

Chapter NR 820

GROUNDWATER QUANTITY PROTECTION

Subchapter I — General Provisions

NR 820.10	Purpose.
NR 820.11	Applicability.
NR 820.12	Definitions.
NR 820.13	High capacity wells annual pumping reports.

Subchapter II — Groundwater Management Areas

NR 820.20	Groundwater management area designation.
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Subchapter III — Environmental Review of High Capacity Well Applications

NR 820.29	Review periods.
NR 820.30	High capacity wells in groundwater protection areas.
NR 820.31	High capacity wells near springs.
NR 820.32	Projects with high water loss.
NR 820.33	Public utility wells.

Subchapter I — General Provisions

NR 820.10 Purpose. The purpose of this chapter is to designate areas of the state, consistent with s. 281.34 (9) (a), Stats., in which impacts from groundwater drawdown and pumpage are such that regional planning and management is necessary to avoid, minimize and manage future impacts. This chapter also establishes review criteria applicable to high capacity well applications involving wells situated near springs, trout streams, outstanding resource waters, and exceptional resources waters, and involving groundwater withdrawals with high water loss.

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NR 820.11 Applicability. This chapter applies to all counties, cities, towns, villages, utility districts under s. 66.0827, Stats., that provide water, public inland lake protection and rehabilitation districts that have town sanitary district powers under s. 33.22 (3), Stats., joint water authorities created under s. 66.0823, Stats., and municipal water districts under s. 198.22, Stats. This chapter also applies to persons who are owners of high capacity wells and high capacity well systems including persons that propose to construct a high capacity well.

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NR 820.12 Definitions. In this chapter:

(1) “Approval” means an approval issued by the department under s. 281.17 (1), 2001 Stats., s. 281.34 (2) or 281.41, Stats., prior to construction of a high capacity well.

(2) “Class 1 trout stream” means a stream, portion of a stream or a farm drainage ditch with a prior stream history that contains a self-sustaining population of trout and is classified as such in Wisconsin Department of Natural Resources publication PUB–FH–806 2002, Wisconsin Trout Streams. Farm drainage ditches that support self-sustaining populations of trout but do not have a prior stream history are not trout streams for purposes of this chapter.

Note: Copies of this document may be obtained from the Department of Natural Resources, Bureau of Fisheries Management and Habitat Protection, 101 South Webster Street, Natural Resources Building, PO Box 7921, Madison, Wisconsin 53707–7921.

(3) “Class 2 trout stream” means a stream, portion of a stream or a farm drainage ditch with a prior stream history that contains a population of trout made up of one or more age groups, above the age one year, in sufficient numbers to indicate substantial survival from one year to the next, but in which stocking is necessary to fully utilize the available trout habitat or to sustain the fishery and is classified as such in Wisconsin Department of Natural Resources publication PUB–FH–806 2002, Wisconsin Trout Streams. Farm drainage ditches that meet these criteria but do not have a prior stream history are not trout streams for purposes of this chapter.

(4) “Class 3 trout stream” means a stream or portion of a stream that has marginal trout habitat with no natural reproduction of trout occurring, requiring annual stocking of trout to provide

trout fishing, and generally without carryover of trout from one year to the next and is classified as such in Wisconsin Department of Natural Resources publication PUB–FH–806 2002, Wisconsin Trout Streams. Farm drainage ditches that meet these criteria but do not have a prior stream history are not trout streams for the purpose of this chapter.

(5) “Consumptive use coefficient” has the meaning specified in s. NR 142.02 (4).

Note: s. NR 142.02 (4) defines “consumptive use coefficient” to mean “a constant numerical measure, as determined under s. NR 142.04 (1) to (4) which is used to determine the consumptive use portion of a facility’s withdrawal”.

(6) “Department” means the department of natural resources.

(7) “80% exceedance flow” means the flow in a stream that, based on statistical probability, will be exceeded 80% of the time on an annual basis.

(8) “Groundwater management area” means a multi-jurisdictional area including towns, cities, villages and counties within which the level of the groundwater potentiometric surface in any of its underlying aquifers has been reduced by 150 feet or more from the level at which the potentiometric surface would be if no groundwater withdrawals had occurred.

(9) “Groundwater protection area” has the meaning specified in s. 281.34 (1) (a), Stats.

Note: s. 281.34 (1) (a), Stats., defines “groundwater protection area” to mean “an area within 1,200 feet of any of the following:

(a) An outstanding resource water identified under s. 281.15 that is not a trout stream.

(b) An exceptional resource water identified under s. 281.15 that is not a trout stream.

(c) A class 1, class 2, or class 3 trout stream, other than a class 1, class 2, or class 3 trout stream that is a farm drainage ditch with no prior stream history as identified under sub. (8) (a).

(10) “High capacity property” has the meaning specified in s. NR 812.07 (52).

Note: s. NR 812.07 (52) defines “high capacity property” to mean “one property on which a high capacity well system exists or is to be constructed.”

(11) “High capacity well” has the meaning specified in s. 281.34 (1) (b), Stats.

Note: s. 281.34 (1) (b), Stats., defines “high capacity well” to mean “a well that, together with all other wells on the same property, has a capacity of more than 100,000 gallons per day.”

(12) “High capacity well system” has the meaning specified in s. NR 812.07 (53).

Note: s. NR 812.07 (53) defines “high capacity well system” to mean “one or more wells, drillholes, or mine shafts used or to be used to withdraw water for any purpose on one property, if the total pumping or flowing capacity of all wells, drillholes or mine shafts on one property is 70 or more gallons per minute based on the pump curve at the lowest system pressure setting, or based on the flow rate.”

(13) “Local governmental unit” has the meaning specified in s. 281.34 (1) (c), Stats.

Note: s. 281.34 (1) (c), Stats., defines “local governmental unit” to mean a “city, village, town, county, town sanitary district, utility district under s. 66.0827 that provides water, public inland lake protection and rehabilitation district that has town sanitary district powers under s. 33.22 (3), joint local water authority created under s. 66.0823 or municipal water district under s. 198.22.

(14) “One property” has the meaning specified in s. NR 812.07 (68).

Note: s. NR 812.07 (68) defines “one property” to mean “all contiguous land controlled by one owner, lessee, or any other person having a possessory interest. Lands under single ownership bisected by highways or railroad right-of-ways are considered contiguous.”

(15) “Owner” has the meaning specified in s. 281.34 (1) (d), Stats.

Note: s. 281.34 (1) (d), Stats., defines “owner” to mean “a person who owns property on which a well is located or proposed to be located or the designated representative of that person.”

(16) “Potentiometric surface” has the meaning specified in s. 281.34 (1) (e), Stats.

Note: s. 281.34 (1) (e), Stats., defines “potentiometric surface” to mean “a measure of pressure of groundwater in an aquifer based on the level to which groundwater will rise in a well placed in the aquifer.”

(17) “Prior stream history” means a determination made by the department that an artificial waterway or a portion of such waterway was originally a navigable stream before it was ditched or channelized.

(18) “Reconstruction” has the meaning specified in s. NR 812.07 (85).

Note: s. NR 812.07 (85) defines “reconstruction” to mean “modifying the original construction of a well. Reconstruction includes, but is not limited to deepening, lining, installing or replacing a screen, underreaming, hydrofracturing and blasting.”

(19) “Significant adverse environmental impact” means alteration of groundwater levels, groundwater discharge, surface water levels, surface water discharge, groundwater temperature, surface water temperature, groundwater chemistry, surface water chemistry, or other factors to the extent such alterations cause significant degradation of environmental quality including biological and ecological aspects of the affected water resource.

(20) “Spring” has the meaning specified in s. 281.34 (1) (f), Stats.

Note: s. 281.34 (1) (f), Stats., defines “spring” to mean “an area of concentrated groundwater discharge occurring at the surface of the land that results in a flow of at least one cubic foot per second at least 80% of the time.”

(21) “Water loss” has the meaning specified in s. 281.34 (1) (g), Stats.

Note: s. 281.34 (1) (g), Stats., defines “water loss” to mean “a loss of water from the basin from which it is withdrawn as a result of interbasin diversion, as defined in s. 281.35 (1) (g) or consumptive use or both.”

(22) “Well” has the meaning specified in s. 281.34 (1) (h), Stats.

Note: s. 281.34 (1) (h), Stats., defines “well” to mean “any drillhole or other excavation or opening deeper than it is wide that extends more than 10 feet below the ground surface and is constructed for the purpose of obtaining groundwater.”

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NR 820.13 High capacity wells annual pumping reports. **(1)** Owners of high capacity wells shall record pumpage data on a monthly basis and shall report the information to the department at no less than an annual frequency using methods and forms provided by the department. Reports of annual pumpage for a given calendar year shall be submitted to the department no later than the first day of March in the following calendar year.

Note: Appropriate forms, description of acceptable estimation methodology and reporting procedures will be sent to owners of each high capacity well each year by the department. Copies of these documents may be obtained from the Department of Natural Resources, Bureau of Drinking Water and Groundwater, 101 South Webster Street, Natural Resources Building, PO Box 7921, Madison, Wisconsin 53707–7921.

(2) Individual reports shall be prepared for any high capacity wells with the capacity to withdraw water at a rate of 100,000 gallons per day or more.

(3) If one high capacity property does not contain any single high capacity well with an individual capacity to withdraw water at a rate of 100,000 gallons per day or more, the annual pumpage may be reported as a composite volume for the entire property based on estimated water usage using a method prescribed by the department.

(4) If one high capacity property contains high capacity wells with individual capacity to withdraw water at a rate of at least 100,000 gallons per day and high capacity wells with maximum pumping capacity less than 100,000 gallons per day, a composite

pumpage volume based on estimated water usage using a method prescribed by the department may be reported for those wells with individual maximum pumping capacity less than 100,000 gallons per day.

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Subchapter II — Groundwater Management Areas

NR 820.20 Groundwater management area designation. The areas specified in subs. (1) and (2) are designated as groundwater management areas. Any local governmental unit contained within these areas shall be considered to be part of the groundwater management area unless it is explicitly excluded in sub. (1) or (2).

(1) Southeast Wisconsin Groundwater Management Area consisting of the following:

- (a) All of Kenosha county.
- (b) All of Milwaukee county.
- (c) All of Ozaukee county.
- (d) All of Racine county.
- (e) All of Waukesha county.

(f) The portions of Walworth county consisting of the U.S. Public Land Survey townships of East Troy, Spring Prairie, Lyons, Bloomfield, Linn and Geneva, with the exception of the village of Williams Bay and city of Elkhorn, and including the portion of the U.S. Public Land Survey township of Troy that includes part of the Village of East Troy.

(g) All of Washington county with the exception of the U.S. Public Land Survey townships of Wayne and Kewaskum.

(2) Northeast Wisconsin Groundwater Management Area consisting of the following:

- (a) All of Brown county.

(b) The portions of Calumet county consisting of the U.S. Public Land Survey townships of Woodville and Harrison and the village of Sherwood.

(c) The portions of Outagamie county consisting of the U.S. Public Land Survey townships of Grand Chute, Van den Broek, Buchanan, Freedom and Kaukauna, including the cities of Appleton and Kaukauna and the villages of Kimberly, Combined Locks and Little Chute.

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Subchapter III — Environmental Review of High Capacity Well Applications

NR 820.29 Review periods. **(1)** HIGH CAPACITY WELLS IN GROUNDWATER PROTECTION AREAS. Unless another time period is specified by law, the department shall complete its review and make a determination on all applications for approval of proposed high capacity wells in groundwater protection areas within 65 business days after receipt of a complete application unless the department notifies the applicant under s. NR 820.30 (4) (a) or (b) that additional information is needed in order for the department to prepare an environmental assessment for the proposed high capacity well.

(2) HIGH CAPACITY WELLS NEAR SPRINGS. Unless another time period is specified by law, the department shall complete its review and make a determination on all applications for approval of proposed high capacity wells near springs within 65 business days after receipt of a complete application unless the department notifies the applicant under s. NR 820.31 (4) (a) or (b) that additional information is needed in order for the department to prepare an environmental assessment for the proposed high capacity well.

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NR 820.30 High capacity wells in groundwater protection areas. **(1)** Except as provided in sub. (2), an application for approval of a high capacity well within a groundwater pro-

tection area shall be supplemented to include all of the following information:

(a) The name of each class 1, 2 or 3 trout stream, outstanding resource water or exceptional resource water that is located within 1,200 feet of the proposed well location.

Note: Outstanding resource waters and exceptional resource waters are identified in ss. NR 102.10 and 102.11. Chapter NR 102 is available for viewing and printing on the Internet at: <http://www.legis.state.wi.us/rsb/code/nr/nr102.pdf>. Paper copies of ch. NR 102 may be obtained from the Department of Natural Resources, Bureau of Watershed Management, 101 South Webster Street, Natural Resources Building, PO Box 7921, Madison, Wisconsin 53707–7921.

(b) The distance from each proposed high capacity well to the class 1, 2 or 3 trout stream, outstanding resource water or exceptional resource water.

(c) If the potentially affected water body is a stream, a description of the stream channel at the point nearest to the proposed well location including stream width, depth of water, publicly available information regarding seasonal flow and nature of the substrate.

(d) If the potentially affected water body is a lake or flowage, a description of the lake or flowage including identification and approximate flows of major inlets and outlets, surface area of the lake or flowage, approximate elevation of the current lake or flowage level, analysis of publicly available information pertaining to historic lake level fluctuations, and nature of the lake bed.

(e) A description of all other wells on the high capacity property including location relative to the class 1, 2 or 3 trout stream, or outstanding or exceptional resource water, maximum pumping capacity, estimated actual annual pumpage for each well and frequency of pumping for each well.

(f) A description of the hydrogeologic conditions in the vicinity of the proposed well including flow direction, groundwater elevation, depth to groundwater, and a description of the aquifer characteristics including approximate thickness of each aquifer.

(g) A discussion and analysis of alternative well locations and feasibility of siting the high capacity well outside of the groundwater protection area.

(h) A determination by a registered professional engineer, registered professional geologist or registered professional hydrologist of the 80% exceedance flow for the stream and associated water level at the location closest to the proposed well location.

(i) If the affected water body is a lake, a determination by a registered professional engineer, registered professional geologist or registered professional hydrologist of the 80% exceedance flow and associated water level for the primary surface water outlet and the invert elevation of the primary surface water outlet.

(j) The appropriate consumptive use coefficient.

(2) (a) The department may approve a high capacity well as described in pars. (b) to (e) within a groundwater protection area without preparing an environmental assessment if it determines that construction and operation of the proposed well will not result in significant adverse environmental impact. The information specified under sub. (1) (h) to (j) is not required for a proposed well if any of the conditions in pars. (b) to (e) apply. Based on information submitted by the applicant under sub. (1) and other available information, the department may determine that supplemental information and review is needed in order to issue or deny the necessary approval. The department shall include in any approval issued using the standards under s. 281.34, Stats., conditions to ensure that the high capacity well will not result in significant adverse environmental impacts to trout streams, outstanding resource waters and exceptional resource waters. The conditions may include but are not limited to conditions as to location, depth of lower drillhole, depth interval of well screen, pumping capacity, pumpage schedule, months of operation, rate of flow and conservation measures.

(b) The proposed high capacity well is a well that does not have a pump capacity of greater than 20 gallons per minute and the well is to be used solely for domestic purposes for a single residence.

(c) The proposed high capacity well is intended to be used for purposes such as fire suppression and similar non-commercial, non-industrial and non-agricultural irrigation purposes, and the well will only be used on a sporadic basis averaging less than 30 days each year and will generally operate for no more than 2 consecutive days.

(d) The high capacity well application is for reconstruction of an existing high capacity well and the application does not seek an increase in the approved pumping capacity of the well.

(e) The high capacity well application is for temporary dewatering of a single construction site in unconsolidated deposits and the duration of the project will not extend more than one construction season.

(3) (a) The department may approve a proposed high capacity well without completing an environmental assessment under ch. NR 150 if the proposed well is not a well described in sub. (2) (b) to (e) and the department determines that construction and operation of the proposed well will not result in significant adverse environmental impacts to the stream or lake and at least one of the conditions in subd. 1. to 5. is satisfied. In making this determination, the department shall consider impacts caused by other wells on the high capacity property and take into account actual or current conditions of the Class 1, 2 or 3 trout stream, outstanding resource water or exceptional resource water.

1. The potentially affected water body is a trout stream and the proposed pumping capacity of the high capacity well is less than 10% of the value for the 80% exceedance flow for the stream.

2. The potentially affected water body is an outstanding or exceptional resource water that is a stream and the proposed pumping capacity of the high capacity well is less than 10% of the value for the 80% exceedance flow for the stream.

3. The potentially affected water body is an outstanding or exceptional resource water that is a lake with a surface outlet and the proposed pumping capacity of the high capacity well is less than 10% of the value for the 80% exceedance flow for the primary surface outlet from the lake.

4. The potentially affected water body is an outstanding or exceptional resource water that is a lake with a surface water outlet and a surface area of at least 600 acres.

5. The potentially affected water body is an outstanding or exceptional resource water that is a lake with a surface water outlet, a surface area of less than 600 acres and the volume of water that would be pumped from the well in 30 days of continuous pumping at maximum capacity is less than 5% of the volume of the lake.

(b) The department shall include in any approval issued using the standards under s. 281.34, Stats., conditions to ensure that the high capacity well will not result in significant adverse environmental impacts to trout streams, outstanding resource waters and exceptional resource waters. The conditions may include but are not limited to conditions as to location, depth of lower drillhole, depth interval of well screen, pumping capacity, pumpage schedule, months of operation, rate of flow and conservation measures. The department may also modify the approvals or place additional conditions on the approvals of other previously approved wells on the high capacity property to prevent significant adverse environmental impacts.

(4) All of the following provisions shall apply to proposed high capacity wells that are not included under sub. (3) (a) 1. to 5. and proposed wells that satisfy the conditions under sub. (3) (a) 1. to 5. but for which the department has determined that the proposed well may have a significant adverse environmental impact on the trout stream, outstanding resource water or exceptional resource water:

(a) The department shall notify the applicant that the proposed high capacity well may have a significant impact on the stream or lake and may require additional information concerning flow characteristics of the affected stream or lake, site-specific geo-

logic and hydrogeologic information and pertinent regional information.

(b) Within 65 business days of receipt of a complete application, the department shall identify additional informational requirements necessary to evaluate the proposed well and may determine that the applicant shall develop and submit an environmental impact report in accordance with s. NR 150.25.

(c) Following receipt of the requested information, the department shall prepare an environmental assessment in accordance with the procedures of s. NR 150.22 and shall develop and publish a news release in accordance with s. NR 150.21.

(d) If the department determines that operation of the proposed high capacity well will not result in significant adverse environmental impact on critical resources within the stream or lake and other uses of the stream or lake, the department shall approve the well and include in any approval issued using the standards under s. 281.34, Stats., conditions to ensure that operation of the proposed well will not cause significant adverse environmental impact to critical aquatic resources or other existing uses of the stream or lake. The conditions may include but are not limited to conditions as to location, depth of casing, depth of lower drillhole, depth interval of well screen, pumping capacity, pumpage schedule, months of operation, rate of flow, ultimate use and conservation measures. In the case of Class 1, 2 and 3 trout streams and outstanding or exceptional resource waters that contain warm water sport fisheries, flow conditions in the stream shall be maintained such that the fish populations and critical habitat are not adversely affected.

(5) As part of an approval issued using the standards under s. 281.34, Stats., the department may require the owner of the high capacity well to implement a monitoring plan to document stream flow or lake level conditions in the vicinity of any well located within a groundwater protection area and based on results of the monitoring program may revise the approval.

(6) The department may not issue an approval using the standards under s. 281.34, Stats., for a high capacity well within a groundwater protection area unless it is able to include and includes conditions that ensure that the well does not cause significant adverse environmental impact.

(7) The department may order the owner of a high capacity well constructed prior to May 7, 2004 that is located in a groundwater protection area to mitigate the effects of the well. Mitigation may include abandonment of the well, replacement of the well, if necessary, and management strategies. If mitigation is ordered, the department shall provide funding for the full cost of the mitigation, except that full funding is not required if the department is authorized under ch. 280, Stats., to require the well to be abandoned because of issues regarding public health.

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NR 820.31 High capacity wells near springs. (1) For any application for approval of a high capacity well under s. 281.34, Stats., the department shall determine if there is a spring, as defined in this chapter, located in the vicinity of the proposed well.

(2) If the department determines that a proposed high capacity well is located near a spring the department shall assess the proposed well to determine whether construction and operation of the well will result in substantially reduced flow from the spring and significant adverse environmental impact to the spring. The department shall consider the location of the well relative to the spring, well construction details, information regarding construction and operation of all other wells on the property, available information concerning the geology and hydrogeology of the area, historical flow data for the spring and other pertinent information.

(3) If the department determines that construction and operation of the proposed high capacity well will not result in a substan-

tial reduction in flow from the spring or result in significant adverse environmental impact to the spring, the department may approve the proposed well and shall include in any approval issued using the standards under s. 281.34, Stats., conditions to ensure that the well will not result in significant adverse environmental impact to the spring. The conditions may include but are not limited to conditions as to location, depth of casing, depth of lower drillhole, depth interval of well screen, pumping capacity, pumpage schedule, months of operation, rate of flow, ultimate use and conservation measures.

(4) All of the following provisions shall apply to proposed high capacity wells that are determined to reduce flow in a spring such that significant adverse environmental impact to the spring or related aquatic and terrestrial resources may result:

(a) The department shall notify the applicant that the proposed high capacity well may have a significant adverse environmental impact on a spring and may require additional information concerning flow characteristics of the affected spring, site-specific geologic and hydrogeologic information, a discussion and analysis of alternative well locations, and pertinent regional information.

(b) Within 65 business days of receipt of a complete application, the department shall identify additional informational requirements necessary to evaluate the proposed well and may determine that the applicant shall develop and submit an environmental impact report in accordance with s. NR 150.25.

(c) Following receipt of the requested information, the department shall prepare an environmental assessment in accordance with the procedures of s. NR 150.22 and shall develop and publish a news release in accordance with s. NR 150.21.

(d) If the department determines that operation of the proposed high capacity well will not result in significant adverse environmental impact to the spring and related resources, the department shall approve the well and include in any approval issued under s. 281.34, Stats., conditions to ensure that operation of the proposed well will not cause significant adverse environmental impacts to the spring or critical resources related to the spring. The conditions may include but are not limited to conditions as to location, depth of casing, depth of lower drillhole, depth interval of well screen, pumping capacity, pumpage schedule, months of operation, rate of flow, ultimate use and conservation measures. The department may approve a proposed high capacity well that is predicted to result in a reduction of flow in a spring only if the predicted reduction would not cause permanent and irreversible impacts to the spring and related resources. The department may not approve a proposed high capacity well that is predicted to result in a reduction in flow from a spring such that the spring does not flow at one cubic foot per second or greater at least 80% of the time or that will reduce the average annual flow from a spring by greater than 20%.

(5) As part of an approval issued using the standards under s. 281.34, Stats., the department may require the owner of the high capacity well to implement a monitoring plan to document conditions of the spring and related resources and based on results of the monitoring program may revise the approval.

History: CR 06-121: cr. Register August 2007 No. 620, eff. 9-1-2007.

NR 820.32 Projects with high water loss. (1) For any application for approval of a high capacity well under s. 281.34, Stats., the applicant shall identify and the department shall verify whether the proposed use of the well will result in an annual water loss of greater than 95%. The department may require submittal of a detailed water balance as part of the application in order to determine the approximate water loss.

(2) If the department determines that a proposed high capacity well will result in an annual water loss of greater than 95%, the department shall notify the applicant that the proposed well may result in a water loss of greater than 95%. Within 65 business days of receipt of a complete application, the department shall identify

additional informational requirements necessary to evaluate the proposed well and may determine that the applicant shall develop and submit an environmental impact report in accordance with s. NR 150.25.

(3) Following receipt of all requested information, the department shall prepare an environmental assessment in accordance with the procedures of s. NR 150.22, and shall develop and publish a news release in accordance with s. NR 150.21.

(4) If the department determines that construction and operation of the proposed high capacity well will not result in significant environmental impact to surface and groundwater resources, the department shall approve the well and include in any approval issued using the standards under s. 281.34, Stats., conditions to ensure that operation of the proposed well will not cause significant adverse environmental impact to surface water or groundwater resources. The conditions may include but are not limited to conditions as to location, depth of casing, depth of lower drillhole, depth interval of well screen, pumping capacity, pumpage schedule, months of operation, rate of flow, ultimate use and conservation measures.

(5) As part of an approval issued using the standards under s. 281.34, Stats., the department may require the owner of the high capacity well to develop and implement a water conservation and

management plan that minimizes, to the extent technically and economically feasible, the degree of water loss related to operation of the high capacity well system.

(6) As part of an approval issued using the standards under s. 281.34, Stats., the department may require the owner of the high capacity well system to implement a monitoring plan to evaluate environmental impacts caused by operation of the high capacity well system and based on results of the monitoring program may revise the approval.

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NR 820.33 Public utility wells. Sections NR 820.30 to 820.32 do not apply to proposed high capacity wells that are water supplies for public water systems operated by a public utility, as defined by s. 196.01, Stats., engaged in supplying water to or for the public, if the department determines that there is no other reasonable alternative location for the well and includes in the approval conditions that ensure that the environmental impact of the well is balanced by the public benefit of the well related to public health and safety. Conditions of the approval for the well may include, but are not limited to, conditions as to location, depth, pumping capacity, rate of flow, and ultimate use.

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