

# From Rags to Reliable

New headworks improves performance throughout the treatment plant

*Brian Casey, Bob Eimstad, Scott Thompson, Jim Wodrich,  
Greg Mooney, Tracy Cork,  
and Mike Guthrie*



The new headworks building uses translucent panels to let natural light in while reducing cleaning requirements.

**T**he largest city in central Oregon, Bend, has a population of about 78,000 and a wastewater reclamation facility with an average design flow of 11.8 mgd (44,660 m<sup>3</sup>/d). The facility's headworks had long since surpassed its intended design life, and system reliability was faltering. One of the two existing screens had failed completely, and the other's capacity was overwhelmed regularly, sending solids and floatables downstream. Facility staff members were spending significant time each week removing rags from primary clarifiers, secondary clarifiers, and the digester's heat exchanger. Furthermore, the captured screenings contained so much moisture and organics that they had to be taken to the landfill weekly.

In short, Bend needed a new screening system. So, a few years ago, the plant began a project that would reduce maintenance requirements and trips to the landfill, as well as be safer than the existing headworks — considered a somewhat hazardous environment — and use “green” energy.

## Better Solids Capture

The project team began by evaluating the capture rates of various screening technologies, including step screens, fine screens, and band screens. The team determined that band screens were the best option, primarily because their capture rate was more than 80% — roughly 10% more than fine screens, according to a 2001 study by UK Water Industry Research Ltd. (London).

Band screens consist of rotating panels that are parallel to the flow. Wastewater enters the middle of the screen and then flows through the panels to the outside, while the solids are dropped into a channel that conveys them to the screenings-handling equipment. The sealed design prevents solids from being carried past the screen and dramatically increases capture efficiency.

The new headworks design provided for four screening units (see Figure 1, p. 60); however, only three were installed initially because the additional capacity was unnecessary to address near-term flows. The design called for all three screens to be 6 mm, but the project team decided during construction to make one a 3-mm screen so operators could quantify the benefit of finer screening before another plant expansion that may involve membrane filtration.

The band screens were installed in stainless steel boxes with common hydraulic connections upstream and downstream of all screens. Upstream and downstream liquid levels were monitored.

Unfortunately, the common hydraulic connections prevent operators from adjusting screen speed based on the liquid surface differential. In this case, all downstream surfaces are equal, so the only difference among screens is flow rate, which depends on screen blinding. After evaluating the many complicated control solutions available, the project team settled on a relatively simple solution: Keep the screen speed constant and use a downstream butterfly valve to vary the flow rate through the screen.

There are two methods for cleaning the screens. During routine operations, spray nozzles jet debris off, dropping the material into the effluent solids trough. Then, after each 120 hours of operation, a screen is isolated from service by closing the upstream and downstream valves, and the stainless steel box is filled with hot water and a degreasing agent to thoroughly remove fats, oils, and grease from the screen. After 20 minutes, the washwater is drained to the common sump and pumped back into the influent line.

## Safer Conditions

To contain potentially harmful gases, the project team enclosed the liquid stream and routed it through pipes in the lower floor of the headworks building (see Figure 2, p. 61). The team also provided two ventilation systems: one that exhausts foul air from the enclosed liquid streams and one that circulates air throughout the building.

In addition, the project team used differential pressure to ensure that all areas outside the enclosed liquid stream met National Fire Protection Association (NFPA; Quincy, Mass.) requirements for “unclassified” environments (NFPA 820: *Standard for Fire Protection in Wastewater Treatment and Collection Facilities* and NFPA 70: *National Electric Code*). As a result, the team could use quick connections for all electrical equipment, so the facility does not need a certified electrician for most maintenance activities.

## Cleaner Screenings

Each screening train has a dedicated washer-compactor, which grinds the solids (to expose more surface area), washes them, and then compacts them. The cleaner, dryer, and more compacted product then is conveyed to a dumpster. The design includes one dumpster for each pair of screens. Sensors under the dumpsters enable operators to track the dumpsters’ weight and calculate a relatively accurate density, so Bend



CAROLLO ENGINEERS

**Influent flows through the band screen while rags and other inorganics are trapped and collected in dumpsters.**



**The liquid stream is completely enclosed to contain odors and harmful gases.**

can monitor changes in related screenings characteristics and maximize each dumpster's capacity before hauling it to the landfill.

Washwater from the washer-compactor is collected by food-grade stainless steel piping routed to the building sump. The piping has quick-connect couplings so it can be disassembled easily for cleaning. The thorough cleaning process has resulted in washed and compacted solids that contain far more inert materials and much less water, decreasing dumpster trips from a weekly to a monthly basis.

## Greener Energy

Before the headworks project began, Bend used some of its digester gas to fire boilers that

were part of a hot-water loop designed to heat the contents of the digesters. The rest of the gas was flared. The project team decided that the flared gas could be put to better use as a source of green energy in the new headworks design.

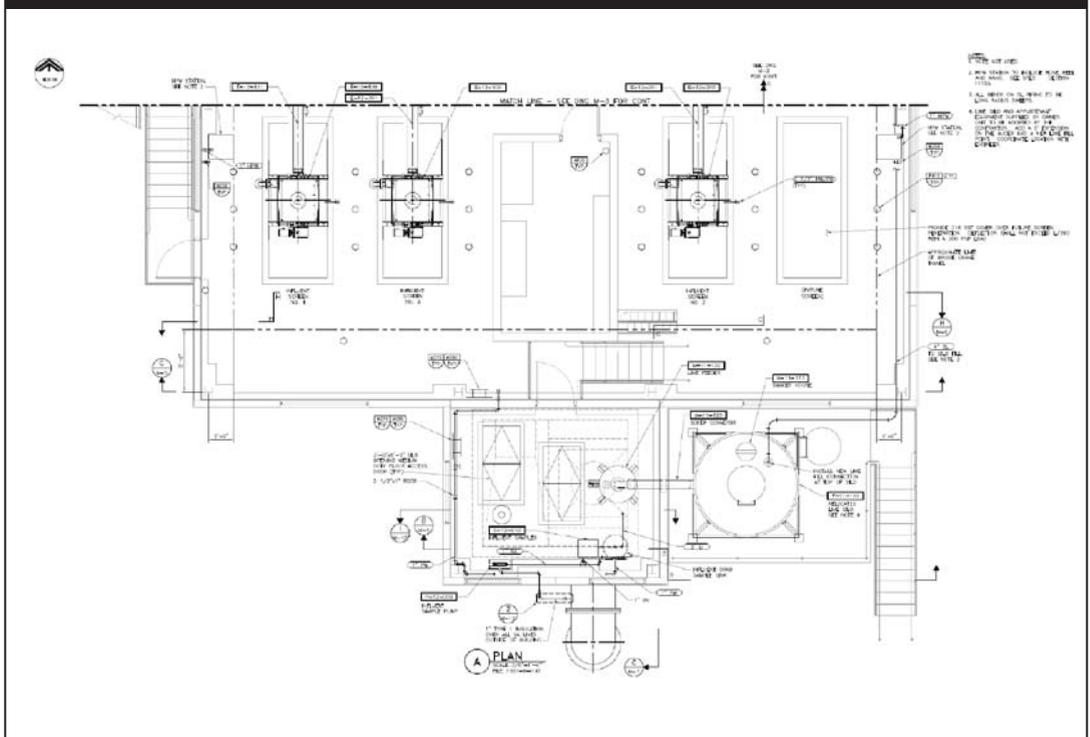
The digester and new headworks building are about 1000 ft (305 m) apart, so the team had to design the new 1400-ft (427-m) hot-water loop carefully so the water would not cool too much to be useful. As a result, the new loop uses insulated polyethylene tubing. The team also installed extra connections so Bend could add hot-water loops later for use in the administration building and other sites.

The primary hot-water loop runs continuously between the digester and the headworks. Inside the headworks, ancillary loops branch off to

- heat the building by running water through a heat exchanger in the air-handling unit,
- heat the building's front walkway to reduce snow and ice buildup, and
- heat the water used to clean both the equipment and the structure (via high-pressure wash stations).

Additionally, to reduce the energy costs associated with lighting, the project team designed the headworks building with high ceilings. And rather than use glass windows, which must be cleaned and sometimes expose less-than-desirable views, the team installed translucent panels along the entire height of the building

**Figure 1. South Plan View of Upper Level of Headworks**





**The new biogas-heated hot water loop has ancillary branches to heat the building, front walkway, and headworks washwater.**

(sometimes replacing wall panels). The panels provided enough light for facility personnel to need electrical lights only after sunset. Although the related savings were minimal (because the facility already uses energy-efficient lights and typically is not occupied), the extra visibility makes the area more staff-friendly.

## Plantwide Benefits

Completed in September 2008, this state-of-

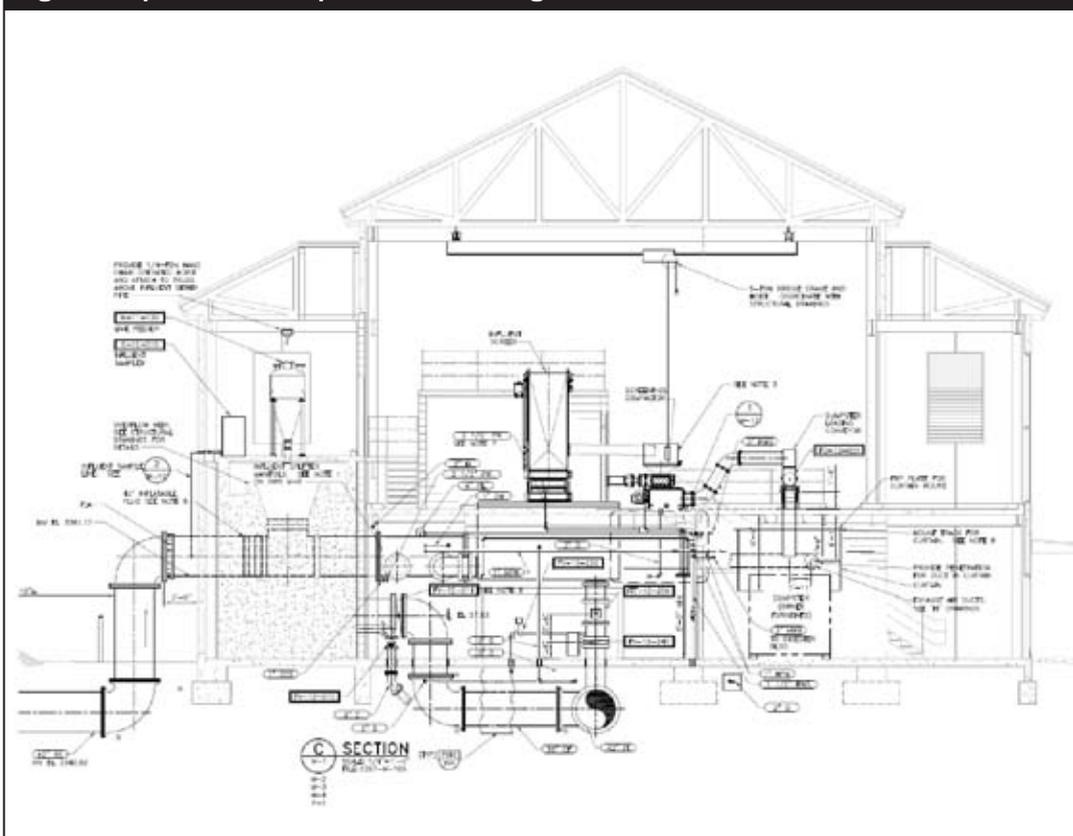
the-art facility has exceeded expectations for both performance and functionality. The solids content of Bend's screenings has increased from a soupy 5% to a relatively dry 30%. Also, the less-wet screenings contain significantly less organic material, because the new screens are more selective and better at washing organics back into the flow stream (see Table 1, p. 62).

While it may be too soon to say for certain, preliminary data suggest that the primary clarifier influent now contains about 3.5% more biochemical oxygen demand than it did before the new headworks started up — organic materials are being returned to the plant rather than land-filled (see Table 2, p. 62). Continued data tracking is planned to confirm this initial assessment.

These improvements have resulted in a 40% increase in solids capture over the old facility, saving Bend about \$18,000 per year in dumping fees and reducing landfill waste by nearly 400 ton/yr (363 Mg/yr).

Meanwhile, the biogas-heated hot-water loop saves Bend about \$25,000 each year in electricity (natural gas is not available at the facility). The treatment facility saves another \$5000 per year in power costs by using biogas to heat the washdown and cleaning water.

**Figure 2. Liquid Stream Is Separated From Building Environment**



**Table 1. Comparison of Captured Screenings**

	Landfill trip frequency	Approximate density of material	Solids concentration	Annual landfill impact	Annual landfill fees
Old screening system	52 trips per year	1270 lb/yd <sup>3</sup> (753 kg/m <sup>3</sup> )	5%	500 ton/yr (454 Mg/yr)	\$24,000
New screening system	12 trips per year	950 lb/yd <sup>3</sup> (564 kg/m <sup>3</sup> )	30%	115 ton/yr (104 Mg/yr)	\$6000

**Table 2. Primary Effluent Biochemical Oxygen Demand (BOD) Change**

	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Average
BOD <sup>1</sup> before (mg/L)	187	206	226	242	249	238	238	242	226	215	227
BOD <sup>2</sup> after (mg/L)	223	243	226	223	254	236	252	234	227	235	235
Change (mg/L)	36	37	0	-19	5	-2	14	-8	1	20	8

<sup>1</sup>Old headworks, 2007–2008.<sup>2</sup>New headworks, 2008–2009.

The new headworks also has provided other benefits. For example, Bend used to have a screen on the secondary clarifier's scum-collection launder. The screen collected floatables from the clarifier surface and required routine cleaning. Now, the screen is unnecessary and has been removed, enabling staff to focus maintenance efforts on other areas.

Also, solids handling and digestion operations have improved. Bend now only needs to clean the digester's heat exchanger once a quarter; staff used to have to clean it once a month. More benefits are expected over the next year or two,

as fewer routine maintenance activities are performed. (A digester project under construction at press time prevented such investigations.)

*Brian Casey is a project manager and engineer, and Bob Eimstad is a partner in the Portland, Ore., office of Carollo Engineers (Phoenix). Scott Thompson is water reclamation operations supervisor, Jim Wodrich is a principal engineer, and Greg Mooney is a water reclamation plant senior operator for the City of Bend, Ore. Tracy Cork and Mike Guthrie are engineers and owners of Vision Engineering (Redmond, Ore.).*

## subscribe to succeed

WEF gives you powerful tools to build your career and stay well informed of the latest in water quality. We offer premier journals and periodicals, unparalleled technical education, updates on the latest developments and information, cost saving opportunities and proven solutions, as well as access to water quality experts and advocates.

It is our goal to be a leading source for all that is water quality, by bringing to you a world of knowledge, education, networking, and solutions.

**SUBSCRIBE TODAY!**

**WWW.WEF.ORG/MARKETPLACE**

