Optimization of Surface Water Treatment Plants

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Compliance Region 1 – South
MDC – Copepods & Rotifers
- Originally found in Distribution via consumer complaint – Surface Water Treatment Plant (SWTP) performance issues followed
- Precautionary Boil Water Notice to consumers
- Intensive water quality & public health monitoring

Aquarion – Greenwich – Algal bloom & filter breakthrough
- Increased loading on filters
- Monitoring & alarm interpretation issues
- Tier 2 Treatment Technique (TT) Violation
2009 – The Year in Review (con’t)

- **Jewett City Water Company – Algal bloom & raw water changes**
  - Increased raw water turbidity & alkalinity decrease
  - Monitoring equipment constraints > 1.00 NTU
  - Knowledge of NTU standard for direct filtration
  - Back to back Tier 2 TT Violations
- **DPH – Increased awareness & enforcement of SWTP issues**
  - Circular Letter DWS #2009-01 – Optimization
  - Three TT Violations in 2009
  - One TT violation between 1994 and 2008
  - Re-evaluation of Sanitary Survey Process for SWTPs
  - Emphasis on treatment plant optimization
Invertebrates & Problem Organisms

- Invertebrates (copepods & rotifers) traditionally viewed as an aesthetic concern
- Copepods & rotifers (0.5-1.0mm)
- Giardia (8-14 um) Crypto (4-6 um)
- Inactivation vs. Removal/Live vs. dead
- Required Cl₂ residuals for inactivation ~ 1.5 mg/L
- Pre-filter/backwash supply/entry point
- Adverse effects of increased Cl₂ dosage
  - TOC removal
  - DBP formation
  - Taste & Odor
- Limitation of rapid sand filtration???
Tier 2 Treatment Techniques

- Raw water quality changes – alkalinity/pH/algal counts
- Water quality changes → evaluation → operational changes
- Routine monitoring beyond regulatory requirements
  - Algae
  - Alkalinity/pH
  - Temperature
  - Turbidity
- Online monitoring equipment capabilities/calibration
- Interpretation of data/alarms → Response SOPs
- Routine/Continuous calculation of CT/log inactivation
- Know your compliance triggers – 0.3 or 1.0 NTU CFE
- DPH notification requirements

Treatment process changes in order to maintain compliance
Regulatory Requirements

- Maintaining 95% of CFE result < 0.3 NTU
- No CFE samples > 1.0 NTU
- CT/log requirements
  - 3-log inactivation/removal of Giardia
  - 2-log inactivation/removal of Crypto
  - 4-log inactivation/removal of viruses
- Reporting Requirements – ASAP or end of the next business day
  - Waterborne disease outbreak
  - CFE > 1.0 NTU
  - EP Cl2 < 0.2 mg/L (restored within 4 hours)
Regulatory Requirements – con’t

- IFE > 1.0 NTU in consecutive measurements requires the submission of filter profile (> 10,000 population)
- IFE > 0.5 NTU in consecutive measurements after first 4 hrs requires the submission of filter profile (> 10,000 population)
- IFE > 1.0 NTU in consecutive measurements in 3 consecutive months requires self assessment of the filter(s)
- IFE > 2.0 NTU in consecutive measurements in 2 consecutive months requires Comprehensive Performance Evaluation (CPE)
Non-Regulatory Requirements

- Filter loading – turbidity & hydraulic
  - Design or Industry Standards
  - Other rates are possible depending on SWTP design/performance
- Raw water quality – alkalinity/pH/turbidity/crypto/giardia
  - Control parameters based on chemicals & processes in operation
  - Algal blooms effect treatment operations/changes
  - Crypto/Giardia test results always a factor in DPH consultation
- Backwash cycle & filter-to-waste/filter resting
  - SOPs to maintain backwash objectives
  - Physical observation – don’t rely on SCADA
- Other treatment processes – coagulation & flocculation
  - All treatment processes should be optimized
  - Inter-process water quality monitoring
Treatment Optimization - CPE

- Comprehensive Performance Evaluation (CPE) very useful tool to evaluate filter plant performance and optimization
- Comprehensive review of all treatment processes (not just filtration)
- Identifies weak links in the multiple barrier treatment process
- Refer to EPA Handbook *Optimizing Water Treatment Plant Performance Using the Composite Correction Program*
- CPEs will be considered by DPH in response to regulatory compliance and public health incidents
Treatment Optimization

- Avoid frequent shut downs and start ups of filter plants – may cause “surging” effect
- Practice filter-to-waste (FTW)
- If no FTW capabilities, filter resting must be considered
  - 30 mins is minimum recommended guideline, not universal
  - Some plants may need 1 hour or longer
- The addition of a coagulant during backwash may also help to condition filters
- Source of backwash water – finished water/filtered water/etc.
- Backwashing is critical to maintain filter performance
  - Adequate bed expansion and complete media fluidization
  - 50% bed expansion objective
  - Need to account for cold water temperatures
  - Physical observation/SOPs
Treatment Optimization – con’t

- Improperly functioning ancillary equipment such as surface wash or air scour, etc is important
- Design filter loading rates should not be exceeded
  - Design/Industry standard - 2.0 – 4.0 gpm/ft² on average
- Filter maintenance is essential. “South African Article” suggests that “Older filters do not achieve the required minimum backwash rate for fluidization and are therefore less efficient in invertebrate removal, compared to new filters that achieve more than the minimum required backwash rate for fluidization.”
- Routine inspection of filter media/core sampling
- Jar testing or other tools to monitor/optimize coagulation
- Focus on all treatment processes not just filtration
Treatment Optimization – Goals

- Circular Letter DWS #2009-01 – focus on SWTP optimization
- Sedimentation performance:
  - Settled water turbidity < 1 NTU when raw water turbidity < 10 NTU
  - Settled water turbidity < 2 NTU when raw water turbidity > 10 NTU
- Filtration performance:
  - IFE turbidities below 0.1 NTU 95% of time
- Filtration backwash recovery:
  - With FTW, return filter to service when turbidity < 0.1 NTU
  - Without FTW, maximum turbidity spike no greater than 0.3 NTU, turbidity should recover to 0.1 NTU or less within 15 minutes
  - Practice filter resting
Invertebrates – need more occurrence data:
- Did cool and wet first half of 2009 contribute to higher numbers of these organisms? Is this a Connecticut issue? A New England issue? A National issue? We need more occurrence data!
- Continued monitoring and collaboration with DPH
- Treatment methods for controlling these organisms in the treatment plant must continue to evolve

The million dollar question: Are there limitations of rapid sand filtration technology? – relative to invertebrates
- DPH will continue to stress the need for more research with the AWWA – Research Foundation, EPA – ORD, ASDWA – not on the immediate agenda
Conclusions – con’t

- ASDWA on behalf of CT DPH conducted national survey on this issue in September 2009:
  - 18 States responded to survey
  - 2 (Maine and Colorado) of those 18 responded that they were aware of PWS that detected live or dead copepods in filter effluent or distribution system

- Consumer complaints/public health surveillance critical components to event detection

- DPH will be reviewing sanitary survey process/capabilities
  - Review of backwash operations/SOPs
  - Trending CFE/IFE data

- Remain vigilant and guard against complacency
Conclusions – con’t

- Conventional measures of filtered water quality (i.e. turbidity) are not enough to evaluate SWTP performance
- Non-regulatory measures and maintenance critical to maintaining compliance and optimization
- Identify and monitor for water quality control parameters
- Awareness of regulatory triggers and communication requirements
- Consult with DPH ASAP
  - Supporting data critical to assessing public health impact & compliance – CT, giardia, crypto, complaints, etc.
- Always be prepared for public notice – especially Tier 1
- Bottom line – SWTP optimization to ensure/maintain compliance
Thank You

Useful References:

- AWWA Manual M7 *Problem Organisms in Water*
- Water Filtration Practices (Gary Logsdon)
- Self Assessment for Treatment Plant Optimization (AWWA)
- “South African Article” *Invertebrates as biomonitors of sand-filter efficiency.*
- Various AWWA Journal and OpFlow articles on optimization. (AWWA Water Library)