CONTAMINANTS | METALS AND MINING

Per- and Polyfluoroalkyl Substances (PFAS) Strategic Risk Management and Liability Planning for Mine Closure

Sustainability is our business

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Introduction

PFAS present complex and cross-functional risk to companies, spanning their entire operational footprint and strategic enterprise.

Evolving regulations, rapidly increasing public scrutiny, and ubiquity in the supply chain and environment result in a unique enterprise-wide risk profile for PFAS. Potential releases to environmental media may not be the only risk driver for your business.

Regulations and technical advancements are developing quickly. Effectively mitigating these risks is essential to business resiliency and avoiding costly impacts to your business. Understanding of where PFAS may exist, currently and historically, within your business is critical to developing a sound risk management strategy and avoiding surprises.

PFAS – What is it?

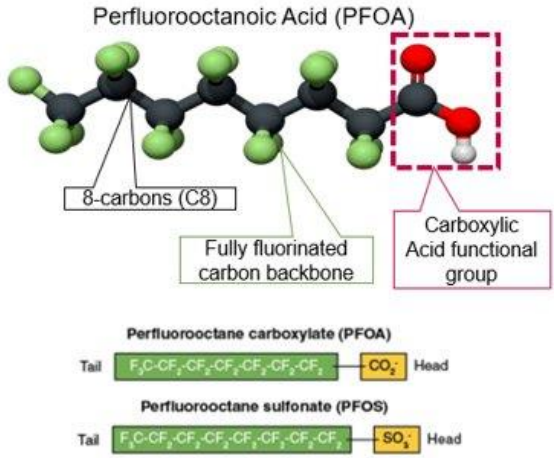
PFAS BACKGROUND

Per- and Polyfluorinated Alkyl Substances (PFAS) are a complex family of >10,000 compounds that contain a fluorinated carbon chain and usually one or more functional groups.

They have been produced since the 1940's and members of the family exhibit a wide range of chemical and physical properties. They have found uses in almost all industries and many consumer products due to unique chemical and physical properties including oil, water, stain and soil repellence, chemical and thermal stability and/or friction reduction.

CHARACTERISTICS

- Carbon-fluorine bonds are strong and stable: Many PFAS do not degrade readily and resist thermal, chemical, biological attack.
- Generally, highly mobile in the environment, soluble and potentially volatile.
- Long and Shortt Chain have significantly different properties.
- Can bioaccumulate in animals and people.
- Exposure can lead to reproductive effects, developmental effects or delays in children, and increased risk of some cancers, among other potential effects.
- Limited Treatment Options available.



These characteristics have caused PFAS to become the focus of many regulators internationally.

Unique Remediation Problem

PFAS can be released to the environment through deposition from air emissions or at low concentration through wastewater treatment plant effluent, stormwater effluent, and even minor long-term use during operational activities. This can result in large areas of low concentration impacted media that exceed generally very low regulatory guidance values. At some sites, the area of impacted media with PFAS can be measured in square miles. This distribution of contaminants is unique to PFAS and requires formulation of an innovative management plan. Point of exposure treatment can be the best approach.

PFAS Use in Mining

Mining activities have long used PFAS within primary and ancillary operations and are now being identified as potential sources of PFAS release to the environment. As a result, PFAS could be released to the environment and require consideration and management during mining operation and closure.

Primary uses of PFAS have included ore leaching in copper and gold mines, ore floating, separation of uranium from ore/minerals, concentration of vanadium compounds, acid mist supressing agent, wetting agents, hydrocarbon foaming agent, and the use of fluoropolymer in pipes, cables, hoses and conveyor belts (Gluge et al. 2020).

PFAS may also be present at mining sites for uses that are ancillary to the mining operation, such as PFAS-containing AFFF for fire suppression/firefighting activities, cleaning of metal surfaces, and use as a foaming agent in drilling fluids, paints and coatings. In the case of AFFF, fire suppression systems may routinely be tested, and normally this would involve discharge of AFFF to the ground surface covering long distances causing widespread impacts.

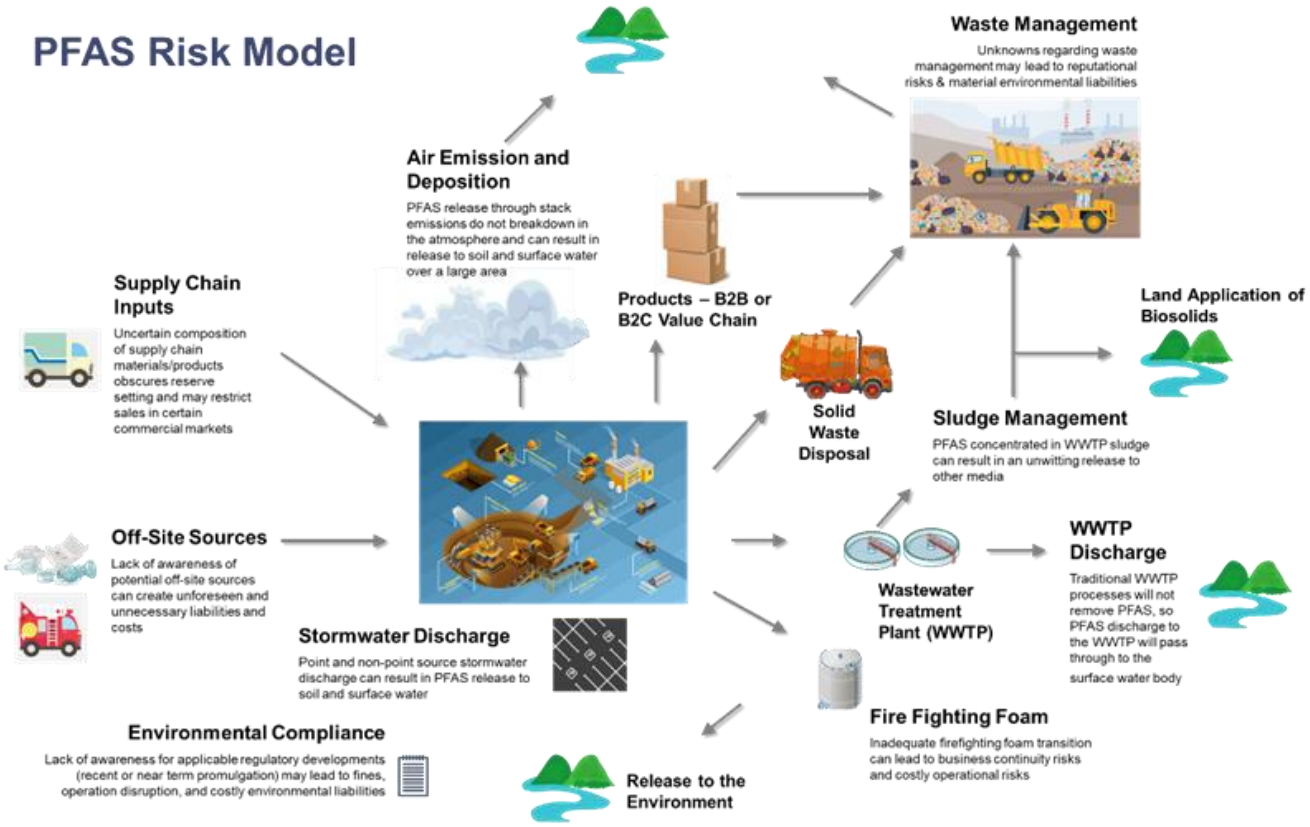
PFAS use in Mining

Primary Activities	Ancillary Activities
Ore leaching in copper and gold mines	Fire-fighting foams
Ore floating	Water & Effluent Treatment
Separation of uranium contained in sodium carbonate and/or sodium bicarbonate solutions by nitrogen floatation	Lubricants & Greases
	Pipes Pumps Fittings & Liners
	Pesticides
Concentration of vanadium compounds	Textile, Upholstery & Floor Coverings
	Personal Care Products

After Gluge et al Environ. Sci. 2020, 22, 2345

PFAS – Wide Distribution

At a site level PFAS distribution is complicated by its characteristics, its long-lived nature, the very low contaminant concentrations of concern and site management practices that draw treated water for many purposes including dust suppression.



Investigation and Sampling

Planning environmental sampling activities represents some unique challenges for PFAS and as such require special consideration. Few analytical methods have been validated and published and those that have generally target a relatively small number of PFAS. These target lists often exclude PFAS precursors. Other speciality analysis can include Total Oxidizable Precursors (TOP) assay and Total Organic Fluorine (TOF) which can be used to help develop understanding of the wider picture.

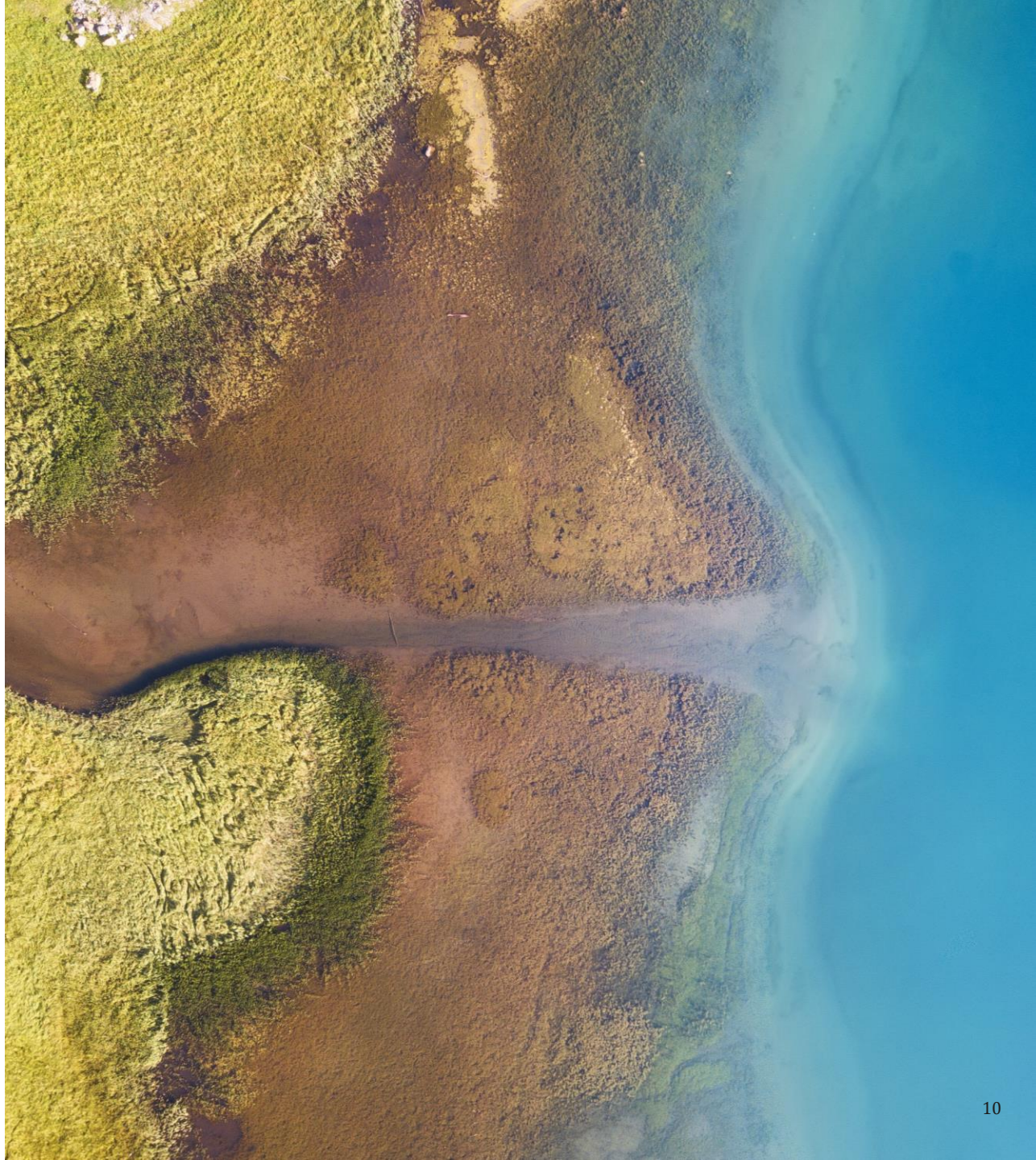
PFAS can be present in materials that are commonly used in environmental sampling or handled worn by sampling personnel including equipment previously thought 'inert'. PFAS absorb to containers and exhibit loses from transfer between containers and as such simultaneously have the high potential for cross contamination and loses when sampling programs are not planned and executed properly.

Precursors

Precursors refer to PFAS that may be present but may or may not be currently identified by analytical methods. Certain compounds can transform in the environment to form more potent “terminal” PFAS such as PFOS and PFOA. This non advantageous transformation can also be enhanced by conventional remediation technologies used for other contaminants such as air sparging, soil vapour extraction and chemical oxidation.

Limited Remediation Options

PFAS were developed to be resistant to biological, chemical and thermal destruction. Remediation technologies that are effective for PFAS are limited and include more traditional forms of remediation like hydraulic containment and excavation. Technologies proven to effectively remove PFAS from extracted groundwater include granular activated carbon (GAC), some ion exchange resins, and reverse osmosis. Commercially available technologies that use adsorptive media to treat high concentration waste streams are under development. As are technologies capable of sorbing PFAS in place in-situ. These technologies will immobilise PFAS in the subsurface but will not destroy them.

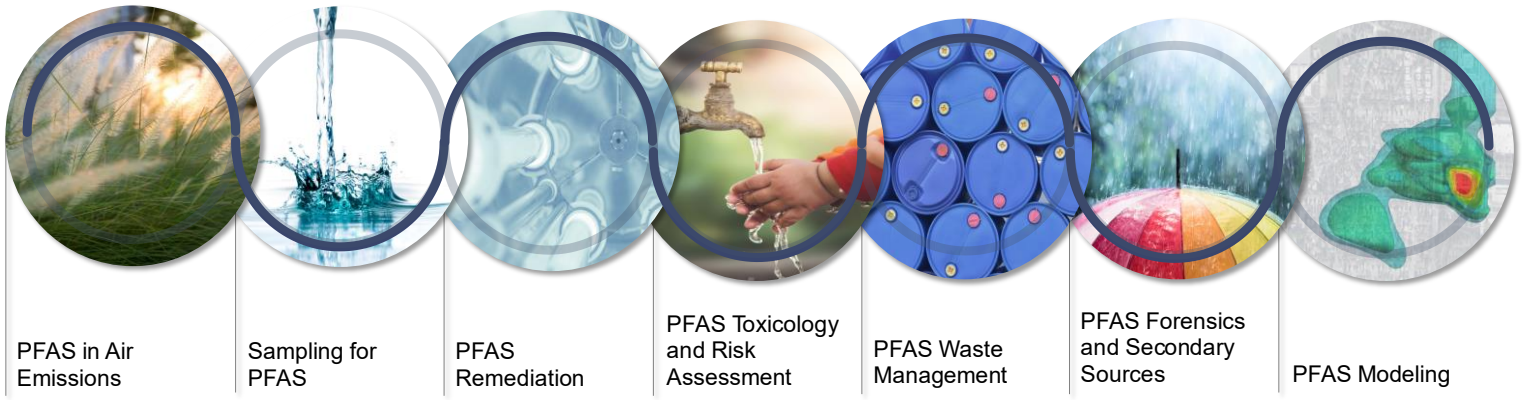


What ERM Can do

As a leading global ESG consultancy ERM is uniquely positioned to support your business in various functional areas to develop and implement multi-disciplinary outcome-orientated solutions.

ERM understands the commercial consequences and technical risks of PFAS alongside more traditional challenges associated with Mining operation and closure and in particular help establish:

1. The nature and extent of PFAS with the operation and released to the environment.
2. How identified risks can be appropriately managed and mitigated.
3. The key drivers around PFAS for achieving stakeholder buy in and mine closure.
4. Post closure provisions based on the unique requirements for PFAS investigations, waste management and remediation.



About ERM

Sustainability is our business

As the largest global pure play sustainability consultancy, ERM partners with the world's leading organizations, creating innovative solutions to sustainability challenges and unlocking commercial opportunities that meet the needs of today while preserving opportunity for future generations.

ERM's diverse team of 8,000+ world-class experts in over 150 offices in more than 40 countries supports clients across the breadth of their organizations to operationalize sustainability. Through ERM's deep technical expertise, clients are well positioned to address their environmental, health, safety, risk, and social issues. ERM calls this capability its "boots to boardroom" approach - a comprehensive service model that allows ERM to develop strategic and technical solutions that advance objectives on the ground or at the executive level.

Thank you

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