate care or correction, or a privately owned water utility serving the foregoing.

(17) "Non–community water system" means a public water system that is not a community water system.

(18) "N.S.F." means the National Sanitation Foundation, 3475 Plymouth Road, P.O. Box 1468, Ann Arbor, Michigan 48106.

(19) "Other–than–municipal water system" means a community water system that is not a municipal water system.

(20) "Person" means an individual, corporation, company, association, cooperative, trust, institution, partnership, state, municipality or federal agency.

(21) "Public water system" means a system for the provision to the public of piped water for human consumption, if a system has at least 15 service connections or regularly serves an average of at least 25 individuals daily at least 60 days out of the year. A public water system is either a"community water system" or a "non–community water system". A system includes:

(a) Any collection, treatment, storage and distribution facilities under control of the operator of a system and used primarily in connection with a system, and

(b) Any collection or pretreatment storage facilities not under such control of the operator of a public water system which are used primarily in connection with a system.

Note: The definition of public water system as regulated by this chapter is broader and includes more water systems than those governed by the public service commission under its definition of a public utility in ch. 196, Stats.

(22) "Reviewable project" shall have the same meaning as in s. NR 108.02 (13).

(23) "Supplier of water" or "owner" means any person who owns or operates a public water system.

(24) "Utility" means a public utility as defined in ch. 196, Stats.

(25) "Waterworks" or "water system" means all structures, conduits and appurtenances by means of which water is delivered to consumers except piping and fixtures inside buildings served, and service pipes from buildings to street mains.

(26) "Well" means an excavation or opening into the ground made by digging, boring, drilling, driving or other methods for the purpose of obtaining groundwater.

(27) "Well driller" means a person defined as a well driller by s. 162.02 (5), Stats.

(28) "WPDES permit" means the Wisconsin pollutant discharge elimination system permit issued by the department under ch. 283, Stats., for the discharge of pollutants.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92; **correction in (22) and (28) made under s. 13.93 (2m) (b) 7., Stats., Register, December, 1998, No. 516.**

NR 811.03 Alternative requirements. (1) If the owner of a proposed reviewable project determines that compliance with the design requirements of this chapter is impracticable, the owner may submit in writing to the department prior to submission of final plans a request to use alternative criteria. This request shall contain the reasons that compliance with the design criteria is impracticable and alternative criteria for which department approval is sought and all pertinent facts, data, reports and studies supporting the proposed alternative.

(2) If the department determines that compliance with the design requirements of this chapter would be impracticable in any specific case, or that an alternative proposed has additional benefits with adequate safeguards, it may approve alternative criteria which are in substantial compliance with the requirements of this chapter.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

Subchapter I —Operation and Maintenance

NR 811.04 General requirements. The supplier of water shall be responsible for insuring that the public water system is operated to provide an adequate quantity of safe drinking water to consumers. This responsibility includes maintaining or contracting for an adequate number of trained staff to perform all duties necessary, performing maintenance and replacement of equipment when necessary to keep the facilities in good operating condition, and providing adequate laboratory testing equipment to control and monitor treatment processes and chemical addition programs.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.05 Required sampling, testing and reporting. The supplier of water shall be responsible for sampling, testing and reporting to the department water source, treatment plant and distribution system water quality, and water system operational data in accordance with the applicable requirements of chs. NR 108, 809, and this chapter. In addition the following requirements shall be met:

(1) SAMPLING AND TESTING. (a) Sampling and testing for water quality, quantity and system collection of operational data

shall be performed by the supplier of water as required by chs. NR 108, 809, 149 and this chapter.

(b) Additional sampling and testing shall be performed by the supplier of water as required by the department in writing. The department may require the additional sampling and testing when necessary to verify water quantity and quality, treatment plant effectiveness, adequate distribution system operation, and to protect water consumers as well as the environment from adverse impacts.

(2) REPORTING. (a) All suppliers of water for municipal water systems shall submit monthly reports on forms supplied by the department to the appropriate district office of the department as required by s. NR 108.06 (4). Computer generated forms are acceptable if, at a minimum, all the required data are submitted on the form, and if the form of the report receives the approval of the appropriate department district office prior to use. Reports shall include the following data if applicable:

1. Daily quantities of water pumped;
2. Daily quantities of chemicals added to the water;
3. Daily operation of treatment processes;
4. Results of chemical, physical or other tests performed for plant control;
5. Calculated theoretical residuals and residual test results;
6. Groundwater depth measurements, static and pumping, at least weekly where applicable;
7. Totals and averages of the above where spaces are provided on the report form;
8. Other data determined necessary by the department.

(b) Suppliers of water for other–than–municipal water systems which have groundwater source capacity exceeding 70 gallons per minute or which are chemically treating the water supply, or both, shall submit monthly reports on forms supplied by the department. Where chemical addition or water treatment is practiced, reporting shall be in conformance with par. (a). Reports shall include the following data:

1. Total monthly pumpage of water;
2. Groundwater depth measurements, static and pumping;
3. Other data, including information on any chemical addition, as required by the department in writing.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92; correction in (intro.) and (1) (a) made under s. 13.93 (2m) (b) 7., Stats., Register, August, 1994, No. 464.

NR 811.06 Drinking water standards. Where practical, the quality of the raw water source shall meet the primary maximum contaminant levels of ch. NR 809 and other applicable requirements of ch. NR 809 and this chapter without treatment. In all cases, the quality of finished water supplied to consumers shall meet the primary drinking water standards contained in ch. NR 809.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92; correction is made under s. 13.93 (2m) (b) 7., Stats., Register, August, 1994, No. 464.

NR 811.07 General treatment and disinfection requirements. Treatment shall be provided by each supplier of water where necessary in order to insure that the finished water supplied to consumers meets the primary maximum contaminant levels contained in ch. NR 809 and is not objectionable to an appreciable number of consumers. In addition, the following requirements shall be met:

(1) TREATMENT OF WATER FROM SURFACE WATER SOURCES. (a) All public water supply systems drawing water from lakes, rivers, streams or other surface water sources shall, after the water is drawn, treat the water as provided in this chapter. In general, this treatment shall include disinfection, coagulation, sedimentation and filtration. All deviations from required treatment methods shall be approved by the department and based on data which shows that the requirements of this chapter are unnecessary in the specific case.

(b) The free chlorine concentration in the water entering the distribution system shall be at least 0.2 mg/l at the entry point to the distribution system and detectable throughout the distribution system or the total combined chlorine concentration shall be at least 1.0 mg/l at the entry point to the distribution system and detectable throughout the distribution system. Residual monitoring of the water entering the distribution system shall be provided as required in s. NR 809.70.

(c) Treatment plant CT values shall meet the applicable requirements of ch. NR 809.

(2) TREATMENT OF WATER FROM GROUNDWATER SOURCES. (a) The department may require continuous disinfection of water drawn from groundwater sources if water quality data or well or system construction indicates a potential health hazard. Disinfection of water drawn from groundwater sources is to supplement and not replace proper well location, construction and source protection. When disinfection of water drawn from a groundwater source is required to maintain bacteriologically safe water, the residual maintained in the distribution system and the residual monitoring shall be the same as that required for surface water in sub. (1) (b).

(b) Water drawn from those groundwater sources which are most susceptible to contamination, such as springs, shallow wells and wells developed in limestone which are not overlain with sufficient protective material, shall be disinfected and provided with an adequate detention period as determined by the department before the water reaches the consumers.

(c) Disinfection of water drawn from groundwater sources shall be required in facilities which expose the water to the atmosphere, such as open basins, filters, air stripping towers or gravity aerators. Chlorination of groundwater shall also be required prior to treatment through a pressure vessel such as an ion exchange softener or an iron/manganese filter unless deemed unnecessary or inappropriate by the department.

(d) If water drawn from a groundwater source exceeds primary standards in ch. NR 809 or a department health advisory, the well from which such water is obtained shall be removed from service and reconstructed or abandoned. Under emergency conditions, the department may permit temporary use of a well from which bacteriologically contaminated groundwater is drawn if disinfection adequate to insure safe water is provided. Use shall be terminated when the well from which contaminated water is drawn is replaced or reconstructed. A continuous boil water notice may be required by the department during all or a part of this interim period if deemed necessary to protect public health.

(e) The department may allow the use of water drawn from a groundwater source deemed to be under the direct influence of surface water provided treatment facilities meeting the requirements of ch. NR 809 and this chapter are provided. Where use is allowed, the disinfectant residual maintained in the distribution system and residual monitoring shall be the same as required for treatment of water drawn from a surface water source. Treatment requirements for other–than–municipal public water systems may be modified where surface water treatment is impractical, where sufficient treatment can be provided, and if approved by the department. The supplier of water shall contact the department to determine allowable treatment in these cases.

(3) CONSTRUCTION AND MODIFICATIONS. (a) After construction, maintenance, repair or modification, waterworks facilities shall be disinfected by procedures outlined in A.W.W.A. Standard A100 (1–7), (June 10, 1984), C651, (January 26, 1986) or D105 (January 26, 1986), C652 (January 26, 1986), C653 (January 25, 1987). In addition, waterworks may not be placed in service until bacteriological samples have established that the water is safe for consumption in accordance with par. (b). Copies of these standards are available for inspection at the office of the department of natural resources, the secretary of state's office and the office of the revisor of statutes, and may be obtained for personal use

from the American Water Works Association, 6666 West Quincy Ave., Denver, Colorado, 80235.

(b) At least one bacteriologically safe sample shall be obtained before waterworks are placed into service. In the case of new or reconstructed wells, a minimum of 2 bacteriological safe samples, taken at least 8 hours apart during the test pumping period, or on 2 separate days, shall be obtained. When new systems or extensions on a number of streets are installed, bacteriological samples shall be taken at representative locations to establish that all of the improvements are free of contamination. When water main breaks are repaired in water systems that do not maintain a detectable chlorine residual a bacteriological sample shall be taken in the area of the break within one working day. The main may be returned to service prior to receiving the results provided that the main has been disinfected and flushed. The supplier shall comply with s. NR 809.31 when system sampling indicates the presence of coliform organisms. For water storage facilities, 2 or more successive safe samples, taken at 24–hour intervals, shall be obtained which indicate bacteriologically safe water or one safe sample shall be obtained only if a free chlorine residual of at least 0.1 mg/l is remaining when the results of the safe sample are reported.

(4) CHEMICAL TREATMENT. (a) All municipal water systems and all other–than–municipal water systems serving subdivisions shall be equipped with chemical feed equipment and the necessary appurtenances which can continuously disinfect the water. The department may require the installation of chemical feed equipment at any other–than–municipal water system where deemed necessary to assure a safe water supply.

(b) All surface water treatment plants and other waterworks where treatment is required to produce a water quality meeting the primary maximum contaminant levels shall be equipped with backup chemical feed equipment for all chemicals required for treatment in the event of failure of the primary equipment.

(c) Written approval from the department is required prior to the addition of any chemical to a community water system. A 30–day supply of chemicals shall be kept on hand as required by s. NR 108.06 (3). Chemicals shall meet current A.W.W.A. standards and be approved by the department. Department approval will normally consist of, but is not be limited to, approval of the chemical for use in potable water under National Sanitation Foundation (N.S.F.) Standard 60. Laboratories evaluating products for compliance with N.S.F. shall be certified by the American National Standards Institute. Colored chemicals shall be approved if coloring agents are not used in toxic concentrations or in amounts which impart taste, odor or color to the water supply. The department may require the analysis of chemicals if necessary to insure use of safe chemicals. Copies of these standards are available for inspection at the office of the department of natural resources, the secretary of state's office and the office of the revisor of statutes.

(d) Chemical containers shall be labelled to include the chemical name, purity, concentration and name and address of the supplier.

(e) Requests for the substitution of disinfection agents in lieu of chlorine for bacteriological control may be approved by the department. However, substitute disinfection agents may not be used without specific approval by the department.

(f) Written approval from the department is required prior to the use of any indirect chemical or material that may affect the quality of the water supply due to immersion or incidental contact in the water system. Examples include process media, protective materials such as liners, paints and coatings, sealants, gaskets, fittings and lubricants. Department approval shall include, but not be limited to, approval of the chemical or material for use in potable water under National Sanitation Foundation Standard 61. Laboratories evaluating products for compliance with N.S.F. 61 shall be certified by the American National Standards Institute. Copies of the standard are available as provided in par. (c). Written department approval is not required where existing equipment is being replaced with similar equipment during maintenance or repair provided that the supplier of water can document that the equipment used meets the approval requirements of this section.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92; corrections made under s. 13.93 (2m) (b) 7., Stats., Register, August, 1994, No. 464.

NR 811.08 Distribution systems. (1) OWNERSHIP OF MUNICIPAL WATER SYSTEMS. The distribution system of a municipal water system, shall be owned and maintained by the waterworks owner.

(a) All water mains on private property which are, or in the future may be, connected to the distribution system at more than one point, thereby allowing flow through the piping system, shall be owned and maintained by the waterworks owner except where the water main connections meet the requirements of par. (b). To insure the use of approved materials and the proper installation and maintenance, the department recommends that fire hydrants and water mains serving fire hydrants on private property be installed in easements and owned and maintained by the waterworks owner.

(b) Water mains to be connected to the distribution system at more than one point may be privately owned and maintained provided that a check valve is installed on the water main at each point of connection to the distribution system to prevent water from flowing back into the publicly owned distribution system. Each check valve shall be located in a manhole or vault and shall be immediately preceded and followed by a shut–off valve on the main. The water supplier shall have access to the manholes and valves for inspection purposes.

Note: Refer to s. Comm 82.40 for standards for the construction of private water mains.

(2) NORMAL PRESSURE. System pumps, the distribution system and related storage facilities shall be operated to maintain a minimum of 35 pounds per square inch at ground level at all locations in the distribution system under normal operating conditions including maximum day demand averaged over a 24 hour period. In areas where this pressure cannot be maintained, corrective action shall be taken to maintain a minimum of 35 pounds per square inch. If the corrective action requires a reservoir or booster pumps, the requirements of ss. NR 811.60 (1) and 811.72 to 811.77 shall be met.

(3) FIRE FLOW PRESSURE. The system shall be operated so that under fire flow conditions the residual pressure in the distribution system is not less than 20 pounds per square inch at ground level. Fire pumpers may not be connected to fire hydrants if 20 psi cannot be maintained during operation of the pumpers. In addition, the system owner shall notify the fire chief in writing of the location of all fire hydrants that cannot be used by fire pumpers and color code or tag the affected hydrants.

(4) LOSS OF PRESSURE. The supplier of water shall be responsible for taking corrective action when positive distribution system pressure is lost in an area affecting 25% or more of the distribution system. In addition to restoring system pressure, the supplier of water shall perform the following as necessary:

(a) Notify the appropriate district office of the department as soon as possible, but no later than one working day, as to the extent of the problem, cause and corrective actions taken.

(b) Start emergency disinfection of the water supply if the system is not already continuously disinfected. At a minimum, the free chlorine residual shall be 0.2 mg/l at the entry point to the distribution system and detectable throughout the distribution system or the total combined chlorine residual shall be 1.0 mg/l at the entry point and detectable throughout the distribution system. Higher disinfectant residuals may be required by the department if deemed necessary to assure a safe water supply. Water mains and storage facilities in the area that lost pressure shall be flushed to remove contaminated water and to quickly establish an ade-

quate disinfectant residual. Emergency disinfection shall be maintained until approval is obtained from the department to cease.

(c) Collect distribution system water samples for bacteriological analyses from the pressure loss area as soon as adequate pressure is returned to the system. The number of samples collected shall increase as the extent of problem areas increases, but in no case may less than 2 samples be collected. The department shall be contacted to determine the number of samples and sampling locations. The supplier shall comply with s. NR 809.31 when system sampling indicates the presence of coliform organisms.

(d) Issue an immediate boil water notice to all affected water consumers unless it is determined by the department that an acute threat to public health does not exist. The boil water notice shall be maintained until approval is obtained from the department to cease.

(e) Notify the public in the area affected as prescribed in s. NR 809.81 (1) (a) 3. unless the department determines that no health hazard has existed.

(f) Take all corrective actions necessary to prevent additional significant pressure losses.

(5) MAINTENANCE. Each supplier of water shall perform routine maintenance to ensure proper operation of the water system. A schedule shall be established for flushing dead–end mains or mains in other areas to remove sediment or water of poor quality. A number of hydrants and valves shall be exercised each year depending on system size so that all are routinely exercised. Record keeping shall be established to insure routine scheduling and performance of valve and hydrant exercising and maintenance. Water storage facilities shall be emptied and inspected at least once every 5 years and maintenance provided as necessary. Interior and exterior paint coatings for steel elevated water storage tanks or treatment structures shall be inspected by a person trained to evaluate the integrity of the paint system at least once every 5 years and repainted as necessary to maintain structural integrity. The supplier of water may perform the inspection if experienced in paint inspection.

Note: The department recommends that each valve and hydrant be operated at least once every 2 years.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92; corrections in (4) made under s. 13.93 (2m) (b) 7., Stats., Register, August, 1994, No. 464.

NR 811.09 Cross–connections and interconnections. Installation or replacement of cross–connections is prohibited. Plumbing back–siphonage, cross–connection and potability control regulations are provided in s. Comm 82.41; water system interconnections are prohibited except as provided in sub. (2). In addition the following requirements shall be met:

(1) CROSS-CONNECTION CONTROL PROGRAM. The supplier of water for every municipal water system shall develop and implement a comprehensive control program for the elimination of all existing cross–connections and prevention of all future cross–connections. A record of the cross–connection control program shall be kept current and available for annual review by the department. The control program shall include but not be limited to:

(a) A complete description of the program and the administration procedures, including designation of the inspection or enforcement agency or agencies;

(b) Local authority for implementation of the program, such as ordinance or rule;

(c) A time schedule for inspection and reinspection of consumer premises for cross–connections including appropriate record keeping. Unless otherwise authorized by the department, each supplier of water shall inspect every service a minimum of once every 10 years. It is recommended that industrial and commercial services be inspected once every 2 years.

(d) A description of the methods and devices which will be used to protect the water supply by reference to or inclusion of ch. Comm 82;

(e) Provisions for denial or discontinuance of water service, after reasonable notice, to any premises where an unprotected cross–connection exists.

(f) Submission to the department of a copy of an ordinance establishing a cross–connection control program.

(2) INTERCONNECTIONS WITH OTHER ACCEPTABLE WATER SOURCES. Interconnections between the public water supply system and another source of water are prohibited unless permitted by the department in individual cases. Approval of the department shall be obtained prior to the interconnection.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92; correction in (intro.) and (1) (d) made under s. 13.93 (2m) (b) 7., Stats., Register, December, 1998, No. 516.

NR 811.10 Private well abandonment ordinance. Suppliers of water for municipal water systems shall require the abandonment of all unused, unsafe or noncomplying private wells located on premises served by their system. Abandonment is required to prevent the well from acting as a vertical channel for groundwater contamination or as a source of unsafe water from illegal cross–connections with the public water system. Implementation shall be by local ordinance or water utility rule. The ordinance or rule shall include but not be limited to:

(1) A requirement that all private water supply well or pump installations which are not used currently, or are found to be in noncompliance with ch. NR 812, or wells which test unsafe, shall be abandoned in accordance with ch. NR 812 by an established date which may not extend beyond one year from date of connection to the public system.

(2) Provisions for a permit system that will allow retention of private water supply systems which are found to be safe and in compliance with ch. NR 812 with the limitation that the owner shall demonstrate a need for continued current use. The permit shall require, but not be limited to the following:

(a) Bacteriological sampling, consisting of obtaining a minimum of 2 consecutive safe samples taken a minimum of 2 weeks apart prior to issuing or reissuing the permit, to establish that the water is safe for human consumption.

(b) Prohibition of cross–connections between any private well and pump installations and the municipal water system.

(3) Submission of a copy of the private well abandonment ordinance or rule to the department.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92; corrections in (1) and (2) (intro.) made under s. 13.93 (2m) (b) 7., Stats., Register, August, 1994, No. 464.

NR 811.11 Other requirements. (1) AUTHORIZATION FOR OPERATION OF NEW COMMUNITY WATER SYSTEMS OR IMPROVEMENTS TO EXISTING SYSTEMS. Before a new community water system or improvements to a community water system can be placed into service, written authorization of the department shall be obtained.

(a) To obtain authorization for operation of a new water system, the owner shall meet the following requirements:

1. An inspection of the facilities shall be made by a representative of the department to determine if construction is in accordance with the approved plans and specifications. Deficiencies shall be corrected prior to startup.

2. The department shall be informed in writing of the name of the certified waterworks operator who will be in charge of any municipal water system.

3. The owner of a municipal water system shall have adopted cross–connection and well abandonment ordinances or rules.

(b) To obtain authorization for startup of improvements to existing community water systems that are reviewable projects as specified in s. NR 108.02 (13), an inspection of the facilities and correction of deficiencies may be necessary prior to startup as required in par. (a). Water mains are excluded from the inspection requirement unless required in the department plans and specifications approval letter.

(2) MAPS. Each supplier of water shall keep a current map of the system which shows the size and location of all facilities and appurtenances, such as water mains, valves, hydrants, wells or sources, pumping stations, treatment plants and storage facilities. Contour lines or ground elevations at street intersections shall be shown as well as the overflow elevations of the system storage units. Any pressure zones shall be delineated. Two current copies of this map shall be kept on file with the department at all times. One copy shall be provided to the department's central office and one copy shall be provided to the appropriate department district or area office.

(3) CERTIFIED OPERATOR. All suppliers of water for municipal water systems shall comply with the certified operator requirements in s. NR 108.06 (2) and ch. NR 114.

(4) METERS. Each supplier of water except those other–than–municipal water systems having source capacity less than 70 gallons per minute shall provide a water meter at each source to accurately measure the daily quantity of water pumped or delivered. Water metering shall be provided for all community water systems utilizing chemical addition.

(5) LICENSED PUMP INSTALLER. Any person, firm, corporation or partnership performing well pump installing work as designated in s. 280.01 (5), Stats., shall perform the work in accordance with chs. NR 108, 811 and 812 and shall be a licensed pump installer in accordance with the requirements of ch. NR 146. Pump installing work at municipal water systems is not required to be performed by a licensed pump installer when performed by a department certified waterworks operator who is a full–time employee of the municipal water system.

(6) PROJECTS REQUIRING DEPARTMENT APPROVAL BUT NOT REQUIRING SUBMITTAL BY A PROFESSIONAL ENGINEER. The requirements for plans and specifications submittal for reviewable projects are in ch. NR 108. The water supply owner or the owner's representative may submit reviewable projects to the department for approval without the seal of a professional engineer registered in Wisconsin for most operation and maintenance work and for all nonsubdivision, other–than–municipal water systems as provided in s. NR 108.04 (2) (c) 2. Plans shall be submitted by a registered well driller or pump installer where applicable. Examples of projects not requiring a professional engineer's seal are pump replacement with similar equipment not affecting pumping capacity, test well construction when to be pumped at a rate of 70 gallons per minute or more for a minimum duration of 72 hours, unless the well is to be converted to a municipal or subdivision well, well reconstruction work, pumphouse pump discharge piping and valving replacement, well rehabilitation work as described in s. NR 811.16, changing chemical type when the chemical feed equipment has been previously approved by the department, and painting or coating elevated water storage tank and reservoir interiors.

(7) UNDERGROUND PLACEMENT OF SUBSTANCES. The use of any well, drillhole or water system for the underground placement of any substance shall be prohibited unless it is a department approved activity necessary for the construction, rehabilitation or routine operation of the well or water system.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92; correction in (5) made under s. 13.93 (2m) (b) 7., Stats., Register, August, 1994, No. 464; correction in (5) made under s. 13.93 (2m) (b) 7., Stats., Register, December, 1998, No. 516.

Subchapter II —Submission of Plans

NR 811.12 General requirements. (1) Plans and specifications for all reviewable projects shall be submitted in accordance with ch. NR 108. Plans shall comply with or incorporate the general design and operating requirements in that chapter. Worksheets shall be included with all submittals for reviewable projects for which applicable worksheets are provided by the department.

(2) In addition to the requirements of sub. (1), plans and specifications for all reviewable projects not requiring submittal by a professional engineer shall be submitted in accordance with s. NR 811.11 (6).

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.13 Specific requirements for waterworks, plans, specifications and engineering report. (1) PLANS. (a) *General.* The detailed construction plans shall contain appropriate plan and profile views, elevations, sections and supplemental views which together with the specifications provide all necessary information for construction of the improvements. The elevations shall be based on sea level datum or local datum when a conversion to sea level datum is provided. Manufacturer's drawings are not acceptable as construction plans and will not be approved. Other state and local codes, including those of the department of industry, labor and human relations, the public service commission and the department of health and social services, shall be consulted for other requirements where applicable.

(b) *Wells.* 1. A general plan shall be submitted which shows the location of the proposed well and its relation to proposed or existing water supply facilities. It shall show all features of sanitary significance which could have an effect on water quality. A separate well site plan shall be submitted which shows the property lines, contours or an appropriate number of spot elevations so that drainage can be determined, surficial features, structures and any other relevant data. A detailed well cross section shall be submitted which shows the size and depths of drill holes and casings, depth of grout and geological formations to be penetrated.

2. A copy of a well site investigation report shall be submitted as required in sub. (3) prior to or along with the plans submitted to the department for all final wells or applicable test wells as described in subd. 3. Based upon a review of the submitted well site investigation report, the department may perform an on–site inspection of the well site. Wellhead protection criteria conforming to s. NR 811.16 (5) shall be considered when siting wells. In addition, drawdown effects from the pumping or test pumping of test wells and final wells shall be considered during well siting and design. Information on possible drawdown effects shall be included with all submittals to the department where significant drawdown may occur or when required by the department.

3. Plans and specifications shall be submitted prior to the construction of any test well to be pumped at a rate of 70 gallons per minute or more for a minimum duration of 72 hours. When it is known with reasonable certainty that any proposed test well will be converted to a final well the plans and specifications for the final well shall be submitted for department approval prior to construction of the test well.

(c) *Water loss and interbasin diversion approvals.* A supplier of water shall obtain approval from the department prior to creating a water loss or interbasin diversion as defined in s. NR 142.02, in accordance with the requirements of ch. NR 142.

(d) *Surface water intakes.* 1. Location plan. Plans shall show the location of the intake pipeline and crib relative to the low lift pumping facility. The pipeline shall be referenced by bearing and distance, and the crib location shall be defined by latitude and longitude.

2. Detailed plans. A profile of the proposed pipeline and crib shall be provided in addition to construction plans.

(e) *Treatment plants.* 1. Location plan. The location plan shall show the location of the treatment plant in relation to the remainder of the water system and the water source or intake.

2. Layout. The general layout plans shall include a contour map of the site, the site size, the size and location of plant structures, a schematic flow diagram indicating the various plant units, the piping layout and a hydraulic profile at gravity plants.

3. Detailed plans. The detailed construction plans shall include the location, dimensions, elevations and details of all existing and proposed plant units or equipment.

(f) *Chemical feed equipment.* The plan shall include a layout of the waterworks structure and piping. The following locations and details of the proposed equipment shall be included:

1. Descriptions of feed equipment, including feed ranges;

2. Location of feeders, piping layout and points of application;

3. Storage and handling facilities;

4. Specifications for chemicals to be used;

5. Operating and control procedures;

6. Description of testing equipment and procedures;

7. Well or booster pump discharge rates and pressures.

(g) *Pumping facilities.* The plan shall show a general layout of the pumping equipment, pumpbases, the suction and discharge lines and related housing and appurtenances.

(h) *Water mains.* 1. Location plan. The plan shall show the proposed water main extensions in relation to existing facilities. A map, such as required by s. NR 811.11 (2), of the existing system or a portion thereof with the proposed extensions shown will satisfy this requirement.

2. Detailed plans. The plans shall show the location of the proposed water main within the street right–of–way or easement; the location of other utilities, such as sanitary or storm sewers; elevations at intersections and hydrants or a profile of the proposed water main; location of proposed appurtenances; details or special features and connection to the existing system. Profiles showing the ground surface, the proposed water main, the proposed sanitary sewer and rock depths are necessary when approval of a common trench is requested in high bedrock areas. The size of proposed and existing water mains shall also be shown.

3. Worksheet submittal. Complete information as requested on any required worksheet shall be provided. The forms shall be completed for all water main projects including revisions to existing projects, upgrading of existing mains and resubmittals of projects previously approved by the department.

(i) *Storage facilities.* 1. Location plan. The plan shall show the location of the proposed facility in relation to existing facilities.

2. 'Detailed plans'. Plans shall show contour lines at the site and complete construction details. Overflow elevations for existing and proposed facilities shall be noted.

(2) SPECIFICATIONS. Complete, detailed material and construction specifications shall be supplied for all phases of the proposed project. They shall contain a program for keeping existing waterworks facilities in operation during construction of additional facilities so as to minimize interruptions of service. Specifications shall be included for controlling erosion on or near the construction site as a result of construction activity as specified by the Wisconsin Construction Site Best Management Practice Handbook. This handbook is available for inspection at the office of the department of natural resources. It is available for purchase at Document Sales, 202 S. Thornton Ave., P.O. Box 2840, Madison, WI 53707.

(3) ENGINEERING REPORT. An engineering report shall be submitted with all reviewable projects with the exception of water main extensions. The engineering report, required by s. NR 108.04 (2) (a), shall contain the controlling assumptions made and the factors used in the functional design of the waterworks facility as a whole and of each of the component units. Where applicable, the report shall make reference to available regional, metropolitan, county or local water supply or water quality management plans and shall clearly indicate whether the proposed project is in conformance with the plans.

(3m) REPORT REQUIREMENTS. The report shall, in all cases, indicate the basis of design and shall include the following specific data, if applicable:

(a) *Description.* A brief description of the project and the need for improvements.

(b) *Location.* A description of the geographic location of the project, including reference to maps or exhibits and the location of existing facilities.

(c) *Topography.* A brief description of the topography of the general area and its relation to the area involved in the project.

(d) *Population.* Past census data and estimated future projection to the design year for the area involved in the project.

(e) *Design period.* The design period being used for sizing major system components, based on the population projection.

(f) *Investigations.* The results of any investigations, such as soil borings, test wells, pilot tests, water quality data and fire flow tests.

(g) *Flooding.* Any areas of the project which are located within the floodway or floodplain as defined in ch. NR 116 shall conform to the requirements of that chapter.

(h) *Wetlands.* Any areas of the project which are to be located within a wetland, pass through a wetland or may impact a wetland shall be identified. Copies of the Wisconsin wetland inventory maps are available for inspection at the office of the department of natural resources and may be obtained for personal use from the Wisconsin Geological and Natural History Survey, 3817 Mineral Point Road, Madison, Wisconsin 53705.

(i) *Recommendations.* After discussion of alternatives, a statement of the reasons for selection of the recommended alternative shall be provided. A discussion of estimated capital costs and estimated annual operation and maintenance costs shall be included.

(j) *Specification.* The report shall, in addition, include specific information relevant to the type of project. The specific information required for each type of project is as follows:

1. Groundwater sources – site surveys. A copy of a well site investigation shall be submitted for department review and approval prior to the department approving the construction of a permanent well as required in sub. (1) (b) 2., or where there is reasonable certainty that the location of any test well will be the location of the permanent well. If no test well is to be constructed, site approval may be obtained simultaneously with department approval of plans for the final well. The investigation shall consist, at a minimum, of a map and report indicating:

a. The regional flood elevation.

b. The past and present use of the proposed site.

c. The potential contamination sources within 1/2 mile of the well location. A listing of potential contamination sources that are to be identified if present is available from the department.

d. The proposed test or final well pumping capacity, or both, as applicable.

e. The direction of groundwater flow.

f. The recharge area for the well.

g. The zone of influence of the proposed well at the anticipated final pumping rate when pumpage of the well is assumed to be continuous without recharge for 30 days.

h. The aquifer to be used.

i. The well location by quarter quarter section, township and range.

j. The boundaries of the site and the location of the well on the site.

k. The topography of the site.

L. The results from any previous test wells including details of test well location and construction, water quality, pumping conditions including drawdown effects, if applicable, on other nearby

wells or the environment, geologic borings, and seismic, resistivity or other groundwater investigations.

m. The test or final well construction details, or both, including geologic formations.

n. The anticipated annual volume of water to be withdrawn and the compatibility with the existing water supply facilities.

o. The location and data from any piezometers.

p. A summary evaluation of the site including advantages and disadvantages and the need for any possible water treatment.

q. The location of any nearby wetland.

2. Surface water sources. To assess the water available at the source, a survey and study shall be made and shall include obtaining samples from a number of locations and depths in order to select the best intake site. Sampling shall be sufficient to adequately determine the water quality characteristics. The report shall summarize information on hydrological data, such as safe yield, maximum and minimum water levels or flows, the quality of raw water with special emphasis on results of testing programs, fluctuation in water quality including seasonal variations and effects, the presence of befouling organisms, and existing and future potential sources of contamination.

(4) WATER TREATMENT OR CHEMICAL ADDITION PROCESSES. A summary establishing the adequacy of the proposed processes for the treatment of the specific water under consideration shall be included. Include any data from pilot or full scale plant studies and describe the method of disposal of any wastes and any possible effects on the environment.

(5) PUMPING FACILITIES. A description of the area to be served and the basis for design, including maximum and minimum discharge heads and flows, pump operational controls and provisions for emergency operation shall be included.

(6) WATER STORAGE FACILITIES. A discussion of the high to low static pressure range which the proposed facility will provide for existing and future service areas and the volume of domestic and fire storage required within the design period shall be included. Explain how the proposed and existing facilities will meet these requirements. Also, relate the compatibility of the proposed facilities with existing facilities and any changes that will have to be made to the existing facilities.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92; correction in (3) and (3m) made under s. 13.93 (2m) (b) 1., Stats., Register, August, 1994, No. 464.

NR 811.14 Owner approval requirement. If an engineer or other agent submitting plans to the department is not an employe or otherwise retained by the owner of the water system, written acceptance of the final plans by the owner is required at the time of submission of the plans to the department.

Note: An example would be where an engineer is retained by a developer to design water main extensions which will be connected to a municipal system and eventually be owned by the municipality. The plans shall be accepted by the municipality prior to the submission of plans to the department.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.15 Resident project representative. A resident project representative shall be designated by the water supply owner or by the agent retained by the owner. The resident project representative shall be knowledgeable regarding the proposed construction, and be able to competently determine whether or not the improvements are being constructed in accordance with the department approved plans and specifications and the conditions of the approval. The project representative shall be present on the work site as needed to assure proper construction and installation of the improvements. Hiring a resident project representative does not negate the owner's responsibility to assure proper construction and installation.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

Subchapter III —Source Development – Groundwater

NR 811.16 Wells. (1) GENERAL REQUIREMENTS. (a) All wells shall be terminated above the ground surface. The pump discharge piping for permanent wells shall be exposed above the ground surface within a building or enclosure having a concrete floor.

(b) Permanent wells shall have watertight construction to such depth as may be required to exclude contamination. This shall be below the pumping water level except where exempted by the department on a case–by–case basis.

(c) Permanent wells shall be provided with a grout seal surrounding the protective casing. The grout seal shall be a minimum of 1.5 inches in thickness to the depths specified in ss. NR 811.22 and 811.23.

(d) All permanent wells shall have a minimum of 5 feet of grout in contact with the native geologic formation. Any outer casing shall be pulled back to meet this requirement, if necessary.

(e) All permanent wells shall be provided with a minimum of 60 feet of grouted protective casing wherever practicable.

(f) All wells shall be constructed using water from a source that will not contaminate the aquifer. A chlorine residual shall be maintained in the well during drilling operations.

(g) Test wells shall be drilled for permanent wells proposed in unconsolidated formations to determine geologic formations and water quality and quantity data. Test wells to be converted to permanent wells or test wells to be pumped at a rate of 70 gallons per minute or more for a period of more than 72 hours shall be approved by the department prior to their construction.

Note: In certain areas where geologic data for consolidated formations or water quality data is not available, test wells may be required by the department.

(h) Flowing wells shall be provided with valving to control the flow and the valve shall be throttled as much as practicable to prevent the erosion of the confining bed; every practicable effort shall be made to install the grouted casing below the confining bed.

(i) Materials used as drilling aids, such as drilling muds and foam or other aids shall be compounds approved by the department.

(2) WELL DRILLER REQUIREMENTS. All new wells shall be constructed and existing wells reconstructed by a driller licensed in Wisconsin. A Wisconsin well constructor's report shall be forwarded to the department with a copy to the owner by the driller immediately upon completion of a new well. A revised Wisconsin well constructor's report shall be forwarded to the department with a copy to the owner immediately upon completion of a reconstructed well.

Note: Chapter NR 146 contains the registration requirements for well drillers.

(3) INTERFERENCE BETWEEN UTILITY WELLS. When the department determines that a proposed well may have a substantial effect on the water levels in one or more wells owned by another water utility, the following procedure shall be followed:

(a) The department shall provide the owners of utility wells which may be affected by the proposed well with information on its location, proposed constructional features and the anticipated volume of water to be withdrawn.

(b) If the owner of another utility well wishes to object to the proposed utility well, the owner shall inform the department in writing of the reasons for objection within 30 days of receipt of the information in par. (a).

(c) If notice of objection is filed and good cause is shown, the department may hold a public hearing at which all interested parties may present testimony to be used by the department in determining if a restriction shall be placed on the volume of water withdrawn from the proposed well or existing utility wells.

(4) WELL SITES. The suitability of a site for a well is dependent on geological and topographic conditions and possible sources of contamination. However, the following general requirements shall be met:

(a) For wells to serve municipalities and subdivisions, a lot or parcel of land shall be reserved for the construction of the well which has minimum dimensions of 100 feet by 100 feet. The well shall be located near the center of the lot or parcel. For other wells, the well shall be located a minimum of 50 feet from any property boundary. These dimensions may be modified by the department on a case–by–case basis where they are unnecessary or inadequate to protect water quality.

(b) Wells may be constructed or replaced on sites in the floodplain outside of the floodway provided that the pumphouse floor is 2 feet or more above the regional flood elevation and there is dry land access to the pumphouse. No new well may be constructed or existing well reconstructed on a site in a floodway. Wells shall be located in an area accessible during the entire year. Where necessary, road improvements shall be installed to provide year round access. Wells shall be located on property owned by the water utility owner. Access roads shall be on property owned by the supplier of water or for which easements have been obtained.

Note: Refer to ch. NR 116 for floodplain and floodway criteria.

(c) A well site investigation report as required by s. NR 811.13 (1) (b) shall be prepared by the owner or the owner's representative for each well site and submitted to the department prior to or concurrent with the request for approval of a test well or a permanent well. The report shall be submitted on forms or in a format provided by the department.

(d) The well shall be adequately separated from potential sources of contamination. Unless a hydrogeologic investigation indicates lesser separation distances would provide adequate protection of a well from contamination, the minimum separation distances provided shall be:

1. Fifty feet between a well and a storm sewer main.

2. Two hundred feet between a well and any sanitary sewer main, lift station or single family residential fuel oil tank. A lesser separation distance may be allowed for sanitary sewer mains where the sanitary sewer main is constructed of water main materials and joints and pressure tested in place to meet current AWWA 600 specifications. In no case may the separation distance between a well and a sanitary sewer main be less than 50 feet.

3. Four hundred feet between a well and a septic tank receiving less than 8,000 gallons per day, a cemetery or a storm water drainage pond.

4. Six hundred feet between a well and any gasoline or fuel oil storage tank installation that has received written approval from the department of commerce or its designated agent under s. Comm 10.10.

5. One thousand feet between a well and land application of municipal, commercial or industrial waste; the boundaries of a landspreading facility for spreading of petroleum–contaminated soil regulated under ch. NR 718 while that facility is in operation; industrial, commercial or municipal waste water lagoons or storage structures; manure stacks or storage structures; and septic tanks or soil adsorption units receiving 8,000 gallons per day or more.

6. Twelve hundred feet between a well and any solid waste storage, transportation, transfer, incineration, air curtain destructor, processing, wood burning, one time disposal or small demolition facility; sanitary landfill; coal storage area; salt or deicing material storage area; gasoline or fuel oil storage tanks that have not received written approval from the department of commerce or its designated agent under s. Comm 10.10; bulk fuel storage facilities; and pesticide or fertilizer handling or storage facilities.

(e) Well sites may be inspected by a representative of the department prior to approval of plans.

(5) WELL HEAD PROTECTION PLAN. A well head protection plan shall be provided for all new wells for municipal water systems. The plan shall be developed by the owner of the municipal water system or its agent. No new municipal well may be placed into service until the department has approved the well head protection plan. The plan shall include but is not limited to:

(a) Identification of the recharge area for the proposed well.

(b) Identification of the zone of influence for the proposed well.

(c) Identification of the groundwater flow direction.

(d) An inventory of existing potential contamination sources within a ½ mile radius of the proposed well and an assessment of existing potential contamination sources within the recharge area of the well.

(e) Establishment of a well head protection area for the proposed well. The well head protection area shall encompass, at a minimum, that portion of the recharge area equivalent to a 5 year time of travel to the well. The well head protection area may be determined by a hydrogeologic investigation.

(f) A public education program for well head protection.

(g) A water conservation program.

(h) A contingency plan for providing safe water and protecting the well from contamination based on the inventory and assessment of potential contamination sources.

(i) A management plan, based upon an assessment of alternatives for addressing potential contamination sources, describing the local ordinances, zoning requirements, monitoring program, and other local initiatives proposed within the well head protection area established in subpar. (e). The management plan shall address maintaining the separation distances established by well siting in sub. (4) (d).

(6) CASING AND LINER PIPE FOR DRILLED WELLS. (a) The protective casing shall be new prime steel pipe produced to and meeting A.S.T.M., A–53 Grades A or B, ASTM A–106; ASTM A589–Type I, Grade A or B, Type II, Grade A; or A.P.I., 5L, 5LX, 5A, 5AX specifications. No previously used or reclaimed pipe may be used.

(b) Each length of casing shall be legibly marked in accordance with the ASTM or API marking specification and with s. NR 812.17 (2) (d). The protective casing shall have the minimum weights and thicknesses given in Table 1 except for the allowable variances outlined in par. (c).

(c) If the protective casing is to be installed without driving, it may have a thickness less than indicated in Table 1 but shall be surrounded by at least 4 inches of grout. It shall have a minimum thickness of 0.312 inches except in the case of 6–inch diameter casing which shall be a minimum of 0.280 inches.

(d) Liner pipe installed to seal off a caving zone shall be new, unused and nonreclaimed steel pipe, but may have a lesser thickness than given in Table 1.

(e) All casings and liners shall have additional thickness and weight if standard thickness is determined by the department to be insufficient to assure reasonable life expectancy or withstand forces to which they may be subjected.

(f) Casing and liner pipe shall be equipped with drive shoe when driven and centering guides when set.

(g) Casing and liners shall be assembled watertight by means of joints welded in accordance with the standard welding procedure specifications of NR 812.18 or by threaded couplings meeting or equivalent to the specifications listed in par. (a).

(h) For wells in which the protective casing is suspended, the upper terminus of the protective casing shall be securely attached by welding steel bands to the outer casing or by other approved methods, and the grout shall be supported on a steel ring or approved packer attached to the bottom of the casing. The bottom of the casing may be flared out to meet this requirement.

(i) Copies of the forgoing specifications and standards are available for inspection at the office of the department of natural resources, the secretary of state's office and the office of the revisor of statutes, and may be obtained for personal use from the American Society for Testing and Material, 1916 Race St., Philadelphia, Pennsylvania 19103, and the American Petroleum Institute, Production Department, 211 N. Ervay, Suite 1700, Dallas, Texas 75201.

Table 1

STEEL PIPE

SIZE (inches)	DIAMETER (inches)		THICKNESS (inches)	WEIGHT PER FOOT (pounds)	
	External	Internal		Plain Ends (calculated)	With Threads and Couplings (nominal)
6 id.	6.625	6.065	0.280	18.97	19.18
8	8.625	7.981	0.322	28.55	29.35
10	10.750	10.020	0.365	40.48	41.85
12	12.750	12.000	0.375	49.56	51.15
14 od.	14.000	13.250	0.375	54.57	57.00
16	16.000	15.250	0.375	62.58	65.30
18	18.000	17.250	0.375	70.59	73.00
20	20.000	19.250	0.375	78.60	81.00
22	22.000	21.000	0.500	114.81	
24	24.000	23.000	0.500	125.49	
26	26.000	25.000	0.500	136.17	
28	28.000	27.000	0.500	146.85	
30	30.000	29.000	0.500	157.53	
32	32.000	31.000	0.500	168.21	
34	34.000	33.000	0.500	178.89	
36	36.000	35.000	0.500	189.57	

(7) CONCRETE WALL CASING. Concrete wall casing shall:

(a) Be used only in dug wells and collectors;

(b) Be reinforced and at least 6 inches thick;

(c) Be poured in one operation, if possible;

(d) Not have a construction joint within 10 feet of original ground surface.

(8) PACKERS. Packers shall be of a material that will not impart taste, odors, toxic substances or bacterial contamination to the water in the well. Lead packers may not be used.

(9) SCREENS. Screens shall:

(a) Be constructed of stainless steel, brass with a lead content of less than 8%, everdur or monel which will not be damaged by chemical action of groundwater or future cleaning operations;

(b) Have size of openings based on sieve analysis of the aquifer and gravel pack materials;

(c) Be designed to have an entrance velocity that does not exceed 0.1 feet per second under normal operating conditions;

(d) Be installed and have pumping equipment designed so that exposure of the screen above the pumping level will not occur during normal operation;

(e) Be provided with a bottom plate or wash down fitting of the same material as the screen.

(11) BLASTING. Approval shall be obtained from the department prior to blasting within a well. Information regarding the procedure, number, size and location of charges shall be submitted in writing.

(a) Blasting shall be conducted under the supervision of a blaster licensed by the department of commerce under s. Comm 7.11.

(b) No blasting may occur within 100 feet of the grouted protective casing.

(c) All material dislodged during the blasting shall be completely removed from the well.

(d) Proper safety measures shall be employed to protect the workers and surrounding structures.

(12) CHEMICAL CONDITIONING. Approval shall be obtained from the department prior to chemical conditioning of a well. Information regarding the method proposed, equipment, chemicals, testing for residual chemicals, disposal of waste and inhibitors to be used shall be submitted in writing.

(a) All chemicals used in conditioning shall be compatible with use in potable water supplies.

(b) Acid treatment shall include pH monitoring of nearby private wells, complete removal of the acid from the well, neutralization of the spent acid, use of an inhibitor to protect the metal portions of the well and pump and proper disposal of the spent acid.

(c) The discharge of highly chlorinated water shall be closely supervised by the resident project representative. In no case may water with a measurable total chlorine residual content be discharged to a surface water. Suitable barriers, aeration or chemical dechlorination shall be provided when discharging chlorinated water to a surface water or a storm sewer connected to a surface water to ensure the water discharged does not contain a measurable chlorine residual.

(d) Upon completion of chemical conditioning, a report shall be submitted to the department detailing the well performance before and after chemical conditioning.

(13) OTHER METHODS OF WELL RECONDITIONING INCLUDING HYDROFRACTURING. Approval shall be obtained from the department prior to any reconditioning procedure, including hydrofracturing. Information regarding the procedure, the equipment and the disposal of waste shall be submitted in writing to the department for approval.

(14) GROUTING REQUIREMENTS. (a) 1. Neat cement grout shall be ASTM C150, Type I or API–10A, Portland cement and water from a known safe and uncontaminated source with not more than 6 gallons of water per sack (94 lbs.) of cement. Additives, including bentonite, to increase fluidity, reduce shrinkage or control time of set may be used only with prior department approval. No more than 5 pounds of bentonite may be added per sack (94 lbs) of cement. When bentonite is added, the volume of water shall be increased.

2. Sand cement grout may be used for annular openings greater than 3 inches. The mixture may not exceed 2 parts by weight of sand to one part of ASTM C150, Type 1 or API–10A, Portland cement and not more than 6 gallons of water from a known safe and uncontaminated source per sack (94 lbs.) of cement.

3. Concrete grout may be used for annular openings greater than 6 inches. The concrete shall contain not less than 6 sacks of cement per cubic yard and not more than 6 gallons of water from a known safe uncontaminated source per sack (94 lbs.) of cement. The gravel size may not exceed 3/4 inch. The volumetric ratio of either gravel or sand to cement may not exceed 2.5 parts to one part. Wisconsin department of transportation grade A concrete is also acceptable.

(b) 1. All grout shall be placed from the bottom of the annular opening to the surface in one continuous operation. When a conductor pipe in the annular opening is used, it shall be submerged in the grout during the entire operation. For grout depths in excess of 100 feet, a pump shall be used to inject the grout.

2. Sufficient annular opening shall be provided to permit a minimum of 1½ inches of grout around the protective casing, including couplings, if used.

3. Any materials used as drilling aids shall be removed from the annular opening prior to grouting.

4. Prior to grouting through creviced formations, bentonite or similar approved materials shall be added to the annular opening in the manner indicated for grouting and circulated until the bentonite or other approved material flows to the ground surface.

5. Grout shall be allowed to overflow from the annular opening until such time as the density is the same as that of the grout being placed. The specifications shall outline the method to be used to check the grout density and equipment shall be available on site to determine grout density.

6. Standby equipment and materials in sufficient quantities for continuously placing grout from the bottom upwards in the annular opening shall be available at the well site when the primary grouting method involves forcing a measured quantity of grout down the inner casing by a plug such as the Halliburton method. Use of the Halliburton method shall be clearly identified in the specifications submitted to the department.

7. In some cases, partial withdrawal of an outer casing may be necessary during grouting to comply with sub. (1) (d). The outer casing may also be entirely removed during grouting. The grout level shall be maintained above the bottom of the outer casing during the withdrawal procedure.

8. Plastic pipe may not be used as a grout conductor pipe. A metal conductor pipe or a rubber–covered, fiber or steel braided, reinforced hose with a minimum pressure rating of 300 psi shall be used as a conductor pipe.

9. The conductor pipe or reinforced hose shall be completely withdrawn from the well prior to flushing excess grout from the conductor pipe or hose when grouting down the annular space or shall be disconnected from the grout shoe or street elbow prior to flushing excess grout when grouting within the casing.

(c) Protective casing shall be provided with sufficient centering guides welded to the casing to permit unobstructed flow and uniform thickness of grout.

(d) Drilling operations or other work in the well, including development, may not be performed within 72 hours after the grouting of casings or liners. If quick–setting cement is used, this period may be reduced to 24 hours. Use of quick setting cement shall be clearly indicated in the specifications submitted to the department.

(e) Annular openings outside of surface or outer casings shall also be filled with grout including annular spaces created by drive shoes. When an upper enlarged drillhole has been constructed to accommodate the setting and removal of temporary outer casing, the annular space between the temporary outer casing and the well casing pipe shall be grouted before the temporary outer casing is pulled. When the grout flows at the ground surface, the annular space outside the temporary outer casing shall be grouted by placing a tremie pipe to the bottom of the annular space. The grout shall flow at the ground surface before the temporary outer casing is pulled.

(15) PLUMBNESS AND ALIGNMENT REQUIREMENTS. (a) Every well constructed in rock shall be tested for plumbness and alignment by the method outlined in A.W.W.A. Standard A–100 (June 10, 1984) or by an equivalent method. The test method shall be clearly stated in the specifications. A copy of the A.W.W.A. standard is available for inspection at the office of the department of natural resources, the secretary of state's office and the office of the revisor of statutes, and may be obtained for personal use from the American Water Works Association, 6666 West Quincy Ave., Denver, Colorado 80235.

(b) Variance from the vertical of two–thirds the smallest inside diameter of that part of the well being tested per 100 feet of depth to the depth of the pump setting plus 25% may not be exceeded. Also, the well shall allow free passage of a 40–foot section of pipe or a dummy to the depth of the pump setting plus 25%. The outside diameter of the pipe or dummy used may not be more than 1/2 inch smaller than the diameter being tested.

(c) Kinks and bends which prevent setting a line shaft pump to the desired pump setting plus 25% will not be approved by the department unless accepted in writing by the owner.

(d) A summary of the test results shall be submitted to the department prior to permanent pump approval.

(16) YIELD AND DRAWDOWN TEST. (a) A yield and drawdown test is required and the method to be used shall be clearly indicated in the plans specifications.

(b) The test shall be performed on every municipal or subdivision well for a period of at least 12 consecutive hours. For other wells, the test shall be performed for a period of at least 4 consecutive hours.

Note: It is recommended that the test pumping be continued beyond 12 hours or until the water level stabilizes.

(c) The test shall include pumping a minimum of 4 hours at a rate equal to the capacity anticipated for the permanent well pump.

(d) Water depth measurements shall be made at least every one–half hour during the testing period.

(e) The following data shall be submitted to the department:

1. Static water level;
2. Pumping rate;
3. Drawdown during test;
4. Recovery water levels;
5. Depth of pump setting.

(f) In addition, samples of water shall be collected as required by subs. (19) and (20).

(17) GEOLOGICAL DATA. (a) Formation samples shall be collected from all new wells and from deepening of existing wells at 5–foot intervals and at each pronounced change in formation.

(b) Geological data shall be recorded on the construction report and the formation samples submitted to the Wisconsin state geological and natural history survey, 3817 Mineral Point Road, Madison, Wisconsin 53705.

(18) CAPPING REQUIREMENTS. (a) Wells in which no pump is installed shall be capped by welding a plate to the top of the casing.

(b) During construction, a temporary means of capping shall be provided to prevent debris or any contaminants from entering the well or the annular space.

(19) BACTERIOLOGICAL QUALITY. Every new, modified or reconditioned groundwater source shall be disinfected during or after placement of pumping equipment. Samples for bacteriological analysis shall be collected as provided in s. NR 811.23 (3).

(20) CHEMICAL QUALITY. Every new well shall be sampled for chemical analysis. Reconditioned or modified wells shall be sampled for chemical analysis in cases where changes in water quality may occur. The samples shall be collected and analyzed for the parameters indicated in the department's approval letter for the well construction or modification. The samples shall be collected near the end of the test pumping period. A sample tap shall be installed on the test pump discharge piping at a location suitable for the collection of water samples for volatile parameters and a suitable throttling device shall be provided on the pump discharge piping to facilitate sample collection. The samples shall be submitted to a state certified laboratory or to the state laboratory of hygiene, Madison, Wisconsin. Prior to collection of the samples, the department shall be provided with a detailed description of the sampling protocol for each parameter and with the name and address of the laboratory to conduct the analysis. Wells that do not meet the primary water quality standards of ch. NR 809 may not be placed into service unless adequate treatment is provided.

(21) OBSERVATION WELLS AND TEST WELLS. (a) Observation wells, monitoring wells, test wells, treatment wells or other wells constructed as part of the water system shall be constructed in accordance with the requirements for permanent wells if they are to remain in service after completion of the groundwater supply and if they are located on the well site, unless this requirement is waived by the department. If not to remain in service, the wells shall be abandoned in accordance with s. NR 811.17. Monitoring wells constructed off the well site shall meet the requirements of ch. NR 141.

(b) The wells shall be protected at the upper terminal to preclude entrance of foreign material and the wells to remain in service shall be provided with locking covers.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92; correction in (20) made under s. 13.93 (2m) (b) 7., Stats., Register, August, 1994, No. 464; am. (4) (d) 5., Register, December, 1998, No. 516, eff. 1–1–99; corrections made under s. 13.93 (2m) (b) 6. and 7., Stats., Register, December, 1998, No. 516.

NR 811.17 Abandonment of wells. (1) GENERAL REQUIREMENTS FOR ABANDONMENT OF WELLS. (a) *Obstructions.* Any debris or obstructions that may interfere with sealing operations shall be removed from the well prior to abandonment.

(b) *Procedural limitations.* Filling material for nonflowing wells shall be applied through a conductor pipe unless a dump bailer is used. When concrete is placed under water by a conductor pipe, the bottom end of the conductor pipe shall be submerged in the concrete at all times. Pump piping and removable liner pipes shall be pulled from a well prior to sealing.

(c) *Alternate abandonment procedures.* Approved slow–hydrating bentonite chips may be used to fill both unconsolidated formation and bedrock wells if the following conditions are met:

1. The well diameter is 4 inches or larger.
2. The well is less than 250 feet deep.
3. There is less than 150 feet of standing water in the well.
4. The well is not filled with drilling mud or bentonite slurry.

(2) PERMANENT ABANDONMENT METHODS. When a well is permanently abandoned, the owner shall fill and seal the well, to prevent it from acting as a channel for contamination or vertical movement of water, by the following applicable method:

(a) *Drift or other unconsolidated formation wells.* For drift or other unconsolidated formation wells, a 20–foot concrete plug shall be poured at the top of the well with the remainder filled with concrete or clean puddled clay. Inner ungrouted well casing with screen shall be removed from gravel–pack wells prior to filling.

(b) *Limestone formation wells.* For limestone formation wells, fill any limestone strata entirely with concrete or, as an alternative, with layers of concrete and gravel or stone aggregate, provided that the top 20 feet of the rock formation and the entire cased portion of the well are filled with concrete. Exception to filling the cased portion with concrete under the alternative method may be made where the well casing is set in rock and sealed in place with cement grout. If the alternative is used, a concrete plug at least 40 feet thick shall be placed extending at least 20 feet above and below the bottom of the casing. The remainder of the cased portion up to 20 feet from the surface may be filled with gravel, crushed rock, sand or clay, but the top 20 feet shall be filled with concrete.

(c) *Sandstone formation wells.* For sandstone formation wells, fill any sandstone formations entirely with concrete or, as an alternative, with disinfected sand or pea gravel, provided that the top 20 feet of the formation and the entire cased portion in this alternative method is filled with concrete. The exception to entirely filling the casing with concrete in par. (b) is applicable in this paragraph.

(d) *Shale, granite and quartzite formation wells.* For shale, granite and quartzite formation wells, use the procedure for limestone formation wells in par. (b).

(e) *Mixed formation wells.* For mixed formation wells, fill in limestone, sandstone, shale, granite and quartzite strata as provided in par. (b), and provide concrete or concrete grout plugs at least 40 feet in depth, extending at least 20 feet above and below the point of surface contact between every distinct geologic formation where the alternative methods to filling the well entirely with concrete are selected.

(f) *Flowing wells.* For flowing wells, confine the flow and fill wells in accordance with par. (b) procedures or seal with cement grout applied by a pressure method approved by the department.

(3) TEMPORARY ABANDONMENT. When a well is temporarily removed from service, the top shall be sealed with a water–tight threaded or welded cap or be filled with clean puddled clay. After 5 years of temporary abandonment, the well shall be permanently abandoned and sealed in accordance with sub. (2). Approval of the department shall be obtained for any deviations from the 5 year maximum for temporary abandonment.

(4) REPORT TO DEPARTMENT. A report shall be made to the department by the owner within 30 days after a well has been permanently abandoned or temporarily removed from service. The report shall include a detailed description of location, construction and geologic features, and method of sealing. The report shall be on forms supplied by the department.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.18 Special requirements for wells developed in unconsolidated formations. (1) The cased and grouted depth for screened wells in unconsolidated formations shall be dependent on the controlling geologic conditions. Where practical, the grouted casing shall extend to at least 5 feet below the normal pumping water level and to within 5 feet of the top of the screen unless the grout depth is at least 60 feet. Grouted casing depths less than 30 feet will not be approved if alternatives are available.

(2) Continuous chlorination and an adequate contact time for disinfection shall be required as a safeguard except in cases where the proposed well construction provides sufficient protection as determined by the department.

(3) If clay or hardpan is encountered above the formation to be developed, the protective casing and grout shall extend through the materials, but the outer casing shall be withdrawn at least 5 feet above the clay or hardpan during grouting.

(4) If the well is gravel packed, the gravel shall be acid resistant and free of foreign material, properly sized, washed and disinfected prior to or during placement.

(5) A sand or bentonite seal to prevent leakage of grout into the gravel pack or screen shall be provided. The seal shall be no more than 2 feet thick.

(6) Gravel refill pipes and observation pipes, when used, shall be surrounded by a minimum of 1 ½ inches of grout if installed in the grouted annular opening. Observation pipes installed between the inner and the protective casing may be plastic. Pipes shall be

incorporated into the concrete pump foundation to a point at least 4 inches above the floor, and shall terminate with a threaded cap at least 12 inches above the pumphouse floor.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.19 Special requirements for radial collectors. (1) Continuous chlorination and adequate detention time for radial collectors shall be provided.

(2) Acceptability of the site, as provided in s. NR 811.13 (1) (b), shall be determined by the department prior to any intensive investigation.

(3) The area around the laterals shall be under the control of the supplier of water for a distance approved by the department.

(4) The location of all caisson construction joints and porthole assemblies shall be indicated on the plans.

(5) The caisson wall shall be of reinforced concrete as provided in s. NR 811.16 (7).

(6) Provisions shall be made to assure minimum vertical rise of the caisson.

(7) The top of the caisson shall be covered with a watertight concrete floor, and all openings in the floor shall be curbed and have overlapping covers to protect against the entrance of foreign material.

(8) The pump discharge piping may not be placed through caisson walls.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92; correction in (2) made under s. 13.93 (2m) (b) 7., Stats., Register, December, 1998, No. 516.

NR 811.20 Special requirements for dug wells and springs. (1) Dug wells and springs shall be approved only when it is not feasible to develop a drilled well.

(2) Plans shall include facilities for continuous chlorination and an adequate chlorine contact time before the water reaches consumers.

(3) Springs shall be housed in a permanent concrete structure which terminates above the ground surface and which prevents the entry of surface water.

(4) Dug wells shall be covered by a watertight concrete cover which terminates not less than 12 inches above the permanent ground surface and shall have concrete casing as required in s. NR 811.16 (7).

(5) The dug well pump discharge piping may not be placed through the concrete casing.

(6) The area around the well or spring shall be under the control of the supplier of water for a distance approved by the department.

(7) Dug well and collector pumping stations shall have a watertight concrete floor. All openings in the floor shall be curbed and protected against the entrance of foreign material. The entrance hatch in the floor shall be located adjacent to the inside of the well perimeter; have a curb at least 4 inches high; have the edge of the cover extending down over the curb at least 2 inches; and be kept locked when not in use.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.21 Special requirements for infiltration lines. (1) Infiltration lines may be permitted only when it is not feasible to develop an acceptable well.

(2) Plans shall include facilities for continuous chlorination and an adequate chlorine contact time before the water reaches consumers.

(3) The area around the lines shall be under the control of the supplier of water for a distance approved by the department.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.22 Special requirements for sandstone wells. The requirements of this section apply to wells drilled in formations commonly referred to as sandstones in Wisconsin. This includes the St. Peter sandstone, the Upper Cambrian sandstones, and the Lake Superior sandstone. The following requirements shall be met:

(1) The minimum depth of the grouted casing shall be 60 feet. The casing shall be installed to a depth of 10 feet below the anticipated pumping water level, except in cases when the department determines that this requirement is not necessary to meet the requirements of this chapter.

(2) When the sandstone is overlain by creviced limestone or shale formations, the grouted casings shall be installed a minimum of 15 feet into firm sandstone. The department shall be contacted for locations where this type of construction will be required. Wells constructed to utilize aquifers beneath the Maquoketa shale shall be cased and grouted to beneath the depth of the Maquoketa shale.

(3) Where the depth of unconsolidated material is more than 60 feet, the protective casing shall be seated in firm sandstone where the sandstone is the upper rock formation.

(4) Where the depth of unconsolidated material is less than 60 feet and the sandstone is the upper rock formation, the department shall be contacted for required depth of grouted casing.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.23 Special requirements for limestone wells. This section applies to wells drilled in formations commonly referred to as limestones in Wisconsin. This includes the Niagara dolomite, the Galena–Platteville dolomite and the Prairie du Chien dolomite. The following requirements are intended for wells located in limestone aquifers which are not overlain by consolidated shale or sandstone formations.

Note: When an acceptable sandstone aquifer can be utilized, construction of limestone wells should be avoided.

(1) Continuous chlorination and chlorine detention time shall be required as a safeguard for limestone wells when the department determines that additional protection is necessary.

(2) Where the depth of unconsolidated material overlying the limestone is 60 feet or greater for a minimum radius of ½ mile and there is no record of sinkholes, quarries, improperly constructed wells or outcrops within that area, the minimum depth of grouted casing shall be 60 feet. The casing shall be installed to a depth of 10 feet below the anticipated pumping water level unless the department waives this requirement after finding it unnecessary in meeting the requirements of this chapter.

(3) Where the depth of unconsolidated material is more than 60 feet and only 60 feet of grouted casing is required by the department, the casing shall be seated in firm limestone.

(4) Where the depth of unconsolidated material is less than 60 feet at the well site or within one–half mile of the well site, the department shall be contacted for minimum depth of grouted casing. An inner casing size of at least 12″ diameter shall be required to permit the installation of a grouted liner at a future date if the water from the well shows evidence of contamination. The casing size requirement may be waived by the department if it is demonstrated that it is unnecessary to meet the requirements of this chapter. In such cases, a minimum of 100 feet of grouted casing is usually required and, where conditions dictate, considerably more than 100 feet will be required.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.24 Special requirements for granite wells. The department shall be contacted for specific case–by–case constructional requirements for all proposed developments of wells in Precambrian igneous and metamorphic rock commonly referred to as "granite".

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

Subchapter IV —Source Development – Surface Water

NR 811.25 General requirements. The source of water selected as a surface water supply shall provide the highest quality

water reasonably available which, with appropriate treatment and adequate safeguards, will meet the drinking water standards in ch. NR 809. Source water shall meet the surface water quality standards in ch. NR 102. Minimum treatment shall include disinfection, coagulation, sedimentation and filtration. The design of the treatment processes, equipment and structures shall depend on an evaluation of the nature and quality of the particular water to be treated. Any proposal which would result in a diversion from the Great Lakes basin requires department approval in accordance with ch. NR 142.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92; correction made under s. 13.93 (2m) (b) 7., Stats., Register, August, 1994, No. 464.

NR 811.26 Intakes. Intake structures shall provide for:

(1) Velocity of flow .25 to .50 fps through the inlet structure so that frazil ice will be held to a minimum;

(2) Withdrawal of water from the depth of the best water quality;

(3) Inspection manholes every 1,000 feet for pipe sizes large enough to permit visual inspection;

(4) Adequate protection against rupture by dragging anchors, ice and other activity;

(5) Locations referenced by permanent monuments;

(6) A diversion device capable of keeping large quantities of fish or debris from entering an intake structure where shore wells are not provided.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.27 Shore wells. (1) Shore well structures shall:

(a) Have motors and electrical controls located above grade and flood level;

(b) Be accessible for operation and service;

(c) Be designed to prevent flotation;

(d) Be equipped with removable or traveling screens before the pump suction well;

(e) Provide chlorination or other chemical addition facilities for raw water transmission mains;

(f) Have the intake piping valved with provisions for backflushing and testing for leaks;

(g) Have provisions for controlling surges;

(h) Have sloped bottoms.

(2) The requirements in sub. (1) may be waived by the department on a case–by–case basis if it is demonstrated that they are not necessary to fulfill the other requirements of this chapter.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

Subchapter V —Pumping Stations

NR 811.28 General requirements. Pumping stations shall be designed to maintain the sanitary quality of the water being pumped. Uses of the pumping station and attached buildings shall be compatible with the protection of the water source. For pumping stations at wells for other–than–municipal water systems, excepting subdivision wells, all or part of the building requirements may be waived by the department provided the well is enclosed within a locking shelter which allows access to the well for rehabilitation and the shelter is provided with a concrete floor.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.29 Buildings. (1) CONSTRUCTION. All raw or finished water pumping stations shall:

(a) Have adequate space for the installation of additional pumping units, or chemical feed equipment, if needed, and for the safe servicing of all equipment;

(b) Be durable, fire and weather resistant, and have at least one locking, outward opening door to the outside;

(c) Be landscaped to conduct surface drainage away from the station and have a floor elevation at least 6″ above the finished grade and at least 24″ above the regional flood level. Below grade installations may be permitted only if the terrain at the site is such that a gravity drain system can be provided. Subsurface pits or pumprooms and inaccessible installations intended to house the well pump or pump controls for well pump stations are prohibited;

(d) Have all floors drained without impairing the quality of water being handled;

(e) Provide a suitable outlet for drainage from pump glands without discharging onto the floor;

(f) Be provided with concrete floors;

(g) Be provided with at least one floor drain. The floor drain shall be located no closer than 2 feet to the outer well casing. The floor drain piping shall be constructed of cast iron or PVC piping meeting s. Comm 84.30 standards within 10 feet of the outer well casing;

(h) Have the floor drain connected to a sanitary sewer where available provided that the pump station floor is at least one foot above the elevation of the nearest sanitary sewer manhole rim. Where a sanitary sewer is available but a manhole is not located nearby, the department may require installation of an additional manhole;

(i) Have the floor drain terminate a minimum of 25 feet from the pump station if discharge is to the ground surface. A greater distance may be required for drains of pump stations serving wells constructed in sand and gravel formations. French drains are prohibited.

(2) EQUIPMENT SERVICING. Pump stations shall be provided with:

(a) Crane–ways, hoist beams, eyebolts or other facilities necessary for servicing or removal of pumps, motors or other heavy equipment where appropriate;

(b) Openings in floors, roofs or wherever needed for removal of heavy or bulky equipment. For well pump stations, a roof hatch shall be located over the well.

(3) STAIRWAYS AND LADDERS. Stairways or ladders shall be provided between all floors and in pits or compartments which are to be entered.

Note: Applicants are also advised to consult requirements in applicable local and state codes.

(4) HEATING. Adequate heating shall be provided for the safe and efficient operation of the equipment.

Note: In pump houses not occupied by personnel, only enough heat need be provided to prevent freezing, unless higher temperatures are required for proper chemical addition. Applicants are also advised that other requirements may exist in local and state codes.

(5) VENTILATION. Ventilation for all pumping stations is governed by applicable local and state codes.

(6) DEHUMIDIFICATION. Means for dehumidification shall be provided in areas where excess moisture could cause safety hazards or damage to equipment or piping.

(7) LIGHTING. Pump stations shall be adequately lighted.

(8) SANITARY AND OTHER CONVENIENCES. All pumping stations shall be provided with potable water, lavatory and toilet facilities except unoccupied automatic stations or where such facilities are available elsewhere. Plumbing shall be installed in a manner to prevent contamination of the public water supply. Wastes shall be discharged in accordance with s. NR 811.81.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92; correction in (1) (g) made under s. 13.93 (2m) (b) 6., Register, December, 1998, No. 516.

NR 811.30 Number of pumping units. All pumping stations shall:

(1) Have at least 2 pumping units except where additional pumping stations which can meet the peak demand are available or where the department determines that ample time will be available between pumping periods for necessary repairs. If only 2 units are provided, each shall be capable of carrying the peak

demand. If more than 2 units are installed, they shall have sufficient capacity so that any one pump can be taken out of service with the remaining pumps capable of carrying the peak demand.

(2) Have controls for proper alternation when 2 or more pumps are installed. Provision shall be made to prevent operation of the pump during the backspin cycle. All electrical controls shall be located above grade.

History: Cr. Register, April, 1992, No. 436, eff. 5-1-92.

NR 811.31 Auxiliary power. All pumping stations shall:

(1) Provide a power supply from at least 2 independent electrical substations or from a standby, auxiliary power source dedicated to water supply use unless the department determines that there is sufficient pumping capacity with existing auxiliary power. Tractor driven power take-off units and right-angle gear drives that operate the pump only shall be accompanied by auxiliary generators to operate treatment, chemical addition and monitoring equipment where the treatment or chemical addition is required to meet the primary drinking water standards in ch. NR 809. Where practical, engines shall be fueled by propane or natural gas.

(2) Provide a prelubrication line with a valved bypass around the automatic control and backflow protection, if appropriate, whenever automatic prelubrication of pump bearings is necessary and an auxiliary power supply is provided.

History: Cr. Register, April, 1992, No. 436, eff. 5-1-92; correction in (1) made under s. 13.93 (2m) (b) 7., Stats., Register, August, 1994, No. 464.

NR 811.32 Additional requirements. (1) SUCTION WELLS. Suction wells, including installations where the pumps are installed on top of a reservoir, shall:

(a) Be watertight.

(b) Have bottoms sloped to permit removal of water and entrained solids.

(c) Be vented by means of a pipe or other device terminating in a screened U-bend at least 24″ above the floor.

(d) Have curbs a minimum of 4″ around all access openings, pipes and other equipment which extend through the top of the suction well. Access openings shall have covers which overlap at least 2″.

(2) SUCTION LIFT. Suction lift shall be allowed only for distances of less than 15 feet and where provision is made for priming the pumps. Suction lift may not be permitted if buried piping carries the finished water.

(3) PRIMING. Prime water may not be of lesser sanitary quality than that of the water being pumped. Means shall be provided to prevent backflow. When an air-operated ejector is used, the screened intake shall draw clean air from a point at least 10 feet above the ground or other source of contamination, unless the air is filtered by apparatus approved by the department. Vacuum priming may be used.

(4) AUTOMATIC AND REMOTE CONTROLLED STATIONS. All automatic stations shall be provided with automatic signaling apparatus which will report pump operation (on-off) to the main station and shall also provide pressure monitoring if a separate pressure zone is established. All remote controlled stations shall be electrically operated and controlled and shall have reliable signaling apparatus.

Note: See s. NR 811.77 for booster pumping facilities in the distribution system.

(5) APPURTENANCES. (a) *Valves.* Pumps shall be adequately valved to permit satisfactory operation, maintenance and repair of the equipment. If foot valves are provided, they shall have a net valve area of at least 2½ times the area of the suction pipe and shall be screened. Each pump shall have an automatically closing valve or check valve on the discharge side between the pump and shutoff valve.

(b) *Piping.* Piping shall be protected against surge or water hammer. In addition, each pump shall have an individual suction line or lines so manifolded that they insure similar hydraulic and operation conditions. Discharge piping shall be ductile iron, copper, steel or galvanized pipe.

(c) *Gauges and meters.* Each pump shall have a standard pressure gauge on its discharge line and have a compound pressure gauge on its suction line if suction pressures are expected to be encountered. Where suction or discharge headers are utilized, only one gauge is required on each header. In addition, the station shall have indicating, totalizing and recording metering of the total water pumped.

Note: Discharge pressure recording devices are recommended at the larger stations.

(d) *Water seals.* Water seals may not be supplied with water of a lesser sanitary quality than that of the water being pumped. Where pumps are sealed with potable water and are pumping water of lesser sanitary quality, the water supply shall:

1. Be provided with a break tank open to atmospheric pressure;

2. Have an air gap, at least 6 inches or 2 pipe diameters, whichever is greater, between feeder line and spill line of the tank.

(6) PAINTING OF PIPING. In order to facilitate identification of piping in waterworks, pumping stations and plants, it is recommended that the following color scheme be utilized for purposes of standardization:

(a)	*Water Lines*	Color
	Raw	Olive Green
	Settled or Clarified	Aqua
	Finished or Potable	Dark Blue
(b)	*Chemical Lines*	Color
	Alum	Orange
	Ammonia	White
	Carbon Slurry	Black
	Chlorine -Gas and Solution	Yellow
	Fluoride	Light Blue with Red Band
	Lime Slurry	Light Green
	Potassium Permanganate	Violet
	Sulfur Dioxide	Lt. Green with Yellow Band
(c)	*Waste Lines*	*Color*
	Backwash Waste	Light Brown
	Sludge	Dark Brown
	Sewer – Sanitary or Other	Dark Gray
(d)	*Other Lines*	*Color*
	Compressed Air	Dark Green
	Gas	Red
	Other Lines	Light Gray

(e) If the situation develops where 2 colors do not have sufficient contrast to easily differentiate between them, a 6″ band of a contrasting color shall be painted on one pipe at approximately 30″ intervals. The name of the liquid or gas may also be painted on the pipe. Arrows may be painted on the piping indicating the direction of flow.

History: Cr. Register, April, 1992, No. 436, eff. 5-1-92.

Subchapter VI —Pumping Equipment and Appurtenances

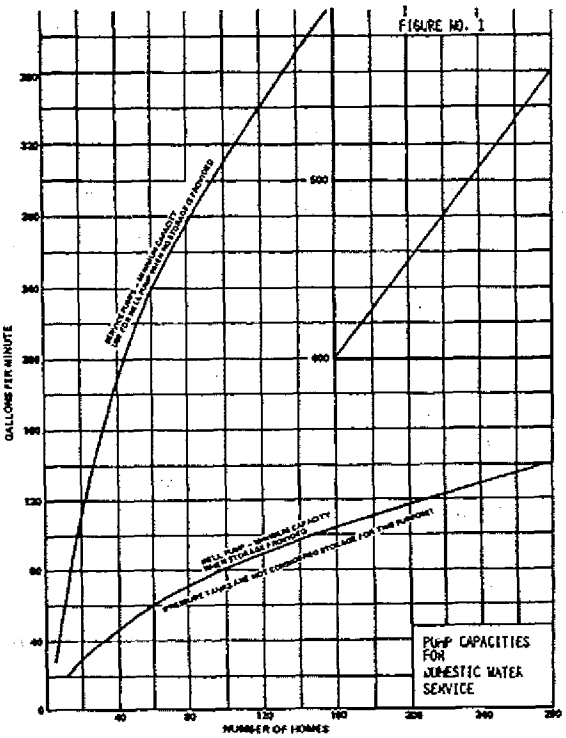
NR 811.33 Pumping capacity requirements. (1) Figure 1 shall be used for determining pump capacities for domestic service only. More detailed engineering studies are necessary for determining pump capacities in systems providing water for mul-

tiple uses, including domestic, commercial and industrial usage and fire protection.

(2) If no elevated storage is available and more than 50 living units are to be served, 2 or more wells or pumping units shall be provided each of which can supply the normal daily demands. An approved interconnection with another water system or a ground reservoir with booster pumps may be used in lieu of this requirement for other–than–municipal water supply systems.

Note: The number of homes may be reduced by one–third for apartment units, condominium units and mobile homes.

FIGURE NO. 1



History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.34 Well pump bases. (1) PUMP INSTALLATION. Line shaft pumps shall be supported by a concrete foundation which is at least 12 inches above the pump station floor. The protective casing of wells shall extend a minimum of one inch above the concrete foundation. Where there is also an inner casing, the inner casing shall extend a minimum of one inch above the foundation and the protective or outer casing shall extend a minimum of 4 inches above the floor and shall be incorporated into the concrete foundation. For these installations, a steel ring shall be welded between the inner and protective casings. The metal surfaces of line shaft pumps between the pump head and base plate shall be machined or gasketed to provide a tight seal. A gasket or grout seal shall be provided between the base plate and the concrete pump foundation.

(2) SUBMERSIBLE PUMPS. Where a submersible pump is used, the top of the well casing shall be effectively sealed against entrance of water under all conditions including vibration or movement of conductors or cables. The protective casing shall terminate at least 12 inches above the floor and be surrounded by a concrete collar to at least 6 inches above the floor.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.35 Pump lubrication. (1) Water lubricated pumps are required, except where oil lubricated pumps are necessary to provide positive lubrication at deep pump settings. The oil for pump lubrication shall be a food grade mineral oil. Oil lubricated pumps may not be installed for wells in unconsolidated formations or wells with shallow pump settings.

(2) For water lubricated pumps with static water levels deeper than 50 feet, provision shall be made for prelubricating the column bearings prior to pump startup. All prelubrication lines shall be equipped with metering or controls to monitor and limit the volume of prelubrication water. At systems where chemical addition is practiced, solenoid control of prelubrication water shall be provided. If auxiliary power is provided, additional valving of the prelubrication water shall be necessary. When pump backspin is allowed to occur after the motor shuts off, the necessity for lubrication during this period shall be determined by the design engineer and provided if necessary.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.36 Motor protection. Where backspin can be expected to occur, a time delay or backspin ratchet shall be provided to protect the motor in the event the pump controls are energized before the pump stops backspinning.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.37 Well appurtenances. (1) WELL VENT. Each well shall be vented to the atmosphere by installing a vent pipe which terminates in a 24 mesh noncorrodible screened "U" bend at least 24 inches above the floor. If the well is flowing, the vent shall terminate above the artesian water level or a suitable automatic valve shall be provided.

Note: See Figure 2.

(2) WATER LEVEL MEASUREMENTS. (a) Provisions shall be made for measurement of static and pumping water levels in the completed well.

Note: This will usually consist of an electric depth gauge or an air line attached to the pump column and an altitude gauge.

(b) Installation shall be made to prevent entrance of foreign material.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.38 Discharge lines. Lines which are to be buried shall be designed so that the line is under a continuous pressure head which is higher than the elevation of the ground surface. The following shall be provided within the pumphouse:

(1) AIR–VACUUM RELIEF VALVE. For well discharge lines with check valves, an air–vacuum relief valve shall be installed between the well and check valve. The discharge line from the relief valve shall face downward and terminate with a 24 mesh noncorrodible screen, at least 24 inches above the floor. For well discharge lines with check valves that discharge to reservoirs, the air relief is not required. However, a vacuum relief shall be provided.

Note: See Figure 2.

(2) METERS. All pump discharges shall be provided with water meters to determine the quantity of water discharged.

(3) SAMPLING FAUCET. All pump discharge piping shall contain a smooth end sampling faucet. Where possible, the faucet shall be prior to any chemical addition points, and where practical 2 faucets shall be provided, one before chemical addition and one after. Petcocks or small diameter bleeder valves which make sample collection difficult are not acceptable as sample faucets.

(4) CHECK VALVE OR OTHER TYPE OF AUTOMATICALLY CLOSING VALVE. A check valve shall be provided. Where extreme surge pressures occur, slow opening valves, voltage ramped motors or other means of surge protection shall be provided.

(5) SHUT–OFF VALVE. A shut–off valve shall be provided.

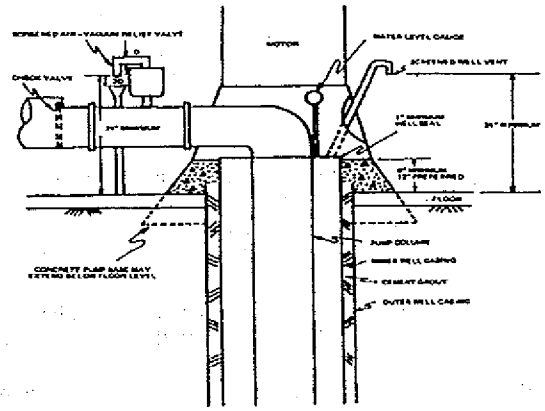
(6) PRESSURE GAUGE. A pressure gauge shall be provided.

(7) CHEMICAL INJECTION TAP OR CORPORATION STOP. A chemical injection tap or corporation stop allowing chemical injection shall be provided.

(8) PUMP–TO–WASTE. All wells shall be provided with a means to pump to waste. This could be a valve and hose connection inside the pump station or a valve and hydrant outside.

(9) SUCTION LINES. Buried suction lines which, under all operating conditions, are not under a positive pressure head which is higher than the elevation of the ground surface are not permitted.

FIGURE NO. 2



TYPICAL WELL PUMP INSTALLATION - PUBLIC SUPPLY WELLS

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

Subchapter VII —Chemical Addition

NR 811.39 General. This subchapter contains general requirements for the design and construction for chemical storage, handling and addition facilities. Specific operating requirements are contained in s. NR 811.07; specific design requirements are contained in subch. VIII.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.40 Feed equipment. (1) NUMBER OF FEEDERS. If chemical feed, such as chlorination, coagulation or other processes, is necessary to produce a water quality meeting the primary maximum contaminant levels, a minimum of 2 feeders shall be provided so that a standby unit or combination of units will be available to replace the largest unit during shut–downs. Spare parts shall be available for all feeders to replace parts which are subject to wear and damage.

(2) DESIGN AND CAPACITY. The design shall insure that:

(a) A separate feed system is provided for each chemical.

(b) Feeders will be able to supply, at all times, the necessary amounts of chemical at an accurate rate, throughout the range of feed. To allow for changes in pumping or application rates, the feeder shall be designed to operate between 30% and 70% of the full pump range for constant speed pumps and between 30% and 70% of the stroke length range and at a minimum speed of 12 strokes per minute for adjustable speed pumps. If this is not possible with stock chemical solution, dilution of the chemical will be required.

(c) Proportioning of chemical feed to rate of flow is provided.

(d) Positive displacement type solution feeders shall be used to feed liquid chemicals. Pumps shall be sized to match or exceed maximum head conditions found at the point of injection.

(e) Chemical solutions are prevented from being siphoned into the water supply by assuring discharge at points of positive pressure and by providing spring–opposed diaphragm type anti–siphon devices, or through a suitable air gap or other effective means approved by the department. A continuous point of positive pressure is assured on the system side of the last shut–off valve. If a second shut–off valve is provided downstream of the primary shut–off valve, the point of injection may be between the 2 shut–off valves. All chemicals shall be fed downstream of the check valve. If feeding at a location without continuous positive pressure, a suitable air gap shall be provided which is at a higher elevation than the chemical solution tank or a dual head feeder with a small break tank located higher than the chemical solution tank shall be provided.

Note: It is recommended that all chemicals be fed downstream of the shutoff valve and is required for strong acids and bases such as hydrofluosilicic acid and sodium hydroxide.

(f) The makeup water supply lines to chemical feed tanks are protected from contamination by chemical solutions either by equipping the supply line with backflow or backsiphonage prevention devices, or by providing a minimum air gap of 2 pipe diameters, but not less than 3 inches, between the supply line and top of solution tank.

(g) Materials and surfaces coming in contact with chemicals are resistant to the aggressiveness of the chemical solution.

(h) Dry chemical feeders measure chemicals volumetrically or gravimetrically; provide effective dissolving of the chemical in the solution pot; provide gravity feed from solution pots, if possible; and completely enclose chemicals to prevent emission of dust to the operating room.

(i) No direct connection exists between any sewer and a drain or overflow from the feeder or solution chamber or tank.

(3) LOCATION. Chemical feed equipment shall be:

(a) Located near points of application to minimize length of feed lines;

(b) Readily accessible for servicing or repair and observation of operation;

(c) Located and have protective curbings so that chemicals from equipment failure, spillage or accidental drainage may not enter the water in conduits, treatment or storage basins;

(d) Located above grade, except as waived by the department;

(e) Located in accordance with s. NR 811.44 (5) if gas feeders are used;

(f) Located in accordance with s. NR 811.46 (2) if hydrofluosilicic acid is used.

(4) CONTROL. (a) Feeders may be manually or automatically controlled if the water supply pumps are manually controlled. Where pumps are automatically controlled, the feeders shall be automatically controlled. In all cases, automatic control shall be capable of reverting to manual control when necessary.

(b) Feeders shall be designed and controlled to provide rates proportional to flow.

(c) Automatic chemical feed rate control in combination with residual analyzers which have alarms for critical values and recording charts may be used.

(d) The electrical outlet used for any chemical feed pump shall be clearly marked and shall be connected with the well pump or service pump as appropriate.

(5) SOLUTION TANKS. The requirements for solution tanks are found in s. NR 811.41 on storage and handling.

(6) WEIGHING SCALES. Weighing scales shall be:

(a) Provided for weighing cylinders at all plants utilizing chlorine gas, Indicating and recording type scales are recommended;

(b) Required for solution feed unless comparable means for determining usage is approved by the department;

(c) Required for volumetric dry chemical feeders;

(d) Accurate enough to measure increments of 0.5% of load.

(7) FEED LINES. Feed lines shall:

(a) Be as short as possible in length of run; of durable, corrosion resistant material; easily accessible throughout entire length; protected against freezing; and readily cleanable;

(b) Slope upward from chemical source to feeder when conveying gases;

(c) Introduce corrosive chemicals in a manner to minimize potential for corrosion;

(d) Be designed consistent with scale–forming or solids–depositing properties of the water, chemical, solution or mixture conveyed;

(e) Not carry chlorine gas under pressure beyond the chlorine feeder room;

(f) Include an injection nozzle when application is into a pipe line; and

(g) Be color coded in accordance with s. NR 811.32 (6).

(8) SERVICE WATER SUPPLY. Water used for dissolving dry chemicals, diluting liquid chemicals or operating chemical feeders shall be from a safe, approved source with appropriate backflow prevention provided. The department may grant an exception in cases where the finished water quality will not be affected by addition of the chemical mixed with untreated water.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.41 Storage and handling. For specific requirements refer to the section covering the particular chemical. The following are general requirements:

(1) STORAGE FACILITIES. The requirements for storage facilities are as follows:

(a) Space shall be provided for at least 30 days of chemical supply; convenient and efficient handling; dry storage conditions; and a minimum of 1 ½ truck loads storage volume where purchase is by truck load.

(b) Covered or unopened shipping containers shall be provided for storage unless the chemical is transferred into an approved covered storage unit. Solution tanks shall have overlapping covers. Large tanks shall be covered and those with top access openings shall have the openings curbed and fitted with overlapping covers.

(c) Solution storage or day tanks supplying feeders directly shall have at a minimum sufficient capacity for one day of operation. When the chemical solution is prepared from a powder or slurry, 2 solution tanks shall be required if necessary to assure continuity of feed.

(d) Solution storage or day tanks supplying feeders directly shall have a maximum capacity that daily solution usage is a minimum of 5% of the tank capacity.

(e) Storage facilities shall be constructed of, or lined with, materials compatible with the chemical being handled.

(f) Mixing equipment shall be provided where necessary to assure a uniform chemical solution strength.

(g) Means shall be provided to accurately determine the amount of chemical applied either by measurement of the solution level in the tank or by weighing scales. Graduation shall be in increments of approximately 2% to 3% of tank capacity. A meter shall be provided on the water fill line to a fluoride saturator.

(h) Liquid chemical storage tanks shall have a liquid level indicator.

(i) Adequate means of draining tanks shall be provided, but there may be no direct connection between any drain piping and a sewer. Drain piping shall terminate at least 2 pipe diameters, but not less than 3 inches, above the overflow rim of a receiving sump, conduit or waste receptacle.

(j) Overflow pipes shall be turned downward, be appropriately screened, have a free discharge and be in a conspicuous location.

(k) Where subsurface locations for solution or storage tanks are necessary, the tanks shall be free from sources of possible contamination and located to assure positive drainage for groundwater, accumulated water, chemical spills and overflows.

(L) The design shall insure that incompatible chemicals are not stored or handled in common areas.

(m) Gases from feeders, storage and equipment exhausts shall be conveyed to the outside atmosphere above grade and remote from air intakes. Acid storage tanks shall be vented to the outside but not through vents in common with day tanks.

(n) Consult local and state safety codes for other safety requirements.

(o) Solution tanks shall be maintained in a sanitary condition.

(2) HANDLING FACILITIES. The requirements for handling facilities are as follows:

(a) Equipment shall be included for measuring quantities of chemicals used to prepare feed solutions.

(b) Piping for chemicals shall be compatible with the chemical being conveyed.

(c) 1. Where the eyes or body of any person may be exposed to injurious corrosive materials, suitable facilities for quick drenching or flushing of the eyes and body shall be provided as required in s. ILHR 32.15 (11).

2. Rubber gloves, protective clothing and safety goggles that form a tight seal with the face shall be provided for each operator who prepares chemical solutions.

3. A dust respirator of the prescribed type shall be provided for handling dry chemicals if required in the respective material safety data sheet or s. ILHR 32.15 (2).

(d) Provision shall be made for the transfer of dry chemicals from shipping containers to storage bins or hoppers in such a way as to minimize dust. Control shall be provided by use of one of the following:

1. Vacuum pneumatic equipment or closed conveyor systems;

2. Facilities for emptying shipping containers in special containers;

3. Exhaust fans and dust filters which place the hoppers or bins under negative pressure.

(e) Carts, elevators or other appropriate means shall be provided for lifting chemical containers to minimize lifting by operators.

(f) Electrical equipment shall be used which will prevent explosions, particularly when using sodium chlorite and activated carbon. Equipment shall comply with ch. Comm 16. A copy of ch. Comm 16 is available for inspection at the office of the department of commerce, the secretary of state's office and the office of the revisor of statutes, and may be obtained for personal use from Document Sales, 202 S. Thornton Ave., Madison, WI 53703.

(g) Procedures for disposing of empty bags, drums or barrels shall minimize exposure to dusts or chemicals.

(h) Acids shall be kept in closed, acid–resistant shipping containers or storage units. Transfer from shipping containers to solution or day tanks shall be through acid resistant hose or pipe by means of a transfer pump.

(3) CHEMICALS. (a) Shipping containers shall be fully labeled to include chemical name, purity, concentration and supplier name and address.

(b) Chemicals shall meet A.W.W.A. specifications and N.S.F. standards, where applicable.

(c) The department may require an assay of chemicals delivered.

(d) A material safety data sheet (MSDS) shall be obtained by the water supplier from the chemical supplier for every chemical shipment.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92; corrections in (1) (f) made under s. 13.93 (2m) (b) 6. and 7., Stats., Register, December, 1998, No. 516.

Subchapter VIII —Treatment

NR 811.415 Design of treatment processes and devices. The design of treatment processes and devices shall depend on evaluation of the nature and quality of the particular water to be treated and the desired quality of the finished water. The requirements of specific treatment processes are in ss. NR 811.42 to 811.54.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.42 Aeration. Aeration treatment devices described in this section may be used for oxidation, separation of gases or for taste and odor control. Section NR 811.48 (1) contains the requirements for air stripping towers. The following requirements shall be met:

(1) NATURAL DRAFT AERATION. The design for natural draft aeration shall provide that:

(a) Water is distributed uniformly over the top tray;

(b) Water is discharged through a series of 3 or more trays with separation of trays not less than 6 inches;

(c) Trays are loaded at a rate of one gallon per minute to 5 gallons per minute for each square foot of total tray area;

(d) Trays have slotted, woven wire cloth or perforated bottoms;

(e) Perforations are $^3/_{16}$ to $^1/_2$ inches in diameter, spaced one to 3 inches on centers, when perforations are used;

(f) Eight to 12 inches of inert media are used, such as coke, limestone or plastic, that will not disintegrate due to freezing cycles.

(2) FORCED OR INDUCED DRAFT AERATION. Forced or induced draft aeration devices shall be designed to:

(a) Provide adequate countercurrent flow of air through enclosed aeration column;

(b) Be insect–proof and light–proof;

(c) Have the air intake located above grade and the air introduced into the column passed through insect–tight screen and be as free of dust as possible;

(d) Insure that the water outlet is adequately sealed to prevent unwanted loss of air;

(e) Insure that the sections of the aerator that can be easily reached and removed for maintenance.

(3) PRESSURE AERATION. Pressure aeration may be used for oxidation purposes if a pilot plant study indicates the method's effectiveness. Pressure aeration will not be approved for removal of dissolved gases. Filters following pressure aeration shall have adequate exhaust devices for release of air. Pressure aeration devices shall be designed to cause a thorough mixing of compressed air with water being treated, and shall provide screened and filtered air, free of obnoxious fumes, dust, dirt and other contaminants. Air compressors shall be oil–less.

(4) OTHER METHODS OF AERATION. Other methods of aeration may be permitted if their effectiveness is demonstrated and approved by the department. Methods include but are not restricted to spraying, diffused air and mechanical aeration. The treatment processes shall be designed to meet the particular needs of the water to be treated.

(5) DISINFECTION. Aerated water shall receive disinfection treatment.

(6) PROTECTION FROM WIND. Aerators that discharge through the atmosphere shall be protected by being placed in a louvered enclosure designed to provide easy access to the interior.

(7) PROTECTION FROM CONTAMINATION. Aerators that are used for oxidation or removal of dissolved gases from waters that will be given no further treatment other than chlorination shall be protected from contamination from insects and birds and windborne debris or dust.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.43 Clarification. Plants designed for processing surface waters shall:

(1) Provide duplicate units for rapid mix, flocculation and sedimentation,

(2) Permit operation of the units either in parallel or series,

(3) Be constructed to permit units to be taken out of service without disrupting operation with drains or pumps provided to allow dewatering in a reasonable period of time,

(4) Provide multiple–stage treatment facilities when required by the department,

(5) Be started manually following shutdown,

(6) Minimize hydraulic head losses between units to allow future changes in processes without the need for repumping. The following specific requirements shall also be met:

(a) *Presedimentation.* Waters containing high turbidity or having unusual treatment requirements may require pretreatment, usually sedimentation or detention either with or without the addition of coagulation chemicals.

1. Basin design. Presedimentation basins shall have a means for sludge removal.

2. Inlet. Incoming water shall be dispersed across the full width of the line of travel as quickly as possible. Short circuiting shall be prevented.

3. Bypass. Provisions for bypassing presedimentation basins shall be included.

4. Detention time. Three hours detention is the minimum period required for presedimentation. Greater detention may be required in individual cases of chemical pretreatment.

(b) *Rapid mix.* Mixing shall mean the rapid dispersion of chemicals throughout the water to be treated, usually by violent agitation.

1. Equipment. Basins shall be equipped with mechanical mixing devices unless other methods, such as baffling, or injection of chemicals at a point of high velocity, are approved by the department after determining that the other requirements of this chapter will be met. Variable speed drive equipment is recommended.

2. Mixing. The detention period for mechanical mixing shall be as short as possible depending upon the velocity gradient provided by the mixing units.

3. Location. The rapid mix and flocculation basin shall be as close together as possible.

(c) *Flocculation – slow mixing.* Flocculation shall mean the agitation of water at low velocities for long periods of time.

1. Basin design. Inlet and outlet design shall prevent short circuiting and destruction of floc. A drain or pumps or both shall be provided to allow dewatering and sludge removal.

2. Detention. Flow–through velocity may be not less than 0.5 nor greater than 1.5 feet per minute with a detention time for floc formation of at least 30 minutes.

3. Equipment. Agitators shall be driven by variable speed drives or other means which vary the peripheral speed of paddles in the range of 0.5 to 3.0 feet per second. Uniform mixing shall be provided to prevent settling in the flocculation basin.

4. Piping. Flocculation and sedimentation basins shall be as close together as possible. The velocity of flocculated water through pipes or conduits to settling basins may be not less than 0.5 nor greater than 1.5 feet per second. Allowances shall be made to minimize turbulence at bends and changes in direction.

5. Other designs. Baffling may be used to provide flocculation only after approval by the department. The design shall be such that the velocities and flows in this section shall be maintained.

6. Superstructure. A superstructure shall be provided over the flocculation basins.

(d) *Sedimentation.* Sedimentation shall follow flocculation. The detention time for effective clarification is dependent upon factors related to basin design as well as the nature of the raw water, such as turbidity, color and colloidal matter, and taste and odor causing compounds.

1. Detention time. Plants with conventional sedimentation shall provide a minimum of 4 hours of settling time. This may be reduced to 2 hours for lime–soda softening facilities treating only groundwater.

2. Inlet devices. Inlets shall be designed to distribute the water equally and at uniform velocities. Open ports, submerged ports and similar entrance arrangements are required. A baffle shall be constructed across the basin, close to the inlet end, and project several feet below the water surface to dissipate inlet velocities and provide uniform flows across the basin.

3. Outlet devices. Outlet devices shall be designed to maintain velocities suitable for settling in the basin and to minimize short circuiting. The use of submerged orifices is recommended in order to provide volume above the orifices for storage when there are fluctuations in flow.

4. Weir overflow rate. The rate of flow over the outlet weir may not exceed 20,000 gallons per day per foot of weir length. If submerged ports or orifices are used as an alternate for overflow weirs, they may not be lower than 3 feet below the flow line with flow rates equivalent to weir loadings.

5. Drainage. Basins shall be provided with a means for dewatering. Basin bottoms shall slope toward the drain not less than one foot in 12 feet where mechanical sludge collection is not provided.

6. Covers. Covers or superstructures are required at all plants. Where covers are used, manholes shall be provided as well as drop light connections so that observation of the floc can take place at the inlet, midpoint and outlet of the basin.

7. Velocity. The velocity through settling basins may not exceed 0.5 feet per minute. The basins shall be designed to minimize short circuiting. Fixed or adjustable baffles shall be provided as necessary to achieve the maximum potential for clarification.

8. Overflow. An overflow weir or pipe shall be installed which will establish the maximum water level desired on top of the filters. It shall discharge by gravity with a downturned pipe elbow a minimum of one foot above a concrete splash pad and shall be covered with 4–mesh noncorrodible screen at a location where the discharge is visible and where the water can be appropriately drained.

9. Safety. Guard rails shall be installed around openings which may be hazardous to maintenance personnel. Permanent holders or handholds shall be provided on the inside walls of basins above the water level.

10. Sludge collection. Mechanical sludge collection equipment may be provided.

11. Sludge removal. Facilities for disposal of sludge are required by the department. Sludge removal design shall provide:

a. Sludge pipes not less than 3 inches in diameter and so arranged as to facilitate cleaning,

b. Entrance to sludge withdrawal piping to prevent clogging,

c. Valves located outside the tank for accessibility,

d. Provisions for the operator to observe and sample sludge being withdrawn from the unit.

12. 'Sludge disposal'. Sections NR 811.84 and 811.86 contain additional specific requirements for sludge disposal. Flushing lines or hydrants shall be provided to backflush sludge lines and basins or for other purposes. Protection shall be provided for all potable water lines used if potable water could become contaminated by nonpotable water.

(e) *Solids contact unit.* Units designed for combined softening and clarification, where water characteristics, especially temperature, do not fluctuate rapidly and flow rates are uniform and operation is continuous, may be used if specifically approved by the department. Units shall be designed for the maximum uniform rate and be adjustable to changes in flow, which are less than the design rate and for changes in water characteristics. A minimum of 2 units are required unless this requirement is waived by the department.

1. Installation of equipment. Supervision by a representative of the manufacturer shall be provided whenever mechanical equipment is installed and, also, at the time of initial operation.

2. Operating equipment. A complete outfit of tools and accessories shall be provided. Laboratory equipment to control the treatment process shall be provided at all waterworks. In addition, sampling taps with adequate piping located to permit the collection of samples of water from critical portions of the units shall be provided.

3. Chemical feed. Chemicals shall be applied at points and by means as to insure satisfactory mixing of the chemicals with the water.

4. Mixing. Mixing devices employed shall be constructed to provide adequate mixing of the raw water with previously formed sludge particles and to prevent deposition of solids in the mixing zone. A rapid mix device or chamber ahead of the solids contact unit may be required by the department.

5. Flocculation. Flocculation equipment shall be adjustable, speed, or pitch or both; provide for coagulation to occur in a separate chamber or baffled zone within the unit; and provide a flocculation and mixing period of not less than 30 minutes.

6. Sludge concentrators. Sludge concentrators shall provide either internal or external concentrators in order to obtain a concentrated sludge with a minimum of wastewater.

7. Sludge removal. Sludge removal design shall provide:

a. Sludge pipes not less than 3 inches in diameter, arranged to facilitate cleaning;

b. Entrance to sludge withdrawal piping to prevent clogging;

c. Valves located outside the tank for accessibility;

d. Facilities for an operator to observe or sample sludge being withdrawn from the unit.

8. Cross–connections. Blow–off outlets and drains shall terminate and discharge at places approved by the department. Cross–connection control shall be included for all potable water lines such as those used to backflush sludge lines or flush basins if potable water could become contaminated by nonpotable water.

9. Detention period. The detention time shall be established on the basis of the raw water characteristics and local conditions that affect the operation of the unit. Based on design flow rates, the minimum detention time shall be 2 to 4 hours for suspended solids contact clarifiers and softeners treating surface waters, and one to 2 hours for the suspended solids contact softeners treating only groundwater.

10. Suspended slurry concentrate. Softening units shall be designed so that continuous slurry concentrates of 1% or more, by weight, can be effectively maintained.

11. Water losses. a. Units shall be provided with suitable controls for sludge withdrawal.

b. Total water loss may not exceed 5% for clarifiers or 3% for softening units.

c. Solids concentration of sludge discharged to waste shall be at least 3% by weight for clarifiers and 5% by weight for softeners.

12. Weir or orifices. The units shall be equipped with either overflow weirs or orifices. Weirs shall be adjustable, at least equivalent in length to the perimeter of the tank, and constructed so that surface water does not travel over 10 feet horizontally to the collection trough.

13. Weir or orifice loading. Weir loading may not exceed 20 gallons per minute per foot of weir length for units used for softeners, or 10 gallons per minute per foot of weir length for units used for clarifiers. Where orifices are used, the loading rate per foot shall be equivalent to weir loadings. Orifices or weirs shall produce uniform rising rates over the entire area of the tank.

14. Upflow rates. Unless supporting data is submitted to the department and an exception granted, the following rates may not be exceeded:

a. 1.75 gallons per minute per square foot of area at the slurry separation line if units are used for softeners.

b. 1.0 gallon per minute per square foot of area at the sludge separation line if units are used for clarifiers.

(f) *Tube or plate settlers.* Proposals for settler unit clarification shall include pilot plant or a full scale demonstration or both satisfactory to the department prior to the preparation of final plans and specifications for approval. Settler units consisting of variously shaped tubes or plates which are installed in multiple layers and at an angle to the flow may be used for sedimentation, following flocculation. General criteria for tube or plate settlers is as follows:

1. Inlet and outlet considerations. Design the inlets and outlets to maintain velocities suitable for settling in the basin and to minimize short–circuiting.

2. Drainage. Drain piping from the settler units shall be sized to facilitate a quick flush of the settler units and to prevent flooding other portions of the plant.

3. Protection from freezing. Although most units will be located within a plant, outdoor installations shall provide sufficient freeboard above the top of settler to prevent freezing in the units.

4. Application rate. A maximum application rate of 2 gal/ft^2/min of cross–sectional area based on 24–inch long 60° tubes or 39.5–inch long 7½° tubes, unless higher rates are successfully shown through pilot plant or in–plant demonstration studies and are approved by the department.

5. Flushing lines. Flushing lines shall be provided to facilitate maintenance and shall be properly protected against backflow or back siphonage.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.44 Disinfection. Chlorine is the principal disinfecting agent used at the present time; other agents may be approved by the department on a case–by–case basis provided reliable feed equipment is available and testing procedures for a residual are recognized in the latest edition of standard methods for the examination of water and wastewater (1989). A copy of this publication is available for inspection at the office of the department of natural resources, the secretary of state's office and the office of the revisor of statutes, and may be obtained for personal use from the American Public Health Association, 1015 Fifteenth St., N.W., Washington, D.C. 20005. Disinfection shall be practiced at all surface water supplies and at any groundwater supplies where the department determines disinfection necessary to maintain water quality. The following standards shall be applied:

(1) EQUIPMENT. (a) *Type.* Solution–feed–gas–type chlorinators and hypochlorite feeders of the positive displacement type may be used.

(b) *Capacity.* The chlorinator capacity shall be such that a free chlorine residual of at least 2 mg/l can be attained in the water after a contact time of at least 30 minutes when maximum flow rates coincide with anticipated maximum chlorine demands. The equipment shall be designed to operate between 30% and 70% of the stroke length for liquid feeders and between 30% and 70% of the rotameter capacity for gas feeders. This may require that 2 rotameters be provided, one for normal feed rates and one for emergency feed rates. The emergency feeder setting shall be designed to provide a minimum of 2 mg/l of chlorine.

(c) *Standby equipment.* Where chlorination is necessary for protection of the water supply, standby equipment of sufficient capacity shall be available to replace the largest unit during shutdowns.

(d) *Automatic proportioning.* Automatic proportioning chlorinators shall be required where the rate of flow is not reasonably constant or where the rate of flow of the water is not manually controlled.

(2) CONTACT TIME AND POINT OF APPLICATION. Chlorine shall be applied at a point which will provide the maximum contact time. The contact time shall be not less than one half hour in cases where suspended solids have been removed. Provisions shall be made to minimize short–circuiting. At plants treating surface water, piping provisions shall be made for applying chlorine to the raw water, settled or clarified water, filtered water and the plant effluent. At plants treating groundwater, provision shall be made for applying chlorine to the raw water and the clearwell inlet or the high–lift pump discharge piping.

(3) RESIDUAL TESTING EQUIPMENT. The equipment shall enable measurement of residuals to the nearest 0.1 mg/l in the range below 0.5 mg/l and to the nearest 0.2 mg/l between 0.5 mg/l to 2.0 mg/l.

Note: Automatic chlorine residual pacers and recorders are recommended where the chlorine demand varies appreciably over a short period of time.

(4) CHLORINATOR PIPING. The water supply piping shall be designed to prevent contamination of the treated water supply by sources of impure or unknown quality.

(5) HOUSING. Chlorine gas feed and storage shall be:

(a) Separated from other operating areas by gas–tight enclosures in order to prevent injury to personnel and damage to equipment;

(b) Provided with a safety glass inspection window installed in an interior wall or exterior door to permit viewing of the interior of the room and the equipment;

(c) Provided with doors having emergency or panic hardware and with a minimum of one door opening outward to the building exterior;

(d) Heated to prevent freezing and insure proper operation of the equipment;

(e) Provided with restraints to prevent movement of the chlorine cylinders;

(f) Full and empty cylinders of chlorine gas shall be:

1. Isolated from operating areas,

2. Restrained in position to prevent movement of the cylinders,

3. Stored in rooms separate from ammonia storage,

4. Stored in areas not in direct sunlight or exposed to excessive heat.

(g) Pressurized chlorine feed lines may not carry chlorine gas beyond the chlorine room. Vacuum chlorine feed lines may carry gas beyond the chlorine room if the chlorine lines are either schedule 40 polyethylene tubing or schedule 80 PVC pipe. Polyethylene tubing shall be enclosed in a protective conduit running from the chlorine room to a point near the ejector. The end of the conduit in the chlorine room shall be sealed. Polyethylene tubing connections shall be made using tube adaptors especially designed for this purpose. PVC pipe joints may be socket welded using PVC cement or threaded using TFE tape.

(h) Premanufactured chlorine cabinets may be used for retrofit situations only. These cabinets shall have an observation window, fan, air intake and light as required in par. (b) and sub. (6) for normal chlorine rooms. It is recommended that these cabinets not be placed on the sunny side of the building.

(6) VENTILATION OF CHLORINE ROOMS. One complete air change per minute shall be provided when the room is occupied, and:

(a) The exhaust fan suction shall be near the floor with the point of discharge located to avoid contamination of air inlets to other rooms and structures, or being blocked by snow or other obstructions;

(b) Air inlets shall be located near the ceiling and controlled to prevent adverse temperature variations;

(c) The exhaust fan switch shall be located outside the entrance to the chlorine room with a signal light indicating fan operation when the fan can be controlled from more than one point. Outside switches shall be protected from vandalism. As an alternative, the fan may be controlled by an automatic door switch with manual shut–off.

Note: It is recommended that switches for fans and lights be interlocked for simultaneous operation.

(d) Vents from feeders and storage shall discharge to the outside atmosphere, above grade as indicated in par. (a).

(7) AMMONIATION. Housing and ventilation for ammoniation shall meet the requirements in subs. (5) and (6) for chlorine. However, the fan inlet shall be near the ceiling and the fresh air inlet shall be near the floor. Ammonia storage and feed facilities shall be separate from chlorine facilities because of the combustion hazard. A plastic bottle of hydrochloric acid shall be available and used for leak detection.

(8) SAFETY EQUIPMENT. The following equipment shall be provided when chlorine gas is used:

(a) At least one gas mask in good operating condition of the type having a self–contained supply of air such as that approved by the U. S. bureau of mines as suitable for high concentrations of chlorine gas. The masks shall be available at all installations where chlorine gas is handled and shall be placed outside every room where chlorine gas is used or stored. At installations utilizing 100– or 150–pound cylinders, an agreement with the local fire department which has an approved type of gas mask may be approved by the department. Instructions for using, testing and replacing mask parts shall be posted. Other protective clothing shall be provided as necessary.

(b) A plastic bottle of ammonium hydroxide for leak detection.

Note: At larger plants where ton cylinders are used, the installation of automatic gas detection and related alarm equipment is recommended.

(c) Where ton cylinders are used, leak repair kits, available at the water works or a nearby fire department.

(9) SODIUM CHLORITE FOR CHLORINE DIOXIDE GENERATION. Proposals for the storage and use of sodium chlorite shall be approved by the department prior to the preparation of final plans and specifications. Provisions shall be made for proper storage and handling of sodium chlorite to eliminate any danger of explosion.

(a) *Storage.* 1. Sodium chlorite shall be stored by itself in a separate room and preferably shall be stored in an outside building detached from the water treatment facility. Sodium chlorite shall be stored away from organic materials with which it could react violently.

2. The storage structures shall be constructed of noncombustible materials.

3. If the storage structure is located in an area where a fire may occur, water shall be available to keep the sodium chlorite area cool enough during fires to prevent decomposition from heat and the resultant explosive conditions.

(b) *Handling.* 1. Care shall be taken to prevent spillage.

2. An emergency plan of operation shall be available for the clean up of any spillage.

3. Storage drums shall be thoroughly flushed prior to recycling or disposal.

(c) *Feeders.* 1. Positive displacement feeders shall be provided.

2. Tubing for conveying sodium chlorite or chlorine dioxide solutions shall be type 1 PVC, polyethylene or materials recommended by the manufacturer.

3. Chemical feeders may be installed in chlorine rooms if sufficient space is provided or facilities meeting the requirements of s. NR 811.44 (5) shall be provided.

4. Feed lines shall be installed in a manner to prevent formation of gas pockets and shall terminate at a point of positive pressure.

5. Check valves shall be provided to prevent the backflow of chlorine into the sodium chlorite line.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.45 Filtration – gravity. The application of any type of gravity filter and media shall be supported by water quality data representing a period of use sufficient to characterize any variations in water quality. Experimental or pilot plant treatment studies may be required to demonstrate the applicability of the method or rate of filtration proposed. Pressure filters will not be approved for surface water applications. The following specific requirements shall be met:

(1) RAPID RATE GRAVITY FILTERS. (a) *Pretreatment.* Rapid rate gravity filters may only be utilized after coagulation, flocculation and sedimentation.

(b) *Number.* At least 2 filter units shall be provided. Provisions shall be made to meet the plant design capacity at the approved filtration rate with one filter out of service. Where only 2 units are provided, each shall be capable of meeting the plant design capacity, normally the projected maximum daily demand.

(c) *Rate of filtration.* The permissible rate of filtration shall be determined after consideration of factors such as raw water quality, degree of pretreatment provided, filter media, water quality control parameters, competency of operating personnel and other factors required by the department. Where effective coagulation, flocculation, sedimentation and filtration processes are to be utilized with relatively clean water sources, the following filtration rates may be approved:

Filtration Rate	Filter Media Type
2 gpm/ft^2	Single Media
3 gpm/ft^2	Dual Media – field tested
4 gpm/ft^2	Tri Media – field tested

In all cases, the filtration rate shall be proposed and justified by the design engineer and approved by the department prior to the preparation of final plans and specifications. Higher rates than indicated in this paragraph may be approved with sufficient justification by the design engineer.

(d) *Structural details and hydraulics.* The filter structure shall be designed to provide:

1. Vertical walls within the filter;

2. No protrusion of the filter walls or other structures into the filter media or the area between the top of the media and the high water line during backwashing;

3. Cover by superstructure;

4. Head room to permit normal inspection and operation;

5. Minimum filter box depth of 8 ½ feet;

6. Minimum water depth over the surface of the media of 3 feet;

7. Trapped pipe or conduit effluent to prevent backflow of air to the bottom of the filters;

8. Prevention of floor drainage to the filter with a minimum 4–inch curb around the filters;

9. Prevention of flooding by providing an overflow if this is not provided in a pretreatment unit;

10. Maximum velocity of treated water in the pipe and conduits to the filter of 2 feet per second;

11. Cleanouts and straight alignment for influent pipes or conduits where solids loading is heavy or following lime–soda softening;

12. Washwater drain capacity to carry maximum backwash flow;

13. Walkways around filters not less than 24 inches wide;

14. Safety handrails or walls around the filter areas adjacent to walkways. Consult local and state codes for requirements;

15. Construction to prevent cross connections and common walls between potable and nonpotable water;

16. Washwater troughs.

(e) *Washwater troughs.* Washwater troughs shall be so designed as to provide:

1. A bottom elevation above the maximum level of expanded media during washing;

2. A top elevation not exceeding 30 inches above the filter surface;

3. A 2-inch freeboard at the maximum rate of wash;

4. A top or edge which is level;

5. Spacing so that each trough serves the same number of square feet of filter area;

6. A maximum horizontal travel of suspended particles not exceeding 3 feet in reaching the trough.

(f) *Filter material.* The media shall be clean silica sand or other natural or synthetic media approved by the department having a depth of not less than 24 inches and not more than 30 inches; an effective size of the smallest material no greater than 0.45 mm to 0.55 mm, depending upon the quality of the raw water; a uniformity coefficient of the smallest material not greater than 1.65; a minimum of 12 inches of media with an effective size range no greater than 0.45 mm to 0.55 mm; and a specific gravity greater than other filtering materials within the filter.

1. Sand. Sand shall have an effective size of 0.45 mm to 0.55 mm and a uniformity coefficient of not greater than 1.65.

2. Anthracite. Clean crushed anthracite or sand and anthracite may be approved by the department if supported by experimental data specific to the project. Anthracite used as the only media shall have an effective size from 0.45 mm to 0.55 mm and a uniformity coefficient not greater than 1.65. Anthracite used to cap sand filters shall have an effective size from 0.8 mm to 1.2 mm and a uniformity coefficient not greater than 1.85. Effective size of anthracite for iron and manganese removal from potable groundwater shall be a maximum of 0.8 mm. Effective sizes greater than 0.8 mm may be approved by the department based upon onsite pilot plant studies.

3. Granular activated carbon (GAC). Granular activated carbon media may be considered only after pilot or full scale testing and with prior approval of the department. The media shall meet the basic specifications for filter media as given in this paragraph except that larger size media may be allowed by the department where full scale tests have demonstrated that treatment goals can be met under all conditions. There shall be provision for a free chlorine residual and adequate contact time in the water following the filters and prior to distribution. There shall be means for periodic treatment of filter material for control of bacterial and other growth. Provisions shall be made for frequent replacement or regeneration of GAC if used for filtration.

4. Other media. Other media may be approved, but only on the basis of pilot tests and experience which demonstrate that the requirements of this chapter will be met.

5. Supporting media. Torpedo sand and gravel shall be provided as supporting media except when proprietary filter bottoms are used. In that case, the department, on the basis of substantiating information provided by the owner, may allow elimination of certain layers of supporting media or a reduction in the depth of the layers. Otherwise, the following apply:

a. A 3-inch layer of torpedo sand shall be used as a supporting media for the filter sand. The torpedo sand shall have an effective size of 0.8 mm to 2.0 mm, and a uniformity coefficient not greater than 1.7.

b. Gravel, when used as the supporting media, shall consist of hard, rounded silica particles and may not include flat or elongated particles. The coarsest gravel shall be 2½ inches in size when the gravel rests directly on the strainer system, and shall extend above the top of the perforated laterals or strainer nozzles. Not less than 4 layers of gravel shall be provided in accordance with the following size and depth distribution when used with perforated laterals or strainer nozzles. Reduction of gravel depths may be considered upon justification to the department when proprietary filter bottoms are specified.

Gravel Size	Gravel Depth
2 1/2 to 1 1/2 inches	5 to 8 inches
1 1/2 to 3/4 inches	3 to 5 inches
3/4 to 1/2 inches	3 to 5 inches
1/2 to 3/16 inches	2 to 3 inches
3/16 to 3/32 inches	2 to 3 inches

(g) *Filter bottoms and strainer systems.* Departures from these standards by using proprietary bottoms may be approved on a case-by-case basis if the effectiveness of the method is demonstrated. Porous plate bottoms may not be used where iron or manganese may clog them or with waters softened by lime. The design of manifold type collection systems shall:

1. Minimize loss of head in the manifold and laterals;

2. Assure even distribution of washwater and even rate of filtration over the entire area of the filter;

3. Provide a ratio of the area of the final openings of the strainer systems to the area of the filter of about 0.003;

4. Provide a total cross-sectional area of the laterals about twice the total area of the final openings of the strainer system;

5. Provide a cross-sectional area of the manifold at 1½ to 2 times the total cross-sectional area of the laterals.

(h) *Surface wash.* Surface wash facilities consisting of either fixed nozzles or a revolving mechanism are required unless air scour equipment is provided. All surface wash devices shall be designed with:

1. Water pressures of at least 45 psi;

2. Volume of flow of 2.0 gpm per square foot of filter area with fixed nozzles and 0.5 gpm per square foot with revolving arms;

3. A vacuum breaker installed above the high water elevation in the filter or other approved device to prevent back siphonage.

(i) *Air scouring.* Air scouring may be provided in place of surface wash. The following apply:

1. Air flow for air scouring the filter shall be 3–5 standard cubic feet per minute per square foot of filter area when the air is introduced in the underdrain; a lower air rate shall be used when the air scour distribution system is placed above the underdrains;

2. A method for avoiding excessive loss of the filter media during backwashing shall be provided;

3. Air scouring shall be followed by a fluidization wash sufficient to restratify the media;

4. Air shall be free from contamination;

5. Air scour distribution systems shall normally be placed below the media and supporting bed interface; if placed at the interface the air scour nozzles shall be designed to prevent media from clogging the nozzles or entering the air distribution system;

6. Piping for the air distribution system may not be flexible hose which will collapse when not under air pressure and may not be a relatively soft material which may erode at the orifice opening with the passage of air at high velocity;

7. Air delivery piping may not pass down through the filter media nor shall there be any arrangement in the filter design which would allow short circuiting between the applied unfiltered water and the filtered water;

8. The backwash delivery system shall be capable of 15 gallons per minute per square foot of filter surface area; however, when air scour is provided, the backwash rate shall be variable and may not exceed 8 gallons per minute per square foot unless operating experience shows that a higher rate is necessary to remove scoured particles from filter surfaces;

9. The filter underdrains shall be designed to accommodate air scour piping when the piping is installed in the underdrain; and

10. Backwash facilities shall meet the requirements of par. (k).

(j) *Appurtenances.* The following shall be provided for every filter:

1. Sampling faucets on the influent and effluent lines;

2. Indicating loss-of-head gauge;

3. Indicating flow rate controls. A modified rate controller which limits the rate of filtration to a maximum rate may be used. However, equipment that simply maintains a constant water level on the filters will not be approved unless the rate of flow onto the filter is properly controlled. A pump in each filter effluent line may be used as the limiting factor for the rate of filtration only after approval from the department;

4. Provisions for draining to waste with appropriate measures for backflow prevention;

5. A means of monitoring the effluent from each filter for turbidity on a continuous basis or on a selective basis where one turbidimeter would monitor more than one filter on a rotating cycle. Recorders shall be provided. Access to the filter interior through wall sleeves shall be provided in several locations to allow the installation of sampling lines, pressure sensors and other devices, at different depths in the filter media;

6. A 1 to 1 ½-inch pressure hose and rack at the operating floor for washing the filter walls.

(k) *Backwash.* Backwashing facilities shall be designed to provide:

1. A minimum rate of 15 gallons per minute per square foot, consistent with water temperatures and specific gravity of the filter media. A rate of 20 gallons per minute per square foot or a rate necessary to provide for a 50% expansion of the filter bed is recommended. A reduced rate of 10 gallons per minute per square foot may be acceptable for full depth anthracite or granular activated carbon filters. A reduced rate of backwashing is acceptable when air scouring is provided, meeting the requirements of par. (i).

2. Backwashing by filtered water at the required rate from washwater tanks, a washwater pump from a reservoir or a high service main, or a combination of these;

3. Washwater pumps in duplicate unless an alternate means of obtaining washwater is available;

4. Backwashing of not less than 15 minutes wash of one filter at the design rate of wash;

5. A washwater regulator or valve on the washwater line to obtain the desired rate of filter wash with the washwater valves on the individual filters open wide;

6. A rate-of-flow indicator and totalizer on the main washwater line, located for convenient reading by the operator during the washing process;

7. Backwashing by a method which prevents rapid changes in the backwash water flow.

(L) *Miscellaneous.* Roof drains may not discharge into the filters and basins or the conduits preceding the filters.

(2) SLOW RATE GRAVITY FILTERS. The use of slow rate gravity filters shall require prior engineering studies to demonstrate the adequacy and suitability of this method of filtration for the specific raw water supply. The following standards shall be applied:

(a) *Quality of raw water.* Slow rate gravity filtration shall be limited to waters having maximum turbidities of 50 NTUs and maximum color of 30 units; turbidity may not be attributable to colloidal clay. Raw water quality data shall include examinations for algae.

(b) *Structural details and hydraulics.* Slow rate gravity filters shall be designed to provide:

1. Not less than 2 filter units; where only 2 units are provided, each shall be capable of meeting the plant design capacity, normally the projected maximum daily demand, at the approved filtration rate. Where more than 2 filter units are provided, the filters shall be capable of meeting the plant design capacity at the approved filtration rate with one filter removed from service;

2. A cover or superstructure;

3. Headroom to permit normal movement by operating personnel for scraping and sand removal operations;

4. Adequate manholes and access ports for handling of sand;

5. Filtration to waste and overflow at the maximum filter water level.

(c) *Rates of filtration.* The permissible rates of filtration shall be based on the quality of the raw water as determined from experimental data. Proposed rates shall be submitted to and approved by the department. The design rate shall be 45 to 150 gallons per day per square foot of sand area. However, rates of 150 to 230 gallons per day per square foot may be approved when effectiveness is demonstrated to the satisfaction of the department.

(d) *Underdrains.* Each filter unit shall be equipped with a main drain and an adequate number of lateral underdrains to collect the filtered water. The underdrains shall be so spaced that the maximum velocity of the water flow in the lateral underdrain will not exceed 0.75 feet per second. The maximum spacing of the laterals may not exceed 3 feet if pipe laterals are used.

(e) *Filtering material.* A minimum depth of 30 inches of filter sand, clean and free of foreign matter, shall be placed on graded gravel layers. The effective size shall be between 0.30 and 0.45 mm, and the uniformity coefficient may not exceed 2.5.

(f) *Filter gravel.* The supporting gravel shall conform to the size and depth distribution requirements in sub. (1) provided for rapid rate gravity filters.

(g) *Depth of water on filter beds.* The design shall provide a depth of at least 3 feet of water over the sand. Influent water shall be distributed in a manner which will not scour the sand surfaces.

(h) *Control appurtenances.* Each filter shall be equipped with:

1. A loss-of-head gauge;

2. An orifice, Venturi meter or other suitable metering device installed on each filter to enable measurement of the rate of filtration;

3. An effluent pipe located at an elevation which will maintain the water level in the filter above the top of the sand.

History: Cr. Register, April, 1992, No. 436, eff. 5-1-92.

NR 811.46 Fluoridation. Sodium fluoride, sodium silicofluoride and hydrofluosilicic acid shall conform to the applicable N.S.F. and A.W.W.A. standards. Other fluoride compounds which may be available shall be approved by the department. The following specific requirements shall be met:

(1) FLUORIDE COMPOUND STORAGE. Fluoride chemicals shall be isolated from other chemicals to prevent contamination. Compounds shall be stored in covered or unopened shipping containers and stored inside a building. Unsealed storage units for hydrofluosilicic acid shall be vented to the atmosphere at a point outside the building.

(2) FLUORIDE HOUSING. Equipment for feeding fluoride in acid form and unsealed acid storage shall be in a separate room within the pumphouse away from controls, electrical contacts and other equipment subject to damage. Unsealed acid storage units or solution tanks shall be vented to the outside. Ventilation shall be provided for the room. Entrance may be from inside the pumphouse but shall include a sealed door.

(3) CHEMICAL FEED INSTALLATIONS. Chemical feed installations shall:

(a) Conform to the requirements in ss. NR 811.39 to 811.41.

(b) Provide scales, loss-of-weight recorders, liquid level indicators or graduated feed drums for determining the amount of

chemical applied. The method shall be accurate to within 5% of the average daily change in reading. A meter shall be provided on the water fill line to a fluoride saturator.

(c) Not allow fluoride addition before lime–soda softening or ion exchange softening.

(d) Provide feeders accurate to within 5% of that prescribed.

(e) Be such that the point of application of hydrofluosilicic acid, if into a horizontal pipe, shall be in the lower half of the pipe with the nozzle projecting upward.

(f) Provide a minimum of 12 injections per minute at the feeding rate.

(g) Provide adequate anti–siphon devices for all fluoride feed lines as required in s. NR 811.40 (2) (e).

(h) Provide soft water for fluoride saturator makeup water.

(4) SECONDARY CONTROLS. Secondary control systems for automatically controlled fluoride chemical feed devices shall be provided as a means of reducing the possibility for overfeed; these may include flow or pressure switches or other equivalent devices. All existing installations shall be required to meet this subsection by January 1, 1994.

(5) DUST CONTROL. (a) Provision shall be made for the transfer of dry fluoride compounds from shipping containers to storage bins or hoppers in such a way as to minimize the quantity of fluoride dust which may enter the room in which the equipment is installed. The enclosure shall be provided with an exhaust fan and dust filter which place the hopper under a negative pressure. Air exhausted from fluoride handling equipment shall discharge through a dust filter to the atmosphere outside of the building.

(b) Provision shall be made for disposing of empty bags, drums or barrels in a manner which will minimize exposure to fluoride dust. A floor drain shall be provided to facilitate the hosing of floors.

(6) PROTECTIVE EQUIPMENT. Protective clothing, gloves, goggles or face shields and aspirator shall be provided if applicable.

(7) TESTING EQUIPMENT. Equipment shall be provided for measuring the quantity of fluoride in the water. Equipment utilizing the SPADNS or electrode method is required. When also feeding phosphates, the electrode method is required. The Alizarin Visual method will be approved only in special cases where the owner can allocate the extra time needed for testing.

(8) DILUTION EQUIPMENT. Where dilution of the chemical solution is necessary, a graduated container and transfer pump shall be provided.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.47 Iron and manganese control. Iron and manganese control refers solely to treatment processes designed specifically for this purpose. The treatment process used will depend upon the character of the raw water. The selection of treatment processes shall meet specific local conditions as determined by engineering investigations, including chemical analyses of representative samples of water to be treated. The department may require the operation of a pilot plant in order to gather all information pertinent to the design. Consideration shall be given to adjusting pH of the raw water to optimize the chemical reaction. Following are requirements for specified treatment processes:

(1) REMOVAL BY OXIDATION–DETENTION–FILTRATION OR OXIDATION–FILTRATION. (a) *Oxidation.* Oxidation may be by aeration, as indicated in s. NR 811.42, or by chemical oxidation with chlorine, potassium permanganate, ozone or chlorine dioxide.

(b) *Detention or reaction.* A detention period of ½ to 3 hours, as determined by pilot studies, shall be provided following oxidation by aeration in order to insure that the oxidation reactions are as complete as possible. The detention period may be omitted where a pilot plant study indicates no need for detention and department approval is obtained. The detention basin shall be designed as a holding tank with sufficient baffling to prevent short circuits. Sludge collection equipment is not required. The floor shall be sloped to facilitate cleaning.

(c) *Sedimentation.* Sedimentation basins shall be provided when treating water with high iron or manganese content or both or where chemical coagulation is used to reduce the load on the filters. Provisions for sludge removal shall be made.

(d) *Rapid rate pressure filters.* Use of rapid rate pressure filters as well as gravity filters may be considered for iron and manganese removal. Use, however, is subject to the following conditions:

1. Minimum criteria relative to number, rate of filtration, structural details and hydraulics, filter media, etc., provided for rapid rate gravity filters in s. NR 811.45 also apply to pressure filters where appropriate.

2. Generally, the design filtration rate shall be 3 gallons per minute per square foot of filter area. High or lower rates may be justified based on in–plant or pilot plant studies.

3. Filter design shall provide for:

a. Loss of head gauges with a suitable range in head on the inlet and outlet pipes of each filter;

b. An easily readable meter or flow indicator on each battery of filters. A flow indicator is recommended for each filtering unit;

c. Filtration and backwashing of each filter individually;

d. Minimum side wall shell height of 5 feet. A corresponding reduction in side wall height may be approved where proprietary bottoms permit reduction of the gravel depth;

e. Wastewater collection 18 inches above the surface of the media;

f. An underdrain system to efficiently collect the filtered water and distribute the backwash;

g. Backwash and air relief valves terminating with an air break at least 24 inches above the floor;

h. Influent and effluent sampling faucets.

(2) REMOVAL BY LIME PROCESSES. The removal of iron and manganese by lime processes shall meet the requirements in s. NR 811.52.

(3) REMOVAL BY MANGANESE GREENSAND TYPE FILTRATION. The removal of iron and manganese by greensand type filtration consisting of a continuous feed of potassium permanganate to the influent of a manganese greensand filter, is more applicable to the removal of iron plus manganese than to the removal of iron only because of economic considerations. As an alternate method, application of the potassium permanganate to the greensand on a "batch" basis may be installed when the department determines "batch" application is as effective as continuous feed. The following apply:

(a) The permanganate shall be applied as far ahead of the filter as practical;

(b) Other oxidizing agents or processes, such as chlorination or aeration, may be used prior to the permanganate feed to reduce the cost of the chemical;

(c) Normal filtration rate shall be 3 gpm per square foot;

(d) Normal wash rate shall be 8 to 10 gpm per square foot;

(e) Air washing may be provided;

(f) Sample faucets shall be provided prior to application of permanganate, immediately ahead of filtration and at the filter effluent.

(4) REMOVAL BY ION EXCHANGE. The removal of iron and manganese by ion exchange may not be used unless pilot plant studies have demonstrated that satisfactory removal efficiencies can be continuously provided. There may be no oxidation of the iron or manganese prior to the process.

(5) TESTING EQUIPMENT. Testing equipment shall be provided for all plants. The equipment shall have the capacity to accurately

measure the iron content to a minimum of 0.1 mg/l and the manganese content to a minimum of 0.05 mg/l.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.48 Organics removal. Organic compounds can be removed by a variety of processes. All process designs shall be based on information from a pilot study with the compounds to be removed. Unless waived by the department, the processes shall be designed to remove a minimum of 99% of the contaminant in question. The following requirements apply:

(1) PACKED COLUMN AERATORS. (a) *Tower requirements.* 1. The tower shell construction shall be of material compatible with potable water and shall be resistant to the aggressiveness of the water and dissolved gasses.

2. A water distribution system shall be provided that distributes the water evenly over the packing.

3. Adequate packing support shall be provided to prevent packing deformation.

4. A moisture barrier shall be provided to prevent tower misting and icing.

5. Access manholes shall be provided in the side of the tower for facilitating inspection and replacement of the packing material.

6. An access ladder with safety cage shall be provided.

7. Adequate foundation and lateral support shall be provided to prevent overturning due to wind loads.

8. A screened, rain proof, outlet for air exhaust shall be provided.

(b) *Packing requirements.* 1. The packing material shall be compatible with use in potable water and shall be resistant to the aggressiveness of the water and dissolved gasses.

2. A method of cleaning the packing shall be provided when iron or manganese fouling of the media may occur.

(c) *Blower requirements.* 1. The blower shall be provided with a weather–proof motor, a tight housing and an adequate foundation.

2. The blower inlet shall be provided with an insect screen and dust filter.

3. A method for measuring air flow shall be provided.

4. The blower shall be adequately sized to provide sufficient air to achieve the desired removal rates.

(d) *Other requirements.* 1. A means shall be provided to drain the influent riser and the tower upon pump shut–down.

2. All buried piping shall be maintained under a positive pressure greater than the elevation of the ground surface.

3. Influent and effluent sampling faucets shall be provided.

4. A meter shall be provided to determine water flow to the tower.

5. The water passing through the tower shall be continuously disinfected and provided with a minimum of 30 minutes of contact time.

6. A means of bypassing the tower shall be provided.

7. Air emission controls shall be provided if necessary to meet air quality standards.

(2) GRANULAR ACTIVATED CARBON FILTERS. (a) The maximum filtration rate for pressure filters shall be 6 gallons per minute per square foot of filter area. The maximum filtration rate for gravity filters shall be 3 gallons per minute per square foot of filter area. Higher rates may be justified based on pilot studies for removal of the contaminant in question.

(b) The water from the carbon filter shall be continuously disinfected.

(c) The filter design shall provide for:

1. Loss of head gauges on the inlet and outlet pipes of each filter.

2. A meter or flow indicator.

3. Adequate freeboard for backwashing based on the specific gravity of the media.

4. An underdrain system to effectively collect the filtered water and distribute the backwash water.

5. Backwash and air relief valves having discharges that terminate in a free air break at least 24 inches above the floor.

(d) The carbon used shall be virgin carbon.

(e) Information supporting selection of the carbon for removal of the contaminants in question shall be provided to the department.

(f) A plan for the disposal of the spent carbon shall be included in the specifications.

(g) An assessment of the impacts of radon and its decay products on operation and waste disposal shall be provided to the department.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.49 Ozonation. Ozonation can be used for a variety of purposes including the removal of color, taste and odors, organics, algae, cyanide, hydrogen sulfide, iron, manganese and heavy metals. In addition to these treatment processes, ozone is an acceptable alternative to chlorine disinfectants. All process designs shall be based on bench or pilot scale studies of dosage requirements and application points. When ozone is used as a disinfectant, ozonation and detention shall provide the required disinfection CT value. Additionally, application of a disinfectant which maintains a measurable residual in the distribution system shall be required. Given the sophisticated nature of the ozone process, consideration shall be given to the need for maintaining qualified operators to operate and maintain the equipment. The following apply:

(1) GENERAL. Where ozonation is approved by the department to be used for disinfection of a bacteriologically unsafe water supply, duplicate process streams shall be provided. This includes air supply, air preparation equipment, ozone generators, ozone contact chambers, ozone diffusers, power supply and post disinfection equipment. This requirement may be waived by the department where other acceptable water sources having sufficient capacity are available.

(2) FEED GAS PREPARATION. Feed gas can be air, pure oxygen or oxygen enriched air. Air handling equipment on the air–feed systems shall consist of an air compressor unless drawn by vacuum, water/air separator, refrigerant and desiccant dryers and particulate filters. For oxygen–feed systems, compressors, separators and dryers may not be required by the department depending on the purity of the oxygen.

(a) *Air compression.* 1. Compressors shall be of the liquid–ring or rotary lobe, oil–less, positive displacement type for smaller systems or dry rotary screw compressors for larger systems.

2. The air compressors shall have the capacity to simultaneously provide for maximum ozone demand, provide the air flow required for purging the desiccant dryers, where required, and allow for standby capacity.

3. Air feed for the compressor shall be drawn from a point protected from rain, snow, condensation, mist and fog to minimize moisture content of the air supply. Outside air intakes shall consist of a downturned pipe elbow installed at a location least susceptible to vandalism and covered with a 24–mesh noncorrodible screen.

4. A compressed air after–cooler or entrainment separator or both with automatic drain shall be provided prior to the dryers to reduce the water vapor.

(b) *Air drying.* 1. Dry, dust–free and oil–free feed gas shall be provided to the ozone generator. Sufficient drying to a maximum dew point of minus 60°C (–76°F) shall be provided at the end of the drying cycle.

2. Drying for high pressure systems shall be accomplished using desiccant dryers. For low pressure systems, a refrigeration air dryer in series with desiccant dryers shall be used.

3. A refrigeration dryer capable of reducing the inlet air temperature to 4°C (40°F) shall be provided for low pressure air preparation systems. The dryer may be of the compressed refrigerant type or chilled water type.

4. The desiccant dryers shall be of the external heated or heatless type.

5. For heat–reactivated desiccant dryers, the unit shall contain 2 desiccant filled towers complete with pressure relief valves, 2 4–way valves and a heater. In addition, external type dryers shall have a cooler unit and blowers. The size of the unit shall be such that the specified dew point will be achieved during a minimum absorption cycle time of 16 hours while operating at the maximum expected moisture loading conditions.

(c) *Air filters.* 1. Air filters shall be provided on the suction side of the air compressors, between the air compressors and the dryers and between the dryers and the ozone generators.

2. The filter before the compressor shall be of the coalescing type and be capable of removing all particles larger than 10 microns in diameter. The filter before the dryer shall be of the coalescing type and be capable of removing all particles larger than 5 microns in diameter. The filter after the dryer shall be of the particulate type and be capable of removing all particles larger than 0.5 microns in diameter or a size specified by the generator manufacturer.

(d) *Air preparation piping.* Piping in a compressed air preparation system shall be common grade steel, seamless copper, stainless steel or galvanized steel. The piping shall be designed to withstand the maximum pressures in the air preparation system. PVC piping may be used in a vacuum air preparation system when located and supported to be protected from physical damage including from heat.

(3) OZONE GENERATORS. (a) *Capacity.* The production rating of the ozone generators shall be provided in pounds per day and pounds per kilowatt–hour. The capacity of any ozone generators shall be determined by ozone demand tests including tests under critical conditions. Where ozone is approved for use by the department as a disinfectant, the generators shall be sized in conjunction with the detention basins to provide the required CT value.

1. The design shall ensure that the minimum concentration of ozone in the generator exit gas will be 1.5% by weight.

2. Low frequency systems that operate at high peak voltages shall be sized to have sufficient reserve capacity so that the system does not operate at peak capacity for extended periods of time. Low, medium and high frequency systems which operate at lower peak voltages require less reserve capacity.

3. Each generator shall have the capability of operating satisfactorily while individual dielectrics are out–of–service. This shall be accomplished through the use of individually fused dielectrics.

4. At least 2 generators, each with a capacity of supplying the normal ozone demand, shall be provided. Where determined by the department to not be critical to maintaining production capacity, smaller installations employing ozone generators with multiple individually fused dielectrics may be able to employ a fewer number of generators each having excess ozone production capacity.

5. If there is to be a variation in the supply temperature of the generator cooling water throughout the year, then curves or other data shall be furnished to the department to show ozone production changes due to the varying temperature of the supplied cooling water. The design shall ensure that the generators can produce the required ozone at the maximum coolant temperature.

(b) *Electrical.* The generators may be low, medium or high frequency type. The specifications shall require that the transformers and other electrical hardware be proven, high quality components designed for ozone service.

(c) *Cooling.* Cooling water to the ozone generators may not be corrosive or scale forming and shall be sufficiently free of microbiological and inorganic contaminants to prevent fouling of the water side of the tubes. If natural water quality does not meet this requirement, treatment shall be required. A closed loop cooling water system shall be used if proper water conditions cannot be assured.

(d) *Materials.* To prevent corrosion, the ozone generator shell and tubes shall be constructed of type 304L or 316L stainless steel.

(4) OZONE CONTACTORS. Selection of the contactor depends on the purpose for which the ozone is being used. Where ozone is used as a disinfectant, a minimum of 2 contact chambers shall be provided with the chambers designed to prevent short–circuiting. Contactors shall be closed vessels. The following apply:

(a) Contactors shall be separate vessels having no common walls with the remainder of the facility unless common walls are approved by the department on a case–by–case basis. If common walls are used, the contactor shall be kept under negative pressure and sufficient ozone monitors shall be provided to protect worker safety. No normally inhabited structure may be constructed over an ozone contactor or reservoir containing ozone.

(b) Contact vessels shall be made of reinforced poured concrete. All reinforcement bars shall be covered with a minimum of 1.5 inches of concrete. Ozone resistant interior coatings shall be approved by the department in accordance with s. NR 811.07 (4) (f). Smaller contact vessels may be made of stainless steel, fiberglass or other material which will be stable in the presence of residual ozone and ozone in the gas phase above the water level.

(c) Contact chambers shall be of sufficient depth and size to allow for adequate contact time and freeboard for foaming where applicable. The depth of water in bubble diffuser contactors shall normally be a minimum of 18 feet unless a shallower depth can be justified to the department.

(d) The contact time for disinfection shall be determined based on required inactivation CT values for viruses and Giardia Lamblia cysts. The minimum contact time shall be 10 minutes. A shorter contact time may be approved by the department if justified by appropriate design and CT considerations. Sufficient ozone capacity and contact chamber size shall be provided to achieve the desired CT value when injecting ozone into only one of the 2 contact chambers. The diffusion system shall normally work on a countercurrent basis such that the ozone shall enter through porous diffusers at the bottom of the vessel and water shall enter from the top of the vessel. Countercurrent flow shall be provided in all chambers of the vessels. Cocurrent diffusion systems shall only be approved by the department where adequate justification can be supplied.

(e) For ozone applications in which precipitates are formed, such as with iron and manganese removal, porous diffusers may not be used.

(f) Where taste and odor control is of concern, multiple application points and contactors shall be considered.

(g) A system shall be provided between the contactor and the off–gas destruct unit to remove froth from the air and return the froth to the contactor or other location acceptable to the department. A potable water spray system shall be placed in the contactor head space if foaming is expected to be excessive.

(h) All openings into the contactor for pipe connections, hatchways, etc., shall be properly sealed to prevent the escape of ozone using welds or ozone resistant gaskets such as Teflon or Hypalon.

(i) A pressure/vacuum relief valve shall be provided in the contactor as appropriate.

(j) Sampling faucets and monitors shall be provided on the inlet and outlet of each contact chamber to monitor water quality and the ozone residual. If allowed by the department, a portable

monitor or a comparable testing method may be used to analyze water collected from sample taps provided on the inlet and outlet of each contact chamber.

(k) A water meter shall be provided on the inlet to the contact chambers to measure water flow.

(L) Where required by the department, contactors or reservoirs used as contactors shall be fitted with the improvements necessary to allow sampling of water from intermediate points for ozone residual.

(m) All contactors shall have provisions for cleaning, maintenance and drainage.

(5) OZONE DESTRUCTION. (a) A method or combination of methods for destroying or recirculating the final off gas from the ozone contactors shall be provided to meet safety and air quality standards. Acceptable methods include:

1. Thermal destruction.
2. Catalytic destruction.
3. Thermal/catalytic destruction.
4. Recycling to some point in the treatment system in addition to the installation of destruction equipment.

(b) A detectable ozone residual may not carry over into the distribution system.

(c) The maximum allowable air ozone concentration in the destruction unit discharge is 0.1 ppm by volume.

(d) At least 2 units shall be provided which are each capable of handling the entire gas flow unless the second unit is deemed unnecessary by the department.

(e) An exhaust blower shall be provided in order to draw off–gas from the contactors into the destruct unit.

(f) Catalysts shall be protected from froth, moisture and other impurities which may harm the catalyst.

(g) The catalyst and heating elements shall be located where they can be easily reached for maintenance.

Note: In order to reduce the risk of fires, the use of units that operate at lower temperatures is encouraged.

(6) MATERIAL ACCEPTABILITY. (a) Only low carbon 304L and 316L stainless steel piping shall be used for ozone service. Schedule 40 or stronger PVC pipe may be used for vacuum ozone piping where approved by the department.

(b) Gasket materials shall be Teflon or Hypalon.

(c) Rubber components may not be used in contact with ozone.

(7) JOINTS AND CONNECTIONS. (a) Connections on stainless steel piping used for ozone service are to be welded where possible.

(b) Connections with meters, valves or other equipment are to be made with flanged joints with ozone resistant gaskets. Screwed fittings and field–cut threaded connections may not be allowed.

(c) A leak–proof backflow prevention check valve system shall be provided in the piping between the generator and the contactor for pressurized ozone generation systems.

(8) INSTRUMENTATION. (a) Pressure gauges shall be provided at the discharge from the air compressor, at the inlet to the refrigerator dryers, at the inlet and outlet of the desiccant dryers, at the inlet to the ozone generators and contactors and at the inlet to the ozone destruction unit.

(b) Each generator shall have a trip which shuts down the generator when the wattage exceeds a preset level. It is recommended that electric power meters be provided for measuring the electric power supplied to the ozone generators.

(c) Dew point monitors shall be provided for measuring the moisture of the feed gas from each desiccant dryer. Where there is potential for moisture entering the ozone generator from downstream of the unit or where moisture accumulation can occur in the generator during shutdown, post–generator dewpoint monitors are recommended.

(d) Air flow meters shall be provided for measuring the air flow from the desiccant dryers to each of the ozone generators, the air flow to each contactor and the purge air flow to the desiccant dryers.

(e) Temperature gauges shall be provided for the inlet and outlet of the ozone cooling water and the inlet and outlet of the ozone generator feed gas, and, if applicable, for the inlet and outlet of the ozone power supply cooling water.

(f) Water flow meters shall be installed to monitor the flow of cooling water to the ozone generators and, if applicable, to the ozone power supply.

(g) At a minimum, ozone monitors shall be installed and maintained to measure ozone concentrations in both the feed–gas and the off–gas from the contactor and the off–gas from the destruct unit. Monitors or a comparable testing method shall also be provided for measuring ozone residuals in water in accordance with sub. (4).

(h) Ambient air ozone monitors shall be installed in rooms where exposure to ozone is possible.

(9) ALARMS. The following shutdown/alarm systems shall be installed where applicable:

(a) A dew point shutdown/alarm shall shut down the generator in the event the system dew point exceeds –60°C (–76°F).

(b) An ozone generator cooling water flow shutdown/alarm shall shut down the generator in the event that cooling water flows decrease to the point that generator damage could occur.

(c) An ozone power supply cooling water flow shutdown/alarm shall shut down the power supply in the event that cooling water flow decreases to the point that power supply damage could occur.

(d) An ozone generator cooling water temperature shutdown/alarm shall shut down the generator if either the inlet or outlet cooling water exceeds the recommended preset temperature.

(e) An ozone power supply cooling water temperature shutdown/alarm shall shut down the power supply if either the inlet or outlet cooling water exceeds the recommended preset temperature.

(f) An ozone generator inlet feed–gas temperature shutdown/alarm shall shut down the generator if the feed–gas temperature exceeds the recommended preset value.

(g) An ambient air ozone concentration shutdown/alarm shall sound when the ozone level in the ambient air exceeds 0.1 ppm or a lower value chosen by the water supplier. Ozone generator shutdown shall automatically occur when ambient ozone levels exceed 0.3 ppm.

(h) An ozone destruct temperature alarm shall sound when the temperature exceeds the recommended preset value.

(i) Alarms and warning lights shall be installed and maintained to insure operators are alerted to improper operating or hazardous conditions.

(10) SAFETY. (a) The maximum allowable ozone concentration in the air to which workers may be exposed may not exceed 0.1 ppm by volume.

(b) Noise levels resulting from the operation of the ozonation system shall be controlled to within acceptable limits by special room construction and equipment isolation.

(c) High voltage and high frequency electrical equipment shall meet current electrical and fire codes.

(d) An exhaust fan shall be provided in the ozone generation and contactor rooms to remove ozone gas if a leak occurs. One complete air change per minute shall be provided when the room is occupied, and

1. The exhaust fan suction shall be located near the floor with the point of discharge located to avoid contamination of air inlets to other rooms and structures, to outside breathable air, or being blocked by snow or other obstructions.

2. Air inlets shall be located near the ceiling and controlled to prevent adverse temperature variations.

3. An exhaust fan switch shall be located outside of the entrance to the room with a signal light indicating fan operation when the fan can be controlled from more than one point.

History: Cr. Register, April, 1992, No. 436, eff. 5-1-92.

NR 811.50 Radionuclide removal. (1) RADIUM REMOVAL. (a) Radium can be removed by using standard water softening processes of zeolite softening and lime-soda softening. Other processes may also be used to remove radium as approved by the department on a case-by-case basis. Consideration shall be given to the fate of radium in the treatment process including waste disposal. Where applicable, disposal of treatment plant wastes containing radium shall normally be to a sanitary sewer or wastewater treatment plant.

(b) Radium removal processes shall be designed to provide a finished water with a radium content as close to 0 picocuries per liter as practical while maintaining a finished water that is not corrosive. The department shall determine allowable plant effluent water quality, including radium concentrations, based on the raw water quality and the treatment process proposed. If corrosive water is produced during the radium removal process, a method of corrosion control shall be provided.

(c) For systems using standard water softening treatment techniques for radium removal, a minimum of 4 consecutive quarters of finished water sampling for radium shall be required after the plant becomes operational to demonstrate treatment effectiveness. For other proposed radium removal treatment methods, the required routine radium content monitoring program shall be established by the department. The sampling shall be conducted under worst case conditions. Radium analyses shall be performed by a U.S. environmental protection agency certified laboratory. A copy of the analyses results shall be forwarded to the department. Water hardness monitoring equipment shall be provided when zeolite softening is to be employed to monitor for hardness breakthrough. Daily water hardness measurements shall be reported on the monthly operating report submitted to the department. Use of hardness monitoring to substitute for radium analyses shall only be allowed if demonstrated effective by simultaneous radium and hardness sampling over the first year of plant monitoring.

(d) Treatment for radium removal using standard water softening processes shall comply with the requirements of s. NR 811.52.

(e) Treatment using other than standard water softening processes shall be approved on a case-by-case basis using information obtained from department approved on-site pilot studies conducted on the water to be treated.

(f) Disposal of treatment plant waste shall comply with ss. NR 811.78 to 811.86.

(2) RADON REMOVAL. (a) Radon can be removed using aeration or pressurized granular activated carbon filters. Consideration shall be given to the gamma radiation and disposal concerns associated with the use of granular activated carbon filters.

(b) The design of radon removal equipment shall be based on a department approved on-site pilot study conducted on the water to be treated. The department may approve manufactured radon removal equipment without pilot study on a case-by-case basis if adequate treatment effectiveness can be demonstrated to the department.

(c) Aerators used for radon removal shall comply with ss. NR 811.42 and 811.48.

(d) Radon gas shall be vented to the atmosphere at an elevation and location to prevent elevated radon gas air concentrations in inhabitable areas.

(e) Granular activated carbon filters for radon removal shall comply with s. NR 811.48. An acceptable ultimate media disposal method shall be provided for carbon filters used for radon removal.

(f) A minimum of 4 consecutive quarters of finished water sampling for radon gas shall be required after the plant becomes operational to demonstrate treatment effectiveness. The sampling shall be conducted under worst case conditions. Radon gas analyses shall be performed by a U.S. environmental protection agency certified laboratory. A copy of the analyses results shall be forwarded to the department.

(3) URANIUM REMOVAL. (a) The department shall be contacted by the designer of any proposed uranium removal equipment prior to the final design of the equipment to allow for department input on design requirements. The design shall be based on information obtained from department approved on-site pilot studies conducted on the water to be treated. Consideration shall be given to the fate of uranium in the treatment process. Disposal of water treatment plant wastes containing uranium shall be in accordance with written department guidance. Where applicable, disposal of treatment plant wastes containing uranium shall be to a sanitary sewer or wastewater treatment plant as approved by the department. The discharged water treatment plant wastes and spent media shall be analyzed for radionuclide content as required by the department. The disposal of spent media containing residual radionuclides shall be as approved by the department.

(b) A minimum of 4 consecutive quarters of finished water sampling for uranium shall be required after the plant becomes operational to demonstrate treatment effectiveness. The sampling shall be conducted under worst case conditions. Uranium analyses shall be performed by a U.S. environmental protection agency certified laboratory. A copy of the analyses results shall be forwarded to the department.

(c) Disposal of treatment plant waste shall comply with ss. NR 811.78 to 811.86.

History: Cr. Register, April, 1992, No. 436, eff. 5-1-92.

NR 811.51 Sequestration. (1) SEQUESTRATION BY POLYPHOSPHATES. This process is suitable only for low concentrations of iron and manganese, generally 1.0 mg/l and 0.3 mg/l respectively, or less. Where phosphate treatment is used, chlorine residuals shall be maintained in the distribution system. In addition:

(a) Polyphosphates may not be applied ahead of iron and manganese removal treatment. The point of application shall be prior to any aeration or oxidation and as far upstream as practical from the chlorine application.

(b) Feed equipment shall conform to the requirements of subch. 7.

(c) Chemicals for new or existing installations shall meet the standards of N.S.F. 60.

(d) Stock phosphate solution shall be kept covered and disinfected by carrying an approximate 10 mg/l free chlorine residual.

(e) The total phosphate applied may not exceed 10 mg/l as PO_4.

(f) Where polyphosphate sequestration is practiced, appropriate phosphate testing equipment shall be provided.

(2) SEQUESTRATION BY SODIUM SILICATES. Sodium silicate sequestration of iron and manganese is appropriate only for groundwater supplies prior to air contact. On-site pilot tests are required to determine the suitability of sodium silicate for the particular water and the minimum feed needed. Rapid oxidation of the metal ions such as by chlorine or chlorine dioxide shall accompany or closely precede the sodium silicate addition. Injection of sodium silicate more than 15 seconds after oxidation may cause detectable loss of chemical efficiency. Dilution of feed solutions much below 5% silica as SiO_2 shall also be avoided for the same reason. The following apply:

(a) Sodium silicate addition is applicable to waters containing up to 2 mg/l of iron, manganese or a combination thereof.

(b) Chlorine residuals shall be maintained throughout the distribution system to prevent biological breakdown of the sequestered iron.

(c) The amount of silicate added shall be limited to 20 mg/l as SiO_2, but the amount of added and naturally occurring silicate may not exceed 60 mg/l as SiO_2.

(d) Feed equipment shall conform to the requirements of subch. 7.

(e) Sodium silicate may not be applied ahead of iron or manganese removal treatment.

(f) Liquid sodium silicate shall meet the standards of N.S.F. 60.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.52 Softening. The softening process selected shall be based upon the chemical qualities of the raw water, the desired finished water quality, the requirements for disposal of sludge or brine waste, the cost of plant and chemicals and plant location. The applicability of the process chosen shall be demonstrated and discussed in detail in the engineer's report. For very hard water, the sodium levels in cation exchange softened water shall be considered in selecting the treatment process. Following are requirements for specific processes:

(1) LIME–SODA PROCESS. The applicable design standards for lime–soda softening of groundwater are the same as those for conventional clarification–filtration surface water treatment plants, except that the minimum settling time may be reduced to 2 hours. Where softening is included in the surface water treatment process, the clarification criteria shall govern. In addition:

Note: See s. NR 811.43 for criteria pertaining to softening with solids contact units and s. NR 811.45 for filtration requirements.

(a) Mechanical sludge removal equipment shall be provided in the sedimentation basin.

(b) Determinations shall be made for the carbon dioxide content of the raw water.

Note: When concentrations exceed 10 mg/l, the economics of removal by aeration as opposed to removal with lime should be considered. See s. NR 811.42 for aeration requirements.

(c) Equipment for stabilization of water softened by the lime–soda process is required.

Note: See s. NR 811.53 for stabilization requirements.

(d) Provisions shall be included for proper disposal of softening sludges.

Note: See s. NR 811.84 for design requirements.

(e) The use of excess lime may not be substituted for chlorination or any other approved method of disinfection.

Note: See s. NR 811.44.

(2) ION EXCHANGE PROCESS. Iron, manganese or a combination of both in the oxidized state or unoxidized state may cause resin fouling in the ion exchange process. Pretreatment shall be required whenever the content of iron, manganese or a combination of both is one milligram per liter or more. In specific instances, the department may also require pretreatment where lesser amounts exist. In addition:

(a) The units shall be of pressure or gravity type, of either an upflow or downflow design, using automatic or manual regeneration. Automatic regeneration is suggested for small plants.

(b) The design capacity for hardness removal may not exceed 20,000 grains per cubic foot when resin is regenerated with 0.3 pounds of salt per kilograin of hardness removed.

(c) The depth of the exchange material may not be less than 3 feet.

(d) The rate of softening may not exceed 7 gallons per square foot per minute, and the backwash rate shall be 6 to 8 gallons per square foot per minute.

(e) The freeboard design shall be based upon the specific gravity of the media and the direction of water flow.

(f) The bottoms, strainer systems and support for the exchange materials shall conform to criteria provided for rapid rate gravity filters in s. NR 811.45.

(g) Facilities shall be included for even distribution of the brine over the entire surface of both upflow or downflow units. Backwash, rinse and air relief discharge pipes shall be installed in such a manner as to prevent back–siphonage.

(h) A bypass shall be provided around softening units to produce a blended water of desirable hardness. Meters shall be installed on the bypass line and on each softener unit. An automatic proportioning or regulating device and shut–off valve shall be provided on the bypass line. The department may require treatment of the bypassed water to obtain acceptable levels of iron or manganese in the finished water.

(i) Waters having 5 units or more of turbidity may not be applied directly to the cation exchange softener. Silica gel materials may not be used for waters having a pH above 8.4 or when iron is present. When the applied water contains a chlorine residual, the cation exchange material shall be a type that is not damaged by residual chlorine. Phenolic resin may not be used.

(j) Brine storage tanks shall conform to the following requirements:

1. The wet storage tank shall be designed to hold at least 1 $^1/_2$ times the volume of salt delivered to permit refill before the tank is completely empty. The volume of both salt and brine storage to be provided depends upon the size of the plant, the proximity and assuredness of the salt source, and the method of delivery.

2. The storage tank shall be isolated from possible sources of contamination, specifically:

a. It shall be properly covered and equipped with manholes having overlapping watertight covers to prevent entry of surface runoff;

b. Overflows and vents shall be designed in accordance with s. NR 811.58 (4) and (6), respectively;

c. The water for filling the tank shall be distributed over the entire surface of the tank by pipes at least 2 pipe diameters above the maximum liquid level in the tank or be protected from back–siphonage;

d. The underdrain collection system shall be covered with a screen or perforated plate to allow brine but not salt to pass through.

3. A sampling tap shall be provided on the brine discharge line in order that the concentration of brine can be determined. A suitable means for measuring the volume of brine used for regeneration shall be provided.

Note: It is recommended that the interior concrete surfaces of brine storage tanks be painted with a salt–resistant sealing compound or paint meeting N.S.F. 61 standards, to prevent deterioration.

(k) The requirements for brine wastes are found in s. NR 811.82.

(L) Smooth–end sampling taps shall be provided for control purposes. Taps shall be located on each raw water source, each treatment unit influent and each treatment unit effluent. Testing equipment shall be provided to adequately control the treatment process at all plants.

(m) Water from ion exchange treatment plants shall be stabilized as required in s. NR 811.53 (4), except where it can be shown that the treated water will be non–corrosive.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.53 Stabilization. Water that is unstable to the extent of causing corrosion or deposition problems in the distribution system, whether a result of natural causes or to treatment given the water, shall be stabilized. The following standards shall apply:

(1) CARBON DIOXIDE ADDITION. (a) Recarbonation chamber design shall provide:

1. A total detention time of 20 minutes.

2. Two compartments, with a depth that will provide a diffuser submergence not less than 7.5 feet nor greater than recommended by the manufacturer and as follows:

a. A mixing compartment having a detention time of at least 3 minutes.

b. A reaction compartment.

(b) The design shall prevent carbon dioxide from entering the plant from the recarbonation and reaction chamber.

(c) Plants generating carbon dioxide from combustion shall have open top recarbonation tanks in order to dissipate carbon monoxide gas.

(d) Provisions shall be made for draining the recarbonation basin and removing sludge.

(2) PHOSPHATES. Phosphates may be used for sequestering calcium in lime softened water, corrosion control and in conjunction with alkali feed following ion exchange softening. When used:

(a) Feed equipment shall conform to requirements in ss. NR 811.38 to 811.40;

(b) Phosphate chemicals shall meet the standards of N.S.F. 60;

(c) Stock phosphate solution shall be kept covered and disinfected by carrying an approximate 10 mg/l chlorine residual. Phosphate solutions having a pH of 2.0 or less may be exempt from this requirement by the department.

(d) Facilities shall be included to maintain satisfactory chlorine residuals as indicated in s. NR 811.23;

(e) The total phosphate applied may not exceed 10 mg/l as PO_4;

(3) SPLIT TREATMENT. If approved by the department, a lime–soda water treatment plant may be designed using 'split treatment' in which raw water is blended with lime–treated water to partially stabilize the water. Treatment plants designed to utilize 'split treatment' shall contain facilities for further stabilization by other methods.

(4) ALKALI FEED. An alkali feeder shall be provided for all ion exchange water softening plants to provide stable water unless the effluent water is shown to be non–corrosive. Other waters may also be corrosive and require pH adjustment. The chemical shall be adequately mixed and the point of application located such that any deposition in the piping is minimized. The piping shall be accessible for cleaning or replacement. Equipment for monitoring pH shall be provided.

(5) CARBON DIOXIDE REDUCTION BY AERATION. The carbon dioxide content of an aggressive water may be reduced by aeration. Aeration devices shall conform to s. NR 811.42.

(6) OTHER TREATMENT. Other treatment for controlling corrosive waters by the use of sodium silicate and sodium bicarbonate may be used where necessary. Any proprietary compound shall receive the specific approval of the department before use. Chemical feeders shall be as required in subch. VII.

(7) CONTROL. Laboratory equipment shall be provided for determining the effectiveness of stabilization treatment.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.54 Taste and odor control. Waterworks which are designed and constructed to provide taste and odor control shall comply with any requirements stated for the following applicable methods:

(1) CHLORINATION. Chlorination is effective for the removal of some objectionable odors. Adequate contact time shall be provided to complete the chemical reactions involved. Excessive potential trihalomethane or other disinfection by–product production through this process is to be avoided by adequate bench–scale testing prior to design.

(2) CHLORINE DIOXIDE. Chlorine dioxide may be used in the treatment of any taste or odor which is treatable by an oxidizing compound. Provision shall be made for proper storage and handling of sodium chlorite to eliminate any danger of explosion.

(3) POWDERED ACTIVATED CARBON. (a) Powdered activated carbon may be added prior to coagulation to provide maximum contact time. Although facilities to allow the addition at several alternate points is recommended, in no case may carbon be added near the point of chlorine application.

(b) The carbon shall be added as a premixed slurry or by means of a dry–feed machine if the carbon is properly 'wetted'.

(c) Continuous agitation or resuspension equipment shall be provided to keep the carbon from depositing in the mixing chamber/slurry storage tank.

(d) Dust control shall be provided.

(e) The required dosage of carbon in a water treatment plant depends upon the tastes and odors involved. Provisions shall be made for adding sufficient amounts to meet peak demands.

(f) Powdered activated carbon shall be handled as a potentially combustible material. It shall be stored in a building or compartment as nearly fireproof as possible. Other chemicals may not be stored in the same compartment. A separate room shall be provided for carbon feed installations. Carbon feeder rooms shall be equipped with explosion–proof electrical outlets, lights and motors.

(4) GRANULAR ACTIVATED CARBON. The requirements for granulated activated carbon are in s. NR 811.45.

(5) COPPER SULPHATE AND OTHER COPPER COMPOUNDS. Continuous or periodic treatment of water with copper compounds to kill algae or other growths shall be controlled to prevent a level in excess of 1.0 mg/l as copper in the plant effluent or distribution system. Provisions shall be made for uniform distribution of the chemical.

(6) AERATION. The requirements for aeration are in s. NR 811.42.

(7) POTASSIUM PERMANGANATE. Application of potassium permanganate may be approved by the department if the treatment will be controlled to insure that no residual color will be present in the finished water.

(8) OZONE. Ozonation may be used as a means of taste and odor control. Adequate contact time shall be provided to complete the chemical reactions involved. Ozone is generally more desirable for treating water with high threshold odors. Section NR 811.49 has the requirements for ozonation.

(9) OTHER METHODS. The decision to use any other methods of taste and odor control shall be made only after laboratory or pilot plant tests or both and approval by the department.

(10) FLEXIBILITY. Plants treating water known to have taste and odor problems shall be provided with equipment and multiple chemical addition points to provide several alternative control processes.

Note: Refer to subch. VII, beginning with s. NR 811.39 for requirements for the storage, handling and application of chemicals in treating surface waters.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

Subchapter IX —Hydro–Pneumatic Tanks

NR 811.55 General. Hydro–pneumatic, or pressure tanks, may be approved in the situations described in s. NR 811.56 (2). The following requirements shall be met:

(1) The tanks shall be completely housed, or earth–mounded with one end projecting into an operating house to prevent freezing. A tank may be installed below grade provided one end is exposed in a basement or manhole. If the tank is installed below grade, all electrical controls and air release valves and any appurtenances which may permit water flooding the basement or manhole and contaminating the water supply shall be extended to at least 24″ above grade and terminate in a U–bend and be screened with 24 mesh noncorrodible screen where appropriate.

(2) The tanks shall have bypass piping to permit operation of the system while the tank is being repaired or painted.

(3) Each tank not equipped with a bladder or diaphragm to separate the air and water shall have an access manhole, a drain and control equipment consisting of a pressure gauge, a pressure

relief valve, a water sight glass, an automatic air blow–off and pressure or probe operated start–stop controls for the pumps.

(4) Each hydro–pneumatic tank equipped with a diaphragm or bladder shall be equipped with an air inlet. A means for removing individual tanks from service, a pressure relief valve and a pressure–operated start up control for the well pump shall also be provided.

(5) The gross volume, in gallons, of the hydro–pneumatic tank or combination of tanks, shall be at least 10 times the capacity of the largest pump, rated in gallons per minute.

(6) An air compressor or other suitable means shall be provided to add air to all tanks not equipped with a bladder or diaphragm.

Note: It is recommended that bladder or diaphragm tanks be provided with a means to add air to the tank.

(7) Each tank shall be identified by stamping showing the manufacturer's name, a serial number, the allowable working pressure and the year fabricated.

(8) The tank shall have a ¼–inch minimum side wall and head wall thickness.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

Subchapter X —Storage Facilities

NR 811.56 Volume and pressure. (1) VOLUME REQUIREMENTS. A sufficient quantity of water, as determined from engineering studies, shall be maintained in elevated storage when only one pumping unit to the distribution system is available to serve the water system. This shall be at least an average–day supply under normal operating conditions. When more than one distribution pump is available, the storage shall be in accordance with standard engineering practice. Standard engineering practice is based upon an engineering review of existing and future water supply needs including, but not limited to: type of service and population served; average day, maximum day, peak hour and fire flow demands; water source quality, availability and treatment, pump capacities, auxiliary power, storage capacity, water distribution and costs. The requirement for elevated storage may be waived by the department in cases where the system is designed to serve less than 50 homes; where it is not economically feasible to provide elevated storage; where elevated storage facilities are proposed for a later development phase; or where service is proposed for domestic use only.

(2) PRESSURE REQUIREMENTS. The storage facilities shall be designed to meet the minimum and maximum pressure requirements specified in s. NR 811.60 (1) and, in conjunction with distribution system design, provide flows as specified in s. NR 811.63 (3). A hydro–pneumatic tank, booster pumping facilities or other reliable means shall be provided to maintain system pressure when a gravity storage reservoir is not available.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.57 Location. (1) Storage facilities may not be located within a floodway. If it is necessary to locate a reservoir in a floodplain outside of the floodway the bottom including sumps shall be a minimum of 2 feet above the regional flood elevation as defined in ch. NR 116. All projects shall conform to the requirements of that chapter.

(2) The area surrounding structures shall be graded in a manner that will prevent surface water from standing within 50 feet of the structure.

(3) Storage facilities shall be located in an area accessible during the entire year. Where necessary, road improvements shall be installed to provide year round access. Storage facilities and access roads shall be located on property owned by the water supply owner or for which easements have been obtained.

(4) The bottoms and sumps of ground level reservoirs and standpipes shall normally be placed at or above the normal ground surface. Where the bottom or sump is permitted by the department to be below the normal ground surface, it shall be placed a minimum of 2 feet above the groundwater table. Borings shall be made to determine groundwater elevations where the information does not exist. Sewers, drains, fuel storage tanks, standing water and similar sources of contamination shall be kept at least 50 feet from the reservoir. Water class pipe meeting the requirements of s. NR 811.62 and pressure tested in place to meet current A.W.W.A. C600 specifications may be used for gravity and forcemain sewers at lesser separations with the prior approval of the department.

(5) The top of a ground level reservoir may not be less than 2 feet above normal ground surface.

(a) A higher exposed elevation shall be required by the department in cases where high groundwater, poor surface drainage or tight soils are encountered which will deter subsurface drainage or where necessary to provide positive pressures for pump intake or discharge lines in accordance with s. NR 811.38.

Note: It is recommended that no more than one–half of the reservoir depth be constructed below grade.

(b) Clearwells constructed under filters may be excepted from the 2 foot requirement when the total design gives the same protection.

(c) In addition to meeting the requirements of pars. (a) and (b), the top of any earth covered reservoir shall be covered with a flexible waterproof membrane. The minimum membrane thickness shall be 0.060 inches. Department approval of the specific membrane proposed is required. Protective boards shall be placed over the membrane before applying the earth cover when recommended by the membrane manufacturer. Bentonite panel membranes may not be used to meet the waterproof membrane requirement. Earth covering of reservoirs shall be avoided where possible.

(6) The top of any storage structure shall have a minimum slope of 0.015 feet per foot to facilitate drainage.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92; **correction in (5) (a) made under s. 13.93 (2m) (b) 7., Stats., Register, December, 1998, No. 516.**

NR 811.58 Construction details. (1) MATERIALS. The materials and designs used for finished water storage structures shall provide stability and durability as well as protect the quality of the stored water. Unless the design engineer can justify the use of other materials, only steel or concrete will be approved for use in a water storage facility. Structures shall be constructed in accordance with the current A.W.W.A. standards concerning steel or concrete tanks, standpipes, reservoirs and elevated tanks wherever they are applicable.

(2) PROTECTION. All new finished water storage structures shall have watertight roofs or covers which exclude surface water, rain, snow, birds, animals, insects and dust. Locks on access manholes, fences and ladder cage bottoms and any other necessary measures shall be provided to prevent trespassing, vandalism and sabotage.

(3) DRAINS. Piping used to drain water from a water storage structure shall discharge to the ground surface. The drain piping shall be brought down to within 12 inches of the ground surface and discharged with a free air break over a drainage inlet structure, splash pad or riprap. Discharge with a free air break over a storm sewer manhole or through a valved connection to the overflow piping may be approved on a case–by–case basis by the department. Negative impacts to the environment from the discharge of drainage water shall be prevented. A drain may not be directly connected to a sanitary sewer.

(4) OVERFLOW. The overflow pipe of a water storage structure shall be brought down to within 12 inches of the ground surface and discharge with a free air break over a drainage inlet structure, splash pad or riprap. Discharge with a free air break over a storm sewer manhole may be approved on a case–by case basis by the department. Overflows may not be directly connected to a sanitary sewer. Negative impacts to the environment from the discharge of overflow water shall be prevented. In addition:

(a) When an internal overflow pipe is used on elevated tanks, it shall be located in the access tube. For vertical drops on other types of storage facilities, the overflow pipe shall be located on the outside of the structure.

(b) The overflow of an elevated tank or stand pipe shall be provided with a 4 mesh noncorrodible screen.

(c) The overflow of a ground level structure shall terminate a minimum of 12 inches above normal or graded ground surface, and the pipe shall open downward over a drainage inlet structure, splash pad or riprap. The overflow shall be screened with 24 mesh noncorrodible screen installed within the pipe at a location least susceptible to damage by vandalism.

(d) The overflow pipe shall be of sufficient diameter to permit wasting water in excess of the maximum filling rate.

(5) INLET-OUTLET PIPING. Inlet and outlet piping from a storage structure shall be under positive pressure at all times wherever practical and in conformance with s. NR 811.38. Piping shall be sized to accommodate design fill and removal rates including considerations for future improvements.

(6) BYPASS PIPING. If the water system design is such that all water passes through one ground reservoir, there shall be bypass piping from the well pumps to the high lift pumps to allow the reservoir to be taken out of service for cleaning and maintenance. This requirement may be waived where the well pumps may provide sufficient volume and pressure directly to the distribution system, where the well pumps and high lift pumps are greatly different in capacity, or where the reservoir is divided into multiple cells which can be independently removed from service.

(7) ACCESS. Finished water storage structures shall be designed with convenient access for cleaning and maintenance. Manholes above the waterline shall be:

(a) Framed at least 4 inches above the surface of the roof at the opening on elevated tanks, standpipes and reservoirs covered by inhabitable structures. On ground level structures, manholes shall be elevated no less than 24 inches above the top or covering sod.

(b) Fitted with a solid watertight cover which overlaps the framed opening and extends down around the frame at least 2 inches.

(c) Locked at all times except when being used by authorized personnel.

(8) VENTS. Finished water storage structures shall be vented to the atmosphere. Open construction between the sidewall and roof is not permissible. Vents shall:

(a) Prevent the entrance of surface water, rain and snow as applicable;

(b) Exclude birds and animals;

(c) Exclude insects and dust to the extent this can be done while providing effective venting;

(d) Terminate, on elevated tanks and standpipes, in a "U"–bend or mushroom cap constructed with the opening at least 4 inches above the roof and covered with 4 to 24–mesh noncorrodible screen installed within the pipe or cap at a location protected from the environment;

(e) Terminate, on ground level structures, in a "U"–bend or mushroom cap constructed with the opening 24 to 36 inches above the roof or sod and covered with 24 mesh noncorrodible screen installed within the pipe or cap at a location least susceptible to vandalism;

(f) Be sized to allow an air flow consistent with maximum water inflow and outflow rates.

(9) SILT STOP. The discharge pipes from all reservoirs shall be located in a manner that will prevent the flow of sediment into the distribution system. Removable silt stops shall be required where feasible.

(10) ROOF AND SIDEWALL. The roof and sidewalls of all structures shall be watertight with no openings except vents, manholes, overflows, risers, drains, pump mountings, control ports or piping for inflow and outflow. In addition:

(a) Any pipes running through the roof or sidewall of a finished water storage structure shall be sealed sanitarily. Openings for metal tanks shall be welded or properly gasketed. Pipes running through openings in a concrete structure shall be connected to standard wall castings which were poured in place during the formation of the structure; these wall castings shall have seepage rings embedded in the concrete.

(b) Openings in a storage structure roof or top, designed to accommodate control apparatus, pump columns and other equipment, shall be provided with minimum 4–inch high curbing and sleeved with proper additional shielding to prevent the access of surface or floor drainage water to the structure.

(c) Valves and controls shall be located outside the storage structure so that valve stems and similar projections do not pass through the roof or top of the reservoir unless the department determines that this requirement need not be met to fulfill the other requirements of this chapter. Floor drain piping, electrical conduits, water service piping and chemical feed piping may be allowed to be encased in a concrete reservoir roof. Other appurtenances may not be encased in a concrete reservoir roof.

(11) DRAINAGE FOR ROOF OR COVER. The roof or cover of the storage structure shall be well drained, but downspout pipes may not enter or pass through the reservoir. Where parapets or similar construction which would hold water and snow on the roof are constructed, adequate waterproofing and drainage shall be provided.

(12) SAFETY. The safety of employes shall be considered in the design of the storage structure. The following shall apply:

(a) Ladders, ladder cages or safety climbing devices, balcony railings, landing platforms, guardrails and safe locations of entrance hatches shall be provided where applicable.

(b) On elevated tanks where persons transfer from the access tube to the water compartment railings, handholds and landing platforms shall be provided where applicable.

(c) On elevated tanks with riser pipes over 8 inches in diameter, protective bars over the riser openings inside the tank shall be provided.

(d) Storage structures shall be constructed to meet applicable local, state, including applicable portions of ch. ILHR 32, and federal (O.S.H.A.) codes for specific safety requirements.

(e) Confined space entry should be in accordance with the requirements of ch. Comm 31.

(13) FREEZING. All finished water storage structures and their appurtenances, especially riser pipes, overflows and vents, shall be designed to minimize freezing which would interfere with proper operation. Riser pipes shall be insulated where possible. Recirculation pumps and air bubbler systems installed to minimize freezing shall be approved by the department in writing prior to installation.

(14) INTERNAL CATWALK. Every catwalk over a storage structure containing finished water or water to become finished water shall have a solid floor with raised edges to prevent shoe scrapings, dirt and other contaminants from falling into the water.

(15) PAINTING AND CATHODIC PROTECTION. Metal surfaces shall be protected by paints or other protective coatings. The paints or coatings may be accompanied by cathodic protection devices. Paint systems and application procedures shall be consistent with current A.W.W.A. standard D102, dated January 28, 1978, and be approved by the department in accordance with s. NR 811.07 (4) (f). Cathodic protection shall be designed and installed by competent technical personnel. A copy of the cited standards are available for inspection at the office of the department of natural resources, the secretary of state's office and the office of the revisor of statutes, and may be obtained for personal

use from the American Water Works Association, 6666 West Quincy Ave., Denver, Colorado 80235.

(16) MISCELLANEOUS. (a) A smooth end sampling tap and a threaded tap for chlorination purposes shall be installed in the connecting main or riser pipes of elevated tanks, standpipes and reservoirs if design permits.

(b) Valve vaults installed at the base of storage facilities shall be protected against freezing and provided with floor drainage facilities discharging to the ground surface by gravity if possible or else by a floor sump with a sump pump permanently installed. If constructed outside of the storage facility, the entrance to the vault shall be locked to prevent unauthorized access.

(17) DISINFECTION. Finished water storage structures shall be disinfected before being put into service or before being returned to service following maintenance or repair work to the water storage structure. Detailed procedures for disinfection, equivalent to those outlined in the current A.W.W.A. standard C652, dated January 26, 1986, for disinfection of water storage facilities, shall be written into the specifications by the design engineer. Disinfection and bacteriological sampling requirements shall meet the requirements of s. NR 811.07 (3). Detailed procedures for bacteriological sampling shall be written into the specifications by the design engineer. Consideration shall be given to the amount of chlorine in any water wasted from a storage structure to the environment to prevent harmful impacts. Dechlorination prior to discharge may be necessary in some cases to prevent harmful impacts. Water wasted to surface water may not contain any substances in concentrations that adversely affect the water as determined under chs. NR 105 and 106. For chlorine, no total residual chlorine may be measured in a water being discharged to a surface water. A copy of the cited standards are available for inspection at the office of the department of natural resources, the secretary of state's office and the office of the revisor of statutes, and may be obtained for personal use from the American Water Works Association, 6666 West Quincy Ave., Denver, Colorado 80235.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.59 Plant storage. The applicable design standards of ss. NR 811.57 and 811.58 shall be followed for plant storage. In addition:

(1) WASHWATER TANKS. Washwater tanks shall be sized, in conjunction with available pump units and finished water storage to provide the backwash water required by s. NR 811.45 (1) (j). Consideration shall be given to the possibility of having to wash more than one filter at a time, or several filters in succession.

(2) CLEARWELL. (a) Clearwell storage shall be sized, in conjunction with distribution system storage, to relieve the filters from the strain of fluctuations in water use or peak demands.

(b) When finished water storage is used to provide proper contact time for disinfection, documentation, possibly including but not limited to, dye testing, shall be provided to assure adequate detention time under all operating conditions. The installation of baffle walls or additional reservoir capacity may be required where necessary to prevent short circuiting and to obtain adequate contact times.

(3) ADJACENT COMPARTMENTS. Finished water may not be stored or conveyed in a compartment adjacent to unsafe water when the 2 compartments are only separated by a single wall. This requirement may be waived for backwash water holding compartments meeting potable water reservoir construction on a case–by–case basis.

(4) BASINS AND WET–WELLS. Receiving basins, pump cans, and pump wet–wells for finished water or water to become finished water shall be designed as finished water storage structures.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.60 Distribution system storage. The applicable design standards of ss. NR 811.56 to 811.86 shall be followed for distribution storage. In addition:

(1) PRESSURE VARIATION. The maximum variation between high and low levels in storage structures which float on a distribution system may not exceed 30 feet during normal usage. The minimum and maximum pressure in service areas shall be 35 and 100 psi respectively at ground level. In areas where a minimum of 35 psi cannot be maintained, it shall be necessary to establish a high pressure zone in the distribution system by means of booster pumps and related facilities or pressure boosting systems on individual service lines. The use of individual service line booster pumps shall be limited to the extent possible. When static pressures exceed 100 psi, pressure reducing devices may be required on mains in the distribution system.

Note: Section Comm 82.40 (7) (d) 2. a. requires a pressure reducing device to be installed to protect individual services when the incoming pressure exceeds 80 psig.

(2) DRAINAGE. The design shall allow draining of storage facilities for cleaning or maintenance while maintaining adequate positive pressure in the distribution system. The drains shall discharge to the ground surface as required in s. NR 811.58 (3).

(3) LEVEL CONTROLS. Adequate controls shall be provided to maintain required levels in distribution system storage structures. Level indicating devices shall be provided at a central location. Combination indicating and recording devices are recommended.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

Subchapter XI —Distribution Systems

NR 811.61 Applicability. This subchapter covers water distribution systems for community water systems which are to be located in street rights–of–way or easements. Other piping systems shall be constructed in accordance with the requirements of ch. Comm 82.

Note: See s. NR 811.24 for ownership requirements.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92; correction made under s. 13.93 (2m) (b) 7., Stats., Register, December, 1998, No. 516.

NR 811.62 Materials. All pipe used for water main installations shall be cast iron, ductile iron, steel, reinforced concrete, polyvinyl chloride, copper or materials specially approved by the department for restricted or experimental use, such as polyethylene. Where a restricted or experimental use approval is issued, the department may require special precautions until the time a satisfactory use record has been established. Pipes, joints, fittings, valves and fire hydrants shall have been manufactured in conformity with the latest standards issued by the A.W.W.A. and shall be approved by the department. All pipe shall be minimum A.W.W.A. pressure class 150 except as approved by the department for special low pressure applications. Any pipe, pipe fittings, solder or flux used in the installation or repair of any public water system shall be lead free. Lead free is defined, with respect to solders and flux, as containing not more than 0.2% lead and, with respect to pipes and pipe fittings, as containing not more than 8.0% lead. Repairs to lead joint pipes shall be made using alternative methods. For ductile iron pipe, the use of lead tipped gaskets is prohibited. For polyvinyl chloride pipe, only joints with elastomeric gaskets are acceptable. A copy of the A.W.W.A. standards are available for inspection at the office of the department of natural resources, the secretary of state's office and the office of the revisor of statutes, and may be obtained for personal use from the American Water Works Association, 6666 West Quincy Avenue, Denver, Colorado 80235.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.63 Water main design. (1) PRESSURE. All water mains, including those not designed to provide fire protection, shall be sized after a hydraulic analysis based on flow demands and pressure requirements. The system shall be designed and operated to maintain a minimum residual pressure of 20 psi at ground level at all points in the distribution system under all conditions of flow. The normal static pressure in the distribution system shall be no less than 35 psi at ground level.

(2) DIAMETER. The minimum diameter of water mains to provide water for fire protection and to serve fire hydrants shall be 6 inches. Larger mains shall be required if necessary to allow the required fire flow while maintaining a minimum residual pressure of 20 psi within the main.

(3) FIRE PROTECTION. The minimum flow requirement for water mains serving fire hydrants is 500 gpm at 20 psi residual pressure.

Note: It is recommended that the actual fire flow design be based on the capacity of any fire pumper which may be connected to the water main and the type of services or buildings to be protected.

(4) SMALL MAINS. Any departure from minimum requirements shall be justified by hydraulic analysis and future water use, and will be considered only in special circumstances. The main sizing may be done by a fixture unit determination.

Note: See the requirements of ch. Comm 82 for guidance in sizing mains according to fixture units to be served.

(5) DEAD ENDS. Dead ends shall be minimized by looping mains whenever possible. Where dead end mains occur, they shall terminate with a fire hydrant, if flow and pressure are sufficient, or with an approved flushing hydrant or blow–off for flushing purposes. Flushing devices shall be sized to provide a minimum velocity of 2.5 feet per second in the water main being flushed. Flushing devices on dead end mains shall be downstream of all services. No flushing device shall be directly connected to any sewer.

Note: Refer to A.W.W.A. standard C651–86 for required flows and openings to flush pipelines.

(6) VALVING. Sufficient valves shall be provided on water mains so that inconvenience or sanitary hazard to water users will be minimized during maintenance and construction. Valves shall be located at not more than 500–foot intervals in commercial districts and at no more than one block or 800–foot intervals in other districts.

(7) FRICTION COEFFICIENTS. Unless other values are specially approved by the department, the following "C" values, using the Hazen–Williams formula, shall be used for checking the hydraulic characteristics of new water mains shown on plans and specifications submitted for review:

Cement–lined iron	C = 120
Non–cement lined iron	C = 100
PVC	C = 140

The "C" value of existing water mains is likely to be substantially less than that for new pipe and shall be considered in distribution system analysis.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.64 Hydrants. (1) LOCATION. Hydrants shall be provided at each street intersection and at intermediate points between intersections as recommended by the insurance services office. Generally hydrant spacing may range from 350 to 600 feet depending on the area being served.

(2) SIZE. Fire hydrants shall have a bottom valve size of at least 5 inches, one 4½–inch pumper nozzle, and 2 2½–inch nozzles unless the waterworks has established other hydrant criteria which are in accordance with A.W.W.A. standards and are approved by the department. The connecting main between the supply main and the hydrants shall be a minimum of 6 inches in diameter.

(3) RESTRICTIONS. Fire hydrants may not be installed on proposed water mains which will not have minimum flow and pressure as required in s. NR 811.63 (3). The department may approve the installation of hydrants if system improvements which will make at least 500 gpm available at 20 psi are planned for construction within one year following construction of the proposed improvements. If the exception is granted, the hydrants shall be color coded or tagged and the fire chief notified in writing that fire department pumpers may not be connected to the hydrants until the necessary additional improvements are made and fire flow tests have shown that greater than minimum flow and pressure are available.

(4) DRAINS. Hydrant drains may not be connected to, or located within 8 feet of sanitary sewers or storm sewer inlets. Where groundwater rises above the drain port, hydrant drain ports shall be plugged prior to installation and hydrant barrels shall be pumped dry during freezing weather. Where hydrant drain ports are not plugged, a gravel pocket or dry well shall be provided unless the department finds that the natural earth will provide adequate drainage.

(5) MISCELLANEOUS. Auxiliary valves shall be installed in hydrant leads off transmission mains and mains in commercial districts.

Note: The department recommends that auxiliary valves be installed in all hydrant leads. Also, hydrants of the type that remain closed when the barrels are broken off are recommended.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.65 Air–relief facilities and valve and meter chambers. (1) AIR–RELIEF FACILITIES. Water mains shall, where possible, be laid to avoid high points at which air can accumulate. When high points cannot be avoided, measures shall be taken to remove the air when the main is initially filled with water. Automatic air–relief valves may not be used in situations where flooding of the manhole or chamber may occur. The open end of an air–relief pipe shall be extended to the top of a manhole or chamber and have a screened, downward facing elbow.

(2) CHAMBERS. Chambers, pits and manholes containing valves, blow–offs, meters or other such appurtenances to a distribution system may not be connected directly to any storm drain or sanitary sewer, nor shall any blow–offs or air–relief valves be connected directly to any sewer. Chambers shall be drained to absorption pits underground or to the ground surface where they are not subject to flooding by surface water.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.66 Installation of mains. (1) Installation of mains shall be in accordance with A.W.W.A. standards or manufacturer's recommended installation procedures. Copies of the A.W.W.A. standards are available for inspection at the office of the department of natural resources, the secretary of state's office and the office of the revisor of statutes, and may be obtained for personal use from the American Water Works Association, 6666 West Quincy Ave., Denver, Colorado 80235.

(2) The specifications for installation of mains shall include provisions for the following:

(a) *Bedding.* Continuous and uniform bedding shall be provided in the trench for all buried pipe. Backfill material shall be tamped in layers around the pipe and to a sufficient height above the pipe to adequately support and protect the pipe.

(b) *Stone removal.* Stones found in the trench shall be removed for a depth of at least 6 inches below the bottom of the pipe.

(c) *Testing.* Pressure testing of the installed pipe, including measurement of leakage and testing for electrical conductivity shall be conducted, where appropriate. Pressure and leakage testing shall be in accordance with the latest edition of A.W.W.A. Standard C600.

(d) *Disinfection.* All new, cleaned or repaired water mains shall be disinfected in accordance with A.W.W.A. Standard C651 and s. NR 811.07 (3). The specifications shall include detailed procedures for the adequate flushing, disinfection and microbiological testing of all water mains.

(e) *Cover.* Sufficient earth or other suitable cover shall be provided over mains to prevent freezing. A minimum cover of 5 to 7 feet is required unless determined by the department to be unnec-

essary in specific cases. Insulation may be required at some installations to prevent freezing.

(f) *Blocking.* All tees, bends, plugs and hydrants shall be provided with reaction backing, tie rods or joints designed to prevent movement.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92; correction in (2) (d) made under s. 13.93 (2m) (b) 7., Stats., Register, December, 1998, No. 516.

NR 811.67 Separation of water mains and sewers. **(1)** GENERAL. The following factors shall be considered in planning separation of mains and sewers: materials and type of joints for water and sewer pipes, soil conditions, service and branch connections into the water main and sewer line, compensating variations in the horizontal and vertical separations, space for repair, and alterations of water and sewer pipes.

(2) HORIZONTAL SEPARATION. Water mains shall be laid at least 8 feet horizontally from any existing or proposed sanitary or storm sewer. The distance shall be measured center to center. In cases where it is not practical to maintain an 8–foot separation, the department may allow deviation on a case–by–case basis, if supported by data from the design engineer. Deviation may allow installation of the water main closer to a sewer, provided that:

(a) The bottom of the water main is at least 18 inches above the top of the sewer and the minimum horizontal separation is 3 feet measured edge to edge.

Note: See Figure 3.

(b) A profile of the rock surface as determined from exploration is shown on the plan when high bedrock is the reason for the variance from the 8–foot separation.

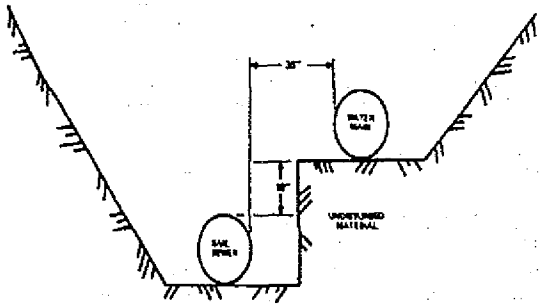
(3) VERTICAL SEPARATION. Whenever water mains cross over sewers, the water main shall be laid at such an elevation that the bottom of the water main is at least 6 inches above the top of the sewer. Whenever water mains cross under sewers, a minimum vertical separation of 18 inches shall be maintained between the top of the water main and the bottom of the sewer. At crossings, one full length of water pipe shall be centered on the sewer so that both joints will be as far from the sewer as possible. Special structural support for the water and sewer pipes may be required by the department after a determination that added support is necessary to meet the requirements of this chapter.

(4) EXCEPTION. When it is impossible to obtain the proper horizontal and vertical separation as specified in subs. (2) and (3), a gravity sanitary sewer shall be constructed of materials and with joints that are equivalent to water main standards of construction and pressure tested to assure water tightness. When the 8–foot separation distance cannot be provided for storm sewers, the horizontal and vertical separation shall be as great as practicable. The department shall specifically approve any variance from the requirements in subs. (2) and (3).

(5) FORCE MAINS. No deviation from the 8–foot separation may be granted for sanitary sewer force main installations unless the requirement in sub. (2) (a) is met.

(6) SEWER MANHOLES. No water pipe may pass through or come into contact with any part of a sewer manhole.

FIGURE NO. 3



COMMON TRENCH INSTALLATION PERMITTED IN SPECIAL CASES FOR WATER MAIN AND SANITARY SEWER.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.68 Separation of water mains and other contamination sources. **(1)** Proposed water mains shall be adequately separated from any potential source of contamination. The following minimum horizontal separation distances shall be maintained:

(a) Eight feet between a water main and a septic tank, septic tank drainfield, lift station or grave site.

(b) Twenty five feet between a water main and a buried fuel tank.

(c) Fifty feet between a water main and a sanitary landfill.

(2) Water mains may not pass through landfills.

(3) Any water main passing through contaminated soils, or contaminated groundwater may be approved only on a case–by–case basis. Pipe and joint materials shall be resistant to the contamination encountered. The department shall be contacted for specific pipe, joint and other requirements.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.69 Surface water crossings. Surface water crossings, whether over or under water, present special problems. For this reason, the department shall be consulted before final plans are prepared. The following are requirements:

(1) ABOVE-WATER CROSSINGS. The pipe shall be adequately supported and anchored, protected from damage and freezing, and accessible for repair or replacement. A means to accommodate bridge expansion shall be provided to the water main if the corresponding bridge has expansion joints.

(2) UNDERWATER CROSSINGS. A minimum cover of 2 feet shall be provided over the pipe. When crossing water courses which are greater than 15 feet in width, the following shall be provided:

(a) The pipe shall be of special construction, having flexible, watertight joints. Polyethylene pipe may be an acceptable alternative on a case–by–case basis.

(b) Valves shall be provided at both ends of water crossings so that the section can be isolated for testing or repair; the valves shall be easily accessible, and not subject to flooding; and the valve closest to the supply source shall be in a manhole. Permanent taps shall be made on the pipe within the manhole on either side of the valve to allow insertion of a small water meter to determine leakage during system pressure testing.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.70 Common casing crossings. In some cases such as highway crossings, it becomes desirable due to extremely high construction costs to install water mains and sanitary sewers within a common casing. The following requirements apply:

(1) Any sewers shall be constructed of water main materials and pressure and leakage tested in accordance with A.W.W.A. Standard C600.

(2) The water main shall be located above the sanitary sewer and be adequately supported.

(3) A vertical separation of 6 inches shall be maintained between the bottom of the water main and the top of the sanitary sewer.

(4) Normal separations shall be provided as close as possible to the ends of the casing.

(5) If the sewer is a force main, it shall be installed within an intermediate casing within the larger casing.

(6) The remaining space in the casing may be filled if desired.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.71 Water loading stations. Water loading stations present special problems since the fill line may be used for filling both potable water vessels and other tanks or contaminated vessels. To prevent contamination of both the public supply and potable water vessels being filled, the following principles shall be met in the design of water loading stations:

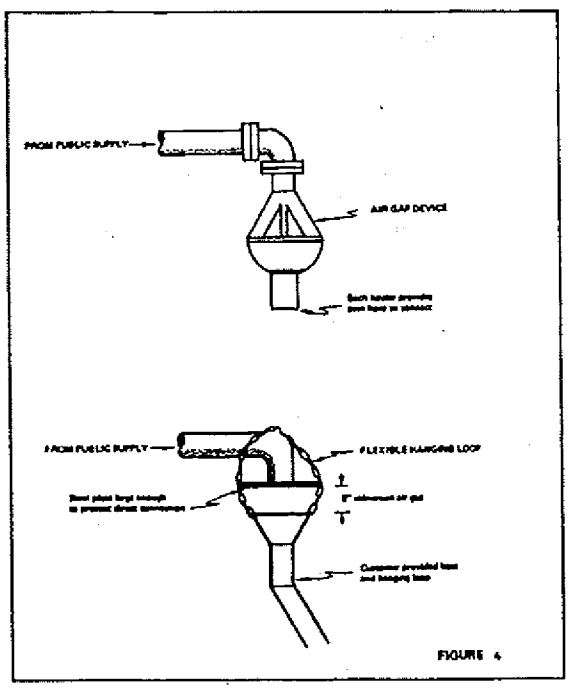
(1) There may be no backflow to the public water supply.

(2) The piping arrangement shall prevent contaminants being transferred from a hauling vessel to others subsequently using the station.

(3) Hoses may not be contaminated by contact with the ground.

FIGURE NO. 4

Acceptable Water Loading Station Devices



History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

Subchapter XII —Water Pressure Booster Stations

NR 811.72 General. Where the storage or primary pumping facilities cannot provide a minimum static pressure of 35 psi throughout the distribution system at ground level, it shall be necessary to create a boosted pressure zone to serve those portions of the system. Design shall be in accordance with the following sections.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.73 Location. (1) Pumps shall take suction from a reservoir, where possible.

(2) For pumps not directly supplied by a reservoir, the suction pressure shall be at least 35 psi when the pumps are supplying design flow rates.

(3) Underground installations shall be permitted only if gravity drainage of large volumes of water from the vault can be provided or if the pumps and drivers are protected from damage by water or can be readily replaced. The gravity drainage requirement may be waived by the department if a minimum of 20 psi can be maintained in the boosted zone by the main zone when the station is out of service. The drain line may not discharge to a storm or sanitary sewer.

(4) In–line submersible pumps may be installed below the ground surface but shall be accessible for servicing and repairs.

(5) Electrical equipment shall be installed above ground except in cases where determined unnecessary by the department to meet the other requirements in this chapter.

(6) Buried stations may not be installed beneath roadways or in a floodplain.

Note: Refer to ch. NR 116 for floodplain definitions.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.74 Pumps and pressures. (1) The booster pumps shall maintain static pressures in the area served within the range of 35 to 100 psi under normal operating conditions.

(2) The pump capacities for domestic service only shall be as established in figure No. 1, subch. VI. Fire protection shall be provided where feasible and will require additional engineering studies.

(3) Pumpstations which serve more than 50 connections shall be designed that the peak demand can be met with the largest pump out of service.

(4) For pumps not directly supplied by a reservoir, the suction pressure shall be at least 35 psi when the pumps are supplying design flow rates. An automatic cutoff control shall be provided that will stop the pumps when the suction pressure falls below 20 psi.

(5) For those stations servicing a boosted zone without elevated storage, one of the following shall be provided:

(a) A continuously running pump to maintain pressure in the boosted zone. A small feed back line or other means shall be provided to prevent the pump from overheating.

(b) A small bladder type hydro–pneumatic tank in the station with a 3 minute minimum run timer on the pump to prevent frequent pump cycling.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.75 Storage requirement. Elevated storage facilities shall be provided for the boosted zone if any of the following situations exist:

(1) In cases where the primary system cannot provide positive pressures in all areas served by the booster pumps.

(2) In cases where more than 50 living units are being served and an emergency power source is not provided for the booster pumps.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.76 Emergency power. If a boosted zone serves more than 50 living units and cannot maintain pressures of over 20 psi from the main system, an emergency power source shall be provided unless sufficient elevated storage is provided. On a case–by–case basis the department may approve a portable generator for water supply use only to meet the emergency power requirement. Emergency power may consist of:

(1) A standby engine,

(2) A dedicated on–site generator, or

(3) Feed lines from 2 separate electrical substations with an automatic transfer switch.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.77 Station requirements. (1) The on–off operation of the pumps and the system pressure at the booster station shall be monitored at one of the main waterworks pumping stations or waterworks facility. At stations serving less than 50 living units, monitoring may be provided by a light or an audible alarm placed in a conspicuous location to indicate pump failure. A continuous recording pressure device may be provided.

(2) Pressure gauges shall be provided on the suction and discharge lines.

(3) A flow meter shall be provided, if practical, in the discharge line.

(4) The design shall provide for automatically bypassing the pumping units when the pumps are not operating and bypassing the station when the station is out of service.

(5) General requirements for above grade stations are in subch. V.

(6) Underground stations shall be equipped with heating, ventilation and dehumidification equipment. Access manways shall terminate a minimum of 24 inches above grade with an overlapping, locking cover. Vents shall terminate a minimum of 24 inches above grade in a fine screened downward facing U–bend.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

Subchapter XIII —Waste Disposal

NR 811.78 General. The discharge of pollutants from a waterworks facility into the waters of the state or into a publicly owned treatment works, as those terms are defined in s. 283.01, Stats., shall conform to all the applicable requirements of ch. 283, Stats., and the rules adopted thereunder. Provisions shall be made for proper disposal of all wastes from waterworks facilities. Wastes may be from sanitary facilities, laboratories or treatment plants. Where new methods are proposed or the treatment results are uncertain, the department may require laboratory, pilot or full–scale testing to establish design parameters. Sections NR 811.81 to 811.86 contain general standards to be utilized in meeting the requirements of ch. 283, Stats. System owners proposing discharges other than to already permitted wastewater treatment plants shall obtain a WPDES permit.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92; corrections made under s. 13.93 (2m) (b) 7., Stats., Register, December, 1998, No. 516.

NR 811.79 Sanitary wastes. Wastes from toilet facilities shall be discharged to a sanitary sewer system. The floor elevation to a building from which there is a discharge shall be constructed at least one foot above the street and nearest sewer manhole cover elevation to prevent contamination from sewer backup. Where a sanitary sewer system is not available, an individual waste disposal facility may be approved by the department providing sufficient protection of the water source can be assured.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.80 Floor drainage. Floor drains in pump stations and treatment plants shall comply with the requirements of s. NR 811.29 (1).

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92; corrections made under s. 13.93 (2m) (b) 7., Stats., Register, December, 1998, No. 516.

NR 811.81 Backwash wastewater from iron & manganese filters. (1) DISCHARGE TO SANITARY SEWER. A holding tank for backwash wastewater from iron and manganese removal filters shall be provided if the department determines that it is necessary to prevent overloading the sewers or sewage treatment plant. When a holding tank is provided it shall meet the requirements of sub. (4).

(2) DISCHARGE TO SAND FILTERS. The following requirements apply when sand filters are used to treat backwash wastewater from iron and manganese removal filters:

(a) Filters shall be designed for a rate of 35 gallons per square foot per day except where testing indicates that higher rates will not cause excessive plugging of the media and a quality effluent can be maintained. Sufficient surface area shall be provided so that during any filtration cycle the wastewater depth over the media does not exceed 2 feet. The filters shall be sized to handle the entire backwash volume from all of the filters at the treatment plant unless the filters are washed on a rotating schedule.

(b) No filter, regardless of the volume of water to be handled, may be smaller than 100 square feet in area. Multiple units may be necessary to facilitate cleaning.

(c) The filter media shall consist of a minimum of 12 inches of sand, 3 to 4 inches of supporting small gravel or torpedo sand, and 9 inches of gravel in graded layers. All fines shall be removed from the media by washing. The filter sand shall have an effective size of 0.3 to 0.5 mm and a uniformity coefficient not exceeding 3.5.

(d) An adequate underdrainage collection system shall be provided. Provision shall be made for sampling the filter effluent.

(e) A cover shall be provided which prevents freezing during the winter months.

(f) The filter shall be located in an area not subject to flooding, and the site shall be graded to prevent ponding of surface runoff. Finished grade elevation shall be designed to facilitate maintenance, cleaning and removal or replacement of surface sand. An overflow may not be provided.

(3) DISCHARGE TO LAGOONS. Lagoons used to settle backwash wastewater from iron and manganese removal filters shall meet the following design requirements:

(a) Lagoons shall be designed with a volume which is 10 times the total quantity of wastewater discharged during any 24–hour period.

(b) Lagoon length shall be 4 times the width, and the width shall be at least 3 times the depth.

(c) Adequate inlet and outlet devices shall be provided so that velocity currents are minimized.

(4) DISCHARGE TO DETENTION TANKS. Detention tanks used to settle backwash wastewater from iron and manganese removal filters shall meet the following design requirements:

(a) Detention tanks shall be designed to maximize settling by means of inlet piping and baffling configurations. Tanks shall be of sufficient capacity to hold at least 2 complete backwash cycles. The floor shall be sloped to a sump and access manholes provided to facilitate cleaning. A cover shall be provided to prevent freezing.

(b) Pumps shall be provided to discharge the decantate to a storm sewer or receiving watercourse over approximately a 24–hour period. A convenient means of sampling the effluent shall be provided.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.82 Brine wastes from ion exchange plants. If permitted by the department, brine wastes may be discharged to a sanitary sewer system or to a watercourse in cases where sufficient flow is available to provide adequate dilution to meet water quality or effluent standards. Dilution in streams shall be based on the 7–day low flow for the previous 10–year period. Except when discharging to large waterways or sewerage systems which will not be overloaded by the discharge, the minimum requirement shall be a holding tank of sufficient size to allow brine discharge over a 24–hour period. Brine wastes from ion exchange plant treating water containing radium 226 and radium 228 shall have

special disposal requirements determined by the department. Where they apply, these special requirements shall modify the requirements for specific disposal practices.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.83 Backwash wastewater from lime softening and surface water treatment plants. Where feasible, the waste filter wash water shall be returned to the inlet end of the plant at a rate of less than 10% of the raw water entering the plant. If permitted by the department, direct or controlled discharge to a sewerage system may be used if the discharge will not overload the facilities or adversely affect the treatment process. Waste filter wash water shall have the suspended solids removed before being discharged to a watercourse. Backwash wastewater from lime softening plants treating water that contains radium 226 and radium 228 shall have special disposal requirements determined by the department. Where they apply, these special requirements shall modify the requirements for specific disposal practices.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.84 Lime softening sludge. Sludge from plants using lime to soften water will vary in quantity and in chemical characteristics depending on the softening process and the chemical characteristics of the water being softened. The sludge from plants treating water containing radium 226 and radium 228 shall have special disposal requirements determined by the department. These special requirements shall modify the requirements for specific disposal methods. Following are requirements for specific disposal methods:

(1) LAGOONS. The design shall provide:

(a) Locations free from flooding, with grading or ditching to divert surface runoff.

(b) Minimum lagoon depth of 4 to 5 feet with interior and exterior slopes of 3:1.

(c) Two years solids storage volume for temporary lagoons and 8 to 10 years storage volume for permanent lagoons.

(d) Multiple cells to provide flexibility in operation.

(e) Adjustable decanting devices.

(f) Means of convenient cleaning where appropriate.

(2) APPLICATION TO AGRICULTURAL LAND. If permitted by the department, liquid sludge may be applied to agricultural land by tank truck when the solids do not exceed 10 to 12% by weight. This method requires proper handling facilities, vehicles and equipment to permit hauling and spreading which does not create a nuisance. Adequate sludge holding facilities are required for use during times that trucks cannot operate. Higher solids content sludges may also be spread. However, prior to increasing the solids content the local department sludge management specialist shall be contacted to evaluate the acceptability of spreading the high solids sludge.

(3) DISCHARGE TO SANITARY SEWER. Discharge to sanitary sewer may be utilized if a study or experience has shown that problems will not occur in the sewage collection system or at the sewage treatment plant. A holding tank may be necessary to even out flows to the sewer system.

(4) MECHANICAL DEWATERING. Pilot testing of mechanical dewatering is necessary to show the results which may be obtained. The department shall review and approve proposals on a case–by–case basis to insure that water quality and effluent requirements will be met.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.85 Spent media. (1) GENERAL. Spent media from water treatment plants may require special handling and disposal. The department shall evaluate on a case–by–case basis the proper handling and disposal techniques for spent media under the following circumstances:

(a) Granular activated carbon shall be evaluated when treating water with volatile organic compounds or radium, uranium or radon gas.

(b) Filter sand, green sand, ion exchange media and support media shall be evaluated when treating water with radium 226, radium 228 or uranium.

(2) DISPOSAL APPROVAL. Prior to disposal of the medias listed in sub. (1), the department shall be contacted for approval. A written request indicating the type of media, the volume of media, the contaminants of concern and their concentration in the influent water and the media, the proposed method of transportation and the proposed method of disposal shall be submitted to the department.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.

NR 811.86 Alum or other coagulant sludge. The following methods may be considered:

(1) LAGOONS. The general design criteria for lagoons is in s. NR 811.84 (1).

(2) DISCHARGE TO SANITARY SEWERS. Discharge to sanitary sewers may be utilized if a study or experience has shown that problems will not occur in the sewage collection system or at the sewage treatment plant. A holding tank may be necessary to even out flows to the sewer system.

(3) MECHANICAL DEWATERING. Mechanical dewatering may be utilized if approved by the department after review of the results of testing.

History: Cr. Register, April, 1992, No. 436, eff. 5–1–92.