An environmentally sound tailings solution for the Kensington Mine

by Chris Howell and Paul Hoeferlin

The Kensington Mine's tailing treatment facility.

After six years of permitting, years of legal delays and a United States Supreme Court Victory, Coeur Alaska Kensington Mine's tailing treatment facility is now operating without a hitch.

Coeur Alaska Inc.'s Kensington Gold Mine, a historic underground mine 72 km (45 miles) north of Juneau in southeast Alaska, currently processes approximately 1,590 t/d (1,750 stpd) through its mill. The mine began commercial production in July 2010 and is expected to average 3 t/a (112,000 oz/year) of gold production over its 12-year mine life, based on current reserves estimates of 25 t (985,000 oz).

There are two contiguous sides to the mining operation – the Kensington and Jualin properties – divided by Lions Head Mountain. In 2007, Coeur built a 4,420-m (14,500-ft) horizontal tunnel through the mountain to allow clear access between the Kensington Mine and the Jualin property, where the mill and processing facility are located.

Full operation of the mill facility began in July 2010 and approximately 160 kt (177,000 st) of ore was processed in 2010. The mill does not use a cyanide leaching process in its operation but, rather, produces concentrate using a flotation process.

The processing facilities are located at an elevation of 300 m (980 ft) above sea level. Ore is received from the underground mine by 36-t (40-st) trucks. Gold recovery is by a combination of flotation and gravity concentration, followed by concentrated regrind and cleaner flotation. A float stream bearing the gold concentrate and a tailings stream both exit the flotation process. The final flotation concentrate is shipped to an offsite facility for final processing.

Approximately 40 percent of the tailings are recycled back into the mine as fill. The remaining tailings are sent to the tailings treatment facility (TTF), which consists of a tailings impoundment and the water treatment plant (WTP). The tailings impoundment was

Chris Howell and Paul Hoeferlin, members SME, are global marketing director and senior sales engineer, respectively with Veolia Water Solutions, email chris.howell@veolia.com or paul.hoeferlin@veolia.com.

Table 1

Treatability study results.

Constitui\ ent	Units	NPDES 002 effluent limits[1]	Predicted tailings water quality[2]		FEIS projected tailing storage facility (TSF) water quality[3]	
			Min	Max	Min	Max
Iron	ug/L	800	453	619	400	900
Aluminum	ug/L	71	416	426	95	781
Cadmium	ug/L	0.1	< 0.2		0.01	0.031
Chromium	ug/L	8	< 1.5		0.94	2.3
Copper	ug/L	1.9	14	19	0.68	1.9
Lead	ug/L	0.5	43	53	0.12	0.67
Nickel	ug/L	13	4	6	0.97	2.1
Selenium	ug/L	4.1	<1.0		0.13	0.71
Silver	ug/L	0.2	5	6	0.02	0.02
Zinc	ug/L	18	109	113	2.8	13
Mercury	ug/L	0.01	< 0.0002		0.002	0.01
TSS	mg/L	30	No data			

[1]EPA NPDES Permit Number AK-005057-1, July 28 2005

[2]Design Basis (based on jar testing, 2006)

[3]FEIS Appendix G, Table 11

created by the construction of an embankment below Lower Slate Lake, a 9-ha (23-acre) lake located in the Tongass National Forest.

The construction of the embankment and use of the lake to temporarily store tailings was not without legal and regulatory challenges, however. It took six years to obtain permits for the Lower Slate Lake tailings disposal option. The project was 50-percent constructed when environmental groups filed a legal challenge, which was eventually thrown out by the Alaska District Court. Coeur continued to build but, when the project was 80 percent complete, the 9th Circuit Appeals Court made an adverse ruling.

The U.S. Supreme Court finally reaffirmed the validity of Coeur's permit to dispose of mine tailings in 2009. Following the Supreme Court's decision, construction activities resumed at the TTF and were completed in the third quarter of 2010, including the construction of the tailings conveyance pipeline from the mill facility to the TTF.

Tailings water treatment

The purpose of the WTP is to remove non-soluble metals and soluble aluminum from TTF water prior to discharge to Slate Creek. The 94-L/sec (1,500-gpm) WTP facility receives water from slurry transport of settled tailings as well as undiverted natural inflows from drainage areas immediately adjacent to the treatment facility and infrequent overflows from the Upper Slate Lake diversion structure.

Coeur Alaska contracted Veolia Water Solutions & Technologies to design the TTF-WTP and provide startup and commissioning. Since 2005, Veolia has worked closely with the mine in providing water and waste water treatment engineering design services, systems and technologies. For Kensington, Veolia designed a tailings water treatment plant that utilizes high-rate, sand-ballasted flocculation and clarification followed by multimedia and carbon filtration. Based on treatability studies it conducted in 2006 (Table 1), Veolia supplied the Actiflo Turbo HCS sand-ballasted clarifier system and the downstream filtration systems.

High-rate flocculation and clarification

Water to be treated is pumped from a reclaim water tank to the Actiflo clarifier (Fig. 1). Prior to entering the clarifier, coagulant, polymer and oxidant are added to the tailings water. The coagulated water then enters the precoagulation tank. The coagulant destabilizes the suspended solids and colloidal matter in the influent stream. Efficient mixing is provided in the precoagulation tank to thoroughly disperse the coagulant over a hydraulic retention time of approximately two minutes at the 94-L/sec (1,500-gpm) average design flow rate. The destabilized particles collide and begin early stage floc formation.

The precoagulated water then underflows into a coagulation tank, where additional mixing over a retention time of two minutes is provided. Treatment continues as water overflows from the coagulation to the flocculation tank where polymer and microsand are added. Here, the combination of draft tube mixing from the TurboMix mixer, and a retention time of six minutes, allow for thorough incorporation of microsand and polymer into the coagulated water to flocculate the solids. This provides ideal conditions for the formation of polymer bridges between the microsand and the destabilized suspended solids

The fully formed ballasted floc then enters the settling tank. Here, the ballasted flocs settle rapidly. Laminar upflow through the lamella-settling zone provides rapid and effective removal of microsand/sludge floc particles that did not settle. Clarified water exits the Actiflo unit by a series of collection troughs into a gravity line. The ballasted floc sand-sludge mixture is collected at the bottom of the settling tank and withdrawn. The sand-sludge mixture is then pumped to the system's hydrocyclone for separation. Energy from pumping is converted to centrifugal forces within the body of the hydrocyclone, causing the sludge to be separated from the higher density microsand.

Once separated, the cleaned microsand is concentrated and discharged from the bottom of the hydrocyclone and reinjected into the flocculation tank for reuse. The lighter density sludge is gravity discharged out the top of the hydrocyclone into the high concentrated sludge (HCS) splitter box.

The sludge enters the splitter box from which the overflow is discharged to waste. The HCS feature supplies an additional sludge return loop to allow for the volume of sludge produced by the unit to be reduced by up to 90 percent. This allows Kensington to bring 2-percent dry sludge off the bottom of the Actiflo compared to its normal 0.5 percent dry sludge.

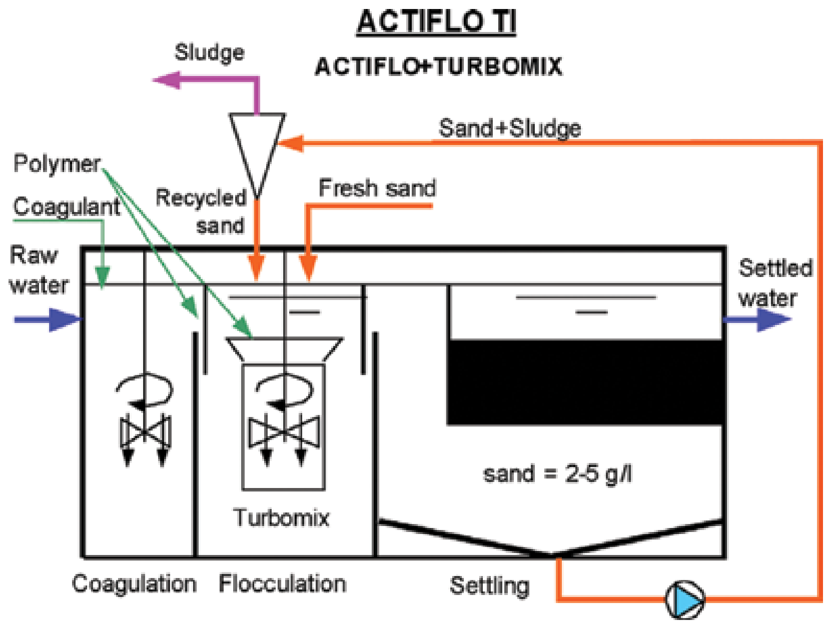
Because the sand-ballasted flocculation and clarification process allows for high overflow rates and short retention times, it provides a significantly smaller footprint than a conventional clarifier system with similar treatment capacity. The high-rate clarifier system is small enough to be housed inside a building, protected from the harsh winter weather and the danger of freezing. This is in contrast to conventional clarifier systems, which can experience problems with polymer lines and recirculation lines freezing in the winter.

Multimedia and carbon filtration

Following sand-ballasted clarification, the tailings water proceeds to three multimedia filters.

Figure 1

Actiflo clarifier diagram.



The filters are capable of removing debris in the range of 5 to 10 microns. Each filter bed consists of three distinct layers of media – anthracite, filter sand and garnet — and two lower layers of garnet and quartz gravel serve as a support bed to prevent loss of fine garnet out of the service lines. The filter columns are of modular design and are operated in a parallel configuration. Normal filter operation has all units in service. However, one or more units may be removed from service through a selector key on the operator interface. Regeneration frequency of the filters depends primarily on the particulate loading of the feed water and the volume and rate of filtrate water being used.

Backwash is initiated when a user-selectable differential pressure set point is reached or by manually initiating through the operator interface. A programmable logic controller sequentially steps all "in service" filters through the cleaning sequence of backwash, settle and fast rinse with the unit returning to service immediately upon completion.

In the final polishing step, carbon filtration is used to remove aluminum from the final effluent. Aluminum levels, however, are only high during springtime, when it becomes bound in organic waste from grass and leaves. The system is of modular design with multiple filter columns operated in a parallel configuration. Through adsorption, the contaminant material physically attaches on the surface of active carbon in the meso-pores and micro-pores of the active carbon.

Following carbon filtration, the final effluent proceeds through the mine's Upper Slate Lake diversion pipe for discharge to Slate Creek under

ME Online Exclusive

Table 2

TTF treated water effluent quality.

Constituent	Units	NPDES 002 effluent limits	Worst case design basis	Commissioning results[1]
Iron	ug/L	800	691	269
Aluminum	ug/L	71	426	10.9
Cadmium	ug/L	0.1	0.2	< 0.1
Chromium	ug/L	8	1.5	< 0.25
Copper	ug/L	1.9	19	< 1.0
Lead	ug/L	0.5	53	< 0.16
Nickel	ug/L	13	6	2
Silver	ug/L	0.2	6	<0.1
Zinc	ug/L	18	113	3.2
TSS	mg/L	30	-	< 5.0

[1]Commissioning data from 11/22/2010

NPDES permit.

Highest standards

The Kensington Mine's TTF-water treatment plant was successfully commissioned and tailings water began discharging to its designated outfall on Dec. 4, 2010.

Since commissioning, the TTF-WTP has performed well and as anticipated, according to Coeur Alaska, and the treatment plant is meeting the highest standards of environmental compliance (Table 2). Approximately 157 kt (173,000 st) of tailings were conveyed to the tailings treatment facility during 2010.

Performance efficiency and flexible operation of the sand-ballasted clarification process ensure optimum plant performance over a range of operating conditions. The short, 10-minute hydraulic residence time in the clarifier enables operators to quickly see the effects of process changes made to the system, thereby enabling quick system optimization and adjustments.

Coeur Alaska has spent close to 20 years developing the mine, generated more than 900 environmental studies at a cost in excess of $30 million. And because of the myriad of water treatment needs – mine dewatering water, tailings supernatant water, low pH water, potable water, sewage and storm water runoff – Coeur and its team have had to develop diverse and innovative solutions for treating water of varying quality.

The development and approval of its tailings treatment facility, however, has been one of it most vigorous water-related challenges.

Geotechnically and environmentally sound

The temporary use of Lower State Lake to hold mine tailings was deemed by Coeur Alaska to be the optimum choice for the Kensington Mine and determined by the U.S. Army Corps of Engineers, U.S. Forest Service and state of Alaska as the environmentally favorable and feasible option. Prior to building the TTF, the water quality of Lower Slate Lake did not naturally meet state standards for aluminum and there had been little or no spawning habitat for native fish.

During mining at Kensington, this area provides a geotechnically sound location for tailings, while reducing impacts to productive wetland and other wildlife habitat. At the end of mining operations, the tailings area will be reclaimed into a nearly 24 ha (60-acre) lake with improved productivity and aquatic habitat, as determined through the final supplemental environmental impact statement prepared by the U.S. Forest Service. Until then, the tailings treatment facility will be providing the necessary operations for the mine to meet all regulatory standards, while helping to protect the natural environment in this pristine area of southeast Alaska. ■