Facility Profile—Billerica WRRF

Billerica Water Resource Recovery Facility  Billerica, MA

Startup Date: 1966  Design Flow: 5.55 MGD  Grade: 7

Type of Facility: Activated Sludge

Collection System: Over 200 miles of sewer, and 21 pump/lift stations send a daily flow of 4.2 million gallons a day to the Billerica plant.

Process Description: Billerica has a sanitary sewer system. Flow enters the plant at the headworks and then through a diverter is split into two channels and sent to preliminary treatment. Preliminary treatment consists of two mechanical bar screens (rags and trash are dewatered with a screw press) and two bucket grit collectors. Flow then enters primary treatment where it is separated into three primary clarifiers. Solids settle and then get pumped to the gravity thickeners. From the primary clarifiers the flow enters a channel where it is mixed with RAS and 50% sodium hydroxide, to pretreat for aeration. The flow then enters the 1.76 MG aeration basin for approx. 12 hours before flowing into a diverter box where it is divided between four secondary clarifiers. The settled solids from the secondary are either returned as RAS or wasted as WAS to the gravity thickeners. The plant from this point changes from a biological process to that of a chemical one (CoMag). The secondary effluent flow then enters a series of reaction boxes where sodium aluminum sulfate (Alum), polymer, and magnetite coagulate the remaining solids in the water and settle them out in two tertiary clarifiers. Those solids removed from the tertiary tanks are sent in a slurry over to a shear mixer that breaks the bonds between the coagulants and the magnetite. The slurry is pumped over a magnetic drum that recovers the magnetite and returns it to the reaction tanks. The remaining solids are sent to the gravity thickener. The flow that came from the tertiary clarifiers is then chlorinated with sodium hypochlorite in the chlorination basin. In the post-chlorination basin the water is then dechlorinated with sodium bisulfite and is discharged to the concord river.

(continued on page 4)
What Should My RAS Rate Be?

by
Eric J. Wahlberg, Ph.D., P.E. (California), former Colorado Class A Operator
WasteWater Technology Trainers (wwtechtrainers@gmail.com)

We’ve all seen this table indicating what our RAS flow (percentage) should be:

<table>
<thead>
<tr>
<th>Modification</th>
<th>Q_RAS % of Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional</td>
<td>25–50</td>
</tr>
<tr>
<td>Complete-mix</td>
<td>25–100</td>
</tr>
<tr>
<td>Step-feed</td>
<td>25–75</td>
</tr>
<tr>
<td>Contact-stabilization</td>
<td>25–100</td>
</tr>
<tr>
<td>Extended aeration</td>
<td>75–150</td>
</tr>
</tbody>
</table>

Notes: Q_RAS = RAS flow, Q = plant flow

Why? Where do these percentages come from? Why are there designers and package plant vendors who don’t give operators the ability to vary the RAS flow percentage through these different ranges or, worse, specify a single-speed RAS pump with no ability to vary the RAS flow whatsoever?

To complicate matters: Too low a RAS flow (or percentage) can lead to the loss of sludge blanket solids in the secondary clarifier effluent, during a storm event, for example; too high a RAS flow (or percentage) is a waste of ratepayer money and can also result in poor secondary clarifier effluent quality as discussed below.

For those of you readers with SBRs, RAS is important to you as well: How much depth is left in the reactor at the end of DECANT is essentially your RAS. If there are three feet of clear supernatant above the solids at the end of DECANT, isn’t it a waste of capacity and money to treat all that water again through FILL and REACT? Of course it is!

This article shows operators and ratepayers there’s a better way (designers take notice). And it’s easy if your designer has provided RAS pumping flexibility.

To begin, however, a long-held belief must be corrected for all the wrong it has caused:

You cannot control the MLSS concentration with adjustments to the RAS flow.

Yes, there are two ways the RAS flow can be used to manipulate the MLSS concentration, but there’s a catch with both:

1. If the RAS flow is lowered to the point the secondary clarifier(s) is overloaded, the MLSS concentration will go down, the direct result of an increasing sludge blanket in the secondary clarifier(s).
2. If a secondary clarifier sludge blanket beyond the minimum already exists, increasing the RAS flow (causing the clarifier to be underloaded) will increase the MLSS concentration, the direct result of the solids in the blanket being transferred to the aeration basin(s).

Neither of these is desirable because secondary clarifier sludge blankets should be kept to a minimum at all times.

Although not shown here, a solids mass balance around the secondary clarifier(s) yields the following equality (“≈” indicates “approximately equal to,” due to four simplifying, yet inconsequential, assumptions made in the mass balance):

\[ TSS_{RAS} = (1 + \frac{Q}{Q_{RAS}}) \times MLSS \]  

(1)

Because mass balances are fundamental, Equation 1 is non-negotiable. From it, we know the following:

1. The RAS TSS concentration (TSS_{RAS}) is a fixed multiple of the MLSS concentration: 1 + (Q/Q_{RAS}).
2. Because this multiple will always be greater than 1, TSS_{RAS} will always be greater than MLSS.

Continued on Page 9
Office of Technical Assistance & Technology (OTA) for Wastewater Treatment Facilities

The Massachusetts Office of Technical Assistance offers free and confidential pollution prevention technical assistance to all Massachusetts toxic users. The OTA would like to partner with wastewater treatment facilities to engage with industries that use chemicals, such as those in the PFAS family, in order to have upstream pollution prevention interventions. OTA and the Toxics Use Reduction Institute (TURI) were created by the Toxics Use Reduction Act (TURA) of 1989. TURA allows Massachusetts to be uniquely poised to act upon emerging contaminants of concern, as OTA and TURI have been providing free services to industries for more than 30 years. By approaching businesses that have a positive relationship with the TURA program, we are able to have proactive conversations and create effective strategies to reduce the sources of PFAS and other contaminants from entering the wastewater treatment facilities. OTA’s staff of engineers and chemists can help your wastewater facility identify and have pollution prevention interventions with businesses within your district. Want More information? Contact: Tiffany Skogstrom, OTA Outreach & Policy Coordinator - tiffany.skogstrom@mass.gov - 617-226-1086

MAWEA Events

MA—CT—VT Ski Day at Stratton Mountain Vermont — Friday, January 31, 2020

MAWEA Annual Trade Show - Wednesday March 18, 2020—Devens Commons, Devens MA

MAWEA Spring Meeting—Wednesday June 10, 2020 Log Cabin Holyoke MA

MAWEA Annual Golf Tournament— Wednesday June 17, 2020 Heritage Country Club, Charlton MA

NEWEA Spring Meeting May 31-June 3, 2020 Lake Morey Resort Fairlee,VT
Comag Process: Billerica is the pioneer specialist in the CoMag process, now owned by Evoqua. CoMag is Billerica's tertiary treatment system that uses a combination of chemicals and equipment to polish off their effluent, removing tertiary solids containing phosphorus. Billerica is the first full size plant that has implemented this process in the world. Representatives from all over the globe (Including: South Korea, England, Germany, Cyprus, Greece and Poland) have come to this plant to tour and look at this system. No less than 100 American cities have also come to ask questions about incorporating a CoMag process in their own facilities.

Solids Handling: Water in the gravity thickeners is approx. 0.2% solids. The sludge is removed from the bottom of the gravity thickener and is mixed with a polymer to create a sludge feed around 2.5% solid for the Fournier Press, where it is dewatered to approx. 25% solids. The solids are then trucked off to parts of New Hampshire, Maine and Vermont for digesting, composting, or landfills.

Staff: 18 employees, which include one superintendent, one clerk, one plant supervisor, one collections supervisor, two O&M specialists, six wastewater operators, one pre-treatment coordinator, four repairmen, and one HMEO.
That Age-Old Confusion: The Difference Between Acidity/Alkalinity and pH

Acidity levels in wastewater indicate its corrosive properties and can take a leading role in regulating biological processes as well as in chemical reactions, such as chemical coagulation and flocculation. Alkalinity, also, contributes to the properties of wastewater, many of which similarly affect biological processes including nitrification and chemical reactions. While both acidity and alkalinity are related to pH, they should not be confused with pH, nor should the terms be used interchangeably.

Acidity is a measure of a solution’s capacity to react with a strong base, usually sodium hydroxide (NaOH), to a predetermined pH value. This measurement is based on the total acidic constituent of a solution (strong and weak acids, hydolyzing salts, etc.) It is possible to have high acidity and have moderate pH values at the same time. Likewise, the pH of a sample can be very low and have a relatively low acidity.

Alkalinity is the measure of a solution’s capacity to react with a strong acid, usually sulfuric acid (H2SO4), to a predetermined pH. The alkalinity of a solution is usually made up of carbonate, bicarbonate, and hydroxides. Like acidity, the higher the alkalinity, the more neutralizing agent is needed to counteract it. In general, a treatment plant and its collection system operate better with moderate pH wastewater having lower acidity and higher alkalinity. In simple terms, both acidity and alkalinity are about resistance to pH change. Lab pH buffers are solutions at a specific pH that are very high in alkalinity and acidity.

Think of it this way: pH is a measure of people and acidity or alkalinity is a measure of their “energy.” A group of seven athletic twenty-year-olds (their pH is 7) insists on running the Boston Marathon. Their energy is high (acidity or alkalinity) and they are together and focused. No one is going to change their minds – at least with not a lot of effort. This example represents a solution with a pH of 7 having high acidity or alkalinity.

In another place, there is a group of seven ninety-year-olds (their pH is also 7), but their energy (acidity or alkalinity) is low. Ask about running the marathon and this group will easily break up - some to play card games and others to watch Wheel of Fortune. It doesn’t take much to change their minds about running the race. This example represents a solution with a starting pH of 7 with low acidity or alkalinity and ending with another pH value. There just wasn’t enough “energy” in this group to keep the pH the same.

Knowing the difference between acidity/alkalinity and pH, coupled with appropriate sampling, you will be far on your way toward accurately monitoring treatment processes including chlorine disinfection and de-chlorination, nitrification in activated sludge, and troubleshooting the chemical addition process for phosphorus removal in the final effluent. If you have any questions, comments, or suggestions, feel free to contact me at TLoftus@ubcleanwater.org

Tim Loftus is the Laboratory and Pretreatment Manager at Upper Blackstone in Millbury, MA.
NEIWPCC Update – Spring 2020

**MWOT Open for Registration** – The Spring 2020 Massachusetts Wastewater Operator Training (MWOT) courses are published on NEIWPCC’s web site (https://portal.neiwpcc.org/training-calendar.asp) and are available for registration. New for this year - laboratory equipment for TSS analysis at the Alden Training Facility, purchased by MAWEA and NEIWPCC, and a revamped Basic Wastewater Laboratory curriculum. Perennial courses include Municipal and Industrial Wastewater Treatment options, Basic Wastewater Math and Wastewater Pumps and Hydraulics. Please note, the Intermediate Municipal Operations course is no longer offered. However, the intermediate topics are covered in the 6-week Basic Municipal Operations Course.

**Operator Certification Exams** - Computer-based testing locations for Massachusetts wastewater certification exams include: Auburn, Boston, Fall River, Lawrence, and Springfield. Are you curious or intimidated about taking a Computer-Based Test (CBT)? Watch the YouTube video showing what the experience is like on the day of your exam appointment. The video link can be found at http://www.abccert.org/testing_services/Computer-BasedTesting.asp

A **one-day Municipal Cybersecurity Forum** is being organized for June 2020 and is anticipated to be located in central or western Massachusetts. Learn about cybersecurity threats, defense, and response. The schedule for all NEIWPCC training will be available on NEIWPCC’s web site (https://portal.neiwpcc.org/training-calendar.asp) soon!

**Massachusetts Management School** – The fifth year-long program sponsored by NEIWPCC, Mass DEP, and MAWEA will wrap-up up in February with the graduation ceremony at MAWEA’s Spring Meeting and Trade Show at Devens Common Center in Devens, Massachusetts.

**Massachusetts Wastewater Operator Training and Certification:** http://neiwpcc.org/learning-enter/massachusetts-wastewater-operator-training-certification/

**NEIWPCC Training Calendar:** https://portal.neiwpcc.org/training-calendar.asp

For more information or questions on NEIWPCC or the MWOT program, please contact us at training@neiwpcc.org or at (978) 323-7929.

---

**You Deserve the Cutter Cartridge® Advantage**

**TASKMASTER® TWIN SHAFT GRINDERS**

with unique Cutter Cartridge® technology set the standard for reliability and performance!

Each Cutter Cartridge combines six individual cutters and spacers into a rugged, one-piece element. This greatly enhances unit strength, reduces maintenance and eliminates the need for cutter stack retightening.

To learn more about this and all of our unique grinding, screening, septage receiving and washing technologies, call us or visit us online today.

---

Locally Represented by:

F.R. Mahony & Associates, Inc. • 781-982-9300

www.frmahony.com

Franklin Miller®

Celebrating 100 Years!

Since 1918

www.franklinmiller.com 973-535-9200
Are you dealing with failing septic tanks? Is I&I from your existing sewer system eating up your budget? Do you have a sewer project with challenging terrain looming ahead? Get after it.

ALL-TERRAIN SEWER™ low pressure systems from E/One are significantly more affordable than conventional gravity sewers, safer than septic systems, and they're a light touch on the land.

Plus, our ALL-TERRAIN SEWER low pressure systems carry a proven track record of reliability with the lowest system life-cycle costs in the industry.

Whether it's dead or dying septic tanks or expensive inflow and infiltration, we can help. Learn more at allterrainsewer.com

Don't let your investment float away.

Make your next E/One® installation an easy one with BAL-LAST Interlocking Ballast Systems.
Catastrophic Force Main Failure Averted through Pro-Active Non-Destructive Hydrogen Sulfide Corrosion Investigation and Rehabilitation in Uxbridge, MA

Anastasia Rudenko, PE, BCEE, ENV SP – GHD, Marc Drainville PE, BCEE, LEED AP – GHD, Benn Sherman, PE – Town of Uxbridge, MA, James Legg – Town of Uxbridge, MA

The Town of Uxbridge, Massachusetts owns and operates a central sanitary system which was originally constructed in the late 1970’s. Raw wastewater collected from the eastern portion of the Town’s collection system is pumped from the station through a 16-inch DI force main which begins at the West River Pumping Station, crosses under the Blackstone River through an inverted siphon, and continues through a Town easement until it is discharged to the main 30-inch RCP gravity interceptor.

The transition from force main to gravity sewer formerly occurred in the main interceptor manhole. The drop in the main interceptor manhole was approximately seven feet. This large drop increased the vulnerability of the manhole to corrosion from hydrogen sulfide gas coming out of solution due to turbulent conditions at this location.

During a site visit, wastewater department personnel noted degradation of the main interceptor manhole. The Town suspected that turbulent conditions at the main interceptor manhole were increasing the vulnerability of the upstream force main to hydrogen sulfide corrosion. Pro-active non-destructive investigation technologies were required to assess the extent of hydrogen sulfide corrosion at this location without taking the force main out of service.

Multiple investigative technologies—including acoustic, electro-magnetic, and ultrasonic—were considered to assess the condition of the force main. Ultrasonic thickness testing at strategic locations was determined to be the least risky and most cost-effective force main inspection option. Data collected through ultrasonic thickness testing was compared to recommended minimum pipe thicknesses to determine whether portions of the pipe were likely structurally compromised.

The testing indicated that a portion of the force main immediately upstream of the main interceptor manhole had lost approximately 45% of its original pipe wall thickness and was likely structurally compromised. Test data indicated that other points in the system met ANSI/AWWA C150 minimum pipe thickness recommendations.

Once the extent of degradation was characterized, multiple rehabilitation options were evaluated including structural epoxy, cured-in-place pipe, and complete replacement. Due to the relatively shallow depth of the infrastructure, complete replacement of the deteriorated infrastructure with corrosion-resistant materials (PVC pipe and epoxy-coated manholes) was determined to be the most cost-effective approach.

Rehabilitation construction was completed in the spring of 2018. As shown in the accompanying photo, the portion of excavated force main exhibited high levels of hydrogen sulfide corrosion. Following excavation, the pipe was thin enough that it was easily broken with a hand shovel. By proactively using non-destructive investigation technologies to evaluate vulnerable infrastructure, the Town of Uxbridge was able to locate the portion of force main suspected of being structurally compromised and avoid a potential catastrophic failure in its collection system.

For questions or additional information on the project please feel free to contact me at anastasia.rudenko@ghd.com

Anastasia Rudenko is a project engineer with GHD based in Hyannis, MA.
3. Because the flow enters the secondary clarifier at the MLSS concentration and sludge is withdrawn from the bottom at the TSS\textsubscript{RAS} concentration, which is greater, there will always be a sludge blanket in an activated sludge secondary clarifier where the solids are concentrating from MLSS to TSS\textsubscript{RAS}. Depending on sludge quality, this blanket may be 3 inches in depth, or 13 inches, but never 13 feet!

4. For constant Q\textsubscript{RAS}, TSS\textsubscript{RAS} will go up when the plant flow (Q) goes up, and down when Q goes down; that is, TSS\textsubscript{RAS} and Q are directly related.

5. For constant Q, TSS\textsubscript{RAS} will go down when Q\textsubscript{RAS} goes up, and up when Q\textsubscript{RAS} goes down; that is, TSS\textsubscript{RAS} and Q\textsubscript{RAS} are inversely related.

Regarding No. 5 in this list, the TSS\textsubscript{RAS} concentration goes down when Q\textsubscript{RAS} is increased because that’s what the mass balance says, not because of “rat-holing” or “coning” through the secondary sludge blanket. Another long-held belief to let go: Rat-holing— aka, conning— probably doesn’t occur to the extent you’ve been told it occurs.

No. 5 in this list is important for other reasons as well. Because TSS\textsubscript{RAS} and Q\textsubscript{RAS} are inversely related, TSS\textsubscript{RAS} increases with decreasing Q\textsubscript{RAS}, which begs the question: Can the TSS\textsubscript{RAS} be increased indefinitely? There are many operators who believe they can increase TSS\textsubscript{RAS} by piling a bunch of sludge in their secondary clarifier, running high sludge blankets. There is a maximum concentration the TSS will concentrate to, as discussed below. This leads us to two monumental conclusions: (1) trying to increase TSS\textsubscript{RAS} by increasing the sludge blanket depth is a failed strategy, and (2) there is a minimum RAS flow (Q\textsubscript{RAS\textsubscript{min}}) that will give the maximum RAS TSS concentration (TSS\textsubscript{RAS\textsubscript{max}}).

The recycle ratio, r, is equal to \( \frac{Q\textsubscript{RAS}}{Q} \). Substituting this into Equation 1 gives Equation 2.

\[
TSS\textsubscript{RAS} \approx (1 + \frac{1}{r}) \times MLSS
\]  

(2)

The main takeaway from this equation: When controlling Q\textsubscript{RAS} with r, TSS\textsubscript{RAS} stays constant regardless of Q and Q\textsubscript{RAS}. If you waste from the RAS line like most plants do, this is a huge consideration because the WAS TSS (TSS\textsubscript{WAS}) concentration varies constantly with Q if Q\textsubscript{RAS} is constant (Equation 1), but stays constant if r is kept constant (Equation 2). If you waste continuously and Q\textsubscript{RAS} is constant, you will waste less pounds between 3 and 4 A.M., when TSS\textsubscript{RAS} is low, than you will waste between 1 and 2 P.M., when TSS\textsubscript{WAS} is high.

Although there are a few who reportedly see things differently, the vast majority of operators have observed what I have always observed in settleometer tests: After 30 minutes, the solids will continue to compact very little, if at all. This also is huge. What it means is that the activated sludge solids will compact very little, if at all, beyond the solids concentration in the 30-min settled sludge volume (SSV\textsubscript{30} in mL/L) measured in a settleometer test. More importantly, the solids concentration in the SSV\textsubscript{30} sludge blanket is the maximum solids concentration one can expect in the RAS. This is TSS\textsubscript{RAS\textsubscript{max}}. If the MLSS concentration used in the settleometer test is known (measure it!), the solids concentration in the SSV\textsubscript{30} sludge blanket (TSS\textsubscript{RAS\textsubscript{max}} in mg/L) is easily calculated:

\[
TSS\textsubscript{RAS\textsubscript{max}} = \frac{MLSS \times 1,000}{SSV\textsubscript{30}}
\]  

(3)

(1,000 is a conversion factor, 1,000 mL/L)

For two extremely important reasons, Q\textsubscript{RAS} should be kept as low as possible:

1. Operating Q\textsubscript{RAS} higher than needed is a waste of electricity and, therefore, ratepayer money (RAS pumps have big motors on them).

2. Research has shown that increasing Q\textsubscript{RAS} increases turbulence in the secondary clarifier(s), which may lead to a higher effluent TSS concentration.

On these accounts, the optimum RAS flow (Q\textsubscript{RAS\textsubscript{opt}}) is the minimum Q\textsubscript{RAS} (Q\textsubscript{RAS\textsubscript{min}}). There is one caveat here: “as low as possible” means Q\textsubscript{RAS} should be kept as low as possible without increasing the secondary clarifier sludge blanket(s). This also holds true for the optimum RAS recycle ratio: \( r\textsubscript{opt} \) is the lowest \( r\) possible (\( r\textsubscript{min} \)) without increasing the secondary clarifier sludge blanket(s). As stated above, because TSS\textsubscript{RAS} and Q\textsubscript{RAS} are inversely related, Equation 1 becomes:
Below are the wastewater certification exam results for January 1 to December 31, 2019

<table>
<thead>
<tr>
<th>Exam Grade</th>
<th>Passed</th>
<th>Failed</th>
<th>Total</th>
<th>% Pass</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Industrial</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1I</td>
<td>39</td>
<td>49</td>
<td>88</td>
<td>44.3</td>
</tr>
<tr>
<td>2I</td>
<td>119</td>
<td>130</td>
<td>249</td>
<td>47.8</td>
</tr>
<tr>
<td>3I</td>
<td>9</td>
<td>38</td>
<td>47</td>
<td>19.1</td>
</tr>
<tr>
<td>4I</td>
<td>8</td>
<td>26</td>
<td>34</td>
<td>23.5</td>
</tr>
<tr>
<td><strong>Municipal</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1M</td>
<td>12</td>
<td>17</td>
<td>29</td>
<td>41.4</td>
</tr>
<tr>
<td>2M</td>
<td>44</td>
<td>83</td>
<td>127</td>
<td>34.6</td>
</tr>
<tr>
<td>3M</td>
<td>25</td>
<td>21</td>
<td>46</td>
<td>54.3</td>
</tr>
<tr>
<td>4M</td>
<td>54</td>
<td>122</td>
<td>176</td>
<td>30.7</td>
</tr>
<tr>
<td><strong>Combined</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5C</td>
<td>32</td>
<td>59</td>
<td>91</td>
<td>35.2</td>
</tr>
<tr>
<td>6C</td>
<td>31</td>
<td>124</td>
<td>155</td>
<td>20</td>
</tr>
</tbody>
</table>
Helmet Use for Skiing and Snowboarding and Safety at Your Wastewater Facility

With colder temperatures at night and reports of heavy snow being reported in the Rockies, ski and snowboard junkies are dreaming and planning on another season of perfect snow. With thoughts of our equipment and its condition as well as whether or not to upgrade begins to roll around in our heads. So please consider the condition and use of your ski or snowboard helmet when thoughts of equipment enters your head (no pun intended). I still manage to get out onto the trails around 12 to 15 days a year and am amazed how many skiers and snow boarders wear helmets. My skiing started in the late 1960s when helmets were not an option so I have experienced my share of wipeouts and witnessed many others as well, some not so pretty. If you wear a helmet already, good, if you don’t wear a helmet please purchase one, your loved ones will thank you, and you may someday thank yourself.

I would like to add that just 7 years ago I started wearing a ski helmet and it took me a few runs to adjust to it, and shortly after found myself feeling safer which helped to push my limits and technique even further because of the impression of safety I felt. So my level of skiing and safety both improved, it turned out to be one of the best ski equipment purchases I ever made. It was a good return on investment.

So what does wearing a ski helmet have to do with safety at your wastewater facility? It’s an example of how safety evolves and advances. Twenty years ago safety procedures and requirements were not what they are today. Many facilities today subscribe to the minimum Personal Protective Equipment (PPE) requirements of hard hat, safety glasses, and safety shoes / boots. In addition the use of additional safety equipment and procedures is memorialized through Job Hazard Analysis (JHA) and Standard Operating Procedures (SOP). These safety requirements did not fall out of the sky. They are advancements that evolved from years of statistics and careful analysis of accidents and injuries. No one wants to be injured at work nor do they want their fellow coworkers to be injured. As water professionals it is incumbent upon us to embrace new safety equipment and requirements. Not only does this make good sense from a moral standpoint, but it also makes good financial sense. If a worker is injured on the job, it costs the facility in terms of lost staff hours, increased insurance costs, workers’ compensation premiums, and legal costs. When employees feel safe in the workplace, they can focus on doing the best job possible. The ultimate goal is for your facility to have a safety culture.

Everyone at the facility has a duty and a responsibility to do whatever they can to keep the working environment safe. Employers need to know and understand the safety regulations that pertain to their facility and make sure that their facility is up to those standards. Workers can do their part by understanding the procedures the facility wants them to follow on the job and by following them.

Conclusion: Whether on the slopes or at the facility safety matters. It matters to you, your friends and coworkers, and especially to your family. Come home safe.

Sincerely
Ken Harwood

Welcome New Members!

<table>
<thead>
<tr>
<th>Name</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brian Tuholski</td>
<td>Zachariah Lamoureux</td>
</tr>
<tr>
<td>Ryan Barnes</td>
<td>Jerry Tolosko</td>
</tr>
<tr>
<td>Leo Potter</td>
<td>David Sannicandro</td>
</tr>
<tr>
<td>Seth Lillis</td>
<td>Blake Buddensee</td>
</tr>
<tr>
<td>Aaron Fox</td>
<td>David Johnson</td>
</tr>
<tr>
<td>John Baldwin</td>
<td>Jason O’Brien</td>
</tr>
<tr>
<td>Peter Topor</td>
<td>Troy Arthur</td>
</tr>
<tr>
<td>Craig Roberts</td>
<td>Paul Hatch</td>
</tr>
<tr>
<td>Timothy Roberts</td>
<td>Aimee Wendolowski</td>
</tr>
</tbody>
</table>
Substituting Equation 3 into Equation 4 for $\text{TSS}_{\text{RASmax}}$ and solving for $Q_{\text{RASopt}}$ gives Equation 5.

$$Q_{\text{RASopt}} = Q \times \frac{\text{SSV}_{30}}{1,000 - \text{SSV}_{30}}$$

By the same reasoning, because $\text{TSS}_{\text{RAS}}$ and $r$ are inversely related, Equation 2 becomes:

$$\text{TSS}_{\text{RASmax}} \approx (1 + \frac{Q}{Q_{\text{RASopt}}}) \times \text{MLSS}$$

Substituting Equation 3 into Equation 6 for $\text{TSS}_{\text{RASmax}}$ and solving for $r_{\text{opt}}$ gives Equation 7.

$$r_{\text{opt}} = \frac{\text{SSV}_{30}}{1,000 - \text{SSV}_{30}}$$

The reader should note the recycle ratio is usually expressed as a percentage. The recycle ratio (%) would have to be divided by 100 to enter $r$ in Equation 2, and the right-hand side of Equation 7 would have to be multiplied by 100 to get $r_{\text{opt}}$ as a percentage. Table 2 shows the impact of sludge compaction, as quantified by $\text{SSV}_{30}$ from the settleometer test, on the optimum recycle ratio ($r_{\text{opt}}$ calculated from Equation 7 times 100).

<table>
<thead>
<tr>
<th>$\text{SSV}_{30}$ (mL/L)</th>
<th>$r_{\text{opt}}$ (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td>18</td>
</tr>
<tr>
<td>250</td>
<td>33</td>
</tr>
<tr>
<td>350</td>
<td>54</td>
</tr>
<tr>
<td>450</td>
<td>82</td>
</tr>
<tr>
<td>550</td>
<td>122</td>
</tr>
<tr>
<td>650</td>
<td>186</td>
</tr>
<tr>
<td>750</td>
<td>300</td>
</tr>
</tbody>
</table>

Return flow optimization is very simple and straightforward, and depends only on solids compaction measured in the settleometer test. The information in Table 2 is easily interpreted. Suppose, for example, you measure $\text{SSV}_{30}$ at your plant and it’s 250 mL/L. Table 2 says that if your recycle ratio is greater than 33%, you’re wasting ratepayer money; if it’s less than 33%, you have an unwanted sludge blanket in your secondary clarifier.

But there’s something else about Table 2: The cost of RAS pumping is massively affected by sludge quality, how the activated sludge solids flocculate, settle, and compact ($\text{SSV}_{30}$ measures compaction). Someday, ratepayers are going to figure out it’s not okay that you operate your plant at a high MLSS concentration and average an $\text{SSV}_{30}$ of 550 mL/L when it’s possible to implement sludge-quality control using SRT, and lower the $\text{SSV}_{30}$ to 200 mL/L or less. That someday is coming quickly.