

BREAKTHROUGH TECHNOLOGY FOR
THE TREATMENT OF ACID AND HEAVY
METALS IN WATER AND SOILS

VIROMINE™ TECHNOLOGY



*“I know of no other practical and economical technology
in the world today that could achieve such conclusive
and wide-ranging results.”*

PROFESSOR DAVID McCONCHIE
Southern Cross University,
a recognised world authority
in the field of Acid Rock Drainage.

VIROMINE™ TECHNOLOGY – AN INNOVATIVE TECHNOLOGY THAT PURIFIES HIGHLY CONTAMINATED WASTEWATER AND SOILS



BRIAN SHEERAN
*Executive Chairman
Virotec International*

“In February, 2000 Virotec achieved an impressive ‘world first’. The company successfully treated a dam containing 1.6 billion litres of highly contaminated water and converted it into water so clean that it met the stringent ANZECC standards for the protection of aquatic ecosystems – 100 times cleaner than drinking water.

This spectacular result was achieved using Virotec’s patented ViroMine™ Technology.

This remarkable technology can be applied to economically treat Acid Rock Drainage (also referred to as Acid Mine Drainage or AMD), tailings dam water, sulphidic mine tailings, acid sulphate soils and waste rock dumps to:

- > Permanently neutralise acid.
- > Trap trace metals and prevent leaching.
- > Enhance nutrient retention capacity and promote vigorous plant growth.

ViroMine™ Technology is a total and highly effective solution. Indeed, ViroMine™ Technology “may be the only acceptable and sustainable solution from an economic point of view to solve acid rock drainage and acid sulphate soils,” according to Professor Schulling from the International Institute of Environmental Engineering in Delft, The Netherlands.

The effectiveness of the technology was further confirmed in October, 2002, through studies carried out by the US EPA.”



Highly acidic water from a Portugal mine site before and after treatment with ViroMine™ Technology Acid B Extra™ reagent.



ARD pollution can poison drinking water, contaminate ground water and destroy aquatic life. Many of the contaminants, such as arsenic, cadmium, copper and lead, are highly toxic, and can produce devastating effects on the environment.

ACID ROCK DRAINAGE

It has only been in the last 25 years that regulators have understood the devastating impact of Acid Rock Drainage (also referred to as Acid Mine Drainage or AMD). It is considered to be the principal threat posed by mining activity, past, present and in the future.

Typical sources of Acid Rock Drainage at mine sites are underground workings where ground water percolates through a honeycomb of tunnels and shafts, piles of waste rock, mining overburden and exposed tailings. Mines may be a source of Acid Rock Drainage for thousands of years.



TAILINGS DAMS

It is estimated that some 13 billion tonnes of stone, 10 billion tonnes of sand and gravel, and 500 million tonnes of clay are used annually in the construction of tailings dams. Accordingly, there are tens of thousands of tailings dams worldwide containing billions of tonnes of mineral processing wastes.

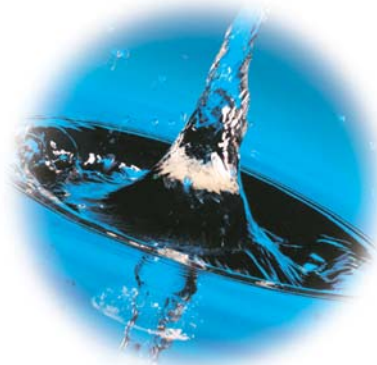
Due to their vast quantities, liquid nature and very high content of toxic metal contaminants, their containment and control are an ongoing management concern at virtually all mine sites. The impact of seepage is a constant concern.

The most serious issue relates to the potential of tailings dams to fail or collapse, claiming lives and causing considerable environmental damage. The damage caused by these failures in terms of human casualties, destruction of property, disruption of communications, pollution of the environment and economic loss to the mining industry is enormous.



There has been a reported failure of a tailings dam almost every year for the past two decades, each with widespread and devastating results.

>>> CLEAN MINING TECHNOLOGY



When ViroMine™ Technology reagents are applied to ARD they purify the contaminated water to stringent environmental standards. Tailings dams and exposed waste rock can be treated both effectively and economically.

VIROTEC'S BREAKTHROUGH SOLUTION

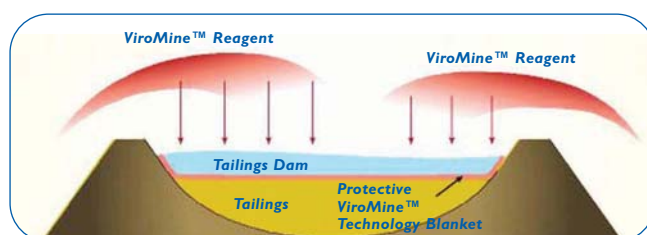
Virotec has developed a proven range of unique ViroMine™ Technology reagents to treat or prevent the devastating effects of ARD.

These new, proprietary reagents are applied in a single-stage, 'in-situ' treatment capable of cleaning large volumes of tailings dam water and converting toxic dams into reservoirs of clean water which meet stringent environmental standards. The treated water can even be emptied into sensitive ecosystems or drinking water catchments.

- > **Alka B™ reagent** Designed to treat alkaline (pH >7) water contaminated with heavy metals.
- > **Neutra B™ reagent** Designed to treat mildly acidic (pH 6-7) water contaminated with heavy metals.
- > **Acid B™ reagent** Designed to treat acidic (pH 4.5-6) water contaminated with heavy metals.
- > **Acid B Extra™ reagent** Designed to treat high acidic (pH <4.5) water contaminated with heavy metals.
- > **Terra B™ reagent** Designed to treat sulphidic waste rock and soil.

When used to treat acid rock waters, ViroMine™ Technology reagents settle through 10 metres of water within 48 hours, extracting metals in the process. Unlike lime, the treatment does not leave behind a toxic sludge. Rather, it generates a thin, non-toxic, stable sediment – typically less than 5mm thick.

The application of these ViroMine™ Technology reagents can prevent the formation of acid rock drainage in the first place by stabilising exposed waste rock, mining overburden and tailings. In most cases treated soils and wastes can be used to create a rich substrate for plant growth safe in the knowledge that immobilised metals cannot be translocated into adjoining non-polluted environments or taken up by plants.



ViroMine™ Technology reagents are applied in a single stage, in-situ treatment.

CASE STUDY – AUSTRALIA



When a heavily contaminated tailings dam threatened to break its banks and spill toxic water into a large drinking water catchment in New South Wales, Australia, ViroMine™ Technology was used with outstanding success to treat and clean the polluted water.

THE PROBLEM



The tailings dam was severely contaminated.

Following the closure of Mt Carrington Gold and Silver mine in northern New South Wales, Australia, in the early 1990's, a legacy of over 100 years of mining was left in the form of a severely contaminated tailings dam.

All Acid Rock Drainage seeping from the various contaminated sources around the site had been pumped into this tailings dam for storage. Until 1996, the evaporation rate matched inflows and the dam experienced a small but steady rise in metal concentrations.

In 1996, a major inflow of water almost filled the 35 acre dam. The situation deteriorated over time, and grave concerns regarding uncontrolled discharge across the spillway or breach of the dam wall were expressed by environment authorities.

THE VIROTEC SOLUTION

In 1999, Virotec undertook the treatment of the 1.6 billion litre tailings dam, using a ViroMine™ Technology Acid B™ reagent which was sprayed on to the surface of the dam.

Following treatment, the dam water met stringent ANZECC standards for heavy metals and the protection of aquatic ecosystems. Approximately 350 million litres of water were subsequently released with safety into the local catchment.



ViroMine™ Technology reagent being applied.



Government officers testing treated water.

Parameter	Before ViroMine™ Technology	After ViroMine™ Technology	% of Heavy Metals Removed
pH Level	3.56	8.27	-
Aluminium (Al)	60.7	0.03	99.95%
Arsenic (As)	0.0053	0.0028	47.17%
Cadmium (Cd)	1.73	0.00023	99.99%
Copper (Cu)	42.6	0.0037	99.99%
Iron (Fe)	7	0.034	99.51%
Lead (Pb)	0.07	0.00002	99.97%
Nickel (Ni)	0.17	0.016	90.59%
Silver (Ag)	0.0017	0.00001	99.41%
Zinc (Zn)	64.9	0.019	99.97%

A Table showing heavy metal and acidity levels before and after treatment (all values in ppm).

CASE STUDY - USA



Gilt Edge Mine in South Dakota was experiencing severe ARD resulting from mining operations. Recent tests conducted by the US EPA have demonstrated that ViroMine™ Technology was able to treat the water to a high standard without creating a toxic sludge.

THE PROBLEM

The Gilt Edge Mine is just five miles east of Lead at the headwaters of cold-water fisheries and municipal water supplies of the northern Black Hills. It is a 110 hectare open pit, cyanide heap leach gold mine, developed in highly sulphidic ore bodies. The mine consists of 570 megalitres of acidic, heavy-metal laden water in three open pits, as well as millions of cubic yards of acid-generating waste rock that need cleanup and long-term treatment.

Sulphide waste rock and exposed ore zones (which generate leachates to surface and ground water) contain heavy metals, including arsenic, cadmium, copper, lead and zinc. Elevated nitrates and sulphates are also present in heap leach residues. Copper, cadmium and zinc are the major polluting risks to the habitats of the receiving water catchment.

THE VIROTEC SOLUTION

“This is the first time that ViroMine™ Technology has been evaluated in the United States, however, it has been used to treat ARD at other sites throughout the world and met applicable water quality criteria,” a consultant to the US EPA reported.

The data collected from the various trials the US EPA performed clearly demonstrate the capability of ViroMine™ Technology to remove heavy metals from water and reduce leachate from waste rock dumps.

As Professor David McConchie of Southern Cross University has stated: “The new technology... is able to reduce the concentration of many environmentally hazardous trace metals by over one hundred thousand times.”

Parameter	Control	ViroMine™ Technology Amended Rock
pH	3.73	8.00
Arsenic	1,975	Below detection
Cadmium	671	0.4
Chromium	85	Below detection
Copper	31,250	12.9
WAD Cyanide	5	2.5
Lead	20	1.8
Nickel	1,985	2
Zinc	34,950	29.2
Concentrations for all elements are recorded in ppb		



One of the three contaminated pits at Gilt Edge.



The application of new ViroMine™ Technology during EPA trials.



Growth trials conducted by the EPA.

A Table showing results from waste rock leachate trials.

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Virotec has proven that it can provide practical, economical solutions for the mining industry to limit environmental damage – and to help mining companies avoid the very heavy financial penalties that Government authorities are now imposing world-wide.

Virotec can provide a total solution to your problem – providing all the necessary knowledge, technology and equipment to achieve this.

If you would like us to assess and devise a management plan to overcome the environmental challenges presented by acid rock drainage, contaminated tailings dam water, or acid sulphate soils or waste rock dumps, don't hesitate – contact us now.

For further information about ViroMine™ Technology please contact:

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