

Wastewater: From Waste to Resource

The Case of Arequipa, Peru

Wastewater Reuse for Industrial Purposes

Context and Challenges

SEDAPAR S.A. (Servicio de Agua Potable y Alcantarillado de Arequipa) is one of the public service enterprises in Peru. It is a limited liability company owned by

8 provincial municipalities and 26 district municipalities in Arequipa Department. It provides water and sanitation services to the metropolitan area of Arequipa and a large part of the department.



Aerial view of La Enzolada wastewater treatment plant.
Source: Cerro Verde, 2018.

SEDAPAR serves over 1.1 million inhabitants through 280,000 connections. Coverage ratios are over 94 percent for water and over 80 percent for sanitation services.

SEDAPAR is the second-largest utility in Peru in terms of population served—after Sedapal in Lima—and is the largest in terms of coverage area. Arequipa Department, at a size of 63,345 square kilometers (km^2), is bigger than many countries, such as the Netherlands, Costa Rica, or El Salvador. The region is crossed by deep valleys and the high mountains of the Andes, and the climate is dry. In this context, sizeable investment in water infrastructure is required to provide quality water services to the entire department. In 2008 more than 90 percent of municipal sewage and wastewater from Arequipa city was discharged directly into the Chili River, polluting an important water source for the region (Fraser 2017).

Sociedad Minera Cerro Verde, located 30 km from Arequipa city, is the largest copper mine in Peru. Its current operator, the multinational mining company Freeport-McMoRan, was planning a large-scale expansion that required access to additional water supply. But gaining such access posed a major challenge, given the region's arid environment and growing population. Moreover, the city's insufficient wastewater treatment capacity was contributing to the increasing pollution of the Chili River watershed (the primary supply source for the Cerro Verde operation).

Cerro Verde explored several options, such as using desalinated seawater or water from faraway aquifers. Utilizing wastewater from the nearby city of Arequipa turned out to be the most sustainable and economical solution. Treating wastewater for reuse was recognized as a key long-term source of water for the mining operations. Moreover, treating Arequipa's wastewater, which was being discharged to the river without treatment, would also benefit the population of Arequipa, improving the river's water quality, reducing waterborne diseases and helping to advance

the sustainability of the region's water supply and sanitation sector.

Proposed Solution

After discussions with regional and local governments, development agencies, civil leaders and Cerro Verde, SEDAPAR agreed that the mine could take, treat, and reuse wastewater from the city of Arequipa. Therefore, rather than a wastewater treatment plant, the final infrastructure would be a water resource recovery facility. The water resource recovery facility, called La Enlozada, would be designed, financed, built, and operated by Cerro Verde under a public-private partnership (PPP) agreement. In exchange, Cerro Verde would receive a percentage of the treated water, to be used for mining processes (about 1 cubic meter per second [m^3/second]) (Cerro Verde 2018). The rest of the treated wastewater would be returned to the river, to be used by farmers downstream.

This solution would allow wastewater generated by the population to be reused, limiting the environmental and human health impacts of untreated wastewater discharge into the Chili River. Consultations between Cerro Verde and the Regional Government of Arequipa, the national government, SEDAPAR, as well as other local institutions provided the backdrop to Cerro Verde raising funds for the construction of the treatment plant.

La Enlozada was built on the grounds of the Cerro Verde mining complex. The initiative was formalized through a framework agreement "*Ampliación y Mejoramiento del Sistema de Emisores y Tratamiento de Aguas Residuales de Arequipa Metropolitana e Interconexión*," which included the wastewater collection system, pumping station, and wastewater treatment plant (Cerro Verde 2011). Cerro Verde committed to finance the capital costs of the plant, pumping station, and conveyance pipelines, and to cover the operation and maintenance costs of the plant and pumping system for the duration of the contract (29 years).

Feasibility studies were conducted to determine the most sustainable technologies to utilize. As a result, the plant uses trickling filters, which do not require forced air to oxygenate the biomass (unlike activated sludge), thereby incurring considerably less energy costs. At over 2,000 meters (m) above sea level, the level of energy needed for activated sludge almost doubles, which increases the advantage of trickling filters.

The plant started operations on December 2016 to treat Arequipa's municipal sewage, and it was built in stages (Cerro Verde, 2018). The current plant capacity is 1.8 m³/second. To meet the growing demand the capacity is projected to increase in two future expansions: in 2029 to 2.1 m³/second with a final expansion in 2036 to 2.4 m³/second (Fraser 2017).

Financial Structure and Instruments

Corporate Finance

Majority owned by Freeport-McMoRan, Cerro Verde is one of the world's largest copper mines. Based in the United States, Freeport-McMoRan is the second-largest copper producer in the world. The company uses many kinds of corporate finance instruments for its operations. To finance La Enlozada and related infrastructure, the company included the project in its internal investment pipeline. The company could have

applied for local financial instruments to reduce costs but decided to finance the project with its own means to avoid any delay.

PPP Agreement Adapted to Local Circumstances

As part of the PPP agreement, SEDAPAR filed the environmental assessment and permit applications for plant operations and the discharge of treated water back to the Chili River. The municipal authorities provided the land. Cerro Verde financed the feasibility and environmental assessment studies and secured a sound engineering, procurement, and construction (EPC) contractor for the design and construction of the plant. Cerro Verde was able to take most of the risks (technical, financial, construction, and operation), which together were smaller than the losses of not expanding the mine operations. The PPP agreement was signed for 29 years. After that, the facility's ownership and management are to be transferred to SEDAPAR. The federal government and the National Water Authority (Autoridad Nacional del Agua, ANA) conducted the water studies, approved the environmental impact assessment, issued the necessary permits, and ensured that permit commitments were met.

Benefits

Under this agreement, SEDAPAR avoided the costs of constructing and operating the wastewater treatment



Panoramic view of the Enlozada wastewater treatment plant.

Source: Photo by Daniel Nolasco, 2016.

plant, resulting in a net savings of over \$615 million: \$538 million from the cost of plant construction and \$77 million from the cost of 29 years of operation and maintenance, as detailed in table 1. Translated into cost per cubic meter, these savings would be in the range of \$0.68–\$0.80/m³ depending upon CAPEX financing conditions (ITAC 2019).

The benefits to Cerro Verde are also substantial—including cost savings relative to the next-cheapest option. The closest water source of similar capacity is the sea, located about 100 km away and at an elevation 2,600 m below that of Arequipa. The infrastructure needed to use sea water for mining processes would be a desalination plant, a power plant, pumping stations, and pipes to bring the water to Cerro Verde. The costs of this option would be at least four times higher than building the wastewater treatment plant La Enzolada (ITAC 2019).

Besides the economic benefits, there are also environmental and social benefits. The city of Arequipa

is benefitting from wastewater treatment at no cost to the taxpayer. More than 95 percent of the city's wastewater is now treated (Fraser 2017). The water quality of the Chili River has improved substantially (figure 1), and aquatic and wildlife are returning to the river.

Because of the improved water quality, including lower fecal coliform levels, communities living downstream can enjoy better health, and incidents of waterborne illness have been reduced. Farmers can also use the better-quality water for irrigating their crops, potentially allowing them to switch to higher-value crops.

Findings and Lessons

Stakeholder Engagement is Key to a Successful Outcome

A key factor in the success of La Enzolada is the ongoing engagement of stakeholders, including those directly influenced by the environmental impacts of the mining operations and also those in areas of indirect influence. Cerro Verde implemented a community relations program that gathered municipal and other community leaders to identify the major problems observed in the affected areas and potential ways to address them.

Moreover, Cerro Verde has been collaborating with local stakeholders to help solve water issues across the region. The company is a member of a multisectoral water users' committee. In 2006, the company signed an agreement with regional officials, elected representatives, and social groups to collaborate in and to support investment in water infrastructure. The company has already helped finance the Bamputaño dam, the Pillones dam, the La Tomilla II potable water plant, and more than 40 km of potable water pipes (Cerro Verde 2018; Fraser 2017).

Finally, by securing a sound EPC contractor for the design and construction of the plant, Cerro Verde ensured that the best wastewater treatment plan option was chosen for the local conditions.

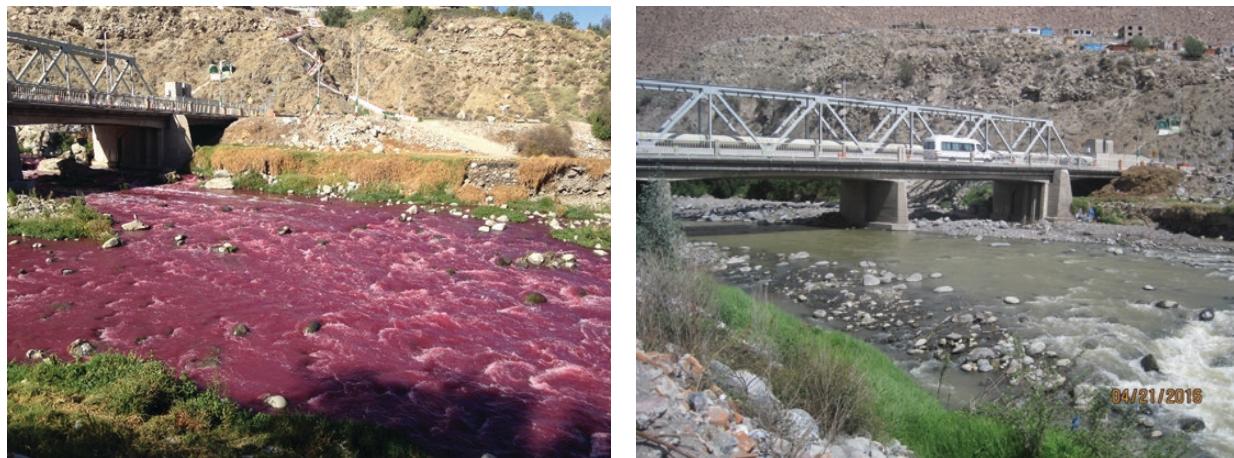
TABLE 1. SEDAPAR's savings due to the terms of the private-public partnership agreement

Capacity, CAPEX, and OPEX			
Average capacity	l/s	1,800	1,800
	m ³ /year	56,764,800	56,764,800
Infrastructure			
		CAPEX	
		US\$	Nuevos soles
Wastewater treatment plant		360,178,329	1,181,384,919
Pumping and canal to the plant		94,140,355	308,780.364
Effluent infrastructure		83,681,316	274,474.717
Total		538,000,000	1,764,640,000
OPEX			
O&M /year	0,1	5,676,480	18,618,854
O&M 29 years NPV		77,147,456	253,043,656
Total savings		615,147,456	2,017,683,656

Source: ITAC 2019.

Note: CAPEX = capital expenditure; NPV = net present value; O&M = operation and maintenance; OPEX = operating expenditure.

FIGURE 1. The Chili River before and after the construction of La Enlozada



Source: Photos by Jose Luis Valverde.

Favorable National PPP Regulations can Foster the Development of Waste-to-Resource Projects

Peru has introduced regulatory instruments for the promotion of private sector participation in infrastructure development, which were applied to this project. Meanwhile, Cerro Verde's proposal to recycle wastewater was an innovation that led to the government's development of new regulations that promote the participation of private companies in contributing to solutions to the health problems caused by water and environmental pollution (2030 WRG 2018).

Water Scarcity Encourages Water Reuse

This case study shows that wastewater reuse is economically viable in water-scarce areas, especially where the cost of tapping the nearest water source is high. It is estimated that for an alternative scenario (desalination and pumping), the cost of water for Cerro Verde would be in the range of \$2.5/m³, in comparison with \$0.68-\$0.80/m³ for wastewater reuse. Given the opportunity costs, Cerro Verde was ready to pay the capital and operation costs of the wastewater treatment plant in full.

Mitigating all Social Risks is Challenging

As was mentioned earlier, Cerro Verde is now retaining 1 m³/s that had been previously discharged (untreated)

to the river and used by downstream farmers. After the wastewater treatment plant's construction, the farmers noticed that the available volume for irrigation had been reduced. Even though the preceding flow of wastewater had been untreated and could cause serious health issues if used to irrigate certain crops, the farmers saw themselves as the rightful owners of the water, and were unhappy when its volume was reduced. Cerro Verde tried to mitigate this risk by investing in canalization projects for farmers in several nearby areas. However, some farmer associations did not receive any compensation and were still dissatisfied with the agreement (Hola Arequipa 2019). SEDAPAR and municipal and regional authorities are reviewing the agreement and exploring ways to compensate these farmers.

Conclusion

This case study demonstrates that well-designed PPPs can result in business benefits while also addressing social issues. The participation of private companies in waste-to-resource projects can reduce the economic and financial burden on local utilities and at the same time generate social and environmental benefits. By working collaboratively with local stakeholders, Cerro Verde and SEDAPAR identified an opportunity to meet both a business and a social need. Cerro Verde secured

water for its mining operations without the conflict that can result from competition for a scarce resource. At the same time, Arequipa benefitted from the project: wastewater treatment coverage has increased, the Chili River has been rehabilitated, and incidents of waterborne illness have been reduced. To mitigate social risks, water resource management and wastewater projects that directly impact a population's well-being should always involve the population's direct participation.

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