COLORADO
Department of Public Health & Environment

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March 24, 2015

CJ Strain
Chief Technical Officer
Blue Water Technologies, Inc.
10450 North Airport Road
Hayden, ID 83835

Subject: Acceptance of the Blue PRO® and Blue NITE® Reactive Sand Filter as an Alternative Technology for Use in Domestic Wastewater Treatment Works in Colorado

Dear Mr. Strain:

The Water Quality Control Division (the Division) has received and reviewed information for the Blue Water Technologies, Inc. Blue PRO® and Blue NITE® reactive sand filter systems in accordance with section 1.8.0 of *Design Criteria for Domestic Wastewater Treatment Works Policy WPC-DR-1* (wastewater design criteria). The Blue PRO® and Blue NITE® system designs are accepted for use as an alternative technology subject to the design criteria in Table 1. This acceptance is not intended as a third-party certification of the technologies.

This acceptance addresses the following:

- Blue PRO® moving bed upflow reactive sand filter system to optimize co-precipitation, adsorption, and removal of phosphorus and metals, and regeneration of the sand media.
- Blue NITE® moving bed upflow reactive sand filter system to provide denitrification and regeneration of the sand media.

This acceptance applies only to the Blue PRO® and Blue NITE® moving bed upflow reactive sand filters and does not constitute construction approval for installation in domestic wastewater treatment facilities. **Review and approval for the design of any domestic wastewater facility proposing to use these technologies will be further reviewed on a site-specific basis by the Division** as required by Section 22.11(1) of the *Site Location and Design Approval Regulations for Domestic Wastewater Treatment Works 5CCR 1002-22* (Regulation 22) and the Colorado Water Quality Control Act (Act), Section 25-8-702, C.R.S. which states in part that: "No person shall commence the construction of any domestic wastewater treatment works or the enlargement of the capacity of an existing domestic wastewater treatment works, unless the site location and the design for the construction or expansion have been approved by the division."

Any modifications to the physical attributes or characteristics of this treatment technology must be submitted to this office for review and acceptance by the Division prior to sale in Colorado. This condition includes changes made to the Blue PRO® and Blue NITE® reactive sand filtration system (e.g., filter media, piping, mechanisms). For any changes to the process or equipment following the issuance of this letter, the Division will review any additional third party verification reports and issue a revised acceptance letter, or denial, as appropriate.

Table 1. Blue PRO® and Blue NITE® Moving Bed Upflow Reactive Sand Filter System Design Criteria:

Design Criteria
1. The approved facility design capacity shall be based on the maximum month average flow and loading. During the site-specific design review, calculations shall be submitted to justify the basis of design (e.g., filter loading, head loss, reagent dose). Flow equalization must be provided when the design peak daily flow is greater than twice the maximum month average daily flow. a. Flow to the Blue PRO® filter shall not exceed a design flow rate of 3.5 gpm/SF of filter surface area based on the maximum month average flow and 5 gpm/SF of filter surface area based on the peak hour flow. Blue PRO® filters shall have at least 60 inches of sand (top of cone to top of sand) or the loading rate shall be reduced proportionately. b. Flow to the Blue NITE® filter shall not exceed a design flow rate of 1.5 gpm/SF of filter surface area based on the maximum month average flow and 2.1 gpm/SF of filter surface area based on the peak hour flow. Blue NITE® filter shall have at least 80-inches of sand (top of cone to top of sand) or the loading rate shall be reduced proportionately. If nitrate concentrations are significantly below the levels provided in item 2(b) below, hydraulic loading rates can be increased on a case by case basis. 2. Influent Pretreatment Considerations. a. The Blue PRO® and Blue NITE® filters are primarily intended for treating secondary clarifier quality effluent. Pretreatment processes shall be incorporated into the site-specific process train, as required, to ensure that the turbidity of the influent to a filter does not exceed approximately 30 mg/L TSS and BOD5, more than five percent of the time within a 24-hour period and never exceeds approximately 45 mg/L TSS and BOD5. b. Provisions for pretreatment of wastewater shall be provided to ensure influent to a Blue NITE® filter has concentrations of: i. ammonia less than 5 mg/L, ii. nitrate less than 30 mg/L, iii. residual alkalinity greater than 50 mg/L, and iv. dissolved oxygen less than 4 mg/L. 3. Reagent Dosing. a. During filter operation, operators may see an increase in removal or decrease in reagent use due to recycle of reject water to upstream processes. The reagent feed design must include adequate capacity of the reagent feed pump to provide operational flexibility at a range of reagent flow rates as noted below. b. The Blue PRO® filters are expected to be used primarily for removal of ortho-phosphorus (e.g., using ferric chloride or ferric sulfate) and can also be used for removal of metals using similar or other reagents (e.g., potassium permanganate). For phosphorus removal alone, the dosing pumps shall be capable of providing a design reagent dosing rate up to 12 mg/L as Fe for peak flow with adequate turn down for low flows and lower doses. Higher dosing capacity may be needed for some conditions, such as alkalinity greater than 150 mg/L. For metals removal, bench scale testing results shall be provided and used to estimate the design reagent dosing rate and determine other necessary water chemistry adjustments (e.g., pH adjustment).

Pilot test results shall be provided if available. For removal of three or more constituents or wastewater with alkalinity greater than 150 mg/L, pilot test evaluations shall be conducted and include, but not be limited to, considerations for: alkalinity impacts, pH dependency, co-precipitation reactions, and beneficial and deleterious interrelationships between reagents. The design shall include provisions to minimize formation of chemical precipitates in pumps, valves, and pipes, based on the reagents proposed for the design. The design shall include evaluations of potential effluent limits for residual reagents or reaction products and necessary treatment considerations. Separate dosing pumps for second stage treatment shall be capable of providing a design reagent dosing rate at least 90% of the first stage dose, unless bench or pilot testing results indicate otherwise.

c. Denitrification in a Blue NITE® filter requires addition of a soluble carbon source to the influent to the filter. The dosing pumps shall be capable of providing a design methanol dosing rate (mg/L) up to [4 x (influent nitrate concentration mg/L)] for peak flow with adequate turn down for low flows and lower doses. The actual design basis for pump capacity will be based on the equivalent carbon content of the selected carbon source.

d. Reagent metering pumps shall include a minimum of two pumps (i.e., duty and standby) with variable frequency controls for low flow. Pumps shall meet filter manufacturer requirements and have chemical compatibility with anticipated conditions.

4. Treatment Credit. The domestic wastewater treatment plant must be designed to meet appropriate effluent discharge limits (e.g., Preliminary Effluent Limits or PELs, permit effluent limits). A facility with the Blue PRO® or Blue NITE® filter technology designed in accordance with these criteria is anticipated to have the following treatment efficiencies through a single stage. Additional, similar phosphorus and metals removal can be achieved with filters in series configuration.

    a. Blue PRO®: Phosphorus removal of 90%.

    b. Blue PRO®: Metals removal based on site-specific testing and design conditions.

    c. Blue NITE®: Nitrate removal of 80% at wastewater temperatures of 15 °C or greater. Nitrate removal of 90% can be achieved when influent nitrate concentrations are less than 15 mg/L, at wastewater temperatures of 15 °C or greater. No TKN or ammonia removal credit is granted for the treatment technology.

5. Airlift Pump Equipment. The Blue PRO® and Blue NITE® filters require adequate air capacity to operate the airlift pumps. Compressor capacity shall be able to provide a minimum of 5 scfm per airlift at 100 psig at the compressor. Compressors shall provide full capacity with largest unit out of service. The design must demonstrate adequate size and capacity based on site-specific conditions and treatment requirements including, but not limited to, elevation, temperature (e.g., seasonal, air, wastewater), pipe sizes, bends, etc. Adequate air dryer shall be included (e.g., refrigerated type if indoor, desiccant type if outdoor).

6. Alkalinity. Use of ferric based reagent in the Blue PRO® / Blue NITE® can lower alkalinity approximately 3 mg/L for 1 mg/L ferric ion. The wastewater must be shown to have sufficient alkalinity (i.e., 50 mg/L excess) or chemical treatment must be included to provide adequate alkalinity.

7. Temperature Adjustments. Design values are based on a wastewater temperature of 15°C or greater. At temperatures less than 15 °C, nitrate loading rate must be reduced, effectively increasing the treatment time that must be provided to achieve equivalent removal rate. Treatment rates (i.e., denitrification) shall be adjusted for anticipated Blue NITE® filter influent wastewater temperatures below 15°C by the following: loading at temperature T =

loading limit at 15 °C x ($1.06^{[T-15]}$) [from WEF, MOP 35, Biofilm Reactors, 2010, equation 5.2]. When loading is decreased, the loading rate shall be decreased by at least 25% at 10 °C to gain the accepted denitrification removal credit. Air or water heating methods may be provided to control the treatment process temperature (e.g., indoor filters, in-line heater or submersible water heater with control sensor).

8. The process design report shall include a description of considerations for low or no flow conditions to maintain treatment during all periods of the diurnal cycle. Designs for seasonal or similar operations shall include an effluent recirculation line to the main process to allow recirculation of effluent when starting treatment following shutdowns.
9. The process design report shall include a description of flows from the Blue PRO® and/or Blue NITE® filters being directed to other unit processes including the reject water, filter effluent, and potential bypass or overflow. The design for the receiving processes must be evaluated for hydraulic and treatment impacts and provisions must be included to mitigate impacts from the filter return flows, as needed. The process flow description shall indicate where and how the reject water is redirected (e.g., to head works, aeration basin, clarifier, waste, by pipe, channel, pump). The process design report must include an evaluation and plan that includes a discussion of residuals management considerations (e.g., metals removal), including as applicable:
    a. Expected waste stream generation quantities and anticipated physical and chemical characteristics for both wastewater discharges and waste materials.
    b. Adequate capacity to store and process waste materials under maximum and minimum flow conditions with redundant waste handling systems.
10. Design Redundancy. Installations shall have at least two Blue PRO® and/or Blue NITE® filters installed for each stage for facilities with design capacity equal to or greater than 40,000 gpd. Where two units are proposed, each unit shall have a design flow of at least 50 percent of the total design flow. Filters and appurtenances shall have the ability to handle the peak wastewater flow (hydraulic capacity, not treatment capacity) without overflow with the largest unit out of service. If a single filter unit is used for a stage, the installation shall include reagent feed pumps and compressors providing full capacity with the largest pump and compressor unit out of service. If a single filter unit is used for a stage, an emergency operation plan (e.g., equipment, procedures, emergency storage, hauling) must be provided to maintain operation during operational impairment, such as power failures, flooding, peak loads, equipment failure, and maintenance shutdowns (e.g., media addition or replacement).
11. If multiple filters are included in parallel, adequate flow splitting devices within the common filter feed channel must be provided to ensure appropriate flow to each unit.
12. For facilities where ambient temperatures can be below freezing, the design shall include adequate cold weather provisions (e.g., heat trace lines, insulated covers, installation in a temperature-controlled enclosure for above ground wet components).
13. Alarm. A compressor malfunction alarm must be provided. The design must identify how the alarm signal will notify operators of alarm activations, when the facility is attended and unattended.
14. Sand Media. Sand media shall be silica sand, spherical, smooth, non-angular surface meeting AWWA/ANSI B-100, having an effective size of 0.92 to 0.95 mm with uniformity coefficient of 1.5. Sand shall be installed, disinfected, and washed in accordance with filter manufacturer's requirements.

15. Filter Tank Design. Filter tank design must be sized in accordance with manufacturer minimum specifications for concrete, steel, or fiberglass reinforced plastic tanks. Below ground tanks must include adequate provisions to protect against tank buoyancy. Outdoor filters shall include covers or other provisions to preclude debris entry (e.g., leaves).
16. Maintenance Access. Design shall include provisions that allow the operator to access, operate, and maintain the treatment technology including observing and maintaining washout box, sand media, etc.
17. Other Processes Required. Although the treatment technology has major unit process components of a treatment plant, it does not constitute a complete package treatment plant and the particular site-specific design must include other unit processes (e.g., influent and effluent flow metering, organic removal, chemical addition, disinfection) to be a fully functioning wastewater treatment plant and meet effluent discharge limits. These other supporting unit processes will be evaluated during the site location and design reviews.
18. Manufacturer Review. A review letter issued by the manufacturer indicating the installation was designed in accordance with manufacturer recommendations must be included with the site-specific design submittal. The manufacturer's review may not supersede criteria in this acceptance. The manufacturer's review may not be substituted for all required engineering documentation and calculations stamped and signed by a Colorado licensed Professional Engineer.

Additional Operations and Maintenance Criteria

1. Startup Considerations. Design must include provisions for seeding Blue NITE® filters.
2. Design must include discussion of residuals management considerations, including expected solids generation quantities and quality, and a discussion of the method of final sludge disposal.
3. Design shall include provision for operator training including, but not limited to: start-up operations, normal operations, hydraulic fluctuations, temperature impacts, sand media monitoring and replacement, and residuals management.
4. An Operations and Maintenance (O&M) Manual shall be provided for all installations and be available for review by the Division during compliance inspections.
5. Individual operations plans shall include scheduled inspections, assessments, and maintenance of the filters, influent and effluent header channels or pipes, reject flow channels or pipes, and sand media condition as an operational safeguard. This plan for scheduled inspections and assessments should include a routine inspection at least annually.
6. Facility Classification. This technology has a Class B Domestic Wastewater Treatment Facility Classification, in accordance with Regulation 100 Water and Wastewater Facility Operators Certification Requirements, for facility flows up to 4.0 MGD.

The owner of the domestic wastewater treatment works is responsible for proper design, operation, and maintenance of the facility to meet permit effluent requirements.

Please be aware that any point source discharges of water from treatment facilities are potentially subject to a discharge permit under Colorado's State Discharge Permit System. Any point source discharges to state waters without a permit are subject to civil or criminal enforcement action.

As part of this review, the Division has evaluated the following documents:

- March 2, 2015 Submittal from Blue Water Technologies, Inc. requesting alternative technology acceptance for Blue PRO® and Blue NITE® filters.
- March 5, 2015 Submittal from Blue Water Technologies, Inc., providing additional requested information for the alternative technology review for Blue PRO® and Blue NITE® filters.

Please direct any further correspondence regarding this acceptance to:

David Kurz, P.E.
Colorado Department of Public Health and Environment
Water Quality Control Division
4300 Cherry Creek Drive South
Denver, CO 80246

If you have any questions or comments, please contact David Kurz at david.kurz@state.co.us or 303-692-3552.

Sincerely,

Digitally signed by David Kurz, P.E.
DN: cn=David Kurz, P.E., o=Engineering Section, ou=Water Quality Control Division, email=david.kurz@state.co.us, c=US
Date: 2015.03.24 13:46:28 -06'00'

David Kurz, P.E.
Lead Wastewater Engineer
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Water Quality Control Division
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cc: CDPHE-WQCD-ES