Real Time Monitoring for Environmental Compliance of Mining Effluent

Mining companies have faced challenges when it comes to environmental monitoring. The latency of data through the traditional lab testing approach creates risk around compliance and treatment. These challenges lead to serious and far-reaching consequences for not only the companies, but also for communities and the environment. If effluent isn't monitored properly this can lead to environmental pollution, public health risks, legal and financial consequences and damage to a mining company's reputation and public image.

The most common method of effluent monitoring is laboratory analysis. This process has potential negatives such as sampling bias, inaccurate measurements, time consuming with a high cost and the inability to detect short term changes. In-line monitoring systems provide real-time data that mitigate these consequences that cause larger scale concerns like the ones previously discussed.

The frequency of effluent testing measurements varies depending on the individual mine and what metal it is mining. Under the ECCC regulations, operators are required to test the effluent at each discharge point weekly for deleterious substances and monthly for acute lethality (fish toxicity) and to record the results of all tests[1]. With that being said, bi-weekly testing has been a standard for some mines, to try to mitigate potential pollutants into the environment. Biweekly sampling and wait times for lab processing from grab and go can lead to detrimental effects on the environment and communities surrounding it.

Below are three case studies of Canadian mining sites that demonstrate the consequences grab sampling standard testing procedures can lead to and demonstrate the importance of real-time monitoring can have mitigating these effects.

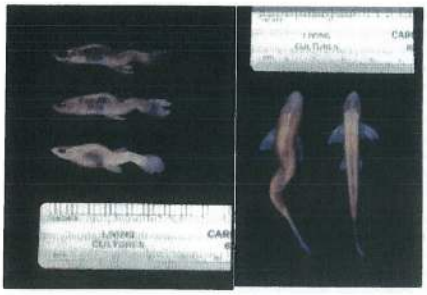
Case Study #1: Teck Coal

In 2012, Teck Coal, a subsidiary of Teck Resources, was found to have discharged untreated effluent from their mining operations into the Elk Valley region of British Columbia, Canada. The discharges of effluent contained high levels of selenium and calcite to a mine settling pond and Fording River from its steelmaking coal operations in this region. Environment Canada found that selenium concentrations were as high as 90 ppb in the Fording River (as compared to 1 ppb upstream).[2]

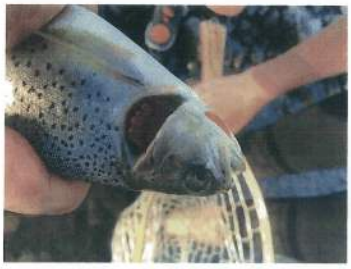
While Teck were doing the required quarterly testing, there were huge gaps in their data set that allowed effluent laden with contamination to be released into the environment.

The discharges of selenium and calcite were investigated by the Environment and Climate Change Canada (ECCC). They were fined $30 million dollars for each infraction which totalled $60 million dollars. This is the largest fine imposed under the *Fisheries Act.* The company disclosed they did not exercise due diligence in terms of waste management. [3] The speed of detection was a major factor in that diligence.

In 2020, ECCC concluded that Teck hadn't mitigated the issues previously investigated. Teck Resources research also concluded that the native and endangered West Slope Cutthroat Trout population had collapsed. This caused spinal and facial deformities, loss of plates that lay over top of gills, and reproductive issues.[4]



In these 1980 photos, Dr. Lemly, an expert asked to prepare a report on selenium pollution in the Elk Valley for Environment Canada, details spinal deformities of mosquitofish (left) and a red-horse minnow (right) as a result of selenium poisoning in North Carolina from a coal-fired power plant. Photo: A. D. Lemly / Environment Canada



A westslope cutthroat trout with a missing gill plate, a telltale deformity caused by selenium poisoning. This trout was caught in 2014 in Coal Creek, a tributary of the Elk River. Photo: Environment Canada

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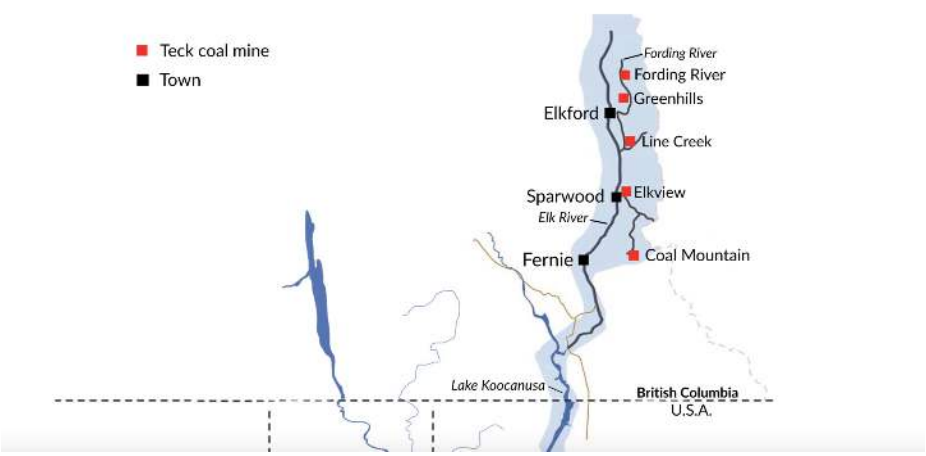
The contaminated water impacted communities including the Ktunaxa Nation Council, the Shuswap Indian Band and the Secwepemc Nation. The Ktunaxa Nation Council has expressed concerns about the contamination's effects on the health and well-being of their people, as well as the environment.[5] Elk River ultimately joins the Columbia River and flows to the Pacific Ocean. The Columbia River is home to an estimated 16 million salmon[6], supplies food for 130 species of animal, and supports 15 million people[7], all of whom were exposed by these infractions. Locally, the Elk Valley region, including the towns of Sparwood, Fernie, and Elkford, have also been affected by the pollution. Residents have reported health problems, including respiratory issues and headaches, that they believe are linked to the mining activities in the area[8].



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Right now, as of 2022 the current water treatment plan for Teck Coal in Elk Valley is to treat up to 77.5 million litres of water a day. Between 2022-2024 Teck has planned to invest $750 million dollars in protecting the watershed. [9] While their dedication to solving the issue today is unshakable, real time monitoring could have prevented the infractions from occurring in the first place. Sadly, it was not available at the time of the incident.

These incidents have so far cost Teck more than $2 Billion dollars in direct expenses, as well as incalculable social license impact. Their name has become synonymous with environmental degradation,

despite their current efforts to treat Elk River. Their infractions have affected more than 34 million people and 170 species of fish.

All of this could be preventable with real time monitoring which was, sadly, unavailable at the time of the incident.

Case Study #2: ArcelorMittal

ArcelorMittal Canada Inc. and 7623704 Canada Inc., mining partners and Canada's largest supply of iron ore, was fined $15 million dollars on June.13/2022 for five charges of violating the *Fisheries Act* and *Metal Mining Effluent Regulations* (MMER) from May 25th 2011 to May 14th, 2013 at the mining site Mont Wright in Fermont, Quebec.

The ECCC opened an investigation in November 2012. During this investigation, it was revealed that there were 33 unauthorized toxic deposits put into water where fish frequent, causing them to be in violation of subsection 36(3) of the *Fisheries Act*. Along with the violation of the Fisheries Act, they found that ArcelorMittal Canada Inc. and 7623704 Canada Inc. were also guilty of failing to conduct the proper testing that was required. ArcelorMittal was liable for "deliberate and unlawful discharge of raw sewage into nearby rivers and wetlands, resulting in ecological damage."

The waterways that were being contaminated by the discharge were lakes Saint-Ange and Webb, they both flow into the Moisie River which is one of the biggest Atlantic Salmon rivers in North America. Effluent being discharged into rivers, streams, lakes, or oceans, can have a negative impact on fish and aquatic ecosystems. Chemical pollution which can cause a range of health problems in fish like reproductive issues, neurological damage, and decreased immune function. Overall, the effects of effluent on fish can be serious and long lasting, with negative impacts on health and survival. Without proper treatment, these effluent discharges can pose serious risk for the environment and the community around.[10]

As well as the surrounding ecosystem, indigenous communities such as the Innu communities of Uashat mak Mani-Utenam and Matimekush-Lac John have been impacted by the pollution, along with people living in the nearby towns of Port-Cartier and Fermont have also been affected. [11]

Monitoring the facility output would have provided the data needed to prevent these events.

Case Study #3: CaNickel

On April.11, 2022 CaNickel was fined $200,000 after pleading guilty in the Provincial Court of Manitoba. They were charged with two offences in December, 2018 by the ECCC on violations of the *Metal Mining Effluent Regulations* in accordance with the *Fisheries Act.* These infractions were due to effluent being leached into Bucko Lake, a fish bearing lake. A sample that was taken in July 2017 contained Nickel and the radioactive element radium 226 in higher than allowed quantities. The improper monitoring of their effluent was responsible for these infractions.

The nearby communities are the Indigenous communities of the Tataskweyak Cree Nation and the War Lake First Nation and the surrounding town of nearby Wabowden were impacted by the direct pollution, as well as the effect this pollution could have on the ecosystem and wildlife.

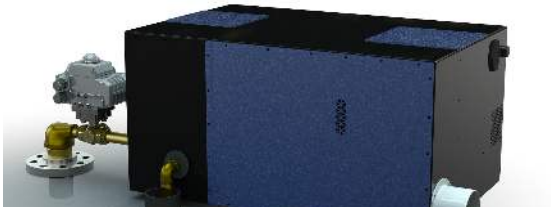
CaNickel was also charged with failing to test their effluent on scheduled dates in 2017. This breaks protocol under the *Metal Mining Effluent Regulations* for mandatory effluent testing before release. Standard testing is used to verify the levels of potentially harmful contaminants in the effluent, which is placed to protect fish and aquatic habitat.

Due to these offences, CaNickle the company's name was added to the Environmental Offenders Registry.[12] The mining operations at Bucko Lake have been a subject of ongoing concern and controversy, and the company has faced criticism and legal action from local communities and environmental groups. The mine was closed in 2015 and is now under care and maintenance. [13]

As previously mentioned in other case studies, discharging of unmonitored effluent into the environment has dangerous side effects on the environment and pose serious risk for health of the ecosystem and the health of the communities around these sites.[14] Intermittent monitoring allows for these risks and problems.

Real-time Monitoring:

Real-time monitoring such as 2S Water's AquaValid provides quick results compared to regular testing. Compared to ICP and the standard collect and test, results are generated every 5 minutes, providing the mining site operators the chance to quickly act if levels have reached an unauthorized level. Mitigating environmental risk and financial penalties, along with the social license to operator. Using real-time data in water treatment will



improve water quality, increase efficiency, allow early detection of problems, improve compliance and enhance safety.

Real-time data can help businesses to:

- Identify inefficiencies: Real-time data allows businesses to monitor key performance indicators (KPIs) and identify areas where processes may be losing revenue.
- Make informed decisions: Real-time data allows operators to make informed decisions based on current data. By having access to up-to-date information, facilities can make more accurate and timely decisions.
- Reduce downtime: Real-time data allows facilities to identify potential problems before they become major issues. By monitoring data in real-time, operators can take proactive steps to prevent downtime and reduce the risk of equipment failure.
- Increase productivity: Real-time data can help facilities optimize processes, reducing the amount of waste generated and increasing overall productivity.

The AquaValid Sensor

Shown in Figure 1. Is an example of the AquaValid detecting a Zinc event. In Figure 2, the 2S Water team used a calibration curve to determine the change in concentration of Zinc at this site over the same sample period. Realtime detection was able to identify this event in between the scheduled testing, which otherwise went undetected.

This method of real-time monitoring would have been beneficial to all the three mining sites in the case studies above. Being able to act quickly and accurately know what is discharging into the environment, allows facilities to address the contaminants before it's too late and damage has been done to the ecosystem and community.

During this event, there was a grab sample taken two days before this Zinc event was recorded on the AquaValid database and there was one taken after. The sample two days before the event showed that Zinc was in compliance with the site limit. At its peak, the Zinc levels that were being discharged were more than 30 times the site limit. This shows how useful in-line, realtime data systems are in mitigating environmental and financial risks by early detection of potential pollution.

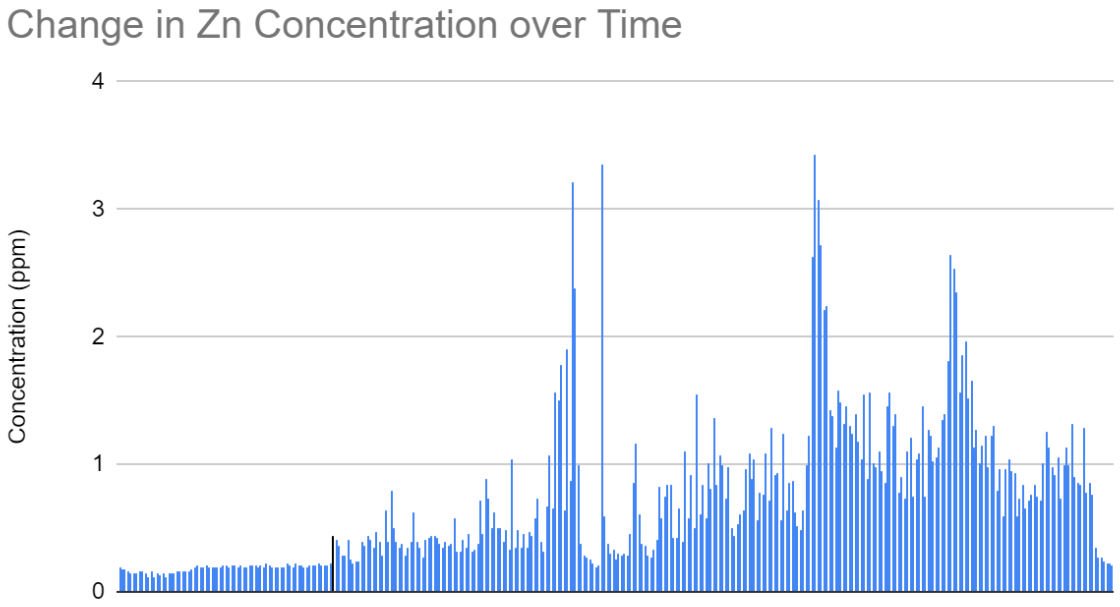


Figure 2: Estimated concentration of Zn from April 14-19. The black line represents the start of the increased signal and occurs on April 15, 2022.

Real-time data can provide numerous benefits to the mining sector. In Southeast Asia, these tech-enabled process optimizations have shown to prove efficiency for all the major front-runners in the mining industry. These technologies, such as sensors and data that are both in frontline and factory operations have been proven to improve productivity and efficiency while also helping companies achieve their sustainability targets such as increasing their productivity while consuming less resources. It has been analyzed that these process optimization solutions can have up to a $5 Billion value in the key metal markets within Southeast Asia. [15]

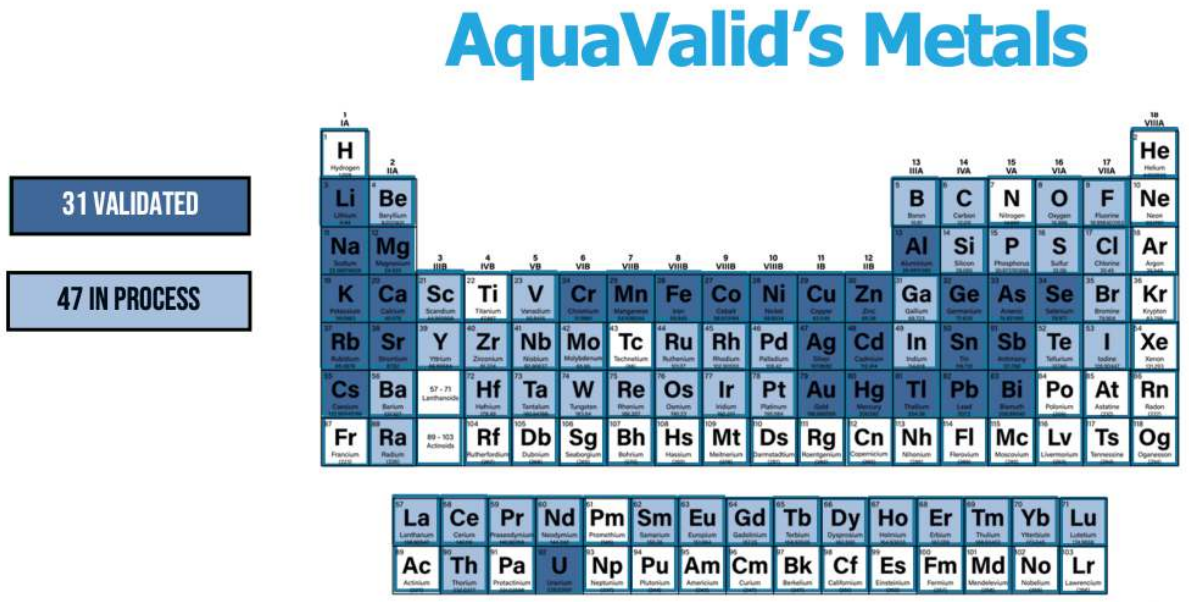
Table 1. Improving copper, gold, nickel, iron ore, and zinc processing could create as much as $5 billion in value across Southeast Asia.

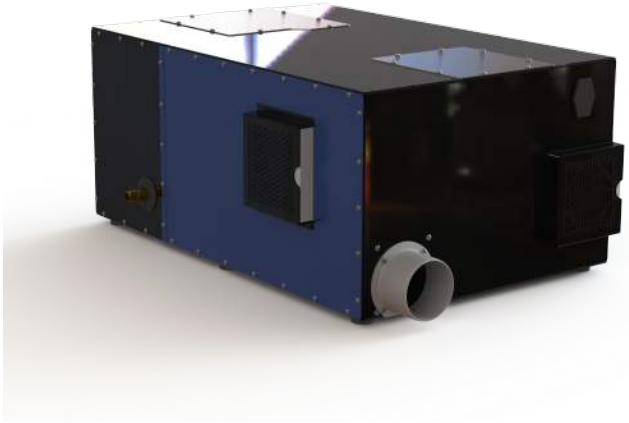
Country	Potential mining processing value in Southeast Asia, $ millions
Indonesia	$2,900–$3,700
Philippines	$700–$900
Laos	$150–$190
Vietnam	$140–$180
Malaysia	$50–$70
Myanmar	$40–$50
Thailand	$16–$20
	$4 billion–$5 billion total potential value across Southeast Asia

Source: McKinsey MineLens

The consequences of not regularly monitoring and lack of reporting are seen in all three case studies, causing not only environmental risk, but also, financial risk. If real-time monitoring of effluent were implemented at these sites, operators would know exactly what, how much and when harmful substances were being leached into the waterways. As well, with a real-time data system, there would be less room for human error and negligence in terms of reporting effluent levels due to the frequency of recorded data.

If you are interested in knowing more about how real time data can work for you, go to www.2swater.com to book a demonstration or a free sample testing. The AquaValid can detect 30 metals with 41 more currently under development.





Endnotes

[1]https://www.canada.ca/content/dam/eccc/documents/pdf/cesindicators/metal-mining/2021/metal-diamond-mining-effluent-quality-en.pdf

[2] https://www.cbc.ca/news/canada/british-columbia/teck-fined-60m-contaminating-bc-rivers-1.5965646

[3] https://www.cbc.ca/news/canada/british-columbia/teck-fined-60m-contaminating-bc-rivers-1.5965646

[4]https://thenarwhal.ca/for-decades-b-c-failed-to-address-selenium-pollution-in-the-elk-valley-now-no-one-knows-how-to-stop-it/

[5]https://www.ktunaxa.org/documents-global-affairs-canada-shelves-a-joint-international-initiative-to-address-kootenay-watershed-selenium-contamination/

[6]https://www.whitehouse.gov/ceq/news-updates/2022/03/28/columbia-river-basin-fisheries-working-together-to-develop-a-path-forward/

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[9]https://www.teck.com/media/Elk-Valley-Water-Quality-Plan-2022-Implementation-Plan-Adjustment-Overview.pdf

[10] McMaster University. (2017, December 5). Fish exposed to treated wastewater have altered behavior. *ScienceDaily*. Retrieved February 21, 2023 from www.sciencedaily.com/releases/2017/12/171205092134.htm

[11]https://www.theglobeandmail.com/globe-investor/quebec-innu-file-900-million-lawsuit-against-iron-ore-co-of-canada/article10018213/

[12]https://www.canada.ca/en/environment-climate-change/news/2022/04/mining-company-in-manitoba-fined-200000-for-violating-federal-environmental-legislation.html

[13]https://www.juniorminingnetwork.com/junior-miner-news/press-releases/3213-tsx-venture/cml/137083-canickel-files-ni-43-101-technical-report-on-updated-mineral-resource-estimate-and-preliminary-economic-assessment-for-the-bucko-lake-mine.html

[14] McMaster University. (2017, December 5). Fish exposed to treated wastewater have altered behavior. *ScienceDaily*. Retrieved February 21, 2023 from www.sciencedaily.com/releases/2017/12/171205092134.htm

[15]https://www.mckinsey.com/industries/metals-and-mining/our-insights/advancing-metals-and-mining-in-southeast-asia-with-digital-and-analytics