BioMag Treatment of High Wet Weather Flows

Concern has been expressed about the ability of BioMag to treat increases in influent flows caused by wet weather surges and the attendant dilution of contaminates in the wastewater. The supposition is that weaker concentrations may adversely affect the ability of magnetite to fuse with the biological floc and thereby result in a degradation of settling and the removal of contaminates such as TSS, TN, TP and BOD.

This has not been our experience. We have performed full-scale BioMag Trials at multiple facilities where the influent organic strength has been weak during storm events. These facilities include Upper Gwynedd, Mystic, Winebrenner and Taneytown. We have not noticed any adverse impact on magnetite impregnation during these low-BOD episodes. In fact, magnetite seems to impregnate activated sludge floc very well under a wide variety of conditions. We have not yet found a floc that has failed to impregnate well. This success is the product of the fine particle size (~10 micron) of the magnetite. Were we to use a larger particle size, the concern might be validated.

Hence, we are very confident that BioMag will successfully treat the wet weather flows anticipated at the St. Agathe WWTP. To corroborate this assertion, we provide the results of full scale wet weather testing at two plants, Winebrenner and Upper Gwynedd.

HIGH FLOW STRESS TESTING AT THE WINEBRENNER WWTP

Seven stress tests were performed to determine the efficacy of BioMag under high flow conditions. The first four tests were performed at elevated MLSS concentrations, in the range of 6,500 to 8,000 mg/l. The last three were performed at reduced MLSS concentrations at 2,400 to 3,000 mg/l.

The first four stress tests were 24-hour, sustained events, where the forward flow was increased 2- to 3-times the average forward flow rate of 60,000 gpd. The results were impressive, as the clarifier blanket depth remained below two feet during each event. The effluent TSS also stayed down, always below 5 mg/l and typically less than 2 mg/l. TN and TP removals were also very good, remaining largely unchanged from the average flow operating conditions.

The last three stress tests with reduced MLSS were 6- or 8-hour episodes, where the forward flow rate was increased to 4- to 8-times the average flow rate of 30,000 gpd. The test durations were limited due to lack of available wastewater and limitations in RAS pumping capacity. The intent of this testing was to stress the clarifier at reduced MLSS concentrations, focusing on the ability of BioMag to control the effluent TSS concentrations and clarifier blanket levels, rather than nitrogen removal. Modeling had shown that nitrification would be temporarily lost at these elevated flow rates.

Again, the results were impressive, as the clarifier blanket levels remained at 0.5 feet during each of the three high flow events which confirmed successful impregnation of the biological

floc. The effluent TSS actually remained below 2.5 mg/l throughout, demonstrating excellent treatment and stability over a wide range of flows and loadings.

High Flow Test #1

- Two sustained 24-hr stress tests
- May 12-13: 67 gpm, 1.5X
- May 13-14: 91 gpm, 2X
- RAS increased from 35 gpm to 45 gpm to 60 gpm
- Temp = 15 C
- MLSS decreased from 8,500 to 6,000 mg/l as solids were pushed from bioreactor into clarifier
- MLVSS dropped from 6,000 to 5,000 mg/l
- Magnetite-to-MLSS ratio was approx 2:1
- Effluent NH3 = 0.03 mg/l
- Effluent NO2 = 0.08 mg/l
- Effluent NO3 = 1.7 mg/l
- Effluent TP jumped from 0.05 mg/l to 0.35 mg/l. Caused mostly by running out of ferric, switched temporarily to PAC
- Effluent TSS < 2 mg/l
- Blanket increased from 1.0 to 1.5 ft

High Flow Test #2

- One sustained 24-hr stress test
- May 18: 84 gpm, 2X
- RAS increased to 53 gpm
- MLSS = 7,000 mg/l
- MLVSS = 4,500
- Influent TKN = 40 mg/l
- Effluent NH3 = 0.05 mg/l
- Effluent NO2 = 0.007 mg/l
- Effluent NO3 = 0.13 mg/l
- TN = 1.2 mg/l
- Effluent TP = 0.05 mg/l, ferric feed rate unchanged
- Effluent TSS remained < 3.5 mg/l
- Blanket = 0.5 ft

High Flow Test #3

- One sustained 24-hr stress test

- May 25: 84 gpm, 2X
- RAS increased to 50 gpm
- MLSS = 7,400 mg/l
- MLVSS = 5,000
- Magnetite-to-MLSS ratio was approx 2:1
- Influent TKN = 20 mg/l, diluted with secondary effluent to simulate rain event
- Effluent NH3 = 0.03 mg/l
- Effluent NO2 = 0.01 mg/l
- Effluent NO3 = 0.07 mg/l
- Effluent TP = 0.04 mg/l, ferric feed rate unchanged. 9 gpd
- Effluent TSS remained < 2 mg/l, actually decreased
- Blanket = 0.75 ft

High Flow Test #4

- One sustained 24-hr stress test
- May 26: 128 gpm, 3X
- RAS increased to 67 gpm
- MLSS = 6,300 mg/l
- MLVSS = 4,600
- Magnetite-to-MLSS ratio was approx 2:1
- Influent TKN = 17 mg/l, diluted with secondary effluent to simulate rain event
- Effluent NH3 = 0.02 mg/l
- Effluent NO2 = 0.006 mg/l
- Effluent NO3 = 0.2 mg/l
- Effluent TP = 0.04 mg/l, ferric feed rate unchanged. 9 gpd
- Effluent TSS dropped to 1.4 mg/l
- Blanket = 1.0 ft

High Flow Test #5

- One 8-hr stress test
- Goal was to stress clarifier at low MLSS, focus on effluent TSS and blanket, expected loss of nitrification
- July 2: 90 gpm, 4X
- MLSS = 2,400 mg/l
- MLVSS = 1,600
- Effluent TSS = 0.3 mg/l
- Blanket = 0.5 ft

High Flow Test #6

- One 6-hr stress test
- Goal was to stress clarifier at low MLSS, focus on effluent TSS and blanket, expected loss of nitrification due to low HRT and MLVSS
- July 3: 170 gpm, 8X
- MLSS = 2,600 mg/l
- MLVSS = 1,700
- Effluent TSS = 2.2 mg/l
- Blanket = 0.5 ft

High Flow Test #7

- One 6-hr stress test
- Goal was to stress clarifier at low MLSS, focus on effluent TSS and blanket, expected loss of nitrification due to low HRT and MLVSS
- July 4: 170 gpm, 8X
- MLSS = 3,000 mg/l
- MLVSS = 2,000
- Effluent TSS = 1.5 mg/l
- Blanket = 0.5 ft

HIGH FLOW TESTING AT THE UPPER GWYNEDD WWTP

The primary objective of this full scale BioMag trial was to evaluate the potential for the plant to treat a tripling of flows (hydraulically and organically) and to meet potential new total phosphorus (TP) limits, expected to be 0.2 mg/l and TSS treatment objectives of less than 10 mg/l monthly average and less than 30 mg/l max day (storm flow conditions).

The configuration of the plant enabled CWT to transform one full, independent train to BioMag and to compare results with an identical train operating conventionally. The graphs below provide the performance comparisons that corroborate the efficacy of BioMag in treating wet weather surges while maintaining high rates of contaminant removal.

- ✓ Figure 1 compares the flow rates to the BioMag and Control trains, each designed to treat a maximum of 2 MGD. Forced high flowas and a single storm event allowed for sustained flow above 6.0 MGD to be maintained for a 24 hour period. The BioMag system remained stable and performed admirably throughout these flow variations, as are illustrated in subsequent graphs.
- ✓ Figure 2 compares the high Solids Loading Rates (SLR) of the BioMag and Control system
- ✓ Figure 3 compares the Surface Overflow Rates (SOR) of the BioMag and Control system
- ✓ Figures 4, 5, 6 and 7 demonstrate that at flows at 3 times that of the conventional control train, the BioMag train was able to deliver exceptions effluent results for BOD, TSS Turbidity and TP.

SUMMARY

The full scale demonstrations at Winebrenner and Upper Gwynedd demonstrate the effectiveness of BioMag in treating high wet weather and dilute contaminant flows. We have not experienced any degradation in the ability of magnetite to become fully involved in biological floc and thereby enable high SLRs and SORs as well as the achievement of superlative contaminant removal. We see no result that support the supposition that weaker concentrations may adversely affect the ability of magnetite to impregnate biological floc and thereby result in a degradation of settling and the removal of contaminates such as TSS, TN, TP and BOD. Indeed the exact opposite is proven to be the case.

Hence, we are very confident that BioMag will successfully treat the wet weather flows anticipated at the St. Agathe WWTP.

Figure 1. Daily Flow Comparison: BioMag and Control Trains

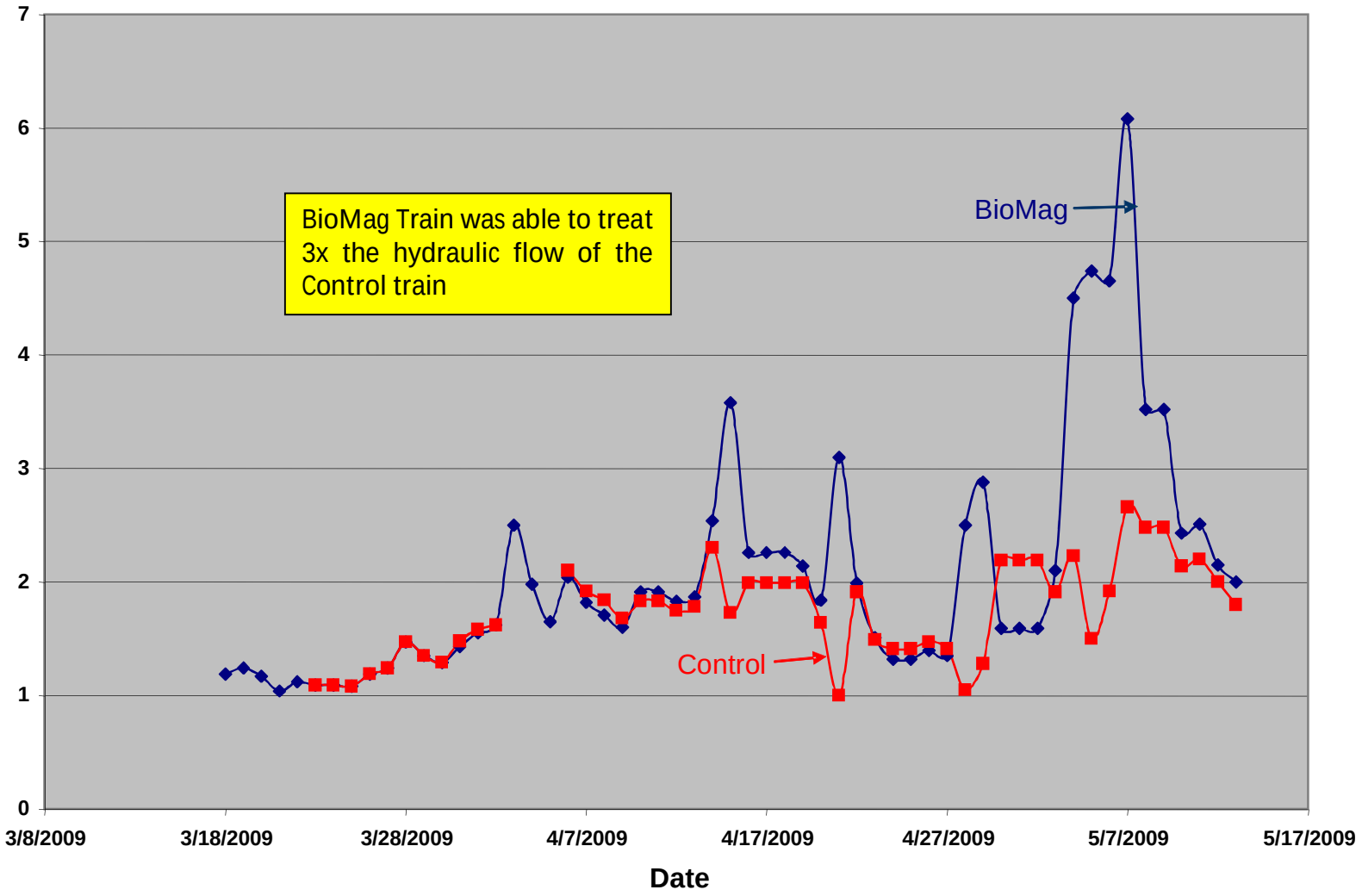

Figure 2. Clarifier Solids Loading Rate Comparison: BioMag and Control Trains

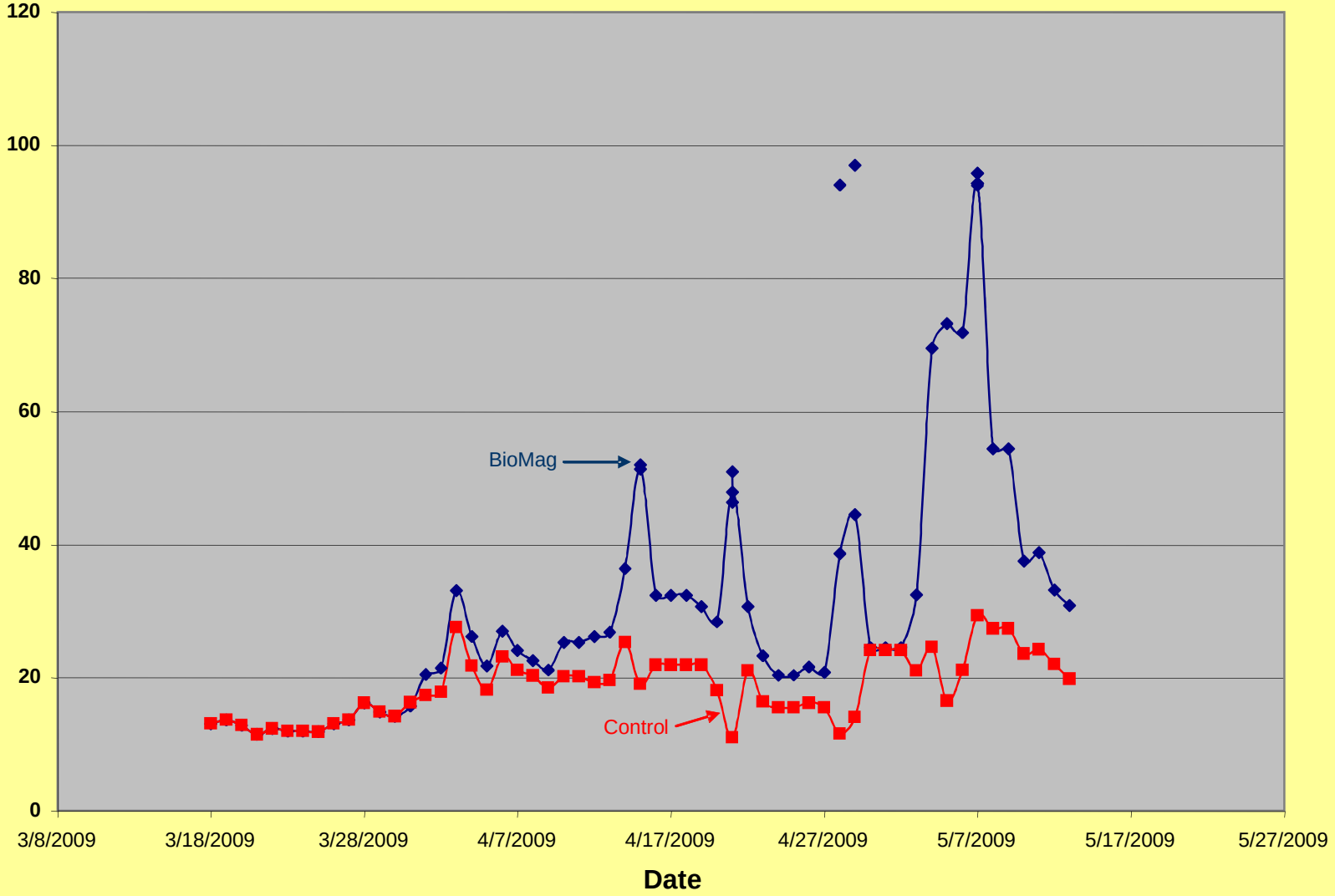

Figure 3. Clarifier Surface Overflow Rate Comparison: BioMag and Control Trains

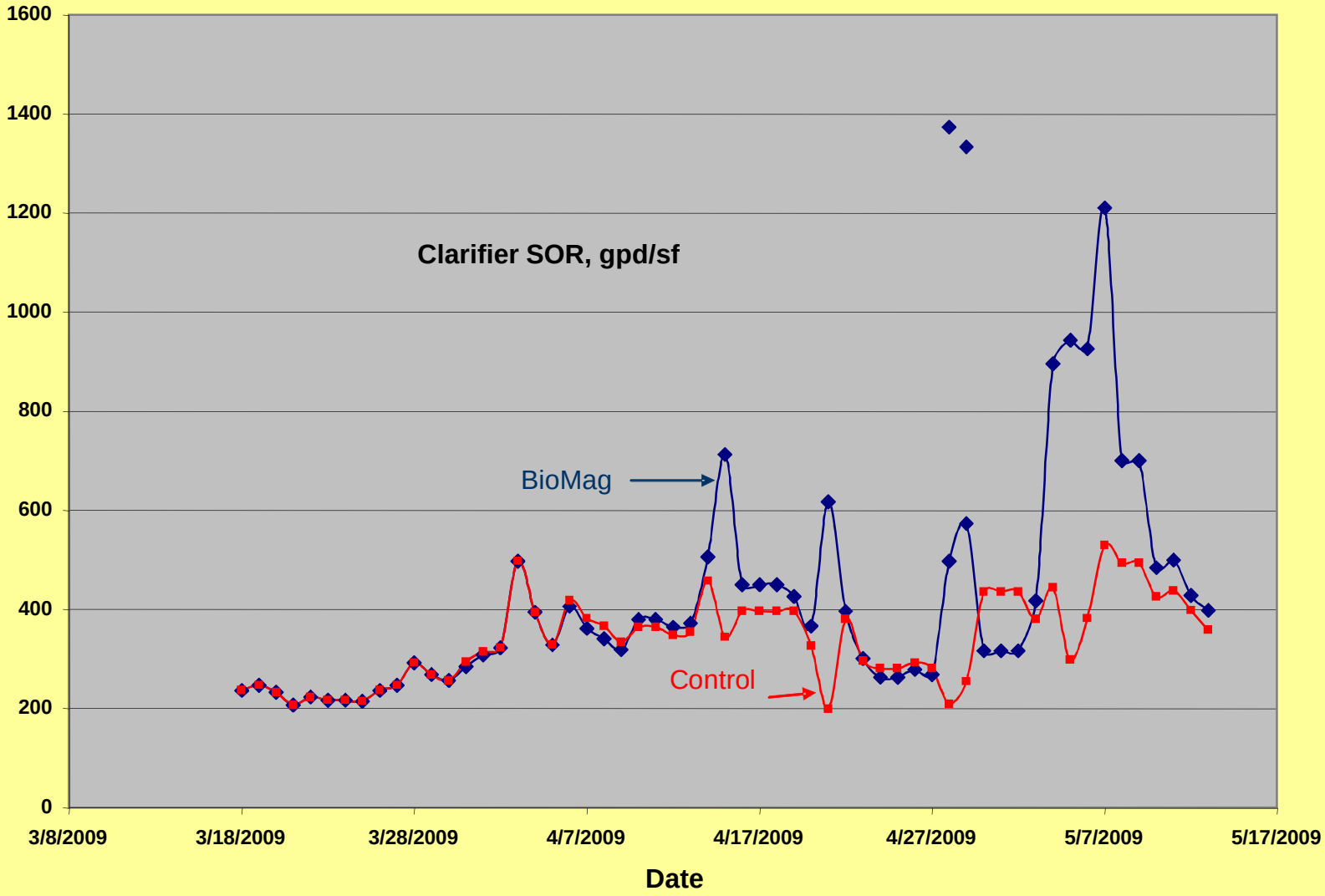

Figure 4. BioMag Effluent CBOD Concentration from the BioMag Train

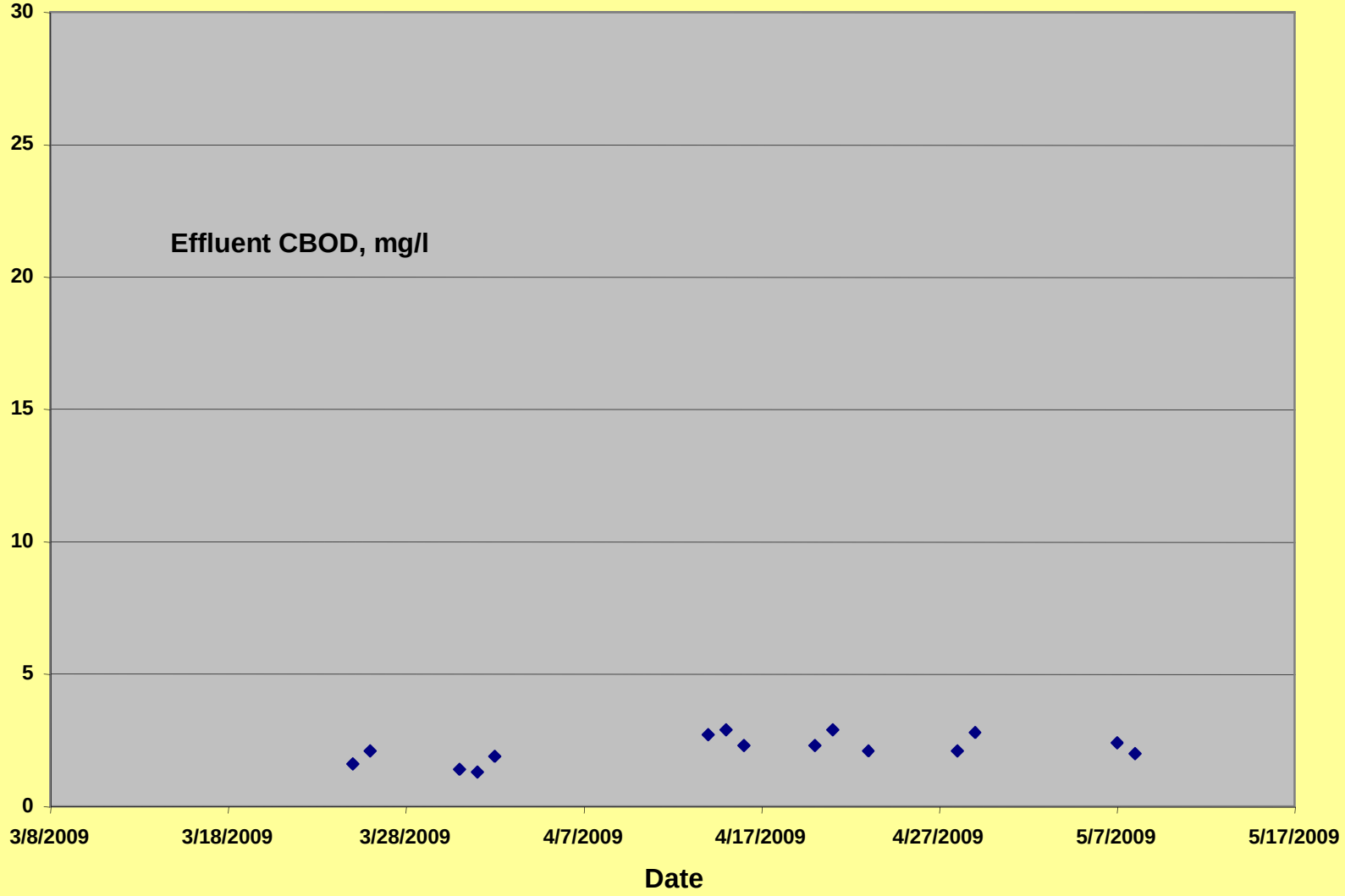

Figure 5. Flow vs. Effluent TSS Comparison: BioMag and Control Trains

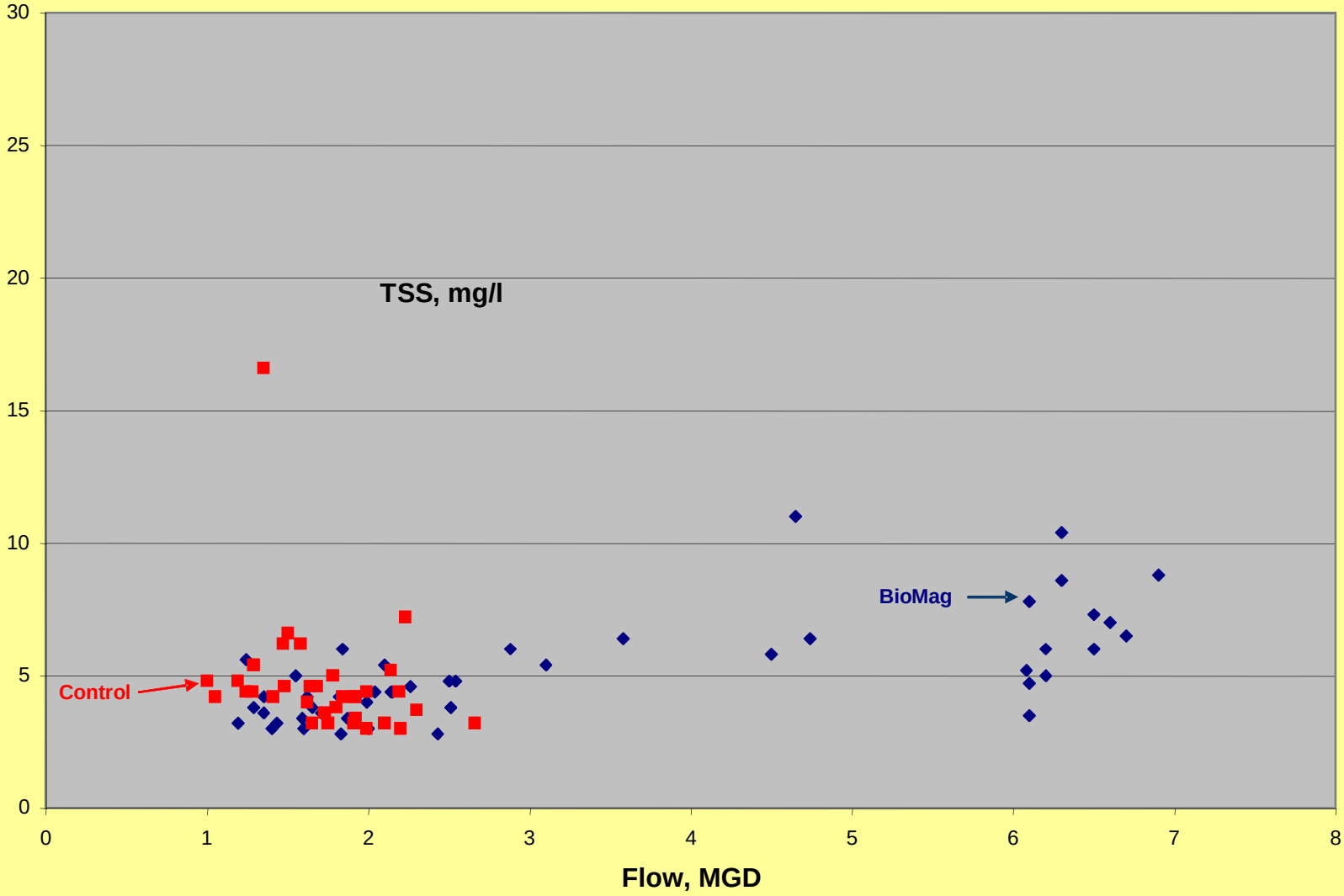

Figure 6. Flow vs. Effluent Turbidity Comparison: BioMag and Control Trains

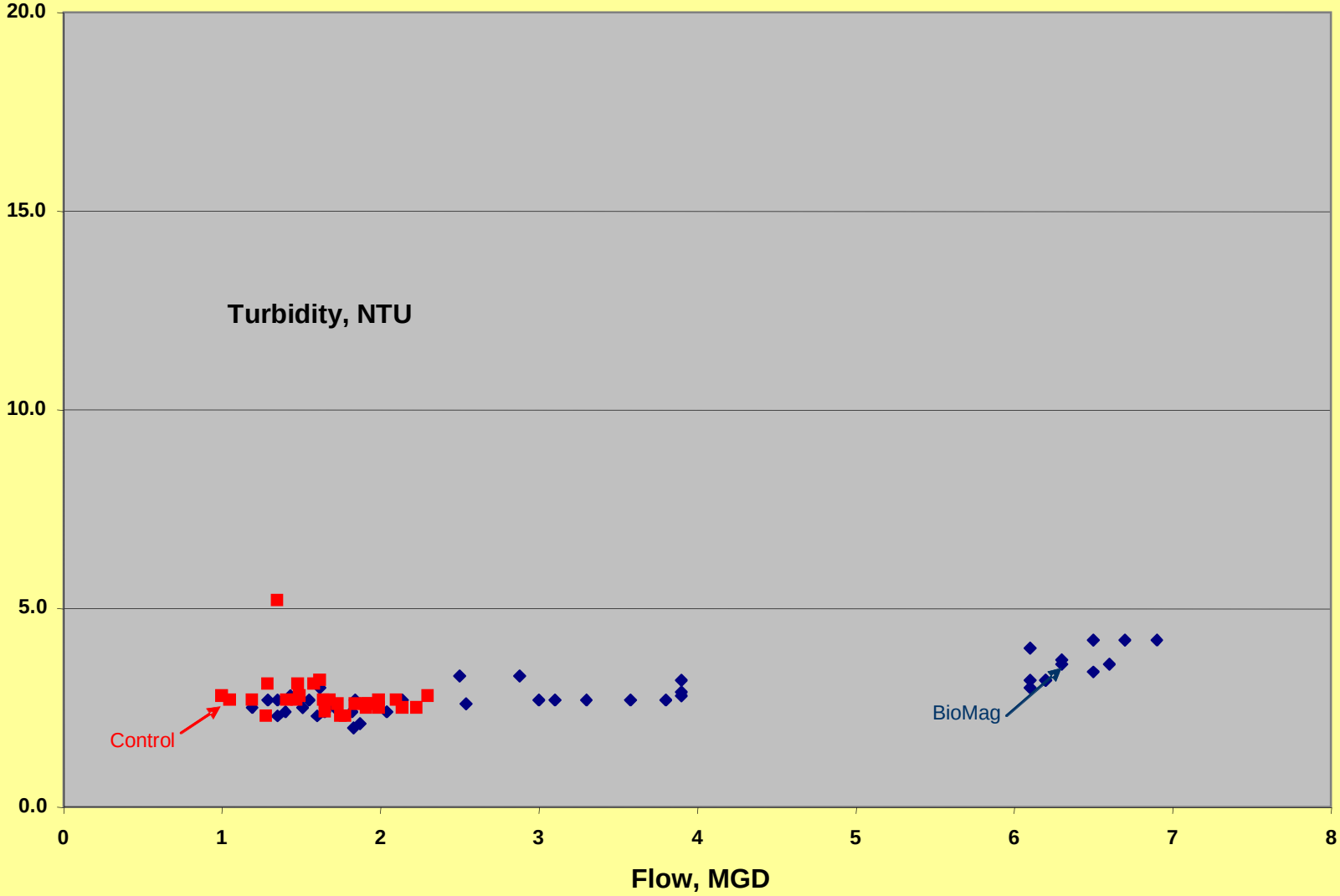

Figure 20. BioMag Effluent Total Phosphorus of the BioMag Train