

## Minimum Standards for Subdivision Applications

### CHAPTER 23

Section 1. **Authority.** This regulation is promulgated pursuant to the Wyoming Environmental Quality Act. Specifically, W.S. 35-11-302 (a) (xi) stipulates that the administrator shall develop standards for subdivision applications submitted to the department under W.S. 18-5-306.

Section 2. **Applicability.** These regulations shall apply to all subdivision permits as required by W.S. 18-5-305 and 306 and submitted to the department upon or after the effective date this rule.

#### Section 3. **Definitions.**

(a) The definitions in Section 35-11-103(a) and (c) of the Wyoming Environmental Quality Act apply to this chapter. For example:

(i) "Administrator" means the administrator of the Water Quality Division of the department.

(ii) "Department" means the Department of Environmental Quality established by the Wyoming Environmental Quality Act;

(iii) "Director" means the director of the Department of Environmental Quality;

(iv) "Public water supply" means any water supply as defined in W.S. 35-11-103(c) (viii).

(b) The following definitions, contained in Section 18-5-302(a) of Article 3, Real Estate Subdivisions as of July 1, 2001, apply to this chapter:

(i) "Sewage System" means all pipelines, conduits, pumping stations, force mains and other constructions used for collecting or conducting wastes to a treatment plant or disposal system; any plant or other works used for the purpose of treating, stabilizing or holding wastes; and any system used for disposing of wastes, either by surface or underground methods, including any treatment plant, disposal wells and absorption fields;

(ii) "Subdivider" means any person who lays out any subdivision or parts thereof either for the account of the subdivider or others;

(iii) "Subdivision" means the creation or division of a lot, tract, parcel or other unit of land for the immediate or future purpose of sale, building development or redevelopment, for residential,

recreational, industrial, commercial or public uses. The word “subdivide” or any derivative thereof shall have reference to the term subdivision, including mobile home courts, the creation of which constitutes a subdivision of land.

(iv) “Water supply system” includes development of the source and all structures for conveyance of raw water to the treatment plant or delivery systems; all water treatment plants including disinfection facilities; and all finished water delivery systems including pipelines, pumping stations and finished water storage facilities. Separate water supply systems used solely for irrigation or stock water are not included.

(c) The following definition supplements those definitions contained in Section 35-11-103 of the Environmental Quality Act.

“Enhanced treatment system” means a facility or system reviewed and approved by the administrator in accordance with Section 5, Chapter 11, Wyoming Water Quality Rules and Regulations, that will meet or exceed the applicable standards contained within this chapter.

#### Section 4. **Submittal and Processing of Subdivision Applications**

(a) Submittal of subdivision applications. Prior to subdivision permit approval by the board of county commissioners, and pursuant to W.S. 18-5-306 (c) and 307, the county, subdivider, or county planning and zoning commission shall send three (3) copies of the portions of the application containing evaluations of the proposed sewage system and water supply system to the department for review of the safety and adequacy of the proposed sewage system and proposed water supply system.

(b) Processing of applications

(i) Pursuant to W.S. 18-5-306(c):

(A) The department may request assistance from the state engineer, the Wyoming water development office and any other state agency or county governmental entity in preparing its review. Any agency or entity requested to assist in the review shall fully cooperate to the extent possible with the department and shall furnish the information or recommendations requested within the time period specified by the department;

(B) The department shall file its written comments and recommendations on the application with the commission or board within 30 days after receipt of the application. The department may extend its review period for an additional 30 days if an extension is necessary to complete the review.

(ii) Incomplete applications will be processed in the following manner:

(A) Additional information shall be requested from the applicant within 30 days of the department's receipt of the application. If the applicant fails to remedy an incomplete application within 60 days of the department's receipt of the application, the department will file an adverse recommendation with the commission or board.

(B) Applications containing plans, specifications, reports, maps, and other documentation submitted under this chapter that are not signed, sealed, and dated, when required, by a licensed professional engineer under W.S. Title 33, Chapter 29, a licensed professional geologist under W.S. Title 33, Chapter 41 or a licensed land surveyor under W.S. Title 33, Chapter 29 will be deemed incomplete by the department and returned to the applicant without further review.

#### Section 5. **Requirements Applicable to All Applications**

(a) All plans, specifications, reports, maps, and other documentation submitted under this chapter must meet or exceed the standards contained within these regulations to be deemed complete;

(b) All plans, specifications, reports, maps, and other documentation submitted under this chapter shall be signed, sealed, and dated, when required, by a licensed professional engineer under W.S. Title 33, Chapter 29, a licensed professional geologist under W.S. Title 33, Chapter 41, and by a licensed land surveyor under W.S. Title 33, Chapter 29, as applicable.

(c) The administrator may, upon review of submitted documentation, modify any, or all, requirements of this chapter when:

(i) The subdivision includes one or more lots with existing sewage systems, water supply systems, or on-lot wells; or

(ii) Holding tanks are used to fully contain on-lot sewage.

Section 6. **Exemptions from Provisions**. Exemptions to the provisions of this chapter are defined in W.S. 18-5-303 and W.S. 18-5-306.

#### Section 7. **Standards for Sewage Systems**

(a) All applications shall contain the following information:

(i) Identification of the type of sewage system to serve the subdivision and identification of the entity or entities responsible for the design, construction, operation and maintenance of the proposed facility;

(ii) An assessment of the adequacy of the proposed sewage system in relation to the proposed population density of the subdivision and any other existing or proposed land and water uses in the vicinity of the subdivision that may affect the adequacy of the system; and

(iii) Demonstration that the proposed sewage system will meet all county, state and federal standards.

The demonstration shall include, but not be limited to addressing the relationship of the development to any local or state approved water quality management plans established pursuant to Section 201 of the federal Clean Water Act, 33 U.S.C. Section 1281 and demonstrate no conflict exists with any state approved local wellhead protection plan or local source water protection plan.

(b) In addition to the information required in part (a) of this section, applications proposing the use of a new central sewage system shall contain the following:

(i) An estimate of the average and maximum number of gallons per day of sewage generated by the proposed subdivision;

(ii) A demonstration that technical requirements and design standards of the department of environmental quality applicable to central sewage systems can and will be met. The demonstration shall include, but not be limited to the information contained within Chapter 11, Section 6 of Wyoming Water Quality Rules and Regulations;

(iii) An estimated schedule for the development and occupancy of the proposed subdivision; and

(iv) A detailed demonstration that the proposed sewage system for the subdivision is compatible with the proposed water supply system for the subdivision. The demonstration must determine that the operation of the sewage system will not affect the suitability or safety of the proposed water supply system and include a determination of the potential impacts of downgradient use of groundwater. The demonstration shall include:

(A) Documentation that the facility poses no threat of discharge to groundwater;

or

(B) A subsurface study and a contaminant fate and transport analysis demonstrating that groundwater standards contained within Chapter 8, Wyoming Water Quality Rules and Regulations will not be exceeded.

(v) Confirmation that the owner of the subdivision collection system will provide for certified operators pursuant to Chapter 5, Wyoming Water Quality Rules and Regulations.

(c) In addition to the information required in part (a) of this section, applications proposing to connect to an existing central sewage system shall contain:

(i) Certification by the owner of the wastewater collection and treatment facilities that the system can and will provide adequate service to the proposed subdivision. This certification should address the willingness and a commitment of the owner to provide service as well as the ability of all downstream sewers, lift stations and treatment facilities to handle the hydraulic and organic loading from the proposed subdivision.

(A) The certification shall clearly identify the point of connection if the connection is not within the boundaries of the proposed subdivision.

(B) It is the responsibility of the owner to consider the capacity and ability of the system to provide sewer service to the proposed subdivision in accordance with existing laws, regulations and permit requirements.

(ii) The information required by Section 6, Chapter 11, Wyoming Water Quality Rules and Regulations shall be provided by a registered professional engineer. If the necessary information is not already available, the owner of the sewage system has the discretion to require the subdivider to provide the required information.

(iii) The party responsible for operation and maintenance of the subdivision collection system will provide for certified operators pursuant to Chapter 5, Wyoming Water Quality Rules and Regulations.

(d) In addition to the information required in part (a) (i) of this section, applications proposing the use of on-lot sewage systems shall contain information to document the following:

(i) Separation of the drainfield relative to groundwater and impervious soils will meet or exceed the minimum standards established in Chapter 11, Part D, Section 36 (c) of Wyoming Water Quality Rules and Regulations.

(ii) Soil percolation rates will meet or exceed the minimum standard established in Chapter 11, Part D, Sections 36 (d) and 38 (b) of Wyoming Water Quality Rules and Regulations.

(A) Percolation tests must be performed according to the procedure described in Chapter 11, Part D, Appendix A of Wyoming Water Quality Rules and Regulations or other procedures approved by the department.

(B) Percolation tests are required for every third lot, or for each soil type as mapped by the Natural Resource Conservation Service (NRCS), whichever requires the least number of percolation tests.

(I) A copy of the NRCS county soil map must be submitted if soil types and distributions were used to establish the number of percolation tests required.

(II) Percolation test data and results from existing permitted on-lot sewage systems on properties adjoining the proposed subdivision may be substituted for new tests when the existing test results were obtained from the same type of soils as those that exist within the proposed subdivision.

(C) Percolation test data, results, and map illustrating test locations shall be submitted in the application.

(iii) Topographic slope, or grade, for sufficient area within each lot within the proposed subdivision will meet or exceed the applicable minimum standards established in Chapter 11, Part D of Water Quality Rules and Regulations, and will not result in a direct or indirect discharge of pollution at the surface, into a surface water body, or into a wetland.

(iv) A 1:24,000 scale U.S.G.S. topographic map illustrating and identifying watersheds located on, or draining into, under, or over the proposed subdivision, including all ephemeral, intermittent, and perennial streams, surface waters, wetlands, and watershed boundaries within one-quarter ( $\frac{1}{4}$ ) mile of the proposed subdivision shall be included in the application.

(v) Each lot contains sufficient area for a replacement leach field.

(vi) The proposed population density of the subdivision, determined from the proposed type of use (e.g., residential, commercial, industrial, multiple use) of the subdivision.

(A) Applications for subdivisions proposing non-domestic use, or domestic use that exceeds 2000 gallons of wastewater per day on one or more lots of the subdivision must identify:

(I) The type(s), strength, and chemical composition of non-domestic wastes most likely to be disposed of, including the average and maximum daily flows;

(II) Specific lots within the subdivision where the disposal of non-domestic wastewater could occur; and

(III) Design(s) and treatment capabilities of the type(s) of on-lot sewage systems proposed to treat such wastes.

(vii) Groundwater and surface water use is protected, as documented by:

(A) Characterization of the geologic setting from well logs, soil borings, and/or published geologic maps and reports, including documentation of:

formations; and

- (I) Thickness, lithology, and extent of surficial materials;
- (II) Stratigraphy, lithology, thickness, and extent of underlying geologic

- (III) Faults, fractures, and karst features.

(B) Characterization of the hydrogeologic setting from well logs, soil borings, test pits, and/or published geologic maps and reports, including documentation of:

- (I) Depth to groundwater, including seasonal fluctuations;

- (II) Degree of groundwater hydraulic confinement;

- (III) Vadose zone thickness, stratigraphy, and lithology; and

- (IV) Degree of hydraulic connection and interaction between groundwater and surface water, where applicable.

(C) Classification of groundwater that is unconfined or semi-confined, according to the standards established within Chapter 8 of Wyoming Water Quality Rules and Regulations must be established according to the following:

- (I) A survey of the existing wells permitted by the State Engineers Office and completed within the unconfined or semi-confined aquifer within one (1) mile of the proposed subdivision must be included and contain:

- (1.) A map illustrating well names and locations relative to the proposed subdivision;

- (2.) State Engineers Office permitted use for each well; and

- (3.) State Engineers Office appropriated production volume for each well.

- (II) If there are no permitted wells within one (1) mile of the proposed subdivision a field survey shall be performed to identify and record all potential locations where unpermitted water users may be located and potential water use.

- (III) If the well surveys in subsections (I) and (II) of this part do not reveal any existing wells used for domestic purposes, ambient groundwater quality of the unconfined or

semi-confined aquifer must be established, either from existing representative sample results or by collection of new representative samples. At a minimum, analytical laboratory results must be provided for:

- (1.) Total Dissolved Solids (TDS)
- (2.) Nitrate + Nitrite as N
- (3.) Total Coliform
- (4.) Sulfates
- (5.) Chloride
- (6.) Zinc
- (7.) Lead
- (8.) Copper
- (9.) Arsenic
- (10.) pH
- (11.) Selenium
- (12.) Additional constituents as may be deemed necessary by the department to classify the groundwater.

(D) When groundwater is unconfined or semi-confined and is Class I groundwater as defined in Chapter 8 of Wyoming Water Quality Rules and Regulations, the following additional documentation must be provided:

- (I) Horizontal and vertical extent of the aquifer;
- (II) Type of flow (i.e., diffuse, porous, or conduit) within the aquifer;
- (III) Direction and degree of hydraulic gradient;
- (IV) Hydraulic conductivity of the saturated zone; and
- (V) Porosity of the saturated zone.

(viii) Separation distances to wells and property boundaries are adequate, according to the following:

(A) Except as provided for in sub-part (B) of this part, where unconfined groundwater is Class I as defined in Chapter 8 of Wyoming Water Quality Rules and Regulations, small wastewater systems designed in accordance with Chapter 11, Part D, requirements and these regulations may be used provided that:

(I) The analysis described in Appendix A is provided in the application and determines that nitrates from on-lot sewage systems will not exceed 10 mg/L at the downgradient property boundary;

(II) The minimum isolation distances between drainfields and wells (completed or proposed within the unconfined aquifer), property boundaries, or surface waters as determined by the analysis described in Appendix B and provided in the application will be achieved or exceeded on each lot; and

(III) The analysis described in Appendix C is provided in the application and determines that nitrates from on-lot sewage systems will not exceed 10 mg/L in existing or proposed on-site public water supply wells, or off-site public water supply wells (completed or proposed within the unconfined aquifer).

(B) Unless the application materials demonstrate through fate and transport analysis that leachate will not impair ground water and/or surface water quality or use, enhanced treatment systems capable of achieving, at a minimum, the enhanced treatment standard must be used where:

(I) Small wastewater systems overlying unconfined Class I groundwater as defined in Chapter 8 of Wyoming Water Quality Rules and Regulations and designed in accordance with Chapter 11, Part D, Wyoming Water Quality Rules and Regulations fail to comply with one or more of the standards established in Section 7 (viii) (A) (I) through (III) of this section; or

(II) The geologic setting of the proposed subdivision indicates that sewage leachate may come into contact with faults, fractures, or karst features.

(C) Enhanced treatment systems must be capable of achieving, at a minimum, the following treatment standards prior to additional treatment or subsurface discharge:

(I) Fecal Coliform: < 800 colonies/100 mL (Maximum 30 day geometric mean);

(II) Total Kjeldahl Nitrogen: < 25 mg/L (Maximum 30 day average).

(D) Where an enhanced treatment system is used it must be constructed and operated in conjunction with a subsurface disposal system that meets or exceeds the requirements of Chapter 11, Part D, Wyoming Water Quality Rules and Regulations.

(E) Where enhanced treatment systems are proposed or required, applications must contain a system design, developed and certified by a Wyoming licensed engineer, documenting the system's ability to achieve the required treatment standards, and include:

(I) Plan view and cross-section view of a proto-type enhanced wastewater treatment system;

(II) Enhanced treatment system performance standards for the proposed system(s);

(III) Number of bedrooms or average daily volume of wastewater flow;  
and

(IV) Operation and maintenance (O&M) requirements necessary to ensure optimum system performance, which include:

(1.) Sampling points for effluent quality monitoring prior to discharge to the leach field shall be identified.

(2.) A conceptual schematic of how the system is constructed and how it is designed to work, including the flow paths of the waste, re-circulation pathways, detention or contact times, etc.

(3.) A complete set of the manufacturer's O&M recommendations and specifications for the system, including part names and identification numbers for each of the system components for replacement purposes.

(4.) A summary or overview of the O&M requirements for all aspects of the system, identifying by component the frequency of inspection or servicing required and type of service needed to be performed to maintain the proper performance of the system.

(ix) Identification of the nearest facility that can and will accept septage wastes, and any limits, or conditions, of acceptance.

## Section 8. **Standards for Water Supply Systems**

(a) All applications shall contain the following information:

(i) Identification of the type of water supply system proposed to serve the subdivision and identification of the entity or entities responsible for the design, construction, operation and maintenance of the proposed facility;

(ii) The estimated average and maximum number of gallons per day for the subdivision water supply system;

(iii) Documentation that the proposed water supply system will be compatible with and not adversely affected by the sewage system proposed for the subdivision or any other sources of pollution within a reasonable distance;

(iv) List of all surface and groundwater rights which will be used or which may be affected, including state engineer application and permit numbers and description of expected effects;

(v) Plans for the mitigation of water right conflicts resulting from the use of water within the proposed subdivision; and

(vi) The information required by W.S. 18-5-306 (a) (xi).

(b) In addition to the information required in part (a) of this section, applications proposing to connect to an existing water supply system shall contain the following:

(i) Documentation concerning the potability of the proposed water supply for the subdivision as evidenced by historic water quality analytical data and current compliance status;

(ii) Certification by the owner of the water distribution and treatment facilities that the system can and will provide adequate service to the proposed subdivision. This certification should address the willingness and a commitment of the owner to provide service, as well as the hydraulic capacity of the distribution system and the ability of the treatment facilities to provide potable water to the proposed subdivision;

(A) The certification shall clearly identify the point of connection if the connection is not within the boundaries of the proposed subdivision.

(B) It is the responsibility of the owner to consider the capacity and ability of the system to provide water service to the proposed subdivision in accordance with existing laws, regulations and permit requirements.

(iii) The information required by Section 6, Chapter 12, Wyoming Water Quality Rules and Regulations shall be provided by a registered professional engineer. If the necessary information is not already available, the owner of the water system has the discretion to require the subdivider to provide the required information.

(iv) The party responsible for operation and maintenance of the subdivision distribution system will provide for certified operators pursuant to Chapter 5, Wyoming Water Quality Rules and Regulations.

(c) In addition to the information required in part (a) of this section, applications proposing to develop a new centralized water supply system shall contain the following:

(i) A demonstration that the water supply system is sufficient in terms of quality, quantity and dependability and will be available to ensure an adequate water supply system for the type of subdivision proposed. The report shall include a narrative summary of:

(A) Where the water supply system source is derived from groundwater, the geologic setting of the water supply system source and the area of influence such as nearby communities, sources of pollution, surface water bodies and aquifers described by a Wyoming registered professional geologist;

(B) A written report demonstrating that the proposed source is sufficient in terms of quality, quantity and dependability for the type of subdivision proposed;

(C) Source of the water to be used including proposed and existing surface and groundwater facilities and their locations;

(D) The proposed disposal of water not consumed, including water obtained under permits, storm drainage, dewatering, sewage and other wastewater sources;

(E) A delineation of primary sources of water, secondary sources and occasional or seasonal sources;

(F) Graphic location of all water supply sources including wells, raw water intakes, treatment facilities, treated water storage facilities and ponds;

(G) Documentation of all data sources on the occurrence and availability of surface and groundwater;

(H) Historic stream flows and well levels;

(I) Senior water rights;

(J) Flood damage and flood protection; and

(K) Impact of and protection from supply shortages.

(ii) The information required by Chapter 12, Section 6 of Wyoming Water Quality Rules and Regulations.

(iii) Confirmation that the owner of the subdivision distribution system will provide for certified operators pursuant to Chapter 5, Wyoming Water Quality Rules and Regulations.

(iv) Water quality data that is representative of the proposed drinking water source must be provided for the metals, inorganic constituents, and microbial constituents with Maximum Contaminant Levels (MCLs) established pursuant to the federal Safe Drinking Water Act.

(d) In addition to the information required in part (a) of this section, applications proposing to use on-lot wells or surface water that will serve fewer than 25 people shall contain information describing the potential availability and quality of groundwater or surface water proposed within the subdivision. This information may consist of new data, existing data on other working wells in the area, or other data, including drilling logs, from a test well drilled within the proposed subdivision indicating soil types, depth, quantity and quality of water produced in the test well.

(i) For subdivisions proposing to use on-lot wells or surface water that will serve individual residences or fewer than 25 people, water quality data that is representative of the proposed drinking water source must be provided for the following analytes:

(A) Total Dissolved Solids (TDS)

(B) Nitrate + Nitrite as N

(C) Total Coliform

(D) Sulfates

(E) Calcium

(F) Magnesium

(G) Sodium

(H) Chloride

(I) Iron

- (J) Zinc
- (K) Lead
- (L) Fluoride
- (M) Manganese
- (N) Copper
- (O) Arsenic
- (P) pH
- (Q) Additional constituents as may be deemed necessary by the department.

(ii) Documentation of activities, within a distance of one quarter ( $\frac{1}{4}$ ) mile of the subdivision's external boundaries, that may have potential to adversely effect the quality of the drinking water supply.

**Section 9. Delegation of Review Authority to Counties**

(a) Pursuant to W.S. 18-5-306 (c), to the extent requested by a county government, the administrator of the Water Quality Division, with the approval of the director of the Department of Environmental Quality, shall delegate authority to the county to:

(i) Review and approve any reports or studies required by this chapter and directed at determining the safety and adequacy of the proposed sewage or water supply system contained as part of a subdivision application;

(ii) Review and approve enhanced treatment systems, in accordance with Section 5, Chapter 11 of Wyoming Water Quality Rules and Regulations, that will meet or exceed the applicable standards within this chapter;

(iii) Issue construction permits as required by W.S. 35-11-301(a) (iii), and;

(iv) Issue operating permits as authorized by W.S. 35-11-301 (a) (iii).

(b) Any authority delegated under this section shall be subject to the following conditions:

(i) The county entity shall demonstrate to the administrator of the Water Quality Division that all sewage or water supply systems will be reviewed by a qualified professional with expertise in surface and groundwater protection from pollution and safe and adequate water supply systems;

(ii) The county entity shall demonstrate that the review of water supply and sewage systems will be in a manner as stringent as the Department of Environmental Quality would require under this section;

(iii) The review of subdivisions with a proposed sewage system consisting of wastes requiring an underground injection control permit under Department of Environmental Quality regulations or sewage systems with a proposed surface water discharge shall not be delegated to the county; and

(iv) The administrator shall periodically review the administrative programs of each county governmental entity receiving a delegation of authority under this section and may, with the consent of the director, revoke or temporarily suspend the delegation agreement entered into with any entity which has failed to perform its delegated duties or has otherwise violated the terms of its agreement of delegation.

(c) To ensure consistent application of this rule, delegation agreements shall include an identification of methods and reporting for oversight of the county's delegated authority.

/pjb  
2-2586-doc.wpd

## Appendix A

### Cumulative Nitrate Loading Analysis

In order to calculate the nitrate concentration from multiple septic systems at the downgradient property boundary of the proposed subdivision the following nitrogen mass balance equation (Wehrmann Model) is used. If  $C_o$  exceeds 10 mg/L  $\text{NO}_3^-$  as N, WDEQ recommend to the County Commission that the subdivision not be approved unless modified to achieve the standards within this chapter.

$$C_o = \frac{V_b C_b + V_i C_i + V_s C_s - V_p C_p}{(V_b + V_i + V_s - V_p)}$$

Where:

- $C_o$  = diluted concentration of  $\text{NO}_3^-$  as N leaving the subdivision
- $V_b$  = volume of ground water entering the subdivision from upgradient area
- $C_b$  = ambient concentration of  $\text{NO}_3^-$  as N contained in the ground water entering the subdivision
- $V_i$  = volume of precipitation infiltrating beneath the subdivision
- $C_i$  = concentration of  $\text{NO}_3^-$  as N contained in the infiltrating precipitation
- $V_s$  = volume of septic effluent introduced beneath the subdivision
- $C_s$  = concentration of  $\text{NO}_3^-$  as N contained in the septic effluent (assume 40 mg/L for conventional septic systems, and manufacturer specifications (mg/L) for enhanced treatment systems)
- $V_p$  = volume of ground water pumped by wells beneath the subdivision (use only if same aquifer as  $V_s$ )
- $C_p$  = concentration of nitrate-nitrogen contained in the pumped ground water

Source: Wehrmann, H.A. 1984. Managing Ground Water Nitrate Quality by Mass Balance Modeling in the Rockton-Roscoe Area, Illinois. In *Proceedings of the NWWA Eastern Regional Conference on Ground Water Management*, National Water Well Association, Dublin, Ohio, pp. 558-587.

## Appendix B

### Minimum Isolation Distance Analysis

#### VERTICAL TRAVEL TIME CALCULATION:

The following equation is used to determine the vertical travel time ( $t_1$ ) from the leach field to the water table:

$$\text{Given: } t_1 = d * \theta \div 0.5(\alpha)$$

Where:

$t_1$  = vertical travel time (years)

$\alpha$  is total recharge (effluent + precipitation in cm/yr)

$\theta$  is volumetric soil moisture in a sandy clay (mL/cm<sup>3</sup>)

$d$  is the depth to groundwater (cm)

**0.5** is the infiltration factor (assumes 50% of precipitation will infiltrate the soil)

(Note:  $\alpha$ ,  $\theta$ , and  $d$  will change from site to site.)

Example calculation of  $\alpha$ :

Assuming that 100 gallons per day of wastewater will be generated per bedroom, a typical 3 bedroom house is expected to discharge an average of 300 gallons per day.

$$\begin{aligned} \text{Total yearly effluent discharge} &= 300 \text{ gallons/day} * 365 \text{ days/year} * 1 \text{ ft}^3/7.48 \text{ gallons} \\ &= 14,639 \text{ ft}^3 \end{aligned}$$

Next, calculate the required soil absorption surface area (square feet) by referencing Figure 7 of Chapter 11, Part D, Section 38 (a) of Water Quality Rules and Regulations. The sizing of a leach field is dependant upon the soil percolation rate and the average daily effluent discharge. For this example use the median soil percolation rate of 15 minutes per inch. Also, use the previously calculated 300 gallons per day effluent discharge per house.

$$\text{Required soil absorption infiltrative area} = 300 \text{ gallons/day} * 1 \text{ ft}^2 \text{ day}/0.52 \text{ gallons} = 577 \text{ ft}^2$$

Next, calculate the pro-rated inches per year of effluent recharge to the aquifer:

$$14,639 \text{ ft}^3 * (577 \text{ ft}^2)^{-1} = 25.4 \text{ ft} * 12 \text{ inches/ft} = 304 \text{ inches/year}$$

To obtain TOTAL average annual recharge to the aquifer (effluent + precipitation) add the average annual precipitation for the area (15 inches/year) to the pro-rated effluent recharge, which equates to 319 inches/year or 810 cm/year ( $\alpha$ ). Note the average annual precipitation for an area can be obtained from Chapter 17, Wyoming Water Quality Rules and Regulations (Figure 2) or from the USDA. National Resources Conservation Service.

**Volumetric Soil Moisture Content at Field Capacity**

<b>Soil Type</b>	<b>Volumetric Soil Moisture Content @ Field Capacity, <math>\theta</math>, mL/cm<sup>3</sup></b>
Cobble sand	0.045
Sand	0.062
Sandy loam	0.190
Loam	0.232
Silty loam	0.284
Sandy clay loam	0.244
Clay loam	0.310
Silty clay loam	0.342
Sandy clay	0.321 (default)
Silty clay	0.371
Clay	0.378

\* Source: WDEQ Water Quality Rules and Regulations, Chapter 17

## HORIZONTAL TRAVEL TIME CALCULATION:

The following equation is used to determine, based upon the advective flow equation, the distance at which leachate in groundwater will reach a downgradient well or surface water body, or migrate beyond the property boundary over a travel-time period of two years\*.

The distance ( $x$ ) which leachate will migrate vertically ( $t_1$ ) and horizontally ( $t_2$ ) over a travel-time period of two years ( $t$ ) is calculated as follows:

Calculate horizontal travel time ( $t_2$ ):

$$(t_2) = 2 \text{ years} - (t_1)$$

Where:

$$(t_1) = \text{vertical travel time}$$

Calculate the horizontal linear velocity:

$$\text{Given: } v = ki/n$$

Where:

- $v$  = average groundwater linear velocity
- $k$  = hydraulic conductivity of the saturated aquifer (feet/day)
- $i$  = hydraulic gradient (feet/feet)
- $n$  = effective porosity (dimensionless)

Next, calculate the horizontal travel distance,  $x$ :

$$x = t_2 * v$$

- $t_2$  = horizontal time of travel
- $x$  = the minimum allowable isolation distance

\* If the calculated vertical travel time is 2 years or greater the horizontal travel time analysis does not need to be completed.

Source: Fetter, C.W. 1994. Applied Hydrogeology, 3<sup>rd</sup> Edition, Prentice-Hall, New Jersey, 691 pp.

## Appendix C

### Public Water Supply Analysis

The following equations are used to calculate the nitrate concentration at a public drinking water supply well from drainfields that fall within the capture zone of the well, as defined below. If  $C_p$  exceeds 10 mg/L  $\text{NO}_3^-$  as N, WDEQ will recommend to the County Commission that the subdivision not be approved unless modified to achieve the standards within this chapter.

First, calculate the capture zone for the water supply well using the following formula:

$$CFR = \sqrt{Qt / 7.48nH\pi}$$

Where:

$CFR =$	Calculated fixed radius of pumping well
$Q =$	average annual pumping rate (gallons/year)
$t =$	time of travel (years); assume 2 years unless a steady-state capture zone is calculated.
$7.48 =$	conversion factor ( $\text{ft}^3$ to gallons)
$n =$	effective porosity
$H =$	length of well screen (feet)
$\pi =$	3.14

Next, the volume of aquifer water flowing beneath a drainfield located within the capture zone is calculated using the following formula:

$$Q_{leach} = (KiA)7.48 * z$$

Where:

$Q_{leach} =$	volume of water flowing beneath the drainfield (gallons/day)
$K =$	hydraulic conductivity (feet/day)
$i =$	hydraulic gradient
$A =$	cross-sectional dimensions of drainfield (length x depth); assumed to be 75 feet long by 30 feet deep.
$z =$	number of wastewater treatment systems within the CFR

Next, the nitrate concentration beneath the drainfield is calculated by mixing the septic leachate with the aquifer water flowing beneath the drainfield ( $Q_{leach}$ ) using the following formula:

$$C_r = ((Q_{septic} * C_{septic}) + (Q_{leach} * C_{leach})) / (Q_{septic} + Q_{leach})$$

Where:

$C_r$  = diluted nitrate concentration beneath the septic drainfield (mg/L)

$Q_{septic}$  = discharge of septic (gallons/day) =  $(300 * z)$

$C_{septic}$  = average nitrate concentration of septic leachate (assume 40 mg/L for conventional septic systems; manufacturer specifications (mg/L) for enhanced treatment systems)

$Q_{leach}$  = volume of water flowing beneath the drainfield (gallons/day)

$C_{leach}$  = ambient nitrate concentration in ground water (mg/L)

300 = average daily leachate discharge for a 3 bedroom home

$z$  = number of wastewater treatment systems within the CFR

Next, the volume of water contained within the well cylinder (from pumping) is calculated using the following equation:

$$Q_{well} = n((\pi)(HCFR^2)) * 7.48 / 730$$

Where:

$Q_{well}$  = well discharge (gallons/day)

Finally, the concentration of nitrates within the well cylinder is calculated using the following equation:

$$C_p = ((Q_{leach} + Q_{septic} * C_r) + (Q_{well} * C_{well})) / (Q_{leach} + Q_{septic} + Q_{well})$$

Where:

$C_p$  = Concentration of nitrates within the pumping well (mg/L)

$C_{well}$  = ambient nitrate concentration in ground water (mg/L) =  $C_{leach}$