

**LANDFORM
DESIGN
INSTITUTE**

Landform Design Quarterly

Fall 2022

Practitioners eager to build on short-course lessons

by David Wylynko

Mining practitioners from within Canada and abroad are expressing tremendous interest in building on the Landform Design Institute's second "short course," which was held in Calgary Nov. 2-4, 2022, to a sold-out audience. The first course, which was held in Edmonton in December of 2019, was met with similar enthusiasm.

The three-day course had three main topics: introduction and physical design, reclamation and cover systems, and construction and monitoring. About a dozen sub-categories were addressed under each of these topics by a range of experienced experts.

The presenters included Gord McKenna, founder and chair of the Institute and an expert in landform design with over 30 years of professional experience; Mike O'Kane of Okane Consultants and a specialist in closure; LDI technical advisory panel member Justin Straker, who specializes in reclamation; and Jerry Vandenberg, also an LDI technical advisory panel member and expert in pit lakes.

Rounding out the list of presenters was



A breakout group conducts a design exercise.

Aileen Cash, who lectured on landform construction, monitoring and maintenance. On the topic of reclamation, a team from JDS Energy and Mining provided an engaging case history, which is critical to helping practitioners see how landform design actually works in the field.

On Day 3, McKenna and Cash coordinated a landform design exercise,

when participants broke into groups to devise actual landform designs. McKenna closed out the course with a session on reflections and key learnings and to solicit feedback.

After the course was completed, in response to a survey on what they learned or liked the most, one participant described the "variety of roles involved in a landform design team." Another admitted to being "surprised how multidisciplinary closure and reclamation work are" and a third mentioned "learning the breadth of expertise in the landform design committee."

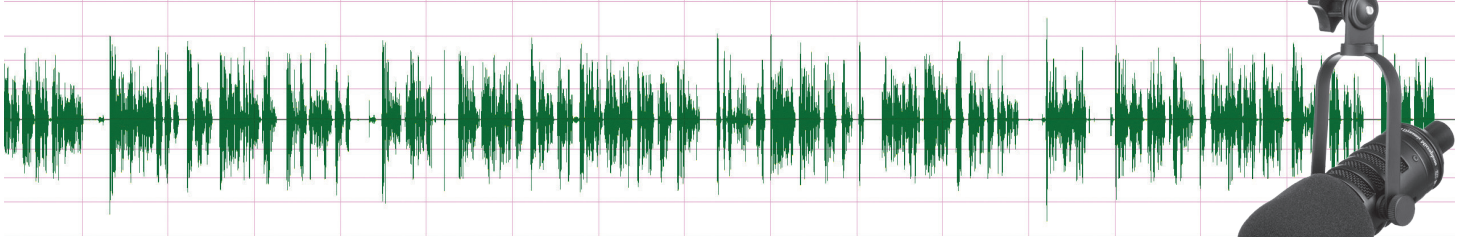
Indeed, for many participants, one of the core take-home messages was that in an era of increasing specialization, sharing information and experience across disciplines has become more important than ever. This reaction means that one of the Institute's core messages is gaining traction in the mining community: that bringing together experts from disparate fields and finding ways to help them work collaboratively is central to effective landform design, which requires input from a dozen

continued on page 7

Making landform design routine worldwide

The Landform Design Institute is dedicated to creating and supporting a community of landform design practitioners. Its intention is to help their teams design and build truly sustainable mining landscapes. Its mission is to make landform design routine in the mining industry worldwide by 2030.

Getting Closure uploads a second season



The second season of the LDI podcast exploring the people and principles behind landform design, *Getting Closure*, begins with three remarkable guests who collectively represent the past, present, and future of the field.

For the first episode of the season, host Mike O’Kane of Okane Consultants (and an LDI Board Member) sits down with Andy Robertson, a pioneering engineer who has been recognized for his forward-thinking approach to reconciling the economics of mining with environmental sustainability. He created the first PC-based mine exploration software (GemCon, now known as GeoVia), was among the first to realize the opportunity posed by the fledgling Internet to spread mining information, and is the R in SRK Consulting.

Mike and Andy’s conversation covers an enormous amount of ground, from Andy’s early work in Africa, his critical role in the development of failure modes and effects

analysis, and how to convince mining companies of the wisdom of taking the long view.

Next, Mike interviews fellow Board Member Lois Boxill, who brings a unique perspective to her work as a mine reclamation specialist. While some of her career history checks conventional boxes — tailings manager at BASF, principal consultant at SRK Consulting — she’s also been a Anglican Priest for 16 years and leads meditation retreats when she’s not working on her MBA at the University of Illinois at Urbana-Champaign.

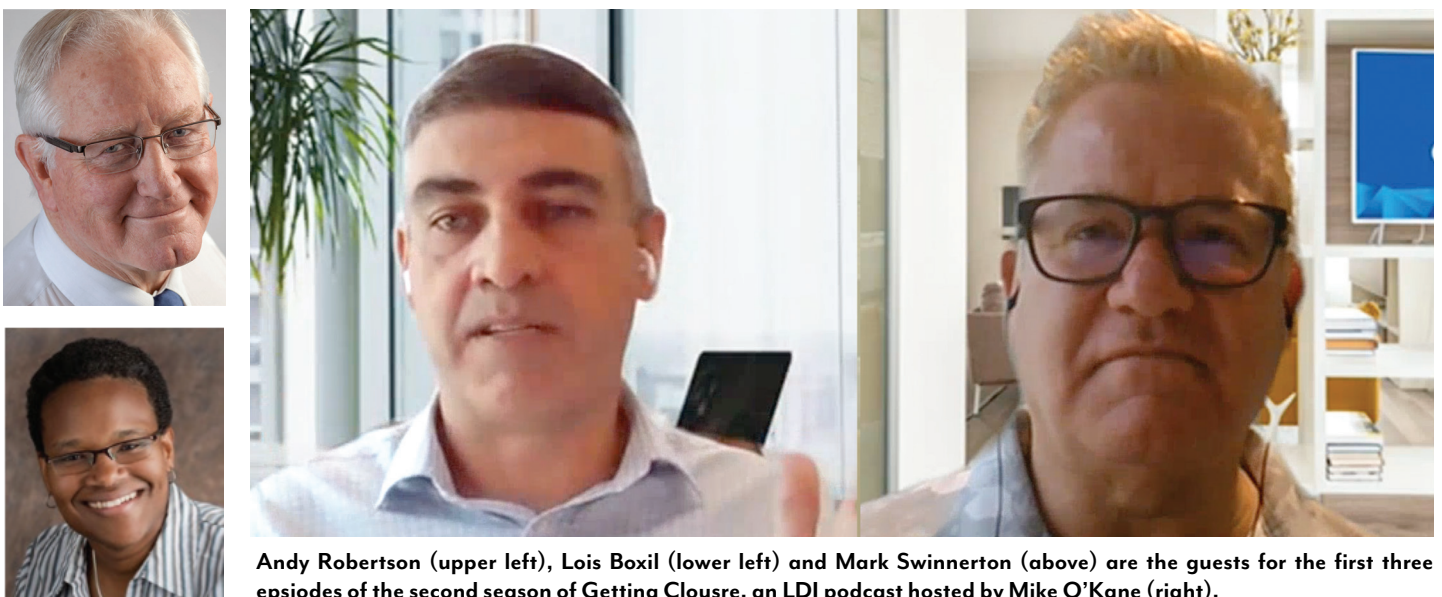
Lois brings a philosophical approach, informed in part by her upbringing in Barbados, to mine closure, particularly when it comes to determining how to manage risks. Among her strongest pieces of advice is emphasizing the need for consultants to listen as much as supply guidance.

Both episodes — “Andy Robertson’s

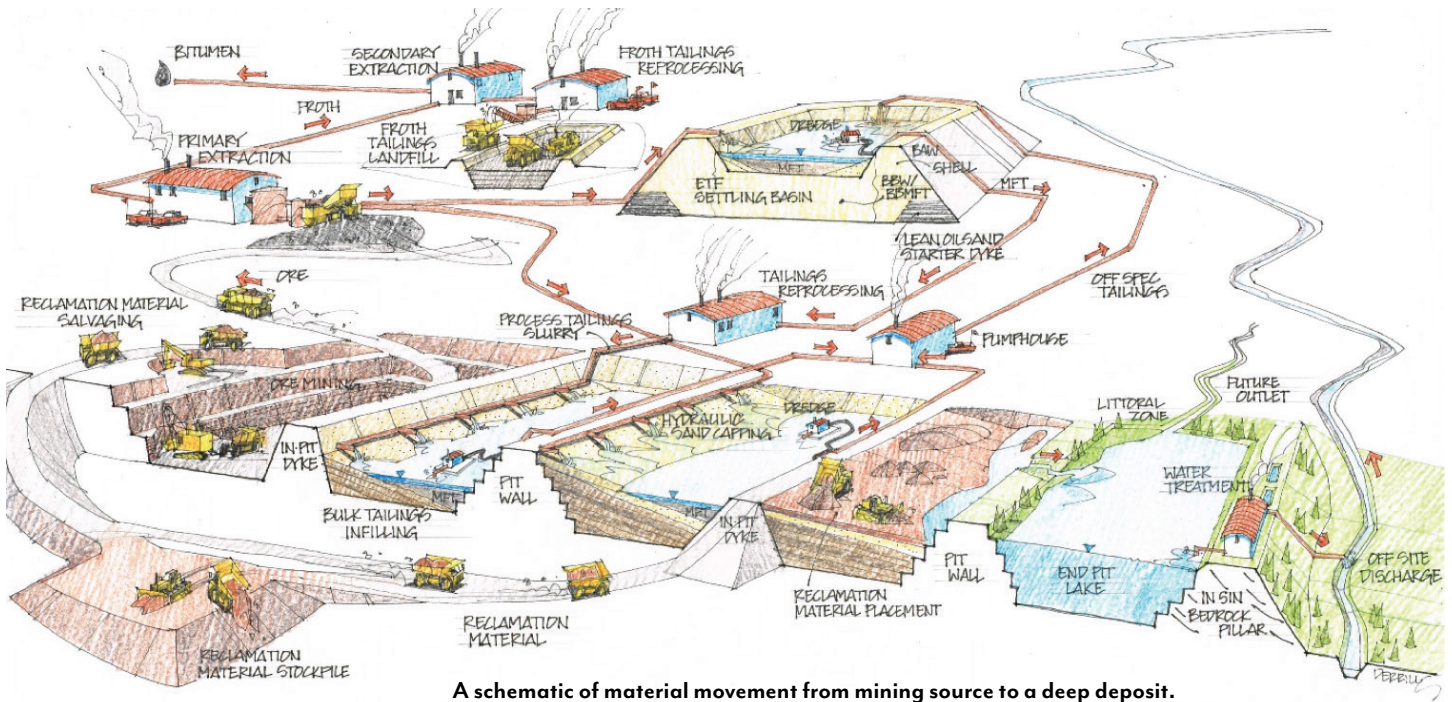
Legacy” and “Thinking Outside the Box with Lois Boxill” — are already available on Apple Podcasts, Spotify, and most other podcasting platforms, as well as at landformdesign.com/pod.html.

The third episode of the season, which was posted in December, introduces an innovative alternative end land use for mines that most engineers have probably never considered. In “Down to Earth,” Mike talks with Mark Swinnerton, the founder and CEO of Green Gravity, an Australian firm that builds “gravitational energy storage systems,” a technology that takes advantage of the topography of decommissioned mines to help electrical grids wean themselves off fossil fuels.

Several more episodes are in the works and should be available early in 2023.



Andy Robertson (upper left), Lois Boxill (lower left) and Mark Swinnerton (above) are the guests for the first three episodes of the second season of *Getting Closure*, an LDI podcast hosted by Mike O’Kane (right).



A schematic of material movement from mining source to a deep deposit.

New guide for deep oil sands deposits unveiled

A major guidance document that embraces the principles of landform design established by the LDI has just been released by Canada's Oil Sands Innovation Alliance (COSIA).

Deep Deposit Design Guide for Oil Sands Tailings was unveiled earlier this month at the Seventh International Oil Sands Tailings Conference in Edmonton, Alberta. The 260-page guide was developed over the last 18 months by an editorial team led by LDI Founder Gord McKenna. It was written to describe how to "design and build an oil sands deep, fine-dominated deposit that meets the design basis for the expected lands uses."

While written primarily for oil sands tailings planners and geotechnical engineers, the guide should prove useful to all those involved in tailings management, landform design, and environmental management and reclamation.

The guide outlines the process of design for deep deposits so specialist teams can prepare work scopes, assign responsibilities, and oversee the deposit design, deposition, stabilization, capping, and reclamation.

McKenna was the primary author of the guide, along with June Pollard, who is a member of the LDI's Technical Advisory Panel. David Wylynko of West Hawk Associates served as managing editor throughout the project and James Hrynyshyn of West Hawk edited and designed the document. West Hawk also oversees communications and editorial services for the Institute. Illustrations were provided by Derrill Shuttleworth.

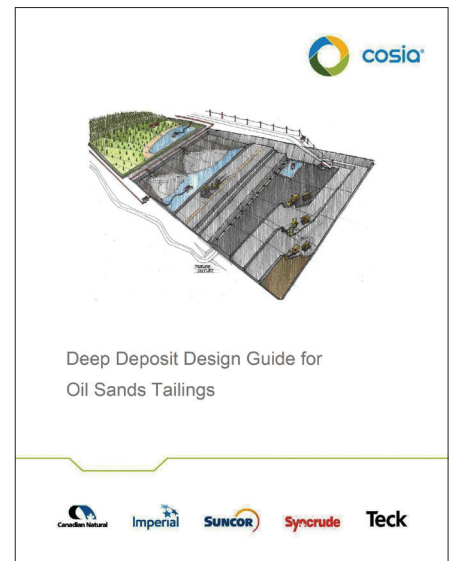
Copies of the guide are available from COSIA (<https://cosia.ca/node/920>).

COSIA is an alliance of oil sands producers focused on accelerating the pace of improvement in environmental performance in Canada's oil sands through collaborative action and innovation.

The Deep Deposit Working Group was assembled by COSIA to develop new approaches to managing deep cohesive deposits and explore capping strategies to reclaiming wetlands and terrestrial landforms. The group was co-chaired by Monica Ansah-Sam of Canadian Natural Resources Ltd. and Paul Cavanaugh of Imperial Oil Ltd.



A comparison of the physics of soft and fluid tailings (above) is included in the Deep Deposit Design Guide (below).



FEATURE

The Practice of Landform Design

Periodically, the *Landform Design Quarterly* publishes an abridged chapter from the LDI position paper, *Mining with the End in Mine*, which was produced in March of 2021. This issue includes the chapter on the practice of landform design. For the full paper, visit www.landformdesign.com.

Landform design is a multidisciplinary approach to reconstructing mine landscapes with confidence and pride. At the outset, it involves the establishment of a landform design team, which typically includes representatives of 6 to 12 disciplines. A lead designer takes overall responsibility for the design and construction. Ideally, the team is formed before mining begins, but for most mines it will be assembled partway through. Larger mines may form several landform design

teams for different areas of the mine site or for different kinds of landforms. Often these teams have overlapping membership.

There is typically a core team (responsible for mine planning, geotechnical, surface water, groundwater, geochemistry, soils, vegetation, wildlife, and risk assessment) supplemented by specialists such as limnologists or aquatic biologists for some types of landforms. Additional specialists are often required. The team will work for decades, often with considerable turnover.

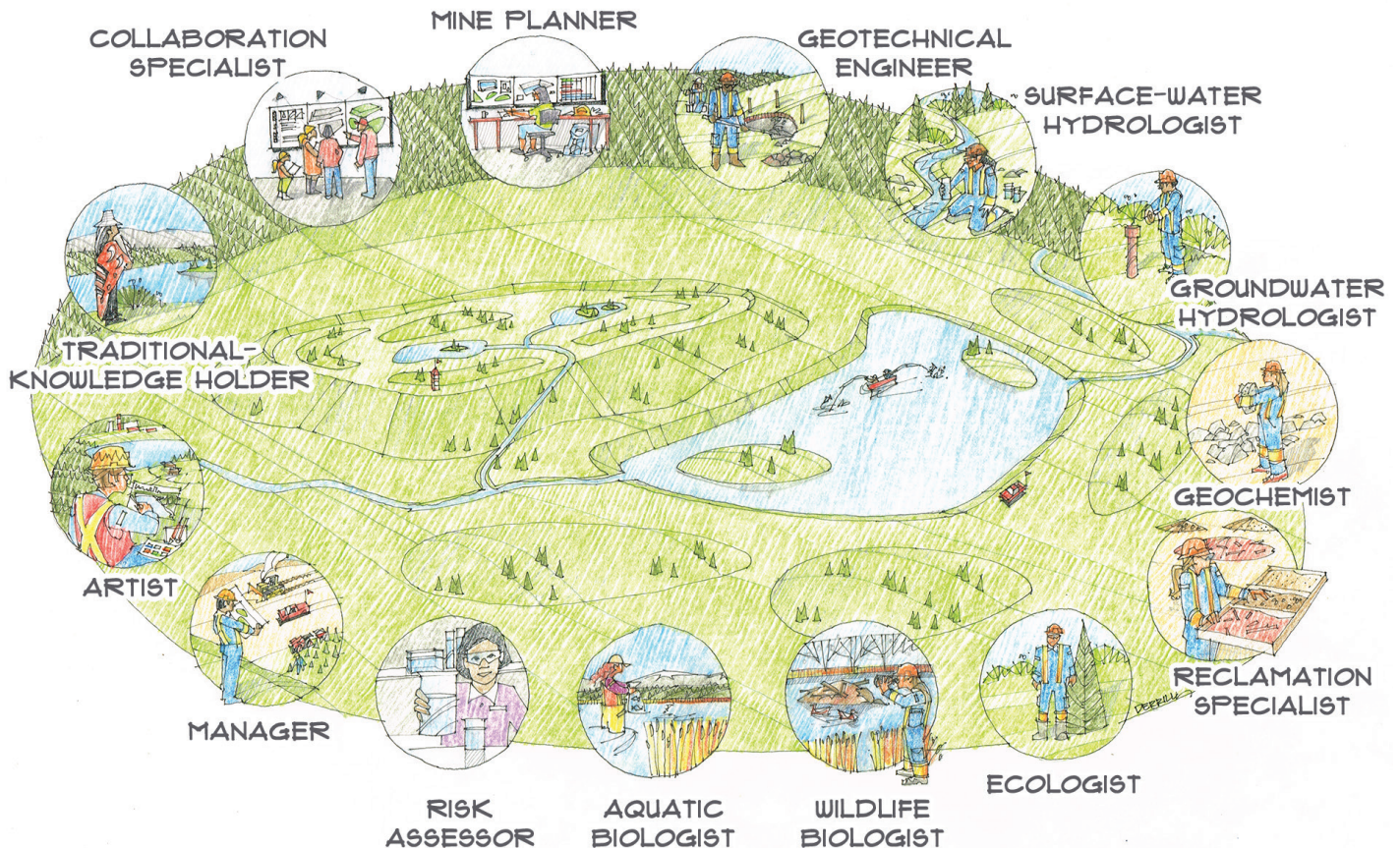
The basis, or factors, for landform design varies in some cases significantly from discipline to discipline; but there are some common themes which influence the design:

- Mine plan and waste material volumes
- Climate and climatic regime

- Post-mine land use
- Watershed characteristics: geological and hydrogeological
- Waste physical properties and geometry (e.g., constructability, settlement, slope stability)
- Waste chemistry (e.g., reactive versus non-reactive, metal leaching versus acidic seepage)
- Cover material characteristics and availability
- Timeframes for establishment of stable and productive landforms
- Governance model and regulatory setting
- Site access and constructability

Many of these design factors are common to those outlined by the International

continued on page 5



The landform design team

The Practice, continued from page 4


Network for Acid Prevention for cover systems.

Historically, target land uses were assigned as the last stage of design — an output rather than an input, or more often simply declared by well-meaning mine management. But one would obviously design a landform differently if it were to be used for a residential subdivision than for wildlife habitat. Mining with the end in mind means the vision and suite of post-mining land uses should be developed with Indigenous peoples and local communities before mining starts.

Climate is a major filter, not only because it affects the land uses and vegetation, but plays a central role in erosion, soil development, and even the foundation conditions (for example, residual soils in tropical regions versus colluvium in semi-arid zones and glacial tills in temperate zones). Many techniques and the expected performance in one climate region can't be translated to other regions, and all designs and construction approaches can be influenced by climate cycles and climate change, often in unexpected ways. Design guidance for accommodating climate change is starting to become available and is a topic under consideration by the Institute.

Landform design is typically documented by the production of the following sequence of activities and design documents:

- An agreed-upon design basis, documented in a design basis memorandum (DBM), which lays out the vision, goals, design objectives, and design criteria, and includes the regulatory requirements and formal commitments with Indigenous and local communities. The evolution of the DBM is closely tracked
- A detailed landform design — documented in a landform design report and issued-for-construction (IFC) drawings and specifications that are signed off by professionals

Mine phase	Mine teams	Landform design teams
Exploration and pre-mining	Permitting and development team <ul style="list-style-type: none"> <input type="checkbox"/> Regulatory and community engagement <input type="checkbox"/> Gaining approval / permit <input type="checkbox"/> Operational feasibility <input type="checkbox"/> Agreed upon post-mining land use plan <input type="checkbox"/> First mine closure and reclamation plan 	 <p>Landform design team</p> <p>Specialists from mine planning, mine operations, local communities, regulatory, geotechnical, surface water, groundwater, vegetation, soils, wildlife, safety with a cohesive vision of meeting mining commitments efficiently at a landform scale</p> <p>Working alongside the mining teams with the priorities of following the process for each landform</p> <ul style="list-style-type: none"> <input type="checkbox"/> Governance <input type="checkbox"/> DBM <input type="checkbox"/> Design <input type="checkbox"/> Risk assessment <input type="checkbox"/> Contingencies <input type="checkbox"/> Construction <input type="checkbox"/> Reclamation <input type="checkbox"/> Monitoring <input type="checkbox"/> Performance assessment
Start of construction		
Construction	Mine development team <ul style="list-style-type: none"> <input type="checkbox"/> Roads and infrastructure construction <input type="checkbox"/> Water management <input type="checkbox"/> Pre-stripping <input type="checkbox"/> Starter dyke construction <input type="checkbox"/> Plant-site construction <input type="checkbox"/> Economical mine plan 	
Startup = first ore		
Operations and progressive reclamation	Mine operations team <ul style="list-style-type: none"> <input type="checkbox"/> Mine plan – efficient mine waste management <input type="checkbox"/> Geotechnical design / dam safety <input type="checkbox"/> Operational water management <input type="checkbox"/> Progressive reclamation and access <input type="checkbox"/> Environmental monitoring and compliance 	
End of ore milling = mine closure		
Decommissioning and post-closure reclamation	Reclamation team <ul style="list-style-type: none"> <input type="checkbox"/> Removal of infrastructure and plantsite <input type="checkbox"/> Final reclamation <input type="checkbox"/> Surface water management and treatment <input type="checkbox"/> Access support for land uses 	
Completion = end of reclamation		
Aftercare, custodial transfer	Corporate mine legacy closure team The Crown / state / local communities <ul style="list-style-type: none"> <input type="checkbox"/> Monitoring <input type="checkbox"/> Future permit approvals <input type="checkbox"/> Safety (water quality / trafficability / geochemistry) <input type="checkbox"/> Stability <input type="checkbox"/> Performance (vegetation, wildlife, water) <input type="checkbox"/> Supporting agreed-upon land uses <input type="checkbox"/> Environmental compliance 	
Relinquishment or abandonment		

- provides specific construction details and specifications for all activities for the landform, including site preparation, initial construction, bulk materials fill, regrading, placement of covers, revegetation, and monitoring / maintenance. This is similar to the process for tailings dam design and construction.
- Clear construction records, documented as a formal as-built report and drawings, detail the history of the landform and ensure the landform was constructed to specifications.
- Ongoing monitoring of the

landscape performance that follows the landform observation, maintenance, and surveillance (OMS) plan, which is in turn based on the DBM. Timely decisions are made when contingencies need to be enacted.

- Documentation that demonstrates that the landform is performing as intended, with signoff by the landform design team, communities, and the regulator.

The mining company, the regulator, and Indigenous and local communities use these

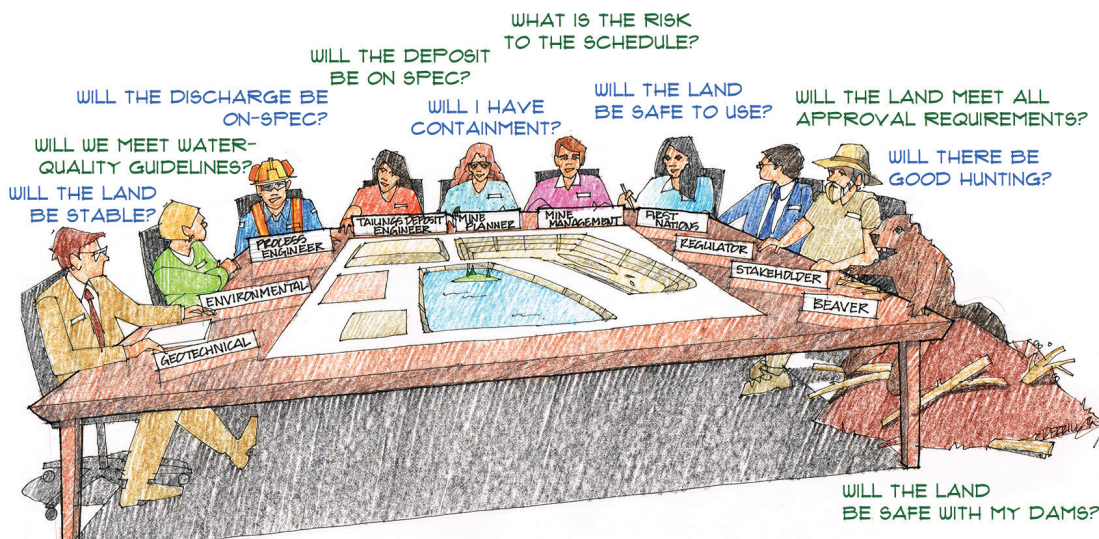
continued on page 6

The Practice *continued from page 5*

records to determine when construction and reclamation activities are complete. A formal completion signoff is then carried out, the landform moves into a funded aftercare program, and there is ongoing access for the intended land uses.

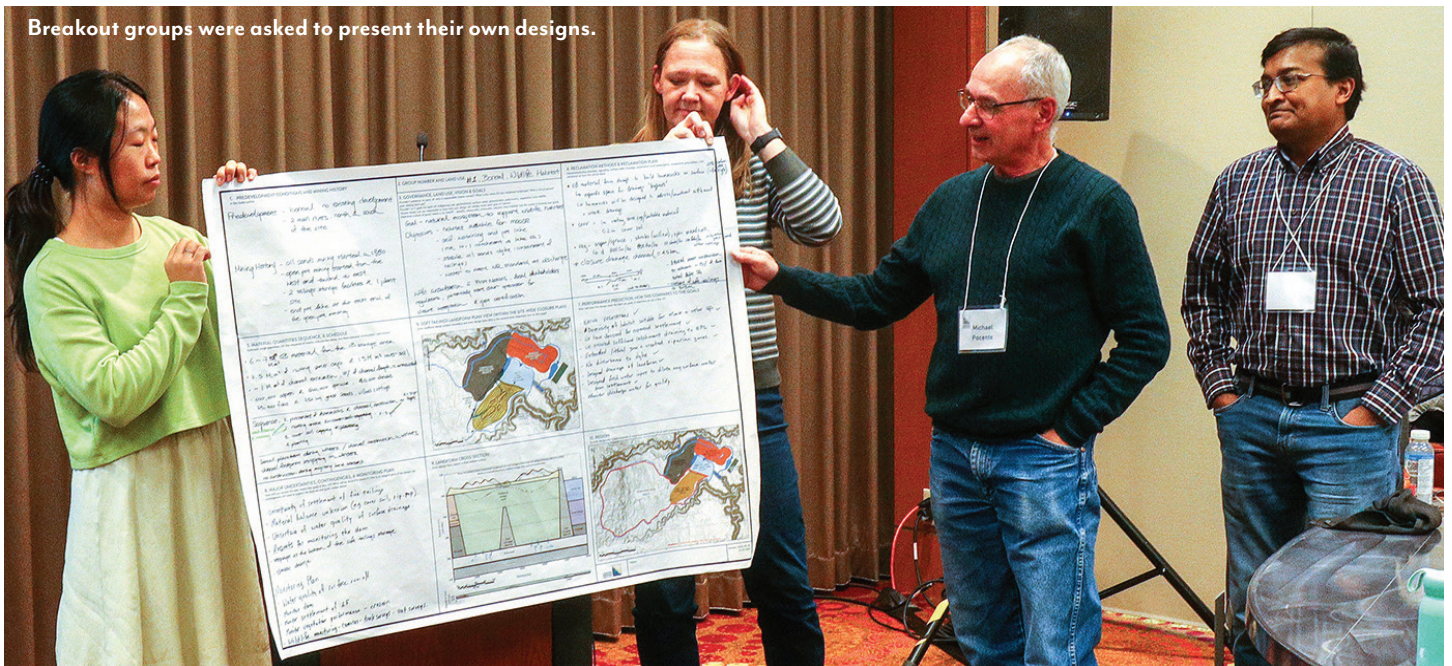
The following are the steps of landform design done well:

- A comprehensive life-of-mine plan completed prior to start-up and executed over the life of a mine that remains on schedule and on budget. Ideally the plan would be fixed, but in practice, the potential for major changes is anticipated, embraced, and to the degree practical, factored into designs and plans. Progressive reclamation, progressive signoff, and progressive access are fully integrated with ongoing operations.
- An effective collaboration process (involving the mine, the regulator, Indigenous and local communities) that begins before mining starts, continues beyond custodial transfer, and entails meaningful ongoing dialogue with all interested parties.
- A steady level of progressive reclamation, including resloping, cover placement, revegetation, creek and river establishment, monitoring and maintenance. Low variation in levels and types of annual activities allow for a steady and experienced reclamation workforce and consistently level budgets. The advantage of this approach is that progressive reclamation and monitoring of performance present an important opportunity for proof of concept of reclamation techniques.
- Land that achieves signoff. After a few start-up years, equal amounts of land have been disturbed, reclaimed, and signed off every year. The work, while still requiring innovation and creativity, becomes a routine part of the mine's annual operating cycle. At closure, the last disturbed land is reclaimed and signed off promptly.
- Reclamation that is indistinguishable from operations, taking advantage of large mining equipment for some tasks, and smaller (often contractor) equipment for finer tasks.
- Research that is carried out in advance of mining and continues during mining to provide timely answers for detailed reclamation designs and activities. Much is learned from studying natural analogs, cover systems, and vegetation trials, ideally within instrumented watersheds designed for reclamation research.
- Goals that are achievable, practical, environmentally sound, and sufficient to ensure reasonable landscape performance. The goals of the mine, regulator, and Indigenous and local communities are coincident but evolve over time.
- The evolution of monitoring and maintenance into aftercare. It is planned for, agreed to by all parties, executed in a timely and economic manner, and funded by the mine.
- A useful landscape that fits into (and supports) local ecosystems and economies. Changes to terms of land uses or properties are understood and accepted by all.
- Trust among the mine, regulator, and Indigenous and local communities throughout the life of the mine. Earning and maintaining trust between all groups is central to success.
- Sufficient funds for the regulator to immediately step into the role of the mine manager and reclaim the land to the standards in the design basis memorandum (DBM) if needed. Acceptance by all parties and pride in the new landscape.



Each member of the design team brings different objectives

Breakout groups were asked to present their own designs.



Practitioners, continued from page 1

different disciplines.

“You sometimes forget that not everyone understands the basics of landform design,” said McKenna. “That’s one of the reasons why we run these courses — to keep us focused on what practitioners need to learn the most.”

Overall, the feedback from the three-day course was positive, with many participants appreciating the chance to work on group exercises and several suggesting they would have enjoyed more such opportunities. Most criticism, meanwhile, revolved around the need to pack a large amount of information into only three days of instruction.

This also was no surprise to the course organizers and leaders, as the LDI is already working toward the creation of a full-fledged university-level curriculum devoted to landform design. “Maybe we should think about offering something that runs for more than three or five days,” said McKenna.

The Institute has also begun work on the development of a virtual design basis memorandum (DBM), which is the core document that mines practicing responsible landform design would start working from before mining at a site begins. The DBM is slated to be completed in the fall of 2023.

Since the course concluded, mining

practitioners and academic institutions have reached out to the Institute to inquire on how more courses could be accessed. Education is one of the pillars of the Institute’s objectives, and LDI plans to continue working toward producing educational materials designed to provide a solid foundation for more formal academic instruction.

Meanwhile, LDI members can access any of the 14 video vignettes on landform design produced by McKenna. Non-members are welcome to visit the LDI website to access a series of infographics, the *Landform Design Quarterly* newsletter, and the podcast series hosted by O’Kane.

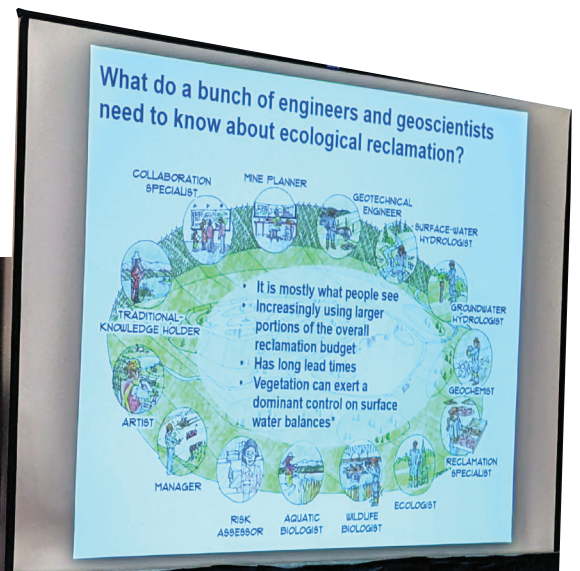
Currently, the LDI is well into

the second series of the Getting Closure podcast, which offers in-depth discussions with some of the leading minds engaged in pushing the frontiers of landform design. The latest episode features an interview with Lois Boxill, a member of the LDI Board of Directors and a mine closure specialist with a unique ability to apply ideas and experiences from far afield.

David Wylynko is the LDI’s director of communication and principal of West Hawk Associates



Justin Straker led a session on mining with the end in mind





Meet the Institute’s administrator

Despite the challenges posed by COVID-19 pandemic in 2020, the LDI continued to grow, eventually reaching the point that expert help was needed to ensure that administrative needs are met, that Board planning and events are well supported, and that student, individual, and corporate member benefits are well communicated.

Among other tasks, that administrator would need to help with the ongoing corporate membership drive, preparation of the Institute’s annual report, and organizing of the next annual general meeting.

And so **Jasmine Winter** was brought on board. A chartered professional in human resources, Jasmine brings to the role more than 10 years of experience in human resources management and has worked in both the public and private sectors, including five years in the oil and

gas industry. She holds a Bachelor of Commerce degree from the University of Alberta. “We are thrilled to bring Jasmine on board, given how the Institute is growing and badly needs the kind of guidance and organization skills that she can bring to the important role of ensuring the organization runs smoothly,” said LDI Chair Gord McKenna.

Based in Edmonton, Jasmine is an avid mountain biker and snowboarder, and enjoys hiking and camping (she once hiked Mount Kilimanjaro). She also holds an open water scuba diving certificate.

“I’m really excited to be part of this dynamic, knowledgeable, and committed team,” Jasmine said of her new appointment. With the Institute now three years old and growing, Jasmine’s role is expected to prove critical in ensuring operations continue to run smoothly.

Next up: a reference Design Basis Memorandum

In 2023, the Landform Design Institute will be producing a design basis memorandum (DBM), working from the success of the position paper, *Mining with the End in Mine*, the *Deep Deposit Design Guide* produced by Canada’s Oil Sands Innovation Alliance (COSIA), and the landform design short course held Nov. 2–4, 2022.

The DBM is a critical piece of the Institute’s contribution to the industry, with making the use of a DBM at every mine worldwide a critical aspect of the LDI mission.

The vision for the DBM is to see that a professional landform design team will be able to use this document to understand how to undertake landform design, who needs to be involved, the timing, and all areas of expertise required. The document will include available literature and a worked example of a DBM.

The Institute hopes practitioners will be able to rely on the document as a useful and complete reference for their purposes.

A team being prepared to work on the DBM will kick off the undertaking in January of 2023.



LANDFORM DESIGN INSTITUTE

The *Landform Design Quarterly* is a publication of the Landform Design Institute, a not-for-profit corporation based in Vancouver, BC. All contents are protected by copyright and may be used only for non-commercial purposes. All other rights are reserved and commercial uses including publication, broadcast, or redistribution in any medium are prohibited. Permission to copy may be sought from the Landform Design Institute. © 2022 The Landform Design Institute

CONTACTING THE LDI

5223 Laurel Dr.
Delta, BC, V4K 4S4
Canada
+1.604.838.6773
info@landformdesign.com

Web: landformdesign.com
Twitter: @LandformDesign

Publisher: Landform Design Institute

Editor: David Wylynko, West Hawk Associates

Design: James Hrynyshyn, West Hawk Associates

Photos: Jasmine Winter (1, 7, 8) **Illustrations:** Derrill Shuttleworth (3, 4, 6,)