No Stone Unturned

THE WISCONSIN VILLAGE OF SLINGER LOOKS TO PROCESS FINE-TUNING, PRETREATMENT AND ADAPTIVE MANAGEMENT TO MEET A TIGHTENING PHOSPHORUS LIMIT WITHOUT A PLANT UPGRADE

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The Slinger (Wisconsin) Wastewater Treatment Plant will face a monthly average phosphorus limit of 0.075 mg/L in 2023.

Since the village (population 5,500) can't afford a multimillion-dollar plant upgrade, including the installation of tertiary filters, the operations team is attacking the challenge on multiple fronts, so far with considerable success. During 2018, the plant's effluent met the future limit during six out of 12 months.

The frontline in the battle is converting the three-ring oxidation ditch to biological phosphorus removal and then continuously fine-tuning the process. Down the line, there's the opportunity to limit phosphorus discharges to the receiving stream through bank stabilization projects under the state's adaptive management provision.

Then there's tackling the problem upstream by surcharging large entities that release substantial phosphorus, in the hope that they'll respond by changing their behaviors. Finally, there's the prospect of trading phosphorus credits with a neighboring city.

Lab analysis lies at the heart of the Slinger team's efforts to reduce effluent phosphorus.

The process optimization effort has been underway for a little more than three years. Slinger's experience shows what smaller treatment plant teams can do to meet the increasingly strict phosphorus limits being imposed across the country. "Every year we've shown improvement," says Greg Moser, utilities superintendent. "We just need a little time."

SIMPLE DESIGN

Slinger, in southeast Wisconsin, built its treatment plant in 1980 with a 0.75 mgd design flow. A 2004 upgrade added a new headworks. In 2008 the plant received a capacity upgrade to 1.5 mgd. It included a new oxidation ditch (Evoqua Water Technologies), two new clarifiers and a UV disinfection system (TrojanUV3000Plus) to replace chlorine. In addition, an old clarifier was converted to a gravity thickener for biosolids, and a second biosolids storage tank was added, boosting total storage capacity to 1.8 million gallons.

Wastewater (0.8 mgd average flow) first passes through a mechanical bar screen (Andritz Separation) with a quarter-inch-hole perforated plate. The flow then enters a wet well and is pumped up to a PISTA Grit system (Smith & Loveless); the grit moves on to a Coanda washer (HUBER Technology). The liquid flow goes to the oxidation ditch, which uses disc aerators (Evoqua Water Technologies), and then to the secondary clarifiers, the disinfection system and on to discharge to a Rubicon River tributary.

Waste activated sludge goes through the gravity thickener and then into storage to await land application, handled by contractor Badger States Waste. The storage tanks have decant valves spaced every 3 feet of height; decant is fed back to the headworks.

The facility's excess capacity helps in optimizing the bio-P process, and so does a significant volume of holding tank waste and septage, up to 50,000

The team at the Slinger Wastewater Treatment Plant includes, from left, Joe Kell, utility operator; Greg Moser, utilities superintendent; and Silas Sopkowicz, Brian Hansen and Tim Pfeifer, utility operators.

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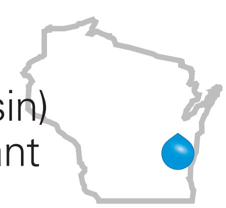
As part of reducing phosphorus in the wastewater, the aeration discs were turned off in part of the oxidation ditch and a small submersible mixer was installed.

Village of Slinger (Wisconsin) Wastewater Treatment Plant



www.vi.slinger.wi.gov

BUILT:
1980, upgraded 2004, 2008

POPULATION SERVED:
5,500

FLOWS:
1.5 mgd design, 0.8 mgd average

RECEIVING WATER:
Rubicon River tributary

TREATMENT LEVEL:
Secondary

TREATMENT PROCESS:
Oxidation ditch with biological phosphorus removal

BIOSOLIDS:
Land-applied by contractor
Annual budget: $1.55 million (operations)

ANNUAL BUDGET:
$1.55 million (operations)

gpd. That high-strength material helps provide the volatile fatty acids that the bio-P microorganisms need. "We can take grease trap waste to a certain extent, and that's another source of VFAs," Moser says. "But too much of that and we get filamentous growth and other problems."

CONTROLLING PHOSPHORUS

The effort to meet the phosphorus limit began before the first adjustment at the plant. The state Department of Natural Resources at first proposed a phosphorus limit of 0.04 mg/L on the grounds that the Rubicon River flows into Pike Lake, a largely spring-fed lake with a state park on its shoreline.

Through extensive testing in the stream, the village documented that the phosphorus in the plant's effluent was so diluted on its journey that the stream was restored to background levels by the time it reached the lake several miles downstream. "To the DNR's credit, they accepted our data and relaxed our limit to 0.075 mg/L," Moser says. Until 2023, the limit is 1.0 mg/L.

The work on effluent phosphorus began in 2016 after Moser and Tim Pfeifer, utility operator, attended a three-day DNR-accredited seminar given by Greg Paul of Op2Myz, a company based in Texas with a specialty in helping clean-water plant operators troubleshoot and optimize biological nutrient removal processes. "Our eyes lit up," Moser says. "A lot of what he taught fit our situation. We came back with a whole bunch of ideas."

Since then, one by one, they have put them to work, on a trial-and-error basis, backed by rigorous lab analysis. "You really have to do the lab work," Pfeifer says. "And you have to do the documentation, so you know that when a change is made, this is what you got. And then look at trends to know what happened over a period of time."

STEP BY STEP

Moser notes that the oxidation ditch provides flexibility to test var-

Greg Moser climbs a tank of polyaluminum chloride (Chemtrade), which is fed into the oxidation ditch. This is one of several measures the Slinger team has taken toward driving down effluent phosphorus.

“In this entire process we’ve been told that a lot of things we want to try aren’t going to work. We’ve been paddling upstream against most advice.”
TIM PFEIFER

ious methods of bio-P optimization. One of the first steps was to install an ORP probe in the outer ring, where the influent enters the system, and tie it to the SCADA system. “That gave us our snapshot of whether we were getting the environment we wanted for those bio-P bugs,” Moser says.

A next step was to revisit the addition points for coagulant chemical that enhances settling and removes phosphorus-bearing particulate in the clarifiers. Traditionally, alum had been injected into the return activated sludge stream introduced in the outermost ditch ring.

“We decided to try adding it in the middle ring,” Moser says. “That showed marginal improvement. Then we tried the inner ring. Ultimately, we landed at the splitter box at the center of the oxidation ditch, right before the flow splits to the two clarifiers. Just changing the chemical addition point was very beneficial.”

At present, the team adds Hyper+Ion 1997 polyaluminum chloride (Chemtrade) at the splitter box. “In the past we played with dual addition points,” Moser adds. “We had good results adding the Hyper+Ion 1997 in the middlemost ring and aluminum chlorohydrate in the splitter box, but that was a little difficult to maintain in winter. We may try it again in warmer weather to see if we can duplicate the results.”

The team also replaced the original chemical feed pumps with Tacmina Smoothflow pumps and variable-frequency drives to deliver more finely tuned dosing. The pulsefree nature of the Smoothflow pumps helped deliver a consistent flow that blended earlier in the process, reducing the amount of chemical needed.

Another process adjustment is the addition of lime to the outer ditch ring

WORKING UPSTREAM

The Slinger (Wisconsin) Wastewater Treatment Plant team doesn’t limit its lab testing to the process stream. Regular sampling in the collections system is part of the team’s effort to bring down effluent phosphorus.

“We have 30-some sites where once a month we take grab samples and analyze them for phosphorus,” says Tim Pfeifer, utility operator. “That way we see where our problem areas are.” In 2018, the village instituted a surcharge of $19 per pound of phosphorus on entities that discharge more than 6 mg/L.

A large service station and convenience store is among those surcharged; plant team members suspect the store personnel dump expired milk down the drain, leading to phosphorus spikes.

The team hopes that in time the large contributors will establish some form of pretreatment instead of paying the surcharges. To date, that hasn’t happened, but Pfeifer observes, “Anything we can do upstream helps. A lot of times we have things reversed. We tend to think we can fix things at the plant because the municipality has the money. But really, the issue is upstream. Keep it out before it gets to the plant.”

Joe Kell adds lime to the oxidation ditch twice a day as another technique for phosphorus reduction.

Slinger Wastewater Treatment Plant
PERMIT AND PERFORMANCE

	INFLUENT*	EFFLUENT*	PERMIT**
BOD	258 mg/L	3.4 mg/L	15 mg/L
TSS	299 mg/L	3.8 mg/L	225 pounds/day January, March, May, July, August, October, December 249 pounds/day February 233 pounds/day April, June, September, November
Ammonia	13.64 mg/L	0.04 mg/L	2.6 mg/L April 1.0 mg/L May-September 3.6 mg/L October 4.1 mg/L November-March
Total phosphorus	6.0 mg/L	0.085 mg/L	1.0 mg/L

** Annual averages ** Monthly averages*

video profile

To learn more about the Village of Slinger (Wisconsin) Wastewater Treatment Plant, watch a video profile at www.tpomag.com

at about 100 pounds per day. That amount doesn't meaningfully affect pH. Its main benefit is to aid in coagulation and so enhance settling; it also helps oxidize BOD. "The problem right now is that we're dumping it in bulk," Pfeifer says. "It works, but it would be better to meter it in."

SPLITTING THE RAS

"We were encouraged with the results we were getting, and then Tim did some further research," Moser says. "Typically we sent the return from the clarifiers to the outermost ditch. Tim suggested we try splitting the flow, sending some of it to the middle ditch."

The outer ring of the ditch, with a roughly 24-hour detention time, essentially functions as an equalization basin and anaerobic system. In the initial stage, the wastewater is stirred slowly by a two-blade submersible mixer (Flygt - a Xylem Brand); the surface aerators run about 95% of the time, but most of the discs have been removed. At the next set of aerators, all the discs are in place but run only about 10% of the time.

The flow becomes increasingly anaerobic as it moves around that first ring. By the time it hits the middle ring, the ORP typically measures about -300. The middle ring functions an anoxic zone with relatively aggressive mixing; the flow there steadily picks up oxygen. The inner ring is entirely aerobic and provides the bulk of BOD and ammonia removal.

The diversion of some RAS from the outer ring serves to help keep that ring more anaerobic and enhance bio-P removal. "We weren't seeming to get to the low ORP numbers we needed in the outer ring," Pfeifer says. "We couldn't get it below -200, when the wheelhouse for our plant is really -250 to -350."

> "Every year we've shown improvement. We just need a little time."
> **GREG MOSER**

He cites research showing that bio-P microorganisms are not strictly anaerobic. "Because we have a long sludge age, it's likely we're accumulating nitrate. The aerobic bugs will use that as an oxygen source when they are starved. So now we're sending about one-third of the RAS to the outer ring and two-thirds to the middle ring. That seems to allow enough return of anaerobic bugs, but not too much return of nitrates that would kill the bio-P system."

BEYOND THE PLANT

Work on the plant process continues. One modification being explored is to change the coupling of the disc aerator shafts. At present, the middle and outer ring aerators are coupled. "It would be better to have the middle and the inner ones hooked together because that's where we want to be introducing air," Pfeifer says.

Meanwhile, Moser and his team are looking to stream bank stabilization to take another bite out of the phosphorus load to the Rubicon River. "We've located a couple of sites that could benefit and could give us a few pounds of phosphorus per year," Moser says. "Even if it's 20 to 25 pounds, that might suffice; we feel we are that close right now."

The journey has been challenging but also exciting. "In this entire process we've been told that a lot of things we want to try aren't going to work," Pfeifer says. "We've been paddling upstream against most advice. There is a resistance to anything new. That's a human condition, and in our industry it's even more profound.

"The big cities can do what they want. They can hire legal teams to fight the regulation, or they can throw resources at meeting it. We can't do that here. Our approach is an option for smaller communities and plants that are cash-strapped. We can see day to day the little changes we make and how they affect things." tpo