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NORTH CAROLINA
Environmental Quality

MEMORANDUM
April 18, 2019

To:	Interested Parties
From:	Linda Culpepper, Director, Division of Water Resources LC
Subject:	Approval of *Remedying Discharging Sand Filters* Nutrient Reduction Practice

I received and have reviewed the practice description entitled "Design Specifications and Nutrient Accounting for Remedying Discharging Sand Filters," dated April 5, 2019. I approve the use of this practice as specified therein toward compliance with Existing Development Stormwater rules, and where it is allowed by other rules, under Division nutrient strategies. This practice adds to the toolbox of management options contributing to more cost-effective water quality restoration in the state.

I understand that this nutrient reduction practice has been developed by the Division's Nonpoint Source Planning Branch in consultation with subject matter experts, vetted through the Nutrient Scientific Advisory Board (NSAB), made available for public comment from December 4, 2018 to January 8, 2019, and that the final product was endorsed by the NSAB at its April 5, 2019 meeting.

Subject to changes in governing nutrient strategy regulations, this practice may be revised in the future through Director approval.

cc: Jim Gregson
Tom Fransen
Rich Gannon
Patrick Beggs

Design Specifications and Nutrient Accounting for Remedying Discharging Sand Filters

I. Summary

A. Description

Remedying Discharging Sand Filters (DSF) is the practice of replacing discharging sand filter onsite wastewater systems serving single family residences with alternatives to reduce nutrient loading to surface waters. As discharging systems, DSF's are treated on an individual basis, not a programmatic basis; credit is given for each system improved.

Three Creditable Remedies:

1. Discharging TS-II Equivalent (nitrogen reducing) System
2. Discharging TS-II WITH Subsurface Soil Dispersal System
3. Connection to a Centralized NPDES Permitted Wastewater Treatment Plant (WWTP)

B. Utility

Discharging sand filter systems are typically found in areas where drainage issues make soils unsuitable for conventional onsite septic systems. Replacing or upgrading these systems results in nutrient load reduction that can be counted towards load reduction requirements under applicable Division nutrient rules.

C. Applicability

This practice applies toward compliance with Existing Development stormwater rules and may be implemented by any credit seeking party.

D. Credit Overview

Credit varies depending on the type of system being replaced, the type of improvement or remedy, and the number of bedrooms served by the system.

Table 1: Range of Nutrient Reduction for Various DSF Types (2-Bedroom Home)

Nutrient	Nutrient Load Reduction Range (lb/yr)		
	Discharging TS-II Equivalent	Discharging TS-II WITH Subsurface Soil Dispersal	Connection to a Centralized WWTP*
Nitrogen	0 - 4.5	6.4 - 11.0	6.6 - 11.1
Phosphorus	(-1.35) - 0	1.35 - 2.70	1.35

*Receive 100% reduction credit for the DSF load connected to a WWTP.

II. Practice Design and Implementation

Acronyms used:

- **DWR** - Division of Water Resources, Department of Environmental Quality
- **DSF** – Discharging Sand Filter
- **NPDES** - National Pollutant Discharge Elimination System
- **OWPB** - Onsite Wastewater Protection Branch, Department of Health and Human Services
- **TN** - Total Nitrogen
- **TP** - Total Phosphorous
- **WWTP** - Wastewater Treatment Plant

Discharging sand filters (DSF) are residential wastewater treatment systems (permitted under the general NPDES permit NCG550000 or NCG570000) that use some form of treatment after the primary treatment a septic tank provides and are permitted to discharge to surface waters, ditches or the ground surface. There are four major types of DSFs and three possible remedies to replace/repair/eliminate them.

<u>Three Major Types of Discharging Sand Filters</u>:

1. Gravity-dosed, single-pass sand filters with regular discharges, either discrete piped or surfacing;
2. Gravity-dosed, single-pass sand filters with no or infrequent discharges (unlined or bottomless systems) whether discrete piped or surfacing;
3. Recirculating filters and other advanced discharging systems.

<u>Three Creditable Remedies</u>:

1. **Upgrade to Discharging TS-II Equivalent (nitrogen reducing) System.** This practice involves the installation of a DWR-approved advanced treatment system, which currently includes recirculating sand filters and EZ Treat and Orenco AdvanTex proprietary recirculating media filter systems.

2. **Upgrade to a Discharging TS-II Equivalent (nitrogen reducing) System WITH Subsurface Soil Dispersal.** This practice involves the installation of an OSBP-approved advanced treatment system AND the installation of an onsite subsurface drain field. Treatment options include the same systems as described in #1 above. The advanced wastewater treatment systems and the subsurface drainage system needs approval by the local health department.

3. **Connect to a Centralized NPDES Permitted Wastewater Treatment Plant (WWTP)**. This practice involves decommissioning or ending the use of the discharging sand filter and connected treatment system and connecting the residence to a permitted NPDES wastewater treatment system such as a municipal WWTP, via a sewer system.

A. Qualifying Conditions and Limitations

1. Applicability

This practice applies toward compliance with Existing Development stormwater rules and may be implemented by any credit seeking party such as a local government or a federal/state agency.

2. Preconditions

No mandatory preconditions. The proximity of existing sewer lines may make connection to permitted NPDES wastewater treatment plant the most viable option. In cases where sewer is either unavailable or cost prohibitive, replacement of the DSF system with a TS-II or equivalent system may still be a cost-effective option.

3. Constraints

- **Upgrade to Discharging TS-II Equivalent (nitrogen reducing) System** requires DWR approval.
- **Upgrade to a Discharging TS-II Equivalent (nitrogen reducing) System WITH Subsurface Soil Dispersal** requires DWR and OWPB approval.
- **Connect to a NPDES Permitted System** requires an agreement with a wastewater treatment plant.

B. Design Guidance

1. Required Elements

Discharging TS-II equivalent systems permitted by DWR must adhere to the standards, limits, management practices, and reporting requirements provided in the general NPDES permit (NCG550000 or NCG570000) to which they are subject. The following requirements are found in 15A NCAC 18A Section .1900, which refers to the NC laws and rules for sewage treatment and disposal systems and includes Rules .1969 and .1970 applies to subsurface system approved by OWPB and local health departments.

- Major installation requirements for all OWPB approved onsite systems, including requirements such as setbacks from wells, design flows, and minimum vertical separation are established in Rules 15A NCAC 18A Section .1900.
- Specific design elements for all TS-II Advanced treatment systems are addressed through existing regulations provided in Rules .1969 and .1970 and product specific approvals.
- Rule .1969 "Approval and Permitting of On-Site Subsurface Wastewater Systems, Technologies, Components, or Devices" provides the process through which a product or system not specifically listed in the Section .1900 “Sewage Treatment and Disposal System” rules, can be approved for use in subsurface wastewater systems in NC.

- Rule .1970 "Advanced Wastewater Pretreatment Systems" establishes advanced pre-treatment performance standards. It addresses TS-II system effluent quality standards, siting and sizing requirements, vertical separation requirements, horizontal setbacks, and design, installation requirements, inspections, and permitting.

Onsite wastewater design professionals may propose provisional or innovative systems that remove nutrients better than the system being replaced. Such departure from Section 1900 rules requires an applicant to provide technical justification to OWPB. Requirements include demonstrating the proposed system design is equally or more protective of water quality than the system being replaced. Vague, anecdotal or isolated evidence is not acceptable. If approved, alternative designs may receive lower regulatory credits, based on case-specific review. Contact OWPB for guidance.

C. Installation/Implementation

1. Required Elements

General installation requirements, maintenance procedures, and inspection frequency for OWPB approved TS-II systems are provided in 15A NCAC 18A Section .1900, Rule .1970, and the system specific approval. Innovative and provisional systems are required to be installed by a manufacturer-authorized installer according to the manufacturer's installation specifications and system-specific conditions prescribed in the product’s approval document on the OWPB website.

D. Operation and Maintenance

1. Required Elements

General Installation requirements, maintenance procedures and inspection frequency for OWPB approved TS-II systems are provided in 15A NCAC 18A Section .1900 and the system-specific approvals.

2. Recommended Elements

Local governments planning to achieve nutrient reduction credit using these measures can adopt USEPA’s Decentralized Management Model II to improve the overall management of these discharging systems. The key provisions of this model program include requiring maintenance service contracts and tracking, system inventories. Search for “Voluntary National Guidelines for Management” at https://www.epa.gov/septic/septic-systems-guidance.

E. Credit Award and Renewal

DWR permitted TS-II equivalent systems must adhere to the standards, limits, management practices, and reporting requirements provided in the general NPDES permit (NCG550000 or NCG570000) to which they are subject.

System performance and reporting for OWPB approved TS-II systems is described in Item (n) of 15A NCAC 18A .1970. It requires:

- certified wastewater treatment facility operators (ORC) monitor each installed system
- annual performance reports submitted to the local health department

Monitoring type and frequency varies by system type, the designated performance standard, system flow, and history of performance. These parameters are described in the systems approval document on the OWPB website and in sub-items (n)(1) through (n)(5) of rule .1970. Compliance is determined by the requirements described in sub-item (o) of the same rule.

To track credit and ensure continued credit, copies of the system performance reports will be required by DWR.

DWR permitted TS-II equivalent systems must adhere to the reporting requirements provided in the general NPDES permit (NCG550000 or NCG570000) to which they are subject.

Verification of reductions achieved through connection to a permitted NPDES facility will be handled through the WWTP's annual discharge reports provided to DWR.

III. Nutrient Credit Estimation

A. Credit Method Description

The load estimation method is a 2-step calculation comparing the remedy measure's per capita loading rate to the original DSF loading rate and multiplying by the assumed number of occupants.

- To determine the credit rate (lb/capita/year), the remedy load rate is subtracted from the DSF load rate it is replacing. (Table 2 & 3)
- To calculate the per system reduction credit (lb/year) which is the credit the onsite system will be given, the credit rate from Table 2 & 3 is multiplied by the number of people in the household where the repair takes place (Table 3). The number of people is based on the number of bedrooms.

The loading rates, reduction credits, and number of people per home in Tables 2-4 are drawn from *Tetra Tech, 2013*.

For context, the nutrient loading rates for DSF systems are less than direct septic tank effluent discharge, which is estimated to have per capita nutrient loading rates of 11.0 lb/capita/yr TN and 1.8 lb/capita/yr TP.

Remedied systems will receive the credit if designed, constructed and maintained in accordance with OWPB Rules. Please note that maintenance of credit is contingent upon compliance with proper maintenance and inspection schedules.

Table 2: TN Load Reduction Credit Matrix

Type of DSF	DSF Loading Rate (DSFLR) (lb/capita/yr)	**Remedy**		
		Discharging TS-II Equivalent	Discharging TS-II WITH Subsurface Soil Dispersal	Connection to a Centralized WWTP
		Remedy Loading Rate (RLR) (lb/cap/year)		
		4.4	.13	0*
		Credit Rate (CR)		
Single-pass w/ regular discharges	7.4	3.0	7.3	7.4
Single-pass w/ no or infrequent discharges	7.4	3.0	7.3	7.4
Recirculating filters and other advanced discharging systems	4.4	0	4.3	4.4

** Assumes all load transferred to major NPDES sector*

Table 3: TP Load Reduction Credit Matrix

Type of DSF	DSF Loading Rate (DSFLR) (lb/capita/yr)	**Remedy**		
		Discharging TS-II Equivalent	Discharging TS-II WITH Subsurface Soil Dispersal	Connection to a Centralized WWTP
		Remedy Loading Rate (RLR) (lb/cap/year)		
		1.8	0	0*
		Credit Rate (CR)		
Single-pass w/ regular discharges	1.8	0	1.8	1.8
Single-pass w/ no or infrequent discharges	0.9	(-0.9)	0.9	0.9
Recirculating filters and other advanced discharging systems	1.8	0	1.8	1.8

** Assumes all load transferred to major NPDES sector*

Table 4: Assumed Number of People Per Household for Various House Sizes

Number of Bedrooms per Household	**Assumed Number of Persons per Household (PH)**
0-2	1.5
3	2.2
4	2.9
5	3.7
Each Additional	0.7

B. Calculation Instructions

The following equation is used to determine N and P removal credit for a given remedy at a residence.

RC = CR x PH = (DSFLR - RLR) x PH

Where:

- RC = Reduction credit (lb/year, RC_N or RC_P)
- CR = Credit Rate (lb/capita/year) = (DSFLR - RLR)
- DSFLR = Discharging Sand Filter Loading Rate (lb/capita/year) from Table 2 and Table 3 for TN and TP, respectively
- RLR = Remedy Loading Rate (lb/capita/year) from Table 2 and Table 3 for TN and TP, respectively
- PH = # of persons per household (#people)

IV. Supporting Technical Information

A. Reductions Obtained

The reduction credit varies depending on:

a) the type of system being replaced,
b) the type of remedy, and
c) the number of bedrooms served by the system.

Letters a and b above result in the Remedy Loading Rates found in Tables 2 (N) and 3 (P). The Remedy Loading Rate is then multiplied by the # of persons per bedroom found in Table 4 to determine the Reduction Credit. A range results from the 3 variables. The two tables below show the range for 3- and 4-bedroom homes. The range for a 2-bedroom home is shown in Table 1.

Table 5: Range of Nutrient Reductions, Various DSF Types (3 BR Home)

Nutrient	Nutrient Load Reduction Range (lb/yr)		
	Discharging TS-II Equivalent	Discharging TS-II WITH Subsurface Soil Dispersal	Connection to a Centralized WWTP*
Nitrogen	0 - 6.6	9.46 - 16.06	9.68 - 16.28
Phosphorus	(-1.98) - 0	1.98 - 3.96	1.98 - 3.96

*Receive 100% reduction credit for the DSF load connected to a WWTP.

Table 6: Range of Nutrient Reduction, Various DSF Types (4 BR Home)

Nutrient	Nutrient Pollutant Reduction Range (lb/yr)		
	Discharging TS-II Equivalent	Discharging TS-II WITH Subsurface Soil Dispersal	Connection to a Centralized WWTP *
Nitrogen	0 - 8.7	12.47 - 21.17	12.76 - 21.46
Phosphorus	(-2.61) - 0	2.61 - 5.22	2.61 - 5.22

*Receive 100% reduction credit for the DSF load connected to a WWTP.

B. Example Calculation

Aromaville lies along a river and many of the older homes have septic systems. A survey of the systems found some with discharging sand filters (DSFs). DSFs can be upgraded in different ways to improve nutrient removal, regardless of whether they are malfunctioning or working as they were designed. Malfunctioning systems would be placed higher on the replacement priority list. One road adjacent to the river has 10 homes with discharging sand filters, all built about the same time, each with 3 bedrooms. Six of these homes abut land behind them that will soon hold a new development with municipal water and sewer. All 6 have single-pass DSFs, 4 with piped regular discharges and 2 with regularly surfacing discharges. These 6 DSFs will be decommissioned, and the homes connected to the municipal sewer system. The other 4 homes have single pass DSFs, 2 with no discharges, 1 with piped regular discharges, and 1 with regularly surfacing DSF system. The town, working with the homeowners will upgrade all 4 of these to a Discharging TS-II equivalent system.

Table 7: Calculations for Aromaville Example (3-BR Homes)

(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)
		N	**P**	**(from Table 4)**	**N**	**P**		**N**	**P**
Current DSF	**Remedy**	**Credit Rate (lb/capita/yr)**		**# people per house**	**Credit per house (lb/year)**		**# houses (10)**	**Total Credit per type of remedy**	
piped, regular discharge	connect to municipal system	7.4	1.8	2.2	16.28	3.96	4	65.12	15.84
regularly surfacing		7.4	1.8	2.2	16.28	3.96	2	32.56	7.92
no discharge	TS-II equivalent	3.0	(-0.9)	2.2	6.6	(-1.98)	2	13.2	(-3.96)
piped, regular discharge		3.0	0	2.2	6.6	0	1	6.6	0
regularly surfacing		3.0	0	2.2	6.6	0	1	6.6	0
Total Credit (lb/year)								**124.08**	**19.8**

RC = CR x PH = (DSFLR - RLR) x PH

Where:

- RC = Reduction credit (lb of nutrient, RC_N or RC_P)
- CR = Credit Rate (lb/capita/year) = (DSFLR - RLR)
- DSFLR = Discharging Sand Filter Loading Rate (lb/capita/year)
- RLR = Remedy Loading Rate (lb/capita/year)
- PH = # of persons per household (#people)

Use Table 2 and 3 to determine the appropriate Credit Rate for Columns C & D. Table 4 gives # people per house for Column E.

To determine the credit per house (Column F/G), multiply the credit rate (Column C/D) by # people per house (Column E). Multiply the credit per house (Column F/G) by the # houses (Column H) using a selected remedy to obtain the total credit for that type of remedy (Column I/J). Summing all Column I/J yields total N and P credit for the entire 10-house project.

For Nitrogen:

RC_N = CR x PH (for all 10 houses) = 124.08 lb/yr

For Phosphorous:

RC_P = CR x PH (for all 10 houses) = 19.8 lb/yr

C. Credit Basis and Relative Confidence

A Confidence Evaluation Matrix (NCDWR, 2018) confidence evaluation compares a range of factors regarding the available science used to determine nutrient credits and meant to guide further research. It is intended to lend structure and consistency to a qualitative evaluation process and can help determine the need for incorporating conservatism into final credit assignments. The matrix focuses mainly on the studies behind estimates, but also on the estimation methods themselves.

The matrix is a structured decision-making tool, designed to help compare different options by choosing one of the confidence levels for each of the eleven factors. Some factors may be more relevant to certain practices and studies. Lack of information or a low-confidence result for a factor does not connote disapproval.

In this case, the load estimation method is a direct comparison of the remedy measure's load to the original estimated load of the DSF, adding no other uncertainty to the assessment.

Using the Confidence Evaluation Matrix, relative confidence in the reductions estimated for Remedying Discharging Sand Filters is Medium to High.

D. Cost Analysis

The cost of implementing the various remedies described in this chapter is highly variable and site specific. Basic comparisons can be made though. The final decision may depend on who pays for the cost, who receives the credit, whether the cost is assessed over a period of years, and fact that it is a recurring credit. Using Columns F &

G from Table 7 we can compare two remedies: hooking up to a municipal system and installing a TS-II equivalent system.

Connection to an existing NPDES permitted discharge (WTTP) varies by municipality and can cost as little as $2,500. However, this low-end estimate assumes a sewer line is accessible in a location close the home desiring to connect. The cost of a one time $2,500 hookup fee translates to $154 per pound TN or $631 per pound TP. Both costs are included in the $2500. If existing sewer lines are not nearby, connecting to the city's sewer system can be considerably more expensive and would likely not be a cost-effective option.

Advanced TS-II equivalent systems can range in costs anywhere from $15K to $25K to install depending on soils, topography, and other site-specific conditions. Ultimately the cost effectiveness of each remedy must be assessed on a site by site basis. The cost of a $15K TS-II equivalent replacement system translates to $2273 per pound TN. (There is no Phosphorous removal improvement and thereby no P credit.)

E. Risks and Benefits

The focus of this guidance is nutrient load reductions through remedying discharging sand filters. However, it is important to recognize that nutrient reducing measures such as those described in this chapter may result in other benefits to the environment and quantifiable ecosystem services that further add to their overall value and desirability. In the case of remedying DSF's, additional benefits may be limited to additional reduction of fecal coliform levels through the elimination of surface discharges or through additional treatment prior to discharge.

F. References & Resources

15A NCAC 18A .1900 "Laws & Rules for Sewage Treatment & Disposal Systems”

15 NCAC 18A .1969 "Approval and Permitting of On-Site Subsurface Waster Water Systems, Technologies, Components, or Devices"

15 NCAC 18A .1970 "Advanced Wastewater Pretreatment Systems"

Chesapeake Bay Program Office (CBPO) 2013 *Recommendations of the Onsite Wastewater Treatment Systems Nitrogen Reduction Technology Expert Review Panel, Draft* Final Report. Onsite Sector Best Management Practices Panel, CBPO, U.S. Environmental Protection Agency.

City of Durham Stormwater Services. 2008. *Nutrient and Bacteria Characterization of Surface Discharging Sand Filter Systems.*

Hazen and Sawyer. 2013. *A Review of Onsite Wastewater System Performance and Nutrient Trading Policy to Support Falls Lake Nutrient Strategy Development.* Report Submitted to City of Raleigh Public Utilities Department, January 2013.

Metcalf and Eddy. 2003. *Wastewater Engineering, Treatment and Reuse.* 4th ed. McGraw Hill Higher Education, New York, NY.

NC Division of Water Resources – NPDES General Permits NCG550000 & NCG570000. https://deq.nc.gov/about/divisions/water-resources/water-quality-permitting/npdes-wastewater/npdes-permitting/general

NC Department of Health and Human Services 2013. *Experimental and Innovative Laws, Rules and Approval Process*. Prepared by the DHHS DEH Onsite Wastewater Protection Branch (OWPB), October 2013. https://ehs.ncpublichealth.com/oswp/approvedproducts.htm

NC Division of Water Resources Confidence Evaluation Matrix. 2018.

Tetra Tech. 2013 *North Carolina Piedmont Nutrient Load Reducing Measures Technical Report***.** Report Submitted to Division of Water Resources, September 2013.

USEPA. 2003. *Voluntary National Guidelines for Management of Onsite Wastewater Systems*

G. Credit Development Documentation

Design rules were subjected to a rigorous public process and scrutiny by technical experts, as such these design and operation requirements are considered reliable and sufficient for the purposes of sustained nutrient removal function. It is essential to sustained nutrient removal that single-family discharging systems receive ongoing operation and maintenance by a professional management entity or certified contract operator. Overall, while some amount of performance variability must be assumed associated with variation in actual levels of operation, practice O&M specifications are well developed, helping to minimize additional uncertainty regarding operational based loads.