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MEMORANDUM

To: Aquifer Protection Section Central Office
Aquifer Protection Section Regional Supervisors
Interested Parties

From: Ted L. Bush, Jr., Chief
Aquifer Protection Section 

Subject: Water Balance Calculation Policy

For non-discharge wastewater irrigation projects, the effluent storage calculation may be the most critical success factor. Historically, many wastewater irrigation systems have experienced runoff and ponding as a result of insufficient storage and/or excessive loading rates. The Division has previously used the method from the *EPA Process Design Manual: Land Treatment of Municipal Wastewater Effluents (EPA 625/R-06/016)*. This policy uses the same basic method; however, there are additional considerations that are addressed. In addition to this document, the reader should review the applicable rules in 15A NCAC 02T, the Soil Scientist Evaluation Policy¹ and the Hydrogeologic Investigation and Reporting Policy². In addition, each site should be considered individually and may require more storage than provided by this policy. This policy does not apply to individual single-family residence systems permitted under 15A NCAC 02T .0600.

Water Balance / Storage Calculations

Storage requirements shall be based on the following information: 80th percentile yearly precipitation; potential evapotranspiration (PET); soil drainage based on actual (measured) saturated hydraulic conductivity (K_{sat}); groundwater mounding; agronomic rates; crop maintenance considerations; rainfall inputs into the storage unit; and wastewater design flows.

Allowable irrigation shall be calculated by subtracting outputs from inputs. Wastewater generated in excess of allowable irrigation is the required storage for the system. Over a 12-month period there must be a net positive allowable irrigation. If the water balance calculation results in zero storage required, a minimum amount of storage must still be provided since irrigation cannot occur during inclement weather (i.e., precipitation, windy conditions, freezing conditions, etc.), or during cover crop maintenance. For systems serving residential facilities not covered under 15A NCAC 02T .0600 (e.g., municipalities, subdivisions, residential institutions, etc.) this must be at least 14 days. This requirement is also not applicable to high-rate infiltration systems (Section .0700), infiltration basins (Section .0800), and similar systems, where information is submitted clearly documenting that the effluent can be assimilated regardless of precipitation events or temperature and there are no crop or equipment maintenance issues that would necessitate storage.

¹ The Soil Scientist Evaluation Policy is available on the internet at: <http://h2o.enr.state.nc.us/lau/policies.html>

² The Hydrogeologic Investigation and Reporting Policy is available at: <http://h2o.enr.state.nc.us/lau/policies.html>

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The calculated storage volume does not include freeboard requirements or permanent volume (e.g., below pump cutoff, treatment volume, etc.). Calculations for storage requirements can be made by any licensed professional developing reports for the overall project (LSS, PE, or LG); however, the calculations must be submitted under that professional's signature and seal. Overall, the most limiting factor of those considered (soil drainage, groundwater mounding analysis, nutrient limitation, or crop management activities) shall be used to determine the required storage and the long-term loading rates.

A. Rainfall consideration

The 80th percentile yearly precipitation shall be used. This is the expected annual amount of rainfall equaled or exceeded only 2 years out of 10. This annual value shall be pro-rated over the year based upon factored monthly average precipitation. The source data shall be representative of the area where the facility is (will be) located and shall be based on long-term data (minimum of 30 years).

B. Potential Evapotranspiration

PET losses shall be calculated using the Thornthwaite method, another pre-approved methodology, or representative data that is fully documented. Temperature values used in this calculation shall be from the same data location and time as the precipitation data used. If other PET data is used, it must be from a peer reviewed technical journal for the same area and proposed receiver crop and consistent with other area climatic data.

C. Soil Drainage

Soil drainage shall be based on site-specific measurements of the saturated hydraulic conductivity (K_{sat}) of the most restrictive soil horizon as detailed in the Soil Scientist Evaluation Policy. The soil drainage value used in the calculation shall be the geometric mean of K_{sat} from site specific measurements multiplied by a reduction factor (i.e., drainage coefficient). Typical values for this reduction factor are in the 4% - 10% range. Values exceeding 10% will be considered if technical information is provided documenting water movement allowing irrigation without compromising the risk of ponding or runoff as well as other considerations mentioned in this policy. In addition, this may require additional supporting information not required in 15A NCAC 02T (e.g., a hydrogeologic evaluation for systems less than 25,000 gallons per day). Considerations shall include reliability and consistency of K_{sat} data, depth to seasonal high water table, depth to the restrictive horizon including perched conditions, topography (e.g., slope), potential influences from adjacent areas (e.g., receiver site is a lower landscape position, adjacent receiver sites, etc.), artificial drainage, quality of wastewater, ability of cover crop to accept irrigation, etc. The designer shall provide a discussion of considerations in determining the reduction factor selected for the individual system. Soil drainage rates shall be used in the storage calculations if they are lower than those related to groundwater mounding, nutrient limitations, or crop management.

D. Groundwater Mounding Analysis

Of particular concern are irrigation sites with a shallow depth to groundwater and limited groundwater gradient. On these sites, a groundwater mounding analysis must document any limitations associated with a shallow groundwater table (Please refer to applicable sections of Subchapter 02T to determine when a Hydrogeologic Investigation and mounding analysis are required). Groundwater mounding analysis shall be in accordance with the Groundwater Modeling Policy³ related to these calculations. Irrigation rates used in the groundwater mounding analysis shall be used in the storage calculations if they are lower than those related to soil drainage, nutrient limitations, or crop management.

E. Nutrient Limitations and Crop Management Activities

Nutrient limitations and seasonal application times must be considered to ensure wastewater applications do not exceed agronomic rates (See 02T .0103(1)). Nitrogen needs of the crop shall not be exceeded except as provided by rules in 15A NCAC 02T. Crop management activities must also be considered as well. If cessation of irrigation is necessary for crop removal (e.g., hay), then sufficient time must be allocated at the appropriate times in the storage calculations. If management practices also result in potential compaction or other negative impacts on the soil, additional time to accomplish remedial actions may also be necessary. Nutrient limitation or crop management rates shall be used in the storage calculations if they are lower than those related to soil drainage or groundwater mounding.

F. Storage Unit

Precipitation into and evaporation out of the storage facility shall be considered for open storage vessels. If ponds, lagoons, etc. are included as treatment, precipitation inputs into those facilities shall also be considered. Documentation for evaporation rates shall be included with the calculation. Calculations shall be consistent with temperature and precipitation data used in PET and rainfall calculations. Storage unit surface area shall include all areas that drain into the unit.

All permit applications and other site reports shall be reviewed in accordance with this policy for any applications received on or after November 1, 2008. For any application received prior to that time, staff should review the application for adherence to the policy and discuss with the applicant and/or their consultants to encourage consistency with this policy.

³ The Groundwater Modeling Policy is available on the internet at: <http://h2o.enr.state.nc.us/lau/policies.html>