Interpreting operational data for a constructed wastewater treatment wetland

By Archis Ambulkar, Stephen Zeller and Neal Harris

Washington Township is a rural community located in Pennsylvania's Dauphin County. With a population of just over 2,000, the Township is served by a constructed wetlands wastewater treatment plant for handling sanitary sewage. The natural wastewater treatment system was built in 1996 and constructed for half of its permitted design capacity of 0.05 MGD.

The system has a permitted organic loading capacity of 120 lbs BOD/day and discharges to remediated wetlands for final disposal. When built in 1996, it consisted of two facultative lagoons, two free water surface (FWS) beds, an intermediate pump station, two final subsurface flow (SF) stone-media filled beds (with plants planted on top and roots extending down into the water), and an ultraviolet (UV) system for disinfection prior to ultimate discharge of the treated water.

Free water wetlands beds with deeper re-aeration zone.

Brinjac Engineering Inc., municipal engineer for Washington Township, assisted them with obtaining various state and county grants for WWTP upgrades to achieve the plant's permitted design capacity and overcome ongoing operational issues. These included lack of dissolved oxygen in wetlands and lagoons,

Wetlands beds with plant growth.

sludge build-up in lagoons and FWS beds, winter-time high effluent BOD, costly intermediate pumping, and liner damage by burrowing mammals in the wetlands.

An innovative upgrade project was initiated. It also took into consideration the effluent nutrient loading requirements of the Chesapeake Bay Tributary Strategy. Upgrades were planned in two phases, completed in 2005 and 2008. Phase I upgrades involved construction and addition of new treatment beds and mainly included:

• Raising the elevation of two partially excavated, non-constructed (1996 rough-cut only) FWS wetland cells (to eliminate intermediate pumping needs) and re-designing them to make one large FWS cell; and,

• Addition of a new 24-inch-deep re-aeration zone in the central section (approximately one-third of total bed/wetland cell area) and a heavier 40-mm HDPE liner.

Phase II modifications to the existing

continued overleaf...

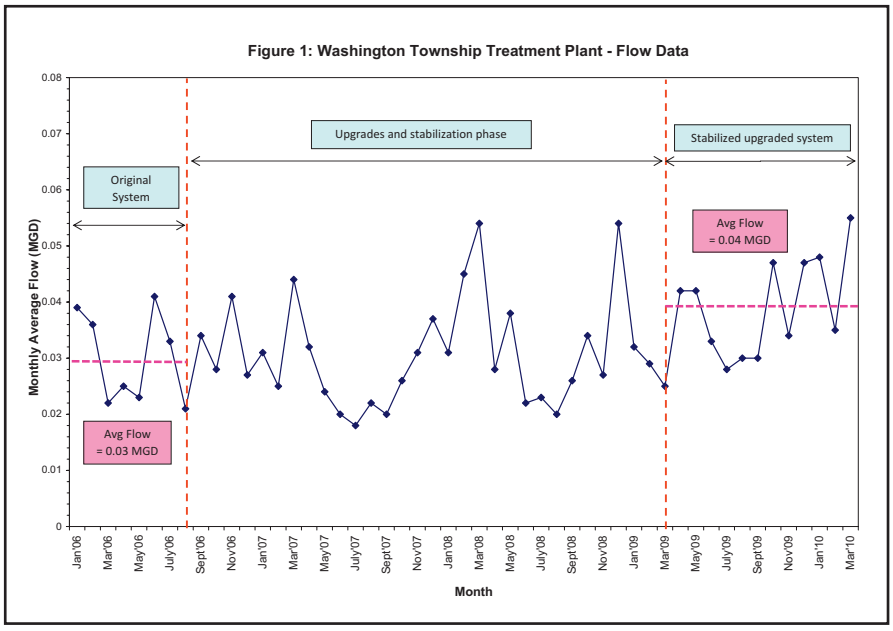

Figure 1: Washington Township Treatment Plant - Flow Data.

1996 wetlands system involved:

• Cleaning of all accumulated sludge solids in the existing FWS cells and their renovation and upgrade, similar to the new design in Phase I.

• Modifications to the existing subsurface beds with new influent and effluent manifolds to allow for more expansive water level control in the beds, enhanced treatment, and to eliminate ponding.

• Elimination of an intermediate pump station.

• Addition of a new effluent flow meter for higher flows; and,

• Installation of a new effluent manifold for additional flows from the wetlands beds.

Both Phase I and Phase II designs included deeper re-aeration zones in the free water wetlands beds to ensure that they would remain well oxygenated and that aquatic plants would not choke the beds out after a number of years, as had occurred in the original FWS beds. Also, proper water levels are now maintained in the FWS beds (two feet or less, versus three to four feet in the original beds).

WWTP operational data were monitored between January 2006 and March 2010, and were compared with the system's National Pollution Discharge Elimination System (NPDES) limits. System performance prior to and after upgrades provided an insight into process improvements.

For analysis purposes, only the stabilized system data were taken into consideration, i.e., prior to upgrades (before August 2006) and after upgrades (March 2009 to March 2010). Although Phase I upgrades were performed prior to August 2006, they mainly involved construction of new wetland cells and did not affect performance of the existing system.

Both Phase I and Phase II designs included deeper re-aeration zones in the free water wetlands beds to ensure that they would remain well oxygenated and that aquatic plants would not choke the beds out after a number of years.

WWTP influent and effluent data were referred for analysis. Influent data indicated that average wastewater influent BOD and TSS concentrations did not show any significant increase before and after upgrades.

Treatment plant flow and effluent BOD data are shown in Figures 1 and 2.WWTP flows increased from 0.03 to

0.04 MGD, whereas the average effluent BOD increased from 4.3 to 15 mg/l. However, concentrations remained within effluent NPDES permit limits. The reason for the increase in effluent BOD was probably due to the use of free water cells versus subsurface cells for the final stage (beds). Sometimes algae add to effluent BOD/ TSS in free water surface beds.

Other NPDES parameters, including TSS (total suspended solids), fecal coliform and pH, remained within the permit limits before and after upgrades. Average treatment plant effluent nutrient data for TKN (total Kjehldahl nitrogen), TN (total nitrogen) and TP (total phosphorus) for the stabilized systems before and after upgrades were monitored.

Sampling data along with Discharge Monitoring Report's data indicate that average effluent TKN, TN and TP concentration decreased from 24.0 mg/l, 24.5 mg/l and 4.0 mg/l respectively before upgrades, to 13.1 mg/l, 15.0 mg/l, and 2.4 mg/l respectively, after upgrades, despite an increase in average daily flows. Considering an average flow of 0.04 MGD and observed nutrient concentrations, the reduction in TN and TP due to upgrades was estimated at around 1,157 lbs/yr and 195 lbs/yr respectively.

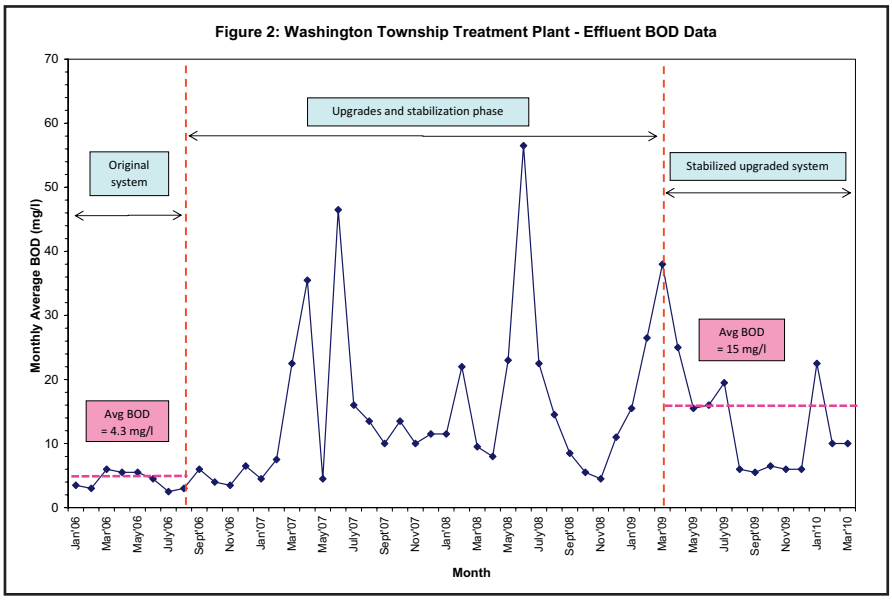

Figure 2: Washington Township Treatment Plant - Effluent BOD Data.

One-year operational data for the stabilized system indicated that the effluent achieved the desired quality, while keeping the system in compliance with NPDES effluent permit limits.

Archis Ambulkar and Stephen N. Zeller are with Brinjac Engineering Inc. Neal S. Harris is with the Washington Township Wastewater Treatment Plant. E-mail: aambulkar@brinjac.com