Daily Agenda

Wednesday, November 15th
Industry Tours and CMP Social

11:00 – 17:30	Nutrien Lanigan Tour *Bus leaves at 11 am from Sheraton Cavalier Saskatoon Hotel.* *Returns at 5:30 pm.* *Lunch & PPE will be provided.*
13:00 – 15:30	Saskatchewan Research Council Pipe Flow Tour *Bus leaves at 12:45 pm from Sheraton Hotel. Tour begins at 1:00 pm.* *Returns at 3:30 pm.* *PPE Provided.*
19:00 – 22:00	Social Event at Saskatoon Club *Doors open at 7 pm.* *Includes networking, trivia, and appetizers.* *Student networking and booths.*

Thursday, November 16th
Conference at the Sheraton Cavalier Saskatoon Hotel

09:00 – 09:30	Coffee and Pastries
09:30 – 09:45	Welcome/Program Introduction
09:45 – 10:50	Technical Program
10:50 – 11:10	Coffee Break
11:10 – 12:00	Technical Program
12:00 – 13:15	Lunch and AGM
13:15 – 13:20	Program Resumes
13:20 – 14:35	Technical Program
14:35 – 14:55	Coffee Break
14:55 – 16:10	Technical Program

Canadian Mineral Processors

MANITOBA/SASKATCHEWAN BRANCH

2023 Regional Conference and Annual General Meeting
Nov 16th, Sheraton Hotel Conference Room, Saskatoon

TECHNICAL PROGRAM

09:00 – 09:30	**Coffee and Pastries**	
09:30 – 09:45	**CMP MB/SK Conference Welcome**	
09:45 – 10:25	**Keynote Speaker: Gary Poxleitner** **CIM Distinguished Lecturer - SRK**	Cutoff grade – The impact of getting it right
10:25 – 10:50	**Will Gibbs - Integrity Mining & Industrial**	Using Bio-Based Frothers in Potash Froth Flotation to Improve Recovery and RCI
10:50 – 11:10	**Coffee Break**	
11:10 – 11:35	**Arthur Lieu - NexGen**	Rook I Project – Novel source-term derivation for cemented uranium paste tailings disposal in a purpose-built underground tailings storage facility
11:35 – 12:00	**Alex Szoke – Hatch**	Direct Lithium Extraction: The Potential for Sustainable Lithium Recovery
12:00 – 13:15	**Lunch Break and Annual General Meeting**	
13:15– 13:20	**Program Resumes**	
13:20 – 13:45	**Jack Zhang - SRC**	Lithium Processing Technologies
13:45 – 14:10	**Tim Mbanga – Nutrien Potash, Rocanville**	Innovation, Adoption & industry Collaboration at Nutrien Rocanville
14:10 – 14:35	**Daniel Hamilton – University of Saskatchewan**	Characterization of Eco-Friendly Bioreagents for Improving the Flotation of a Base Metal Sulphide Ore
14:35 – 14:55	**Coffee Break**	
14:55 – 15:20	**Brendan Holaday – Denison** **Lorne Schwartz – Wood**	Denison's Phoenix Uranium Deposit – Bringing In-Situ Recovery to the Athabasca Basin
15:20 – 15:45	**Farah Kaboodanian – Hatch** **Randy Vu - Hatch**	Unlocking the full potential of your existing assets - Process Control Optimization
15:45 – 16:10	**Tyler Bachman – K+S Potash Canada**	Innovation Through Collaboration: Solving Complex Issues Through Global Efforts
16:10 – 16:15	**Closing Comments**	

TECHNICAL PROGRAM

KEYNOTE: CUT OFF GRADE – IMPACT OF GETTING IT RIGHT

Gary Poxleitner – CIM Distinguished Lecturer - SRK

Cut-off grade (COG) or Cut Off Value (COV), is a standard, industry-accepted method used to determine which part of a mineral deposit to include in a Mineral Resource or a Mineral Reserve estimate, or potentially in an operation's Life of Mine Plan (LOM). It is the minimum grade (or value) at which mineralized material can be economically mined or processed.

Selecting the correct COG is essential. It affects the mine plan, cash flow, mine cost, reflects sustainability and profitability of the operation. However, the work required to generate the optimum COG is often not given the requisite attention and diligence.

The widely adopted method to calculate the COG is a break-even methodology. This approach accepts mining material which will generate revenue from the sale of the finished product that is equal to the cost of certain modifying factors, such as mining, processing, G&A, and ESG among others. The pitfall here is that the method does not clearly outline what specific modifying factors to apply. The decision is often left to the differing opinions and the personal judgement of mine professionals. Therefore, depending on the inclusion of certain factors there is a wide implication on the future and profitability of the mine.

In determining which common modifying factors are used in the industry, a survey of approximately 100 global mines and projects were accessed. We found much common ground although there were items where opinions varied widely.

This paper presents common modifying factors used in the industry, a case study demonstrating the impact on value of various modifying factors used on a deposit and provides guidance on which factors should be applied at your mine. As well as incorporating social and environmental factors into the assessment.

This paper is for anyone interested in maximizing value from their deposit. Ideal for mine managers, mine finance professionals, mineral process engineers, mine engineers, long range planners, mineral economists, mining industry analysts and resource and economic geologists.

This is a case study and provides valued information for mine operators and capital projects to determine the right CoV for their mine.

INNOVATION, ADOPTION & INDUSTRY COLLABORATION AT NUTRIEN ROCANVILLE

Tim Mbanga, Nutrien Potash- Rocanville Division

Rocanville Potash Mine started operation in the early 1970s as an underground mine with a conventional milling facility. The mill has seen several upgrades over the last 53 years, from a 350 tph plant to over a 2600 tph plant today and is by far the largest Potash mine in the world. Over the last 5 decades, there has been a lot of technological advancement in Process Optimization and a significant amount of brownfield expansions requiring a lot of testing to optimize the available footprint and equipment. This testing involved a lot of collaboration, partnership and adoption of new technologies over the years. The new Mill 2, which started production in 2016, embraces some of state-of-the-art processing technologies. Some of the technologies adopted in Mill 2 had not been used in Potash Mining before, so it took a lot of risk and courage, which led a lot of testing and collaboration with industry experts (R&D, manufacturers) to come up with some of the innovative solutions that have been implemented today.
The primary objectives of these innovative solutions were to

- Maximize production at lower cost.
- Reduction in overall Energy consumption
- Less maintenance cost.
- Make use of smart and Autonomous milling technologies
- Reduce environmental impact/ risks.

This paper covers several examples of the technological advancements over the last 10years or so. The papers also describe some of the innovation over that period including adoption of new technologies and a lot of collaboration with industry/ R&D facilities/ Universities/ Manufacturers etc. that went into developing these technologies, specifically at the Nutrien Rocanville site. These examples range from flotation chemistry, equipment selection, new drying technology, Advanced process Control, Autonomous Inspections, New products etc.

ROOK I PROJECT – NOVEL SOURCE-TERM DERIVATION FOR CEMENTED URANIUM PASTE TAILINGS DISPOSAL IN A PURPOSE-BUILT UNDERGROUND TAILINGS STORAGE FACILITY

Arthur. Lieu, Nico. Bezuidenhout
NexGen Energy Limited; WSP

NexGen Energy Ltd. (NexGen) is proposing to develop a new uranium mining and milling operation in northwestern Saskatchewan, Canada called the Rook I Project (Project). The proposed Project is subject to both a federal and provincial environmental assessment (EA) process, and requires federal and provincial licences, approvals, and permits. The Project is currently undertaking a cooperative provincial and federal EA process, as well as advancing the application for a license from the Canadian Nuclear Safety Commission (CNSC) and completing engineering to support Project development.

The Project will generate mine waste rock and tailings (i.e., mine waste) that will be stored at the Project site in perpetuity. Underground deposition of all tailings produced by the Project is one aspect of the Project design that reflects NexGen's commitment to protecting the environment and the safety of workers and the public. The Project will include the underground disposal of cemented uranium paste tailings and process wastes (cemented paste backfill) in mined out stopes and a purpose-built underground tailings storage facility (UGTMF).

Predictive source-terms were developed for the stopes and UGTMF to support the EA conducted for the Project. Source-term derivation started with the conceptualization of two mass transfer processes that will determine the quantum and rate of solute and radionuclide mobilization from the cemented paste backfill. These mass transfer processes, including advection and diffusion, are expected to be active in the post- closure phase of the Project when the underground mine is re-flooded.

A mechanistic modelling approach was followed and supported by a multi-year geochemical characterization program with empirical measurements of key mass transfer processes. Simplifying assumptions and bounding arguments were used to reduce the necessary parameters and variables to those that can be measured using laboratory tests.

For advective mass transfer processes, standard triaxle permeability tests were modified to capture eluent in fractions of pore volume to measure porewater quality evolution as a function of pore volume replacement and determine rate kinetics. Geochemical speciation modelling was used to evaluate the potential effect of secondary mineral and ion exchange controls. Porewater qualities were provided as initial, constant source concentrations in the groundwater solute transport model. Estimated drainage chemistries from the cemented paste backfill were affected by the addition of cement binder and was alkaline (pH > 10), sulphate-calcium-sodium dominated water with selected metals and radionuclides of interest.

The Leaching Environmental Assessment Framework (LEAF) test was used to measure mass transfer from a monolithic sample under diffusion-controlled release conditions. Estimated diffusivity was assigned to the cemented paste backfill in the groundwater solute transport model.

This presentation will provide an overview of the process undertaken to derive predictive source-terms for the stopes and UGTMF for the Project.

DENISON'S PHOENIX URANIUM DEPOSIT – BRINGING IN-SITU RECOVERY TO THE ATHABASCA BASIN

Brendan Holaday, Denison Mines
Lorne Schwartz, Wood Canada Ltd

Phoenix is a high-grade unconformity type uranium deposit, located on Denison's Wheeler River property in the Athabasca Basin of Saskatchewan. A feasibility study was recently completed for In-Situ Recovery ("ISR") mining of Phoenix, advancing the project through technical de-risking and independent third-party validation. The study demonstrates the feasibility of applying ISR to an unconformity type deposit, that will be the first of its kind worldwide.

Denison and Wood will discuss the distinctive processes planned for the application of ISR to the high-grade Phoenix deposit contrasted against conventional ISR, which has to date only been applied at low grade uranium deposits. Also presented will be certain details of the process test programs undertaken to support the Phoenix feasibility study and key outcomes.

LITHIUM PROCESSING TECHNOLOGY R&DS AT SRC

Jack Zhang, Brain Guo - Saskatchewan Research Council, Mining and Minerals

Canada is rich with lithium resources including world-class high grade spodumene, lepidolite, petalite, as well as a large amount brines. Lithium as one of the most important critical minerals is essential to the rapid growth of clean energy production and storage. However, Canada is lagging behind in commercial production of lithium in the global lithium supply. Currently Austria, China, and South Americas supply more than 96% of the global lithium market.

To facilitate lithium commercial production in Canada, the Saskatchewan Research Council (SRC) has been working with the lithium industry closely to develop and validate lithium extraction technologies, ranging from efficient beneficiation technologies to produce high grade hard rock concentrates and selective lithium extraction technologies from low concentration brines, to hydrometallurgical processing technologies to produce battery grade lithium carbonate and lithium hydroxide monohydrate (LHM), as well as lithium recovery from end of life lithium ion batteries. SRC has built pilot plants and production demonstration plants for the lithium industry to test, validate, and demonstrate the viability of their processing technology with adequate tests and risk assessments prior to commercialization.

The presentation will provide an overview of the recent lithium processing technology research, development, and demonstration at SRC with case studies at bench, pilot, and demonstration scale. The beneficiation process of spodumene, petalite, lepidolite and the selective extraction of lithium from low concentration brine will be introduced. The hydrometallurgical processes to produce battery grade lithium carbonate and lithium hydroxide monohydrate will be discussed from three major hard minerals spodumene, petalite, and lepidolite.

USING BIO-BASED FROTHERS IN POTASH FROTH FLOTATION TO IMPROVE RECOVERY AND RCI

Will Gibbs
Integrity Mining and Industrial

With a large focus recently on growing ESG initiatives, there is a large opportunity for companies to demonstrate "environmentally friendliness" and "sustainable supply". Integrity Mining and Industrial (IMI) bases the carbon signature of its biopolymer-based products on its renewable carbon index (RCI). RCI readily classifies the origin of carbon in a molecule, i.e., modern vegetative sources or extracted petroleum derivatives. Specifically, it measures the number of carbons derived from renewable sources compared to the total number of carbons in the product.

IMI has developed a bio-based frother, BioFroth that can be used to replace leading synthetics to meet sustainability and environmental regulations. Preliminary testing was conducted by a third-party laboratory in Saskatchewan comparing BioFroth to a commodity poly-propylene glycol frother, in the rougher and cleaner flotation simulations of a Canadian potash mine, and in both cases BioFroth had a positive effect on the KCl recovery and grade when compared to the standard. In fact, there was a 7% increase in KCl recovery in the rougher flotation, and a 5% increase in the cleaners.

The focus of this presentation will be to continue evaluations of our BioFroth as compared to alcohol-based furthers, propylene glycol, and other glycol ethers, as well as to report on a current Potash plant trial being conducted in Sept 2023. By replacing synthetic frothers with bio-based surfactants, mining companies can take control of the renewable carbon being used in their products.

DIRECT LITHIUM EXTRACTION: THE POTENTIAL FOR SUSTAINABLE LITHIUM RECOVERY

Alex Szoke, Fangyu Liu, Jacqueline Fossenier, Hatch LTD

Direct Lithium Extraction (DLE) is a promising solution to address the challenges of conventional lithium extraction methods and meet the increasing demand for lithium in electric vehicles and renewable energy storage. This presentation will highlight the principles, advantages, and recent advancements of DLE, focusing on brine treatment and processing techniques that enable higher lithium recovery rates, reduced water consumption, and lower carbon emissions.

A focus will also be spent on select studies and pilot projects, showcasing the different brine resources DLE has been utilized for (oilfield brines, O&G applications, geothermal wells), within Canada and globally. The presentation will conclude with an emphasis on future prospects and the crucial role of DLE in establishing a sustainable lithium supply chain to power the clean energy goals of the future.

CHARACTERIZATION OF ECO-FRIENDLY BIOREAGENTS FOR IMPROVING THE FLOTATION OF A BASE METAL SULPHIDE ORE

Daniel Hamilton, Ph.D Student, EIT

Supervisors: Dr. Kerry McPhedran, P.Eng., Dr. Wonjae Chang, P.Eng.
Department of Civil, Geological and Environmental Engineering, University of Saskatchewan

Base metal sulphide mineral ores are effectively processed across Canada using reagents including xanthates, copper sulphate, and cyanide that have potential to cause acute and long-term environmental hazards. This research project examined the use of novel eco-friendly reagents in traditional froth flotation as an attempt to transition these accepted processing methods to incorporating innovative reagents to mitigate environmental impact while maintaining acceptable metal recoveries. Bioreagents produced from naturally occurring, non-pathogenic bacteria found at active and abandoned mine sites were tested with the objective to integrate them into existing mine infrastructure processes. Initially, the research characterized an actual sulphidic polymetallic base metal (copper, zinc) ore. Experimental considerations to efficiently design a froth flotation circuit using traditional methods were related to the effect of particle size, pH, reagent dosage, and bioreagents (dosage and conditioning time) on the grade and recovery of the valuable minerals. Once an optimized flotation procedure was determined, kinetic tests were conducted to determine the overall impact to the flotation system. The feasibility of cultivating and enhancing specific strains to suppress gangue minerals and increase valuable mineral recovery while maintaining recovery rates of valuable minerals from complex base metal sulphide ores was determined.

UNLOCKING THE FULL POTENTIAL OF YOUR EXISTING ASSETS

Farah Kaboodanian and Randy Vu, Hatch LTD

This presentation is to provide insight to an innovative approach to unlock asset potential through process control optimization, remote support, process control training, and specialized production solutions. The methodology starts with a profitability analysis to identify the most favorable systems, which limits giveaways and yields higher returns on investments. This methodology can be seen in action through projects with BHP Jansen, Teck Resources GHO/EVO, Centinela Chile, Barrick Goldstrike, Rio Tinto Iron & Titanium, ArcelorMittal Mines Canada.

INNOVATION THROUGH COLLABORATION: SOLVING COMPLEX ISSUES THROUGH GLOBAL EFFORTS

Tyler Bachman, K+S Potash Canada

The presentation will cover the unique and complex problems that K+S encountered, the roadblocks K+S faced, and how the K+S team overcame all of that through integrating many countries, departments, people, and resources across the globe to find solutions to the problems.

How do you solve a product quality issue that is unique, unmeasurable, and 10,000 km's away? This is something K+S Potash Canada (KSPC) was faced with shortly after their Bethune plant's start up. Early after KSPC's first production in 2017, they realized large scale product degradation within their supply chain that they didn't understand. This problem put business relationships at risk and jeopardized access to some of the industries largest markets.

This presentation will explore how, through intentional action, KSPC was able to respond to these challenges by leveraging focused, ambitious, and widespread collaboration throughout the organization, leading to innovative testing methods and operational practices.

KSPC and the K+S group assembled a dedicated, global team consisting of some of the brightest minds in Operations, Engineering, Analytics, Sales and Marketing, and Research and Development from across the globe. Through this collaborative approach K+S was able to connect operators, process engineers and R&D scientists, with farmers and customers in South America. By getting boots on the ground, the team was able to develop a key understanding of the product behaviour, the problems the customers faced, and how the company was falling short of one of its key mission statements, "enabling the success of our customers". These insights enabled the teams to work together to develop innovative testing methods and metrics that proved vital in the development and eventual implementation of creative and effective solutions to this complex problem.