ABSTRACT

Verification testing of the Waterloo Biofilter Systems (WBS), Inc. Waterloo Biofilter® Model 4-Bedroom system was conducted over a thirteen month period at the Massachusetts Alternative Septic System Test Center (MASSTC) located at Otis Air National Guard Base in Bourne, Massachusetts. Sanitary sewerage from the base residential housing was used for the testing. An eight-week startup period preceded the verification test to provide time for the development of an acclimated biological growth in the Waterloo® system. The verification test included monthly sampling of the influent and effluent wastewater, and five test sequences designed to test the unit response to differing load conditions and power failure. The Waterloo® system proved capable of removing nitrogen from the wastewater. The influent total nitrogen (TN), as measured by TKN, averaged 37 mg/L with a median of 37 mg/L. The effluent TN (TKN plus nitrite/nitrate) concentration averaged 14 mg/L over the verification period, with a median concentration of 13 mg/L, which included an average TKN concentration of 3.7 mg/L and a median concentration of 1.6 mg/L. The system operating conditions (on-demand pump and float settings) remained constant during the test. Routine maintenance and system checks were performed for most of the test, except when media (foam cubes) was added after four months of operation. Adding media may be part of on-going maintenance, especially in the first few months according to the WBS Design, Installation, and Service Manual.

TECHNOLOGY DESCRIPTION

The Waterloo Biofilter® Model 4-Bedroom system is a two stage treatment technology, based on a fixed film trickling filter, using patented foam cubes to achieve treatment. The first stage of treatment occurs in the primary tank (normally a 1,500 gallon two compartment septic tank, a single compartment tank was used for the test) in which the solids are settled and partially digested. The second stage, the Biofilter® unit, is a separate system that provides secondary wastewater treatment. Microorganisms present in the wastewater attach to the Waterloo® patented foam media, and use the nutrients and organic materials provided by the constant supply of fresh wastewater to form new cell mass. The system does not have a fan, as passive aeration to support the microorganisms is provided by openings in the Biofilter® housing and the characteristics of the foam material, allowing air to freely pass through the media.

The Waterloo Biofilter® system is designed to remove total nitrogen from the wastewater by nitrification and denitrification. Nitrification occurs in the aerobic Biofilter® unit, where ammonia nitrogen is converted to nitrite and nitrate (predominately nitrate), while denitrification occurs in the anaerobic/anoxic primary tank, where the nitrite/nitrate is converted to nitrogen gas.

The verification testing was performed using a full scale, commercially available unit, which was received as a self-contained system ready for installation. Primary tank effluent flowed by gravity through an effluent screen (Zabel filter) to the pump/collection chamber. A pump in the chamber transferred the primary tank effluent to the Biofilter® spray nozzles located above the foam media, which was contained in baskets. The pump operated as an on-demand system, with a level control switch turning the pump on whenever the pump chamber accumulated six gallons of wastewater. The system had a gravity recycle line that recirculated approximately 50 percent of the treated effluent and any solids (if present) from the underflow of the Biofilter® back to the primary tank. The spray system and media were housed in an above grade, lined wooden enclosure.

VERIFICATION TESTING DESCRIPTION

Test Site

The MASSTC site, initially funded by the State of Massachusetts and operated by BCDHE, is located at the Otis Air National Guard Base in Bourne, Massachusetts. The site uses domestic wastewater from the base residential housing and sanitary wastewater from other military buildings in testing. A chamber located in the main interceptor sewer to the base wastewater treatment facility provides a location to obtain untreated wastewater.

The raw wastewater, after passing through a one-inch bar screen, is pumped to a dosing channel at the test site. This channel is equipped with four recirculation pumps that are spaced along the channel length to ensure mixing, such that the wastewater is of similar quality at all locations along the channel. Wastewater is dosed to the test unit using a pump submerged in the dosing channel. A programmable logic controller (PLC) is used to control the pumps and the dosing sequence or cycle.

Methods and Procedures

All methods and procedures followed the *ETV Protocol for Verification of Residential Wastewater Treatment Technologies for Nutrient Reduction,* dated November 2000. The Biofilter® was installed by a contractor, in conjunction with the BCDHE support team, in May 1999 as part of an earlier test program. The unit was installed in accordance with the Design, Installation, and Service Manual supplied by WBS. In order to prepare for ETV testing, the entire Waterloo® system was emptied of wastewater and cleaned. Solids were removed from the primary tank, and all pumps, lines, and associated equipment were cleaned. The foam filter media was replaced with new media.

In early January 2001, fresh water was added to the unit and the system was cycled for several days to make sure the unit was operating properly, the dosing pumps were calibrated, and the PLC was working properly. An eight-week startup period, following the startup procedures in the WBS Design, Installation, and Service Manual, allowed the biological community to become established and allowed the operating conditions to be monitored. Startup of the cleaned Biofilter® system began on January 15, 2001, when the primary tank was filled with wastewater from the dosing channel. The dosing sequence was then started, with the unit's pump and level switches set in accordance with the WBS Manual.

All samples were cooled during sample collection, preserved, if appropriate, and transported to the laboratory. All analyses were in accordance with EPA approved methods or Standard Methods. An established QA/QC program was used to monitor field sampling and laboratory analytical procedures. QA/QC requirements included field duplicates, laboratory duplicates and spiked samples, and appropriate equipment/instrumentation calibration procedures. Details on all analytical methods and QA/QC procedures are provided in the full Verification Report.

PERFORMANCE VERIFICATION

Overview

Evaluation of the Waterloo Biofilter® Model 4-Bedroom system at MASSTC began on January 15, 2001, when the Biofilter® pump was activated, and the initial dosing cycles activated. Flow was set at 440 gpd, resulting in 15 doses per day with a target of 29.33 gallons per dose. Six samples of the influent and effluent were collected during the startup period, which continued until March 13, 2001. Verification testing began at that time and continued for 13 months until April 17, 2002. The extra month of dosing and sampling (13 months versus the planned 12 months) was added to the test to obtain data on the system response as the temperatures began to rise in the spring. During the verification test, 53 sets of samples of the influent and effluent were collected to determine the system performance.

Startup

Overall, the unit started up with no difficulty. The startup instructions in the Manual were easy to follow and provided the necessary instructions to get the unit up and operating. No changes were made to the unit during the startup period, and no special maintenance was required. Regular observation showed that biological growth was established on the media during the startup period.

The Biofilter® system performance for $CBOD_5$, TSS, and TN appeared good during the first three weeks of operation, but did not continue to improve over the next five weeks. Effluent $CBOD_5$ varied between 23 and 66 mg/L, with the higher value at the end of the startup period. There was some initial indication that TN removal was occurring, with effluent concentrations of 18 to 31 mg/L during the first three weeks, compared with influent concentrations of 34 to 41 mg/L. However, after eight weeks it did not appear that the nitrifying organisms had established themselves in the system, with low wastewater and ambient temperatures considered the primary reasons for the slow trend toward improved reduction in both $CBOD_5$ and TN. The temperature of the effluent wastewater was about 4 ^{o}C when the unit was started and remained in the 5 to 8 ^{o}C range through March 13. After startup, and early in the verification test in late April, it was discovered that the foam media had settled and short-circuiting was occurring in both media baskets. Foam media was added to the unit (a simple process) in accordance with the WBS instructions. The WBS maintenance recommendations and checklist include a regular check of the foam media and the addition of media, if needed.

Verification Test Results

The daily dosing schedule was designed for 15 doses to be applied every day, except during the Low Load (September 2001) and Vacation stress (February 2002) periods. In September, it was discovered that only 14 doses were being delivered because of a timing issue with the PLC. The issue was resolved and 15 doses were delivered for the last eight months of the test. Volume per dose and total daily volume varied only slightly during the test period. The daily volume, averaged on a monthly basis, ranged from 401 to 444 gallons per day. This was within the range allowed in the protocol for the 440 gallons per day design capacity.

The sampling program emphasizes sampling during and following the major stress periods. This results in a large number of samples being clustered during five periods, with the remaining samples spread over the remaining months (monthly sampling). Therefore, impacts of a stress test or an upset condition occurring during concentrated sampling periods can have an impact on the calculation of average values. Both average and median results are presented, as the median values compared to average values can help in analyzing these

Verification Test Discussion

In late March and early April 2001, when temperatures began to increase, there was evidence of a more established biological pop

at 90° intervals in four (4) directions. The average decibel level was 47.6, with a minimum of 44.8 and maximum of 50.5. The background level was 37.7 decibels.

Odor observations were made monthly for the last eight months of the verification test. The observations were qualitative based on odor strength (intensity) and type (attribute). Observations were made during periods of low wind velocity (<10 knots), at a distance of three feet from the treatment unit, and recorded at 90° intervals in four directions. There were no discernible odors during any of the observation periods. The unit has two charcoal filters to help control odors. No maintenance was required on these units during the test.

Electrical use was monitored by a dedicated electric meter serving the Biofilter® system. The average electrical use was 1.3 kW/day with a maximum of 2.5 kW/day. The Biofilter® system does not require or use any chemical addition as part of the normal operation of the unit.

During the test, no problems were encountered with the operation of the system. The screen on the outlet from the septic tank (influent to the pump chamber) required periodic cleaning. During the test, the filter was cleaned after eight months (two months of startup and six months of testing) in accordance with the WBS recommendation. The distribution plates near the nozzles were cleaned when the outlet screen was cleaned to help maintain a uniform spray pattern over the media. No changes or adjustments were needed to the float switches or the pump. Media was added one time after four months of operation. No additional media was added for the duration of the test.

The treatment unit itself proved durable for the duration of the test and appears to generally be a durable design. The piping is standadp(bto the pump chamber) reququqkan eight d6a46 Tw 7.733 0 Td (tself proved dreqBhescoduaDiod0 1