TAILINGS MANAGEMENT SERVICES

Barr provides comprehensive tailings management services across North America (including Alaska), South America, Africa, Asia, Australia, Europe, and the Middle East to mining operations processing iron ore, lead, trona, potash, graphite, non-ferrous metals, phosphate, lignite, copper, lithium, cobalt, gold, oil sands, and industrial sands.

Which tailings management solution is right for your mine? ↗ Article

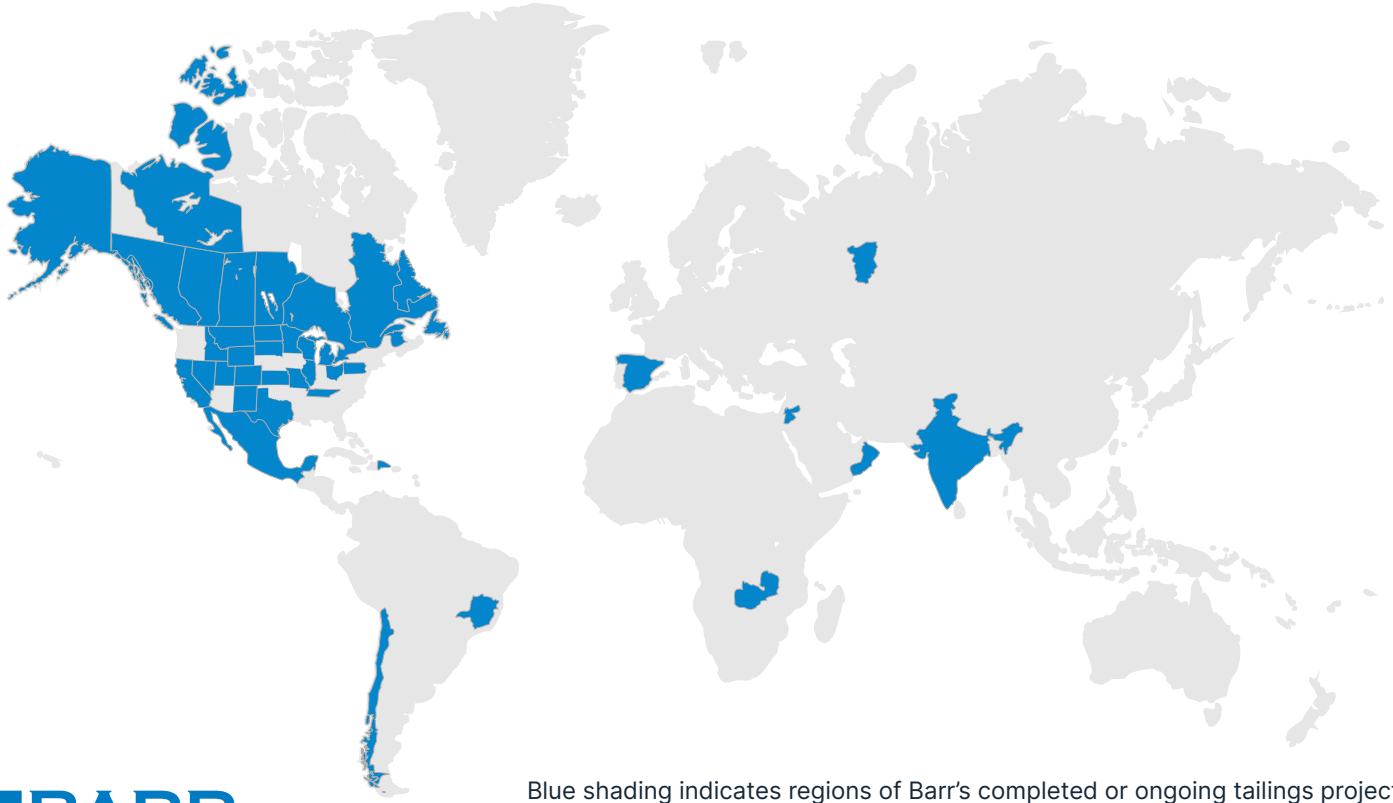
We help clients with every aspect of managing tailings storage facilities (TSF) and mine rock stockpiles from facility siting, planning, permitting, and design through construction and operations to meet environmental requirements as well as processing plant needs.

Uncovering the technical challenges of paste, filtered tailings, and mine backfill ↗ Article

We can help determine the optimal tailings disposal option—**slurry, thickened, paste, or filtered**—for specific needs, goals, and applications.

While conventional **slurry** disposal at the surface is often the most cost-effective and commonly used option, other alternatives, such as tailings dewatering for **thickened**, **paste**, and **filtered** tailings, are becoming more common. Co-disposal of tailings with mine rock on the surface and paste tailings for mine backfill and underground disposal are also options.

Our specialized services for addressing the unique challenges and environmental regulations of fluid fine tailings (**oil sands**) include characterizing tailings, assessing and implementing treatment technologies, designing tailored structures and systems, evaluating and developing progressive reclamation strategies for long-term environmental performance, implementing monitoring systems, and supporting regulatory reporting.



Blue shading indicates regions of Barr's completed or ongoing tailings projects.
View our office locations at **barr.com/locations** ↗

BARR®

Services for every stage of the tailings lifecycle

Facility siting

We evaluate geographical, geological, hydrogeological, geotechnical, and environmental conditions; determine design criteria; explore suitable engineering options for tailings and mine water conveyance and storage; develop effective tailings management strategies; and estimate the associated costs.

Barr developed a plan to dewater an active mining area to its tailings basin by developing four potential pipe alignment options and two options for pumping water from the mine to the basin. The plan considered safety, construction phasing, regulatory requirements, and project costs.

Dewatering alternatives evaluation and design through construction phase services Project example

Environmental impact assessments

Barr supports mining companies with tailings storage environmental considerations. We assist with issues related to fugitive dust, groundwater and surface-water quality, wetlands, and threatened and endangered species by providing baseline studies, impact analyses, and environmental reviews.

Our services include:

- Surface-water and groundwater quality and quantity modeling
- Contaminant mass balances and nondegradation analyses
- Wetland delineation, permitting, and mitigation design
- Archaeological surveys and visibility analyses
- Fish and wildlife studies
- Environmental documentation (EA and EIS)
- NEPA studies
- Permitting (NPDES, SDS, permits to mine)

Permitting

We guide clients through regulatory requirements at local, state/provincial, and federal levels, including strategy and planning, permit application preparation, technical documentation, invested party coordination, and compliance support.

Material (geotechnical) characterization

Barr assesses the physical and mechanical properties of tailings and foundation materials with site investigations, laboratory testing, geotechnical modeling, material classification, and behavior assessments.

We have experience performing detailed material characterization including:

- Index properties
- Hydraulic conductivity
- Unsaturated soil response
- Critical state soil behavior
- Drained shear strength
- Yield undrained shear strength
- Liquefied (i.e., residual) undrained shear strength
- Cyclic (i.e., seismic) stress-strain response
- Shear modulus characterization

Geotechnical practice in tailings has evolved to incorporate static liquefaction and deformation modeling to predict tailings dam performance in response to various loads.

Characterizing a material volumetric response with respect to contraction-dilation and the potential for brittle strain softening is of particular importance. Barr has extensive experience evaluating material-specific critical

state loci—the cornerstone of applying a critical-state soil mechanics framework for static and seismic liquefaction assessments.

Characterization of state parameter and undrained shear strength of mine tailings ↗ Paper

Laboratory vane shear testing apparatus for evaluating critical state parameters and undrained shear strength of mine tailings ↗ Paper

Rheological tailings characterization

We evaluate the flow behavior and handling properties of tailings for TSF design and operation with sampling and testing, thickened and paste tailings analysis, pipeline and deposition modeling, and alternative tailings technology assessments to help optimize tailings transport, improve water recovery, and enhance TSF stability and environmental performance.

Dam breach analysis

Barr assesses potential failure modes and plausible breach scenarios in close collaboration with our clients. Tailings release volume is estimated based on the Canadian Dam Association's technical bulletin on tailings dam breach assessment. Breach hydrograph is generated and routed downstream to produce inundation maps that are often used for risk and consequence analyses as well as emergency preparedness and response plans. These steps are further described in Barr's presentation.

Tailings dam breach analysis ↗ Presentation

Filtered tailings and waste rock storage facility feasibility study ↗ Project example

Static and seismic advanced constitutive modeling and liquefaction assessments

We evaluate the behavior and stability of TSFs under various loading conditions using advanced constitutive deformation modeling as part of a performance-based design approach. Barr has extensive experience using critical-state-based constitutive models to develop the best estimate of facility performance with respect to seismic response modeling, static and seismic liquefaction susceptibility assessment, and post-liquefaction analysis, including runout projections to provide design recommendations.

Static liquefaction assessment of an offset-upstream tailings dam using NorSand in FLAC ↗ Paper

Facility design

Barr performs conceptual and detailed design of TSF layouts, embankment configurations, containment systems, and drainage features; hydrological and hydraulic design to manage stormwater and process water; stability and risk analysis for slope stability, seismic response, and dam safety; design for lifecycle phases; and integration with mine operations.

Barr designed an upstream dam raise to extend the life of a fine tailings storage facility for a Canada potash mine. We also developed a long-term tailings facility plan, helped resolve coarse tailings deposition issues, and developed systems to improve brine management and turbidity.

Planning and design of tailings management area ↗ Project example

Tailings-management area design and construction
↗ Project example

Dam safety services for potash mines
↗ Project example

Tailings dam design

Barr approaches tailings dam design holistically with a focus on technical expertise, dam safety, and environmental stewardship.

Unlike conventional dams, tailings dams are unique in that they are continually raised and generally constructed of tailings and mine rock. They're also designed and constructed to suit plant operations as well as local geologic and climatic conditions, so special expertise is needed to design tailings dams.

Barr has experience with design and construction using upstream, centerline, and downstream methods. We also have an experienced hydro-dam design group that can provide support for designing settling ponds, water storage ponds, water treatment ponds and various appurtenant hydraulic infrastructure including spillways, weirs, and decant structures.

Barr evaluated the capabilities of the client's existing tailings disposal system, conducted on-site reviews of the system, developed an inventory of issues, modeled the pipelines in AFT Fathom, and identified several modifications that allowed the client to extend the production capabilities of its current equipment without major capital expenditures. Then we generated a planned development of the systems to allow continued operations for several more decades.

System evaluation, diagnostics, and planning for the management of tailings at an iron ore facility
↗ Project example

Mine backfill design

We support the safe and efficient reuse of tailings in underground and open-pit mining operations through backfill material characterization, backfill mix design, delivery system design, stability and interaction analysis, and operational planning and support.

Barr provided comprehensive services to a Canadian mine for an expansion of its fine tailings disposal area, including evaluation and alternatives assessment; conceptual, detailed, and final design; bidder and regulator support; and construction observation and administration.

Project implementation

Barr supports construction, commissioning, and operational startup by providing cost estimation, construction management, field engineering, instrumentation and monitoring setup; regulatory compliance, startup/ commissioning, and operations consulting services.

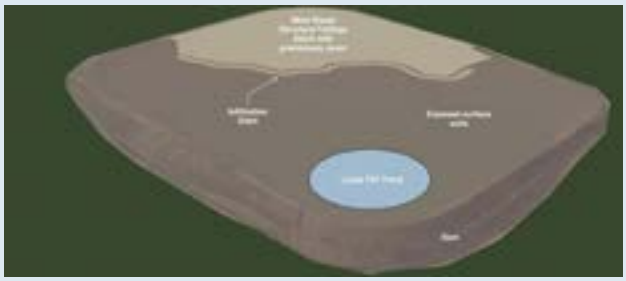
Operations and EOR service

We support tailings system startup and operations with cost estimating, tailings placement and dam construction, construction management, equipment startup, instrumentation and surveillance monitoring audits, operator training, O&M manual development, and EOR services.

Navigating the expanding landscape of mine-tailings standards ↗ Article

Closure and post-closure/reclamation

Barr helps mining operations transition TSFs to stable, self-sustaining conditions that meet environmental and community expectations through thoughtful design, management, monitoring, and support.



Barr's robust approach to closure planning and design for a Canadian tailings storage facility led to approvals from the regulator to proceed with closure and decommissioning activities.

Closure planning and design for tailings storage facility ↗ Project example

Tailings dam safety and independent review

Barr performs dam safety reviews for tailings dams built using upstream, centerline, and downstream construction methods throughout the U.S., Canada, Mexico, Brazil, and India. We also perform third-party/peer reviews at TSFs and have served in advisory roles for international projects in Russia, Jordan, and Brazil.

How safe is your tailings dam? ↗ Article

Third-party dam safety review of tailings-storage facility ↗ Project example

Tailings facility dam safety review ↗ Project example

Tailings dam safety inventory and semiquantitative risk analysis ↗ Project example

Tailings dam safety review ↗ Factsheet

Partnerships to provide world-class services

When outside services are needed to optimize the TSF and provide cost-effective methods for functional and sustainable TSF designs, Barr partners with individuals and/or firms with specific expertise, such as Witteveen+Bos (for Vale) and Deltares (for Delft).

Barr performed a third-party safety review and risk assessment of three dams at a shuttered mining facility in Idaho.

Third-party safety review and risk analysis for three dams ↗ Project example

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