The Industry's Finest

Operators share their experiences with the new breed of wastewater finescreens

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The industry is full of legendary finds at the preliminary stage of wastewater treatment where screens remove inorganic solids and grit removal settles out sand, egg shells, and abrasive material.

Here are some of the odd finds from our files: the front end of an old Volkswagen Beetle, a swimming turtle rescued by an operator, diamond rings, and currency and casino chips that pop out of the channel, making operators happy (or making the woman who lost the ring overjoyed). Then there's the story of the old lady who visited her local treatment plant to inquire about lost dentures. Once they were found, the story goes, she took them home, gave them a good cleaning, and gave new meaning to the term *reuse*.

Far from a punch line, however, wastewater inlet works are undergoing a quiet and revolutionary shift to finer and finer screening, a move helping to improve efficiency, lower operating costs, extend the life of downstream machinery and meet stringent requirements for membrane bioreactors (MBRs).

Switching to finescreens with 1- to 6-mm openings helps remove smaller pieces of trash, such as rags, plastics, cotton swabs, clothing, and latex, that bar screens typically let slip through. Such trash quickly becomes a nuisance for operators as it collects on aeration diffusers, causes scum blanket accumulation in digesters, clogs sludge pumps, results in unsightly material floating in final clarifiers, and ends up as trash in a farmer's field when biosolids are spread.

Choosing Finescreens

Removal of more inorganic solids can benefit treatment processes from activated sludge to oxidation ditches, as well as MBR facilities and lagoons. However, there are several issues end users and consultants should consider when designing an inlet works: type, protection, screenings, and space.

Finescreens were developed in the United States at the turn of the 20th century as traveling water screens. They fall into two basic categories: drum and perforated-plate screens. The perforated-plate screens are further divided into two flow patterns. Straight-through flow is called a finescreen, while in-to-out flow is called a bandscreen. Recent research conducted in London shows other types of screens, such as bar, wedge-wire, and step screens, do not offer a high percentage of solids removal and cannot protect modern high-tech processes, such as MBRs. MBR manufacturers frequently recommend a bandscreen or drum screen with 1- or 2-mm perforations to prevent small trash and hair from fouling the membranes' tiny pores.

Finescreens also require some form of protection from large, potentially damaging debris barreling down the collection system, particularly in combined sewers. A concrete block, rebar, or shopping cart can dent a finescreen's panels even with automatic overload protection, so something — a pump, grinder, bar screen, or primary clarifier — should precede the finescreen.

Treatment plants fed by pumped flow are already protected; the pump will only pass small solids that fit through the impeller. If flow is gravity-fed into the plant, then a bar screen or channel grinder is needed to handle tree branches, rocks, lumber, and other large debris. Some screen manufactures and consultants will assess a gravity-fed system and, if free of storm debris and heavy objects, approve and warranty a finescreen without protective measures, so be sure to ask.

Today's finescreens also generate more discharged screenings than typical bar screens, sometimes twice as much. Manufacturers have responded with heavier-duty washer–compactors to chop and clean up the massive pile of screenings. Wringing out extra water and fecal material helps bring odor and disposal problems under control, making screenings-handling a beneficial and affordable aspect of this new generation of screens.

Finally, some of the civil work actually gets easier with finescreens, since they have a lower profile and are encased in stainless steel — headworks buildings are shorter, and odor control equipment is smaller. This represents a large cost-savings compared to the super-sized headworks buildings and odor control equipment needed to contain mechanical bar screens.

Finescreens Hit the Big Time

In Wisconsin, managers of the Fond du Lac Water Pollution Control Plant recently installed dual finescreens and washer–compactors as part of a major overhaul of the 30-year old facility, switching from comminutors with 24-mm slot openings to stainless steel finescreens with 3-mm perforated openings.

The facility, an activated sludge plant, dealt with solids and trash headaches for years as rags clogged sludge pumps, grease floated in clarifiers, and trash built up on weirs and other spots. When spring storms came, the flow would purge a torrent of trash from the collection system and deposit material throughout the plant.

"Soon after it would start raining, pumps would start plugging," said David Carlson, the plant's sanitary engineer. "Guys would have to go in and clean out the pumps — a messy job for sure."

In 2004, plant managers and their consultant, Strand Associates (Madison, Wis.), looked at various screening options, toured several finescreen sites in Wisconsin, and chose a perforated-plate design. Installed in 2006, the new 8-ft-wide (2.4-m-wide) finescreens remove rags, trash, and even grease, depositing the material into a grinder which then feeds a washer–compactor. It cleans and compacts the material, returning liquefied fecal matter back

PETE FISHER–INAFLASH PHOTOGRAPHY

The Cobourg (Ontario) Water Pollution Control Facility installed a 6-mm finescreen with a compactor–washer with only 12 in. (300 mm) to spare in the headworks. Even though the screen catches more trash and debris — preventing it from affecting other treatment processes — the plant now discharges 75% less screenings by volume.

to the plant flow and pushing the dried screenings into a dumpster ready for the landfill. The facility has an average flow of 9 mgd (34,000 m^3/d) and a peak capability of 50 mgd (190,000 m^3/d).

"The finescreens seem to be working well," Carlson said. "There are huge benefits to not chasing trash all throughout the plant; that's all gone for us."

One surprise, Carlson said, is the ability of the finescreens to remove grease, leading to improvements in several areas. The solids incineration system is running more efficiently, and the solids pumps aren't blocked by grease balls. In addition, less grease in the system will help new heat exchangers operate smoothly without clogging when a new temperature-phased anaerobic digestion process comes on-line. Less grease also helps to improve the activated sludge process by discouraging the growth of filamentous microorganisms.

Another surprise for Carlson is the relatively small pile of screenings left after the washer–compactors chew up the material the finescreens take out. Roughly 15 yd^3 (11 m^3) of clean and compacted screenings are sent to the landfill each month.

"Screenings discharge is considerably less than anticipated, and for a facility our size, that's impressive," Carlson said. "Part of the reason is the grinder on top of the washer–compactor."

Carlson drew the analogy to a large pile of leaves — run a lawnmower over the pile, and you shrink the pile to next to nothing. The same principle applies here, he said.

The project consultants also electronically tied all the preliminary treatment equipment together in the supervisory control and data acquisition system. Now gates, finescreens, compactors, and grit systems turn on and off automatically as the system monitors the upstream and downstream differential via ultrasonic level detectors. In high-flow situations, operators can manually override the system and turn on both finescreens and washers. The finescreens are rated for a combined flow of 66 mgd (250,000 m^3/d).

"The maintenance guys like it a lot," Carlson said. "They don't have to unplug RAS [return activated sludge] and WAS [waste activated sludge] pumps."

Small Town, Big Savings

Small towns certainly aren't sitting on the sidelines as the finescreen trend sweeps North America. Many are jumping at the technology despite some financial and hydraulic hurdles.

At the Cobourg Water Pollution Control Facility on the Canadian shores of Lake Ontario, managers grumbled for decades as an ancient catenary bar screen with 25-mm openings let rags, latex, and other material pass. Trash collected on nearly everything. The grit chamber ran poorly, spitting out wet, sloppy material full of rags. Plastics and latex floated on top of the chlorine contact channel, requiring operators to skim it regularly. Most embarrassingly, plastics and trash made it into the biosolids applied on nearby farms.

In 2004, managers decided to retrofit their headworks and selected a perforated-plate traveling finescreen with 6-mm openings. The system features a continuous band of stainless steel panels which captures trash and lifts it to deck level where a washer–compactor then grinds, washes, compacts, and dewaters the screenings.

Retrofitting is never easy, and the finescreen was a tight squeeze inside the headworks building — a mere 12 in. (300 mm) from the ceiling. It was a tough installation, but well worth the trouble, according to Bill Peeples, manager of the 2-mgd (7570-m^3/d) facility.

"It's unbelievable the difference it has made in cleaning up our facility," Peeples said. "We had been burdened for years by plastic, rubber, and other inorganic and organic solids collecting in various structures all the way through our process."

Triggered by an ultrasonic level detector, a drive moves the panels from the screening zone to a cleaning mechanism at the discharge point. Debris is removed from the panels by a two-stage brush and washwater system; screenings drop into a grinder, then into a washer–compactor.

"There were other screening options with the same 6-mm size, but these were bar screens," Peeples said. "Bar screens, regardless of how narrow they are, cannot properly handle slender objects. For example, a Q-Tip can still pass through lengthwise without much difficulty."

In the washer–compactor, solids are flushed through a grinder to break up clumps of fecal matter, washed, compacted, and then conveyed by an auger. This patented process liquefies soft organics, separating them from the trash and rags, so fecal matter returns to the wastewater channel. The washed solids are then compacted, dewatered, and discharged as a plug into a trash bin.

In planning for the installation, Peeples increased his trash disposal budget by several thousand dollars, expecting the finescreen to discharge more material. Surprisingly, the opposite occurred: The plant now discharges 75% less volume. The washer–compactor with grinder aggressively cleans and compacts the screenings, resulting in a lower volume of material. "We're capturing more but sending less to the landfill — it was all that water we were paying for," Peeples said.

Dozens of areas in the facility are experiencing benefits from the finescreen's higher capture efficiency. The grit chamber is no longer plugged with rags and now removes more sand from the wastewater, producing bone-dry discharged grit. Peeples estimates a 20% to 30% increase in pump service life throughout the plant due to the reduction of abrasive material in the flow.

Removing the trash also makes for cleaner biosolids, which, after digestion, Cobourg offers to local farmers to fertilize their fields.

"Spreading biosolids on land has become a very political issue lately," Peeples said. "If someone sees plastic and latex lying on a field being used to grow crops, even though they are biologically inert, it is not viewed favorably. If we can install a piece of equipment that will remove these items, it can only serve to help our efforts in making the product more widely accepted."

Protecting MBRs

If the trend towards finescreens is a quiet one, the industry's race toward MBRs is an ever increasing roar, as new facilities embrace the microfiltration devices to help meet strict discharge requirements or generate water for reuse. The technology is fast catching on in drought-plagued communities, particularly in the fast-growing West.

The wastewater treatment plant in Star, Idaho, on the outskirts of Boise, knows about growth — nearly 20 housing subdivisions are under construction right now. To keep up, Star recently upgraded its wastewater treatment plant from a lagoon system

Adding a grinder to a washer–compactor can lead to cleaner, more compact screenings for disposal. A head-to-head comparison by the Greater Vancouver (British Columbia) Regional District laboratory showed fecal coliform rates four times higher in screenings that did not pass through a grinder than in those that did.

to an MBR process.

As part of the upgrade, engineers at Keller and Associates (Meridian, Idaho) selected a bandscreen with 2-mm perforated openings set in ultrahigh-molecular-weight plastic panels. The flow pattern is unique — wastewater enters the inside loop of the screen and turns 90 degrees left, right, or down to pass through the perforated panels. This flow pattern ensures that trash and debris only touch the inside loop of the screen, preventing material from adhering to the panels and carrying over the top to the downstream side of the system. Star also uses a washer–compactor topped with a dual-shafted grinder.

"The cleanliness of the discharged solids [from the washer-compactor] allow for hauling to a sanitary landfill, which was a compliance criterion that was assured by our engineers," according to Hank Day, operations foreman for the Star Sewer and Water District.

"We wanted to make sure organics were removed to reduce odor and ensure waste would be accepted at the landfill," added Randy Zollinger, project manager for Keller Associates. "During our initial startup, we saw our decision to utilize the Screenings Washer Monster was justified, as very little odor was generated from the washed compacted screenings."

The effluent from the bandscreen proceeds through a flowmeter to a splitter box, which sends 20% of the stream to three lagoons, which each hold 1600 equivalent dwelling units. The remaining 80% flows into the new MBR plant, where another splitter box creates two separate treatment trains.

"The membranes in the new MBR plant are really expensive, and we wanted to be sure to have the best screening ahead of them so we don't get material that could damage them," Day explained. "We also wanted to filter out as much total solids as we could, to keep the new MBR plant running at optimum capacity. This combination solids processing system allowed us to meet both objectives from the outset of the new plant operation. Anytime you're dealing with wastewater, it's a lot easier and cheaper to do it right the first time than to come back and add stuff later."

The membrane portion currently consists of 200 flat-plate membranes per cassette, and 12 cassettes for each train. Flow in the east and west trains is now about 0.3-mgd (1100 m^3/d) each. Allowance has been made for future expansion of the MBR capacity via more membranes in each train and additional trains. Overall, the 1.2-mgd (4500-m^3/d) peak flow facility is presently operating at about 0.8 mgd (3000 m^3/d).

Day was also in favor of this bandscreen design for two key maintenance reasons: There are no sprockets or bearings submerged in the wastewater flow, and the perforated plastic panels were removable, making repairs and inspections easier.

As Justin Walker, project engineer for Keller Associates pointed out, "We're pleased the MBR plant is operating as designed. The facility is producing great quality water."

The Results Are In

Now to the bottom-line question: How much does

Table 1. Finescreen Solids Capture Rates

Manufacturer	Percent removal
Bandscreens – 3 mm	
Brackett Green CF Bandscreen	93%
Jones & Attwood Hi-Flow	92%
JWC Bandscreen Monster	87%
Bandscreens – 6 mm	
Jones & Attwood Hi-Flow	81%
JWC Bandscreen Monster	78%
Brackett Green CF Bandscreen	78%
Finescreens – 3 mm	
Andritz – Ruthner Aquascreen	84%
Finescreens – 6 mm	
Biwater FSM Filterscreen	76%
JWC Finescreen Monster	73%
Longwood Parkwood Escalator	73%
Andritz Aquascreen 2	71%

Source: UK Water Industry Research, Inlet Screen Evaluation, Year 3 Comparative Report from 1998 and Year 5 Comparative Report from 2003.

a finescreen really capture? The field of research is thin, but an in-depth screening study was completed in 1999 by UK Water Industry Research (London), a nonprofit organization which receives funding from Britain's private wastewater companies. In 2003, it followed up with another round of testing on revised designs from screen manufacturers.

Researchers discovered bar screens typically capture between 15% and 40% of solids, while finescreens had about twice the capture rate, removing 60% to 90% of material. At the top end of the scale were the perforated-plate finescreens. Expressed as the solids capture rate, Table 1 (p. 72) shows the results of some top-performing screens.

Several manufacturers improved their designs, and in 2003 some of the screens were retested. For instance, the Andritz values improved to a 76% capture rate with a 6-mm perforated-plate screen, and JWC's Bandscreen was tested with 3-mm perforations, achieving an 87% removal rate. Today, 2-mm screens are in demand for MBRs, but there have been no follow-up tests. The need for industry-sanctioned screen testing in North America is growing urgent.

Cleaning Up

Since finescreens capture more solids, the next question becomes what to do with the heaping piles of discharged screenings. Handling this increased load of wet, smelly material falls to the washer–compactor — and the beefier the better.

In particular, the compactor must tackle two big problems: Remove clumps of fecal matter and diminish odors. One solution is to place a dual-shafted grinder on top of the compaction chamber; solids are broken into smaller pieces, and more surface area is exposed to the vigorous direct-spray wash nozzles inside the unit. This patented process liquefies the fecal matter, enabling it to flow through a perforated trough and return to the wastewater treatment process. The now cleaned screenings are pushed forward and compacted.

In a number of treatment plants this combined grinder–washer–compactor has resulted in cleaner and more compact screenings with fewer odors. Moreover, discharge is much cleaner than material from a washer–compactor without a grinder. In a head-to-head comparison of technologies, the Greater Vancouver (British Columbia) Regional

Table 2. Finescreen Headloss Calculations

		FORMULA KEY
Velocity in channel with water level known.	V = Q/(WL × CW)	A = panel area. ps = panel shelf depth. CL = clearance from channel to panel (typically .34-ft). CW = channel width (ft). HL1 = headloss screen clean. HL2 = headloss screen blocked X%. MWL = maximum water level upstream. NP = number of panels submerged. NP1 = number of panels submerged at WL1. OA = open area per panel. OAB = open area per panel blocked X%. OP = open area of perforations. P = chain pitch (typically .66 ft). PB = Percentage blocked. pf = panel face height. PW = Panel width. Q = flow (ft^3/s). Sinθ = inclination of the screen (typically 70°). TOA = total perforated area. TOA1 = total perforated area blocked X%. V = approach velocity (ft/s). V1 = velocity through panels. V2 = velocity through panels blocked X%. WL = water level in channel (ft). WL1 = water level upstream clean.
Water level if velocity is known.	WL = Q/(V × CW)	
The finescreen's side frames cause a small loss of the flow area.	PW = CW – .68	
Calculate the area of each panel.	A = PW(pf + ps)	
Based on standard perforated plate, a 6-mm-diameter hole on an 8.5-mm triangular pitch has an open area of 51%, and a 3-mm-diameter hole on a 4.5-mm triangular pitch has an open area of 40%. This open area is represented by OP.	OA = A × (OP/100)	
Number of panels submerged.	NP = (WL/sinθ) / P	
Total open area per panel.	TOA = OA × NP	
Velocity through panels.	V1 = Q / TOA	
Headloss screen clean.	HL1 = .0222 ($V1^2 - V^2$) × 2 (flow must pass through grid front and back)	
Water level upstream clean.	WL1 = WL + HL1	
Open area per panel blocked X%.	OAB = OA × (1 – PB)	
Number of panels submerged at WL1.	NP1 = (WL1/sinθ) / P	
Total perforated area blocked X%.	TOA1 = OAB × NP1	
Velocity through panels blocked X%.	V2 = Q/TOA1	
Headloss screen blocked X%.	HL2 = .0222 ($V2^2 - V1^2$) + (HL1/2)	
Maximum water level upstream.	MWL = WL1 + HL2	

District laboratory showed fecal coliform rates from the grinder system were 7 million MPN/mL, while the grinderless system had four times that level, 28 million MPN/mLs.

More aggressively washing and compacting material also leads to a reduction in the volume of material sent to the landfill, saving the facility time and resources. According to a 2005 study by the wastewater division in King County, Wash., the washer–compactor with a grinder showed the following: "The economic benefits seen were a decrease in 8.3 wet tons [7.5 wet tonne] per week needing to be disposed of and a reduction in hauls, and thus haul costs, of one trip per week. Based on the most current screenings haul and disposal invoice the gross savings would be $855 per week."

Managing the Hydraulics

Now comes the complicated math, but also the important part of installing finescreens: the headloss calculations, or the rate at which water backs up in front of the screen when it is running. To measure headloss, the water levels on the downstream side (where the level is typically lower) and the upstream side of the screen (where the level is typically higher) are compared.

Finescreens operate at a slightly higher headloss than bar screens or comminutors, so attention must be given to the upstream channel configuration in order to prevent an overflow. When the screen is running, headloss should be low, depending on the type of screen and the amount of debris in the channel. If the screen stops, then material will build up on the panels, and the headloss increases. Once the screen starts again, the headloss immediately begins to drop. Table 2 (p. 73) reviews finescreen headloss calculations step by step.

Getting more trash and rags out of the wastewater channel with finescreens and sending less to the landfill with more powerful washer–compactors are two tactics wastewater treatment plant operators are using to improve their workplace and make the treatment process far more efficient.

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