

So...  
...you're planning a Waste Rock Dump

Mike O'Kane, P.Eng.  
Rachel Sawyer, P.Eng.

BC ML-ARD Workshop 2025 – Vancouver BC  
11:00-11:30, Tuesday December 2, 2025



**Why not build...**

**...a Mine Rock Stockpile (MRS)  
w/ Source Control instead?**

**Mike O'Kane, P.Eng.  
Rachel Sawyer, P.Eng.**

BC ML-ARD Workshop 2025 – Vancouver BC  
11:00-11:30, Tuesday December 2, 2025



*Tools for Making Better...*

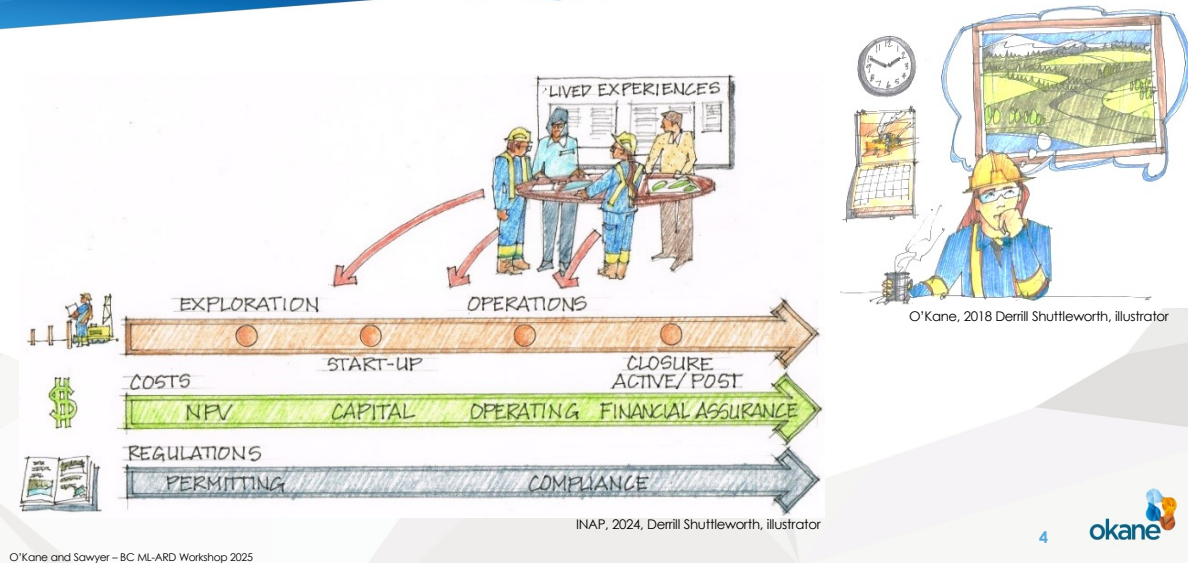
*...Mine Rock Management  
decisions early in Design*

**Mike O'Kane, P.Eng.**  
**Rachel Sawyer, P.Eng.**

BC ML-ARD Workshop 2025 – Vancouver BC  
11:00-11:30, Tuesday December 2, 2025



## ...lived experiences



Let's start with a question.

Do you believe mine closure is truly core business in our industry? Are we embedding closure into strategic and operational decisions—or treating it as an end-of-mine-life obligation?

Choose the option that best reflects your experience.



... lived experience, champions, **system / process**



Rock Placement Strategies to Enhance Operational and Closure Performance of Mine Rock Stockpiles

Phase 1 Work Program – Review, Assessment & Summary of Improved Construction Methods

prepared for

The International Network for Acid Prevention

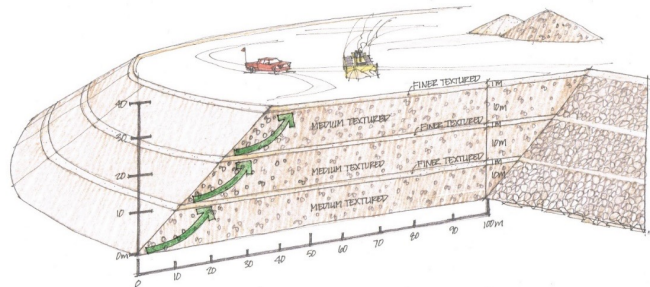
**INAP**



By:

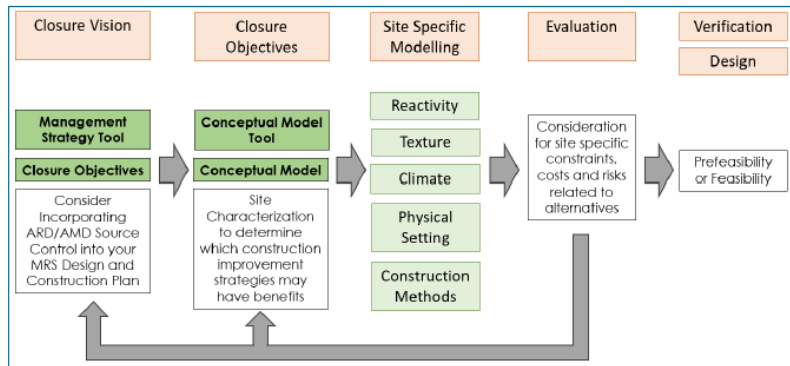
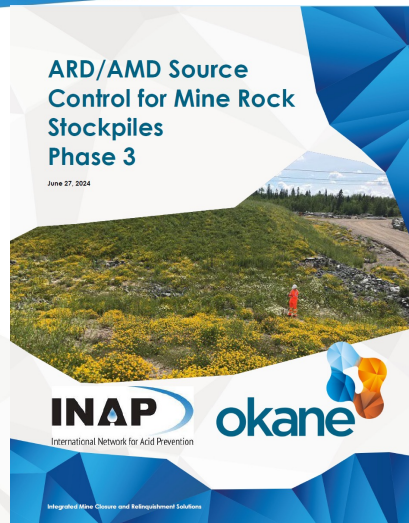


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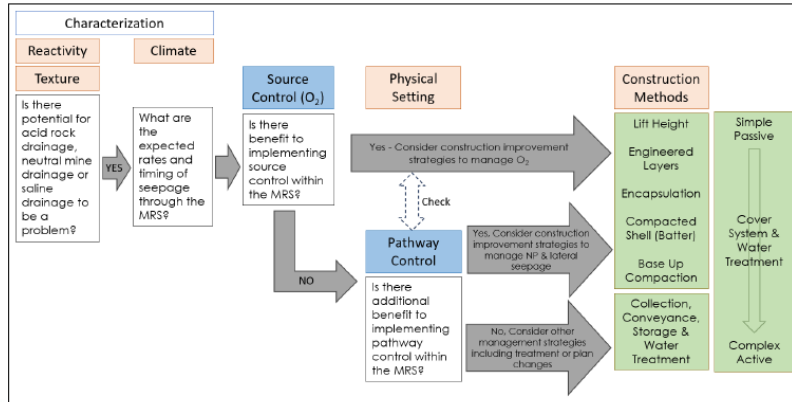
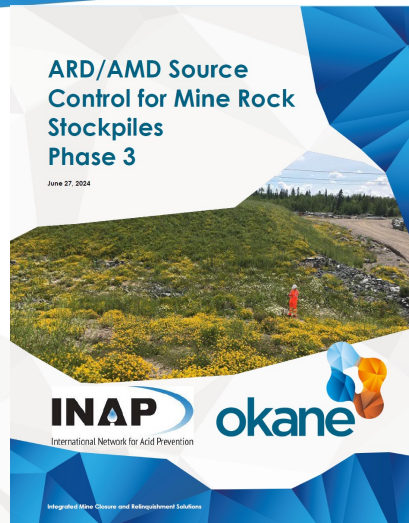


INAP 2020 illustration by D. Shuttleworth

# Tools for Making Informed Decision

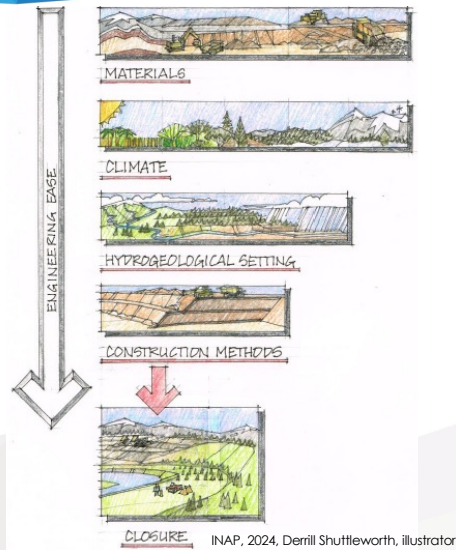
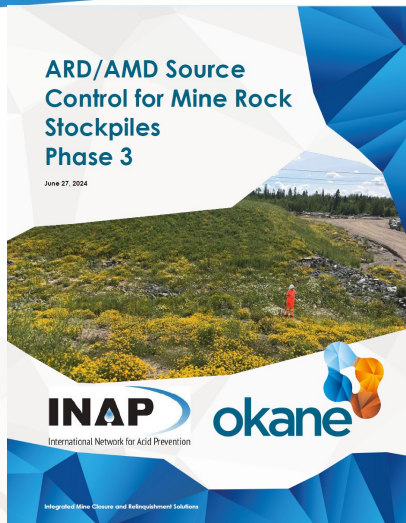


# Tools for Making Informed Decision



O'Kane and Sawyer – BC ML-ARD Workshop 2025

# Tools for Making Informed Decision



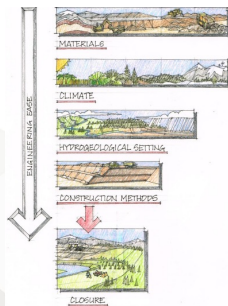
INAP, 2024, Derrill Shuttleworth, illustrator

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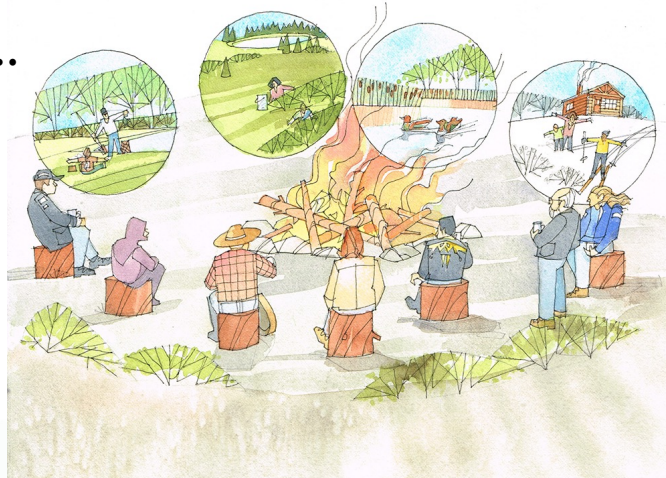


... let's not forgot though...

...Closure Vision...



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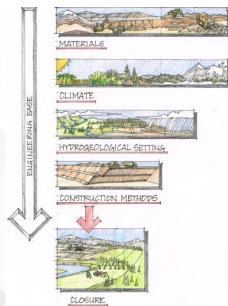
LDI, 2025 Demill Shuttleworth, illustrator



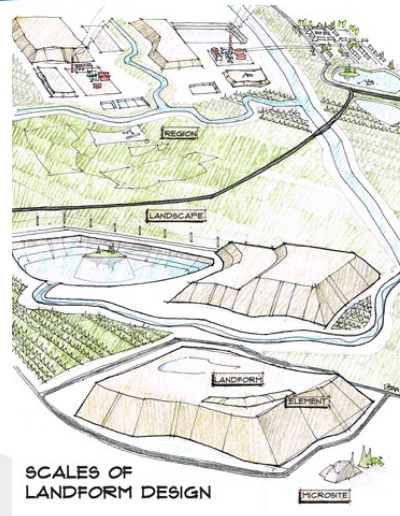
... let's not forgot though...

...Closure Vision...

...Closure Objectives  
and Principles...



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LDI, 2025 Derrell Shuttleworth, illustrator 10



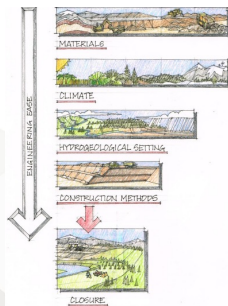


... let's not forgot though...

...Closure Vision...

...Closure Objectives  
and Principles...

...it's about the Land...



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LDI, 2025 Demill Shuffelworth, illustrator

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## ... land acknowledgement...



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## ... land acknowledgement...

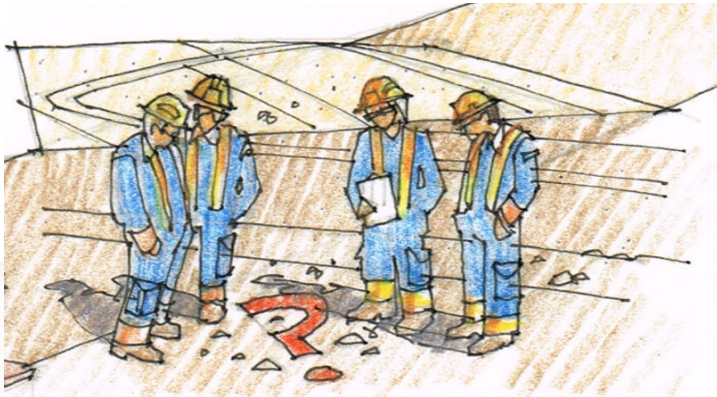


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...OK, so now what...?



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O'Kane, 2018, Derrill Shuttleworth, illustrator



O'Kane, 2018 Derrill Shuttleworth, illustrator

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Let's start with a question.

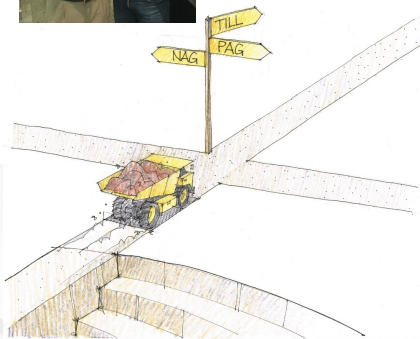
Do you believe mine closure is truly core business in our industry? Are we embedding closure into strategic and operational decisions—or treating it as an end-of-mine-life obligation?

Choose the option that best reflects your experience.

## ...my first lived experience w/ MRS gas transport

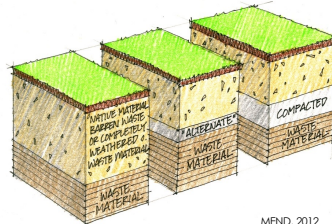


**Dr. Lee Barbour**



O'Kane and Sawyer – BC ML-ARD Workshop 2025

O'Kane, 2018



MEND, 2012



Meinitz and Aziz, 2018

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Meintz and Aziz, 2018 16



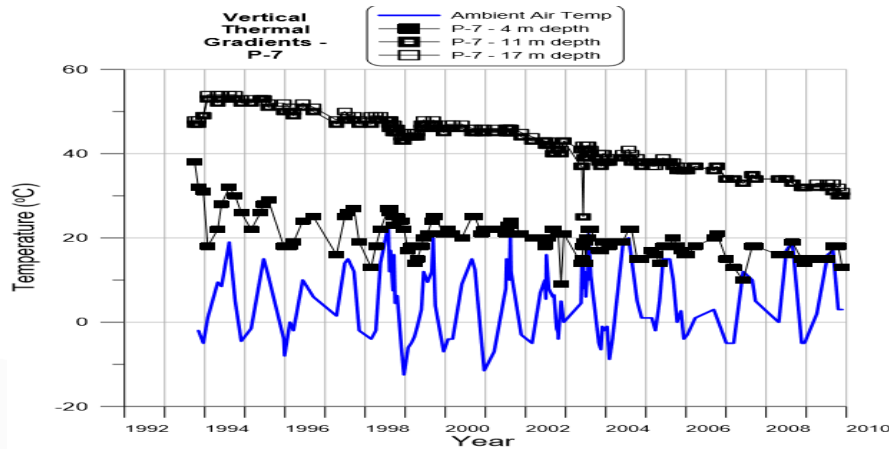
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## ...my first lived experience w/ MRS gas transport

Dfb – hot-summer, humid continental



Morin et al 2010

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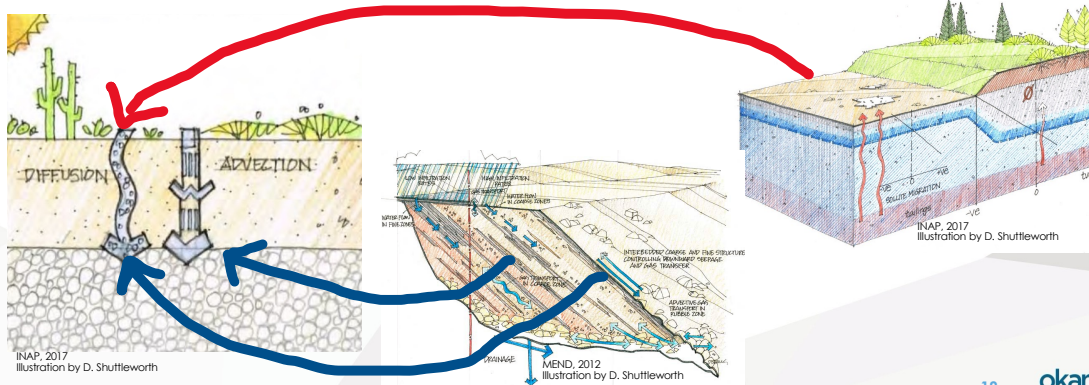
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# TSFs vs MRSs... gas transport??

## Understanding Gas Transport... Foundational Differences...



M. O'Kane – MC2025 Kulturrens Hus, Luleå, Sweden

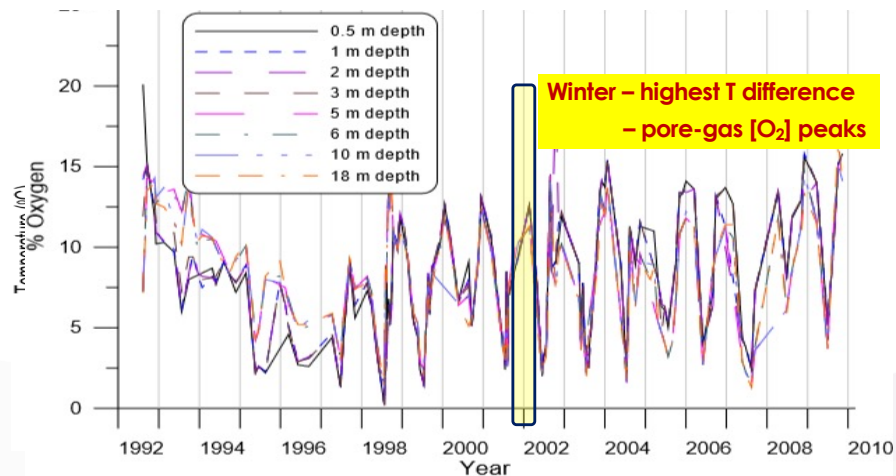
18





## ...my first lived experience w/ MRS gas transport

Dfb – hot-summer, humid continental



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Morin et al 2010

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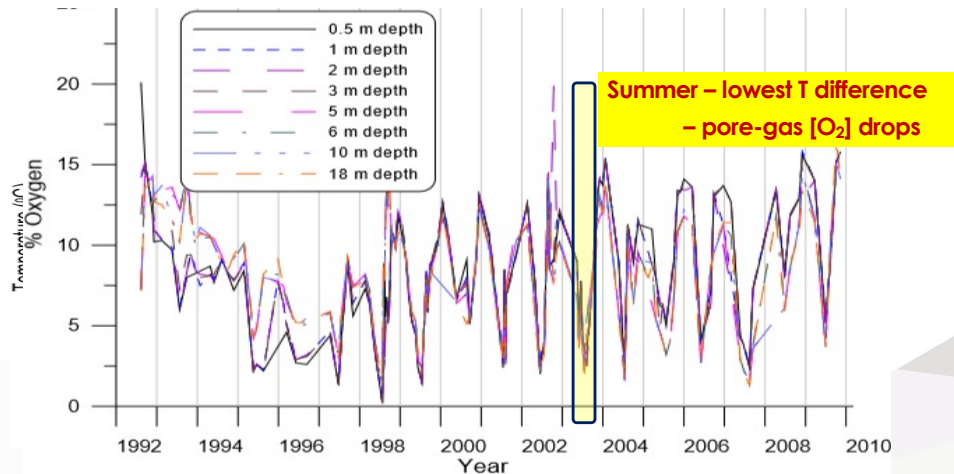
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Morin et al 2010

20

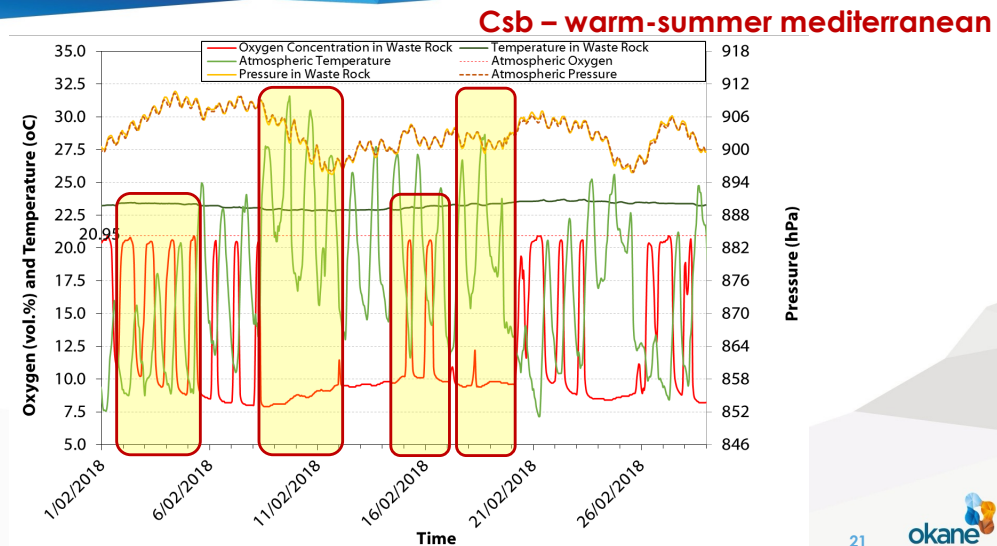


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## ...another site ...this time diurnal cycles



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INAP 2020

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Let's start with a question.

Do you believe mine closure is truly core business in our industry? Are we embedding closure into strategic and operational decisions—or treating it as an end-of-mine-life obligation?

Choose the option that best reflects your experience.

...another site ...a cover system can manage O<sub>2</sub>

Dfb – hot-summer, humid continental

***Whistle Mine Backfilled Pit  
Dry Cover Case Study –  
Performance Based on Six Years  
of Field Monitoring***



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O'Kane et al 2012

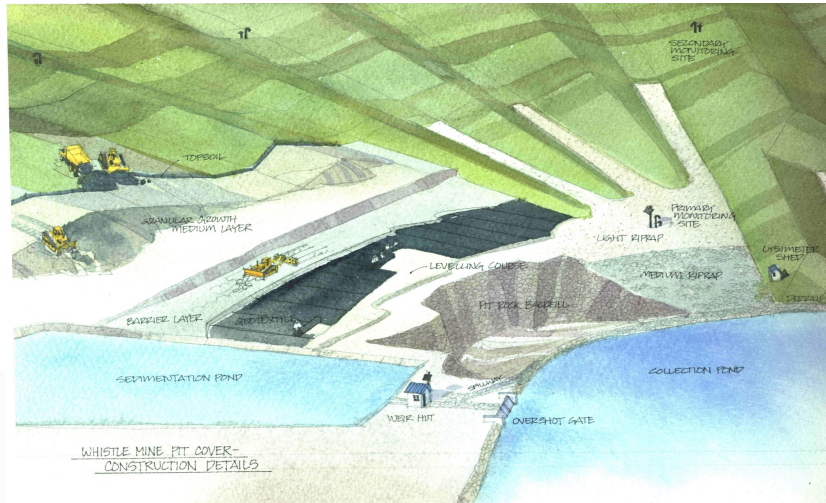
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Dfb – hot-summer, humid continental



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O'Kane et al 2012

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## ...another site ...a cover system can manage O<sub>2</sub>

Dfb – hot-summer, humid continental

|                  | P-01 $D_e$<br>( $10^{-11} \text{ m}^2/\text{s}$ ) | P-02 $D_e$<br>( $10^{-11} \text{ m}^2/\text{s}$ ) |
|------------------|---|---|
| 2006             | 42  | 17  |
| 2007             | 36  | 3.9   |
| 2008             | 14  | 1.8   |
| 2009             | 231   | 1.8   |
| 2010             | 14  | 1.8   |
| 2011             | 6   | 1.9   |
| Minimum required | 376   |   |

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O'Kane et al 2012

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Let's start with a question.

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...let's go 'down under' ... mid-1990s

## Kidston Gold Mine

From Wikipedia, the free encyclopedia

- **Gold first discovered around 1907**
- **Open cut mining had commenced from 1921**
- **Kidston applied to restart modern open cut mining in 1979**
- **Mining continued from 1985**
- **Until it was again closed in 2001**



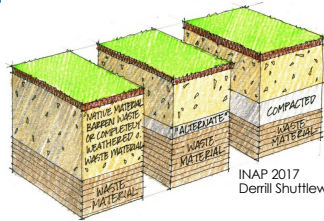
Williams, 2022



Williams, 2022



# “birth” of the **Store-and-Release Cover System** concept



INAP 2017  
Derrill Shuttleworth, illustrator



Williams et al 2006a

## ...types of Cover Systems

### “Enhanced” Store-and-Release

- Lower permeability layer below growth medium
- Not a “barrier” layer
- “Hold” moisture closer to surface until ET rates “catch up”



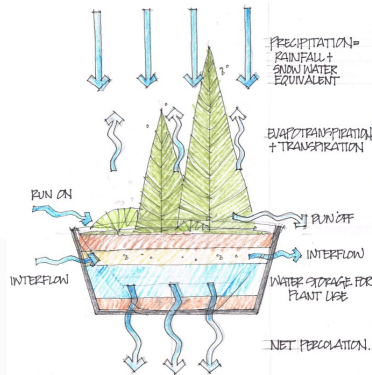
©2020 Spunchem - Okane (Feb 16, 2022)



Moisture  
“Store-and-Release”  
or  
Evapotranspiration Cover  
(“ET” Cover)

## “birth” of the **Store-and-Release Cover System** concept

“...designing a cover system is like figuring out the right sized flower pot...”



O'Kane and Sawyer – BC ML-ARD Workshop 2025 O'Kane 2018 Derrill Shuttleworth, illustrator



**Dr. Lee Barbour**



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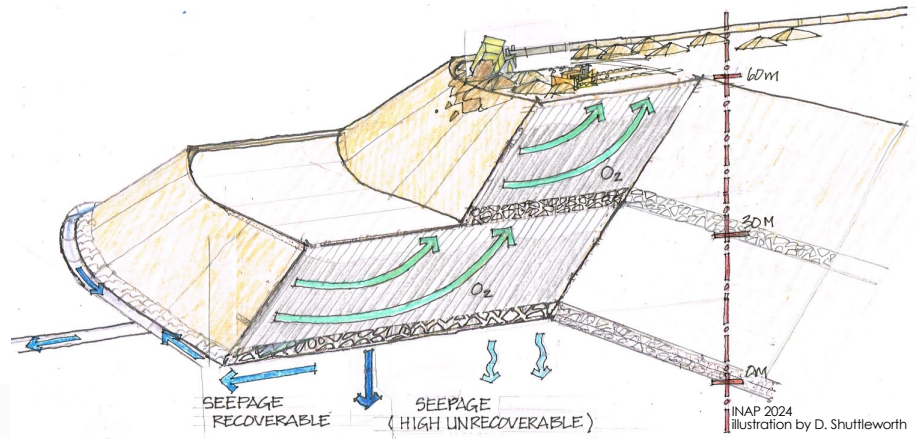


...don't forget...

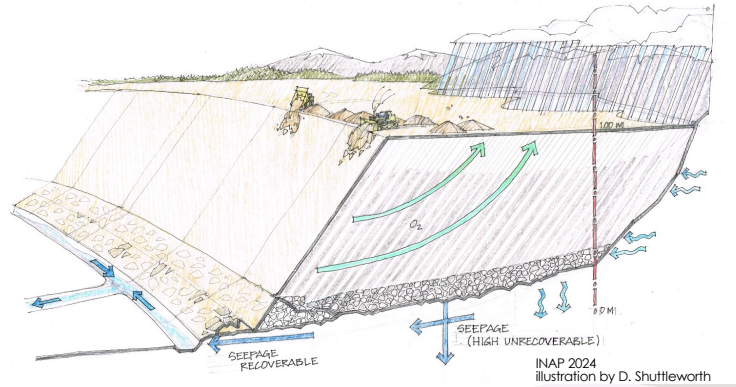


Williams et al 2006b

## Conventional Mine Rock Stockpile Construction



## Conventional Mine Rock Stockpile Construction



...don't forget...

$$T_{in} > T_{out}$$



Williams et al 2006b



...don't forget...

$$\tau_{in} < \tau_{out}$$



Williams et al 2006b

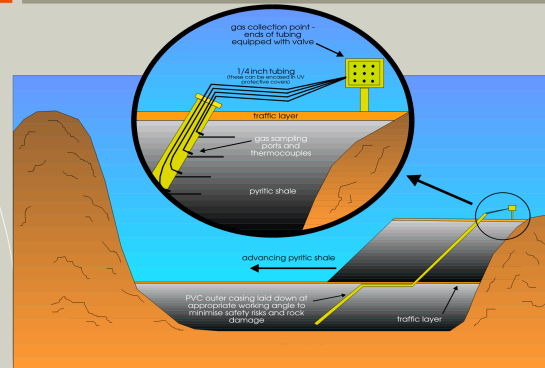


... over to the other side of Australia...

Pond A - Construction

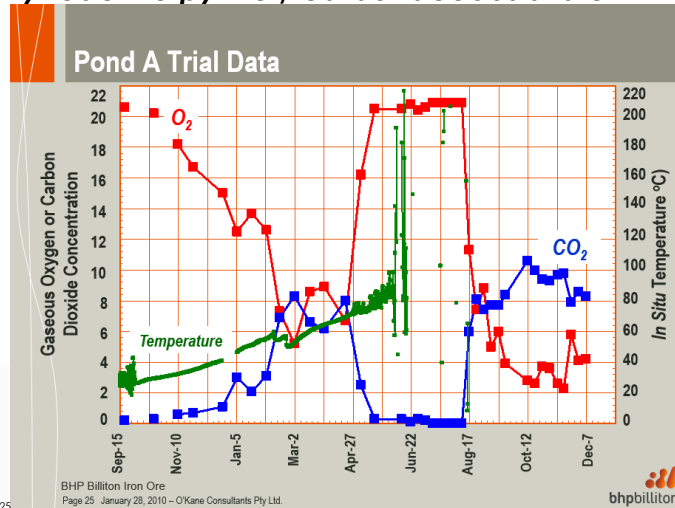


Pond A - Design



... over to the other side of Australia...

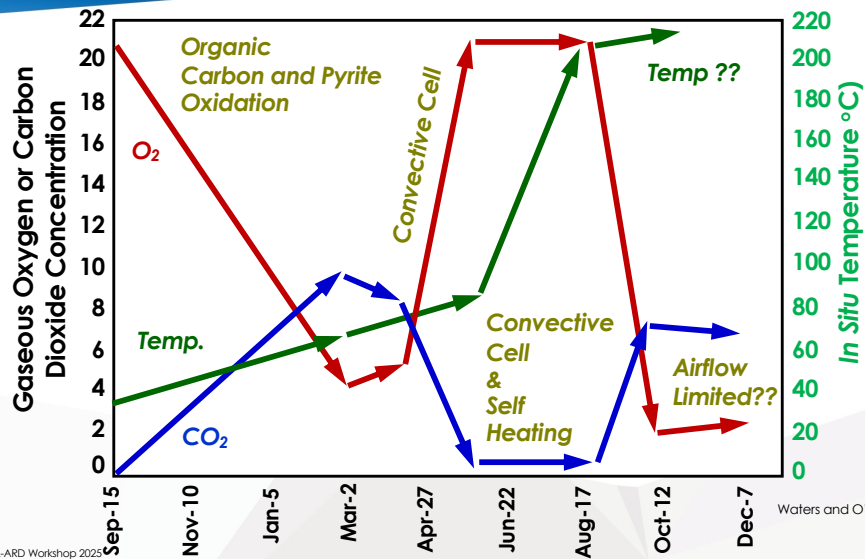
- **Open Pit – Highly reactive pyritic / carbonaceous shale**



O'Kane and Sawyer – BC ML-ARD Workshop 2025

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Waters and O'Kane, 2003

... over to the other side of Australia...



...OK, so now what...?



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Waters and O'Kane 2003



O'Kane, 2018 Derrill Shuttleworth, illustrator

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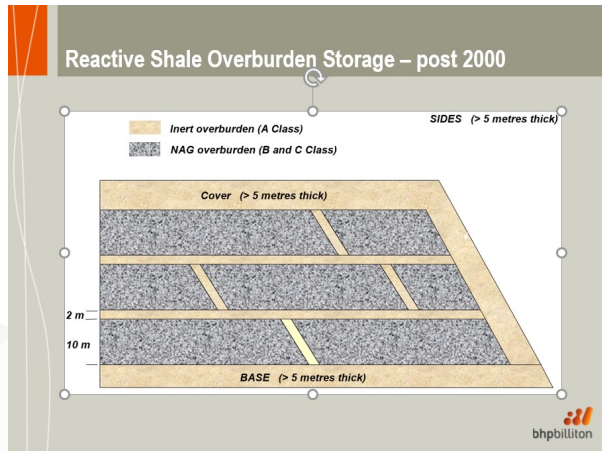


Let's start with a question.

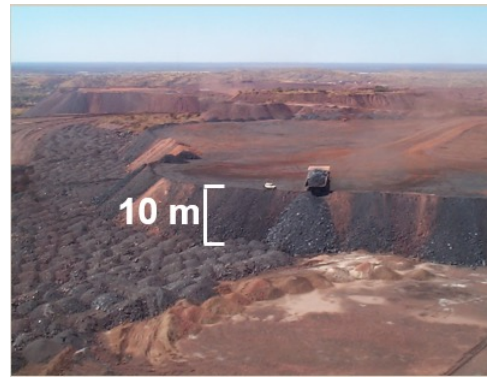
Do you believe mine closure is truly core business in our industry? Are we embedding closure into strategic and operational decisions—or treating it as an end-of-mine-life obligation?

Choose the option that best reflects your experience.

... this is what...



Waters and O'Kane 2003



Waters and O'Kane 2003

... lived experience, champions, **system / process**



Rock Placement Strategies to Enhance Operational and Closure Performance of Mine Rock Stockpiles

Phase 1 Work Program – Review, Assessment & Summary of Improved Construction Methods

prepared for

The International Network for Acid Prevention

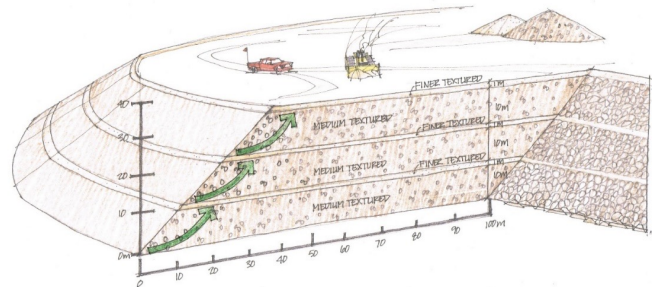
**INAP**



By:



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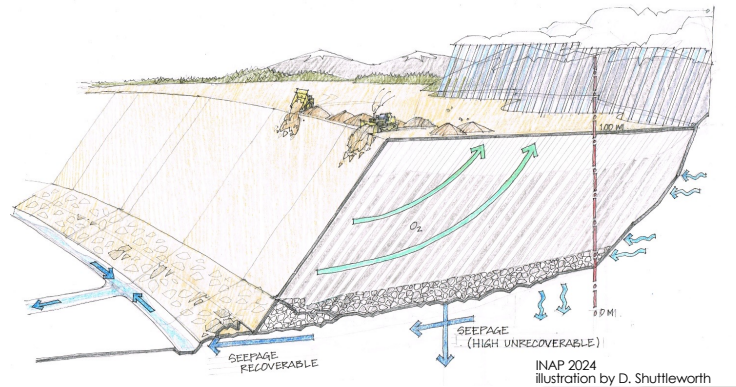


INAP 2020 illustration by D. Shuttleworth

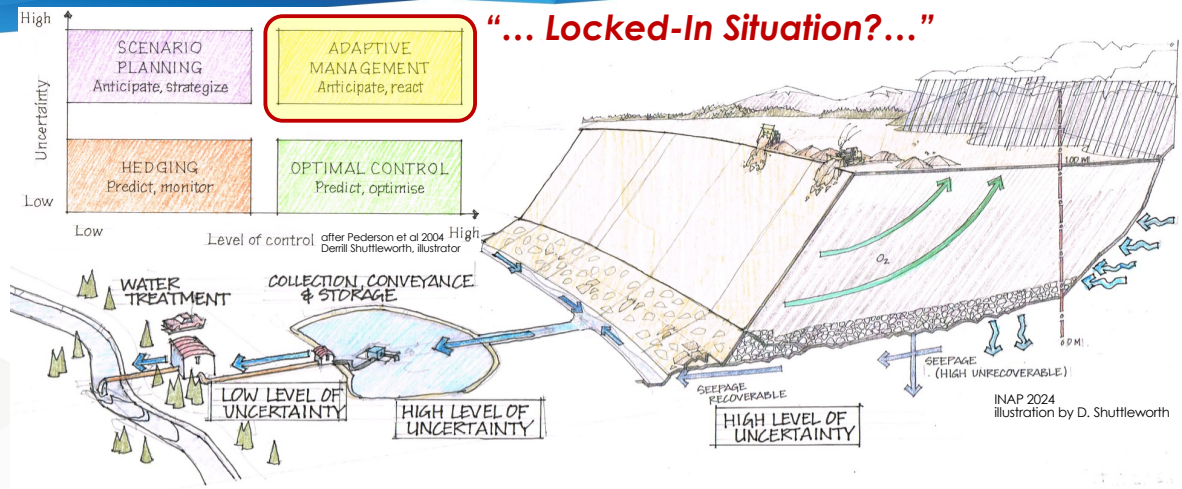




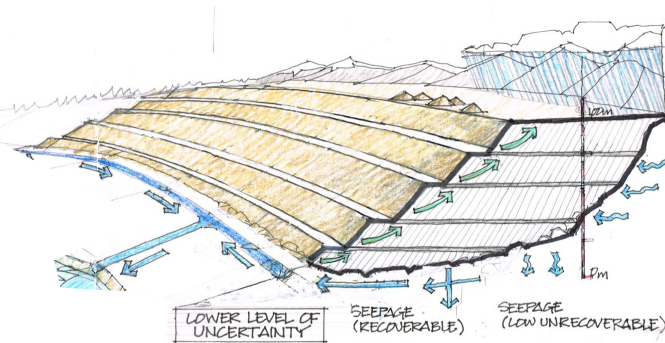
## Conventional Mine Rock Stockpile Construction



# Conventional Mine Rock Stockpile Construction

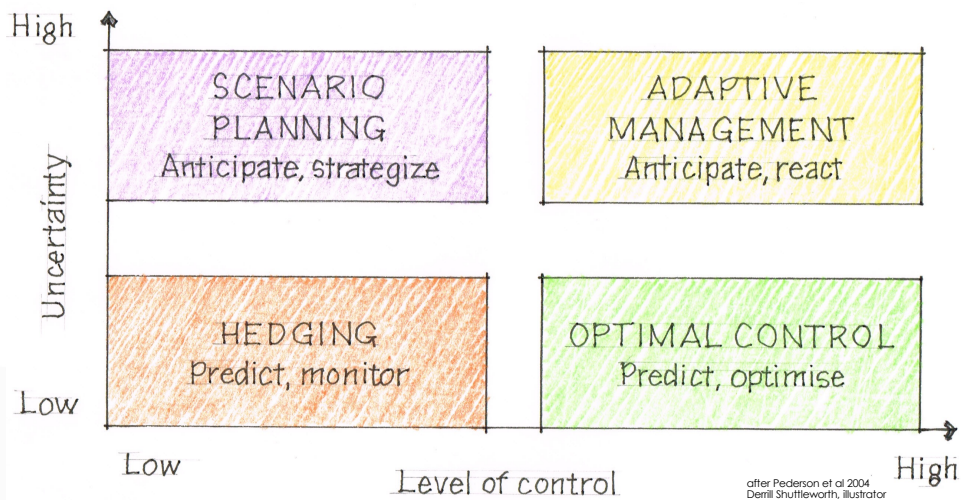


...the Solution? **Reduce Uncertainty, focus on Source Control**



INAP 2024  
illustration by D. Shuttleworth

## ...decision-making tools

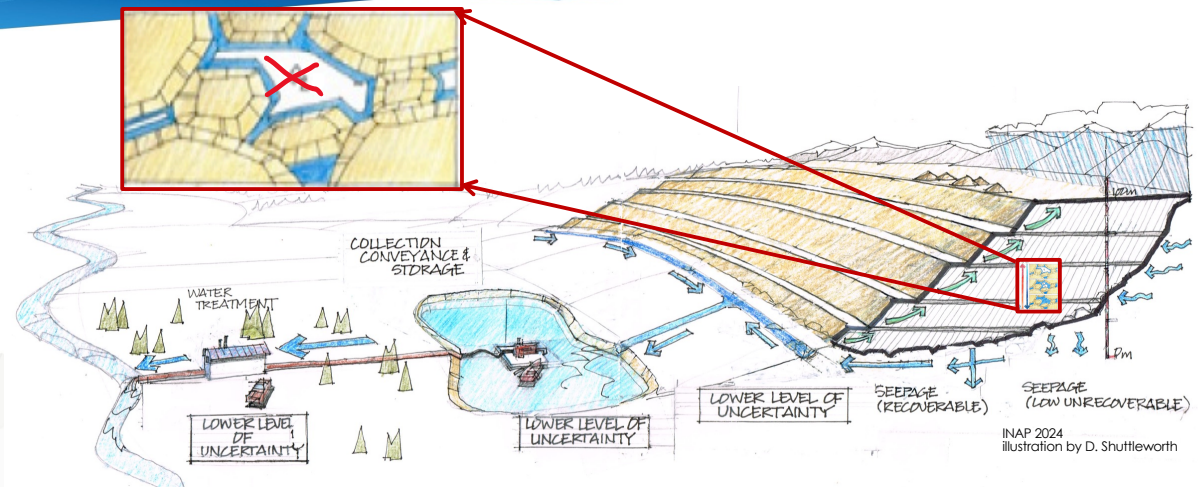


after Pederson et al 2004  
Dermil Shuttleworth, illustrator

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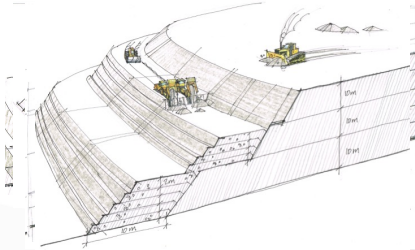
## ...a focus on Source Control ...large-scale suboxia



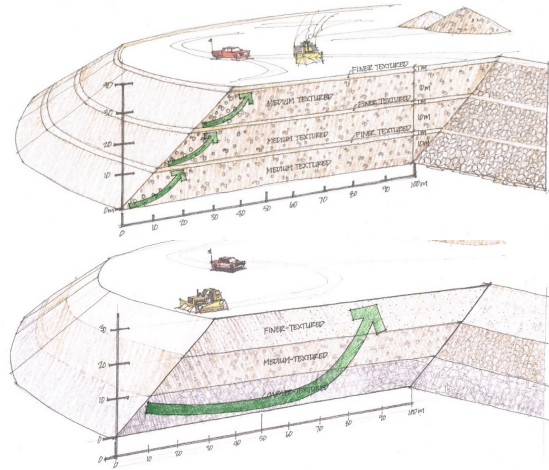


## ...a focus on Source Control ...large-scale suboxia

- Create a system with **Low Vertical** Air Flow Capacity and (and/or)
- **Low Lateral** Air Flow Capacity



- Rather than a system with **High Air Flow Capacity**



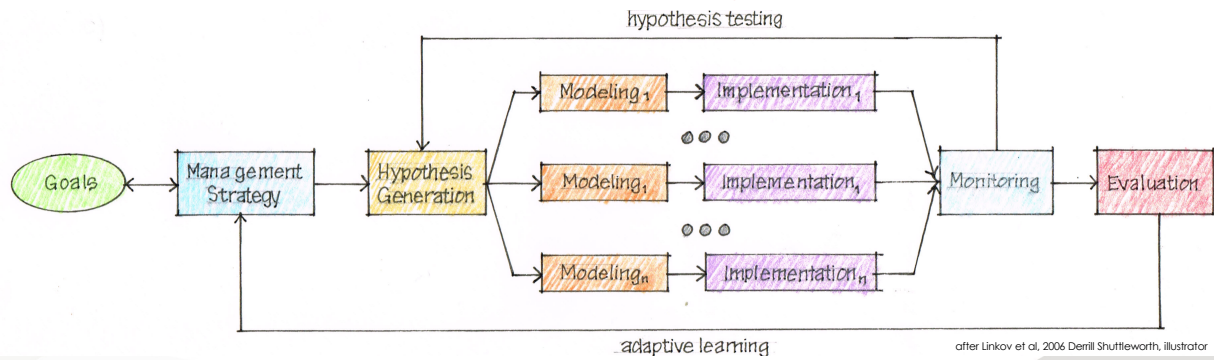
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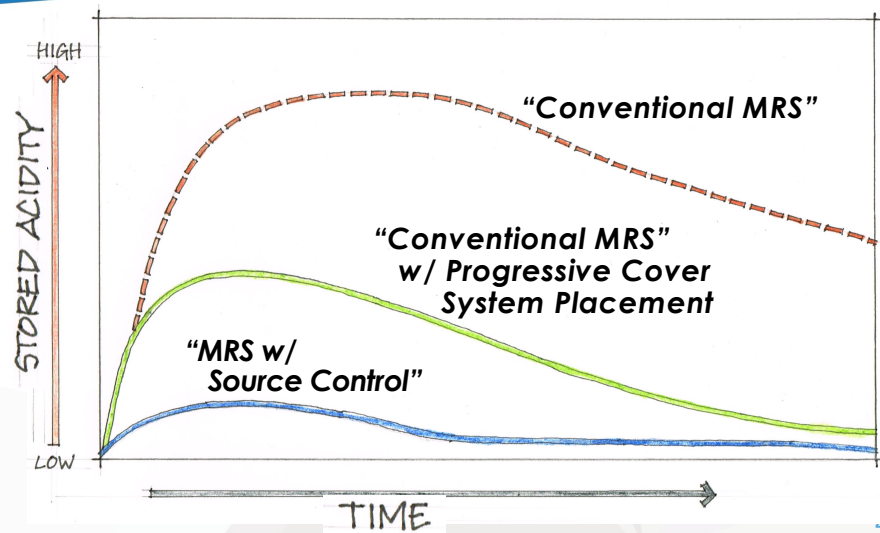


# Passive and Active Adaptive Management

## Active Adaptive Management



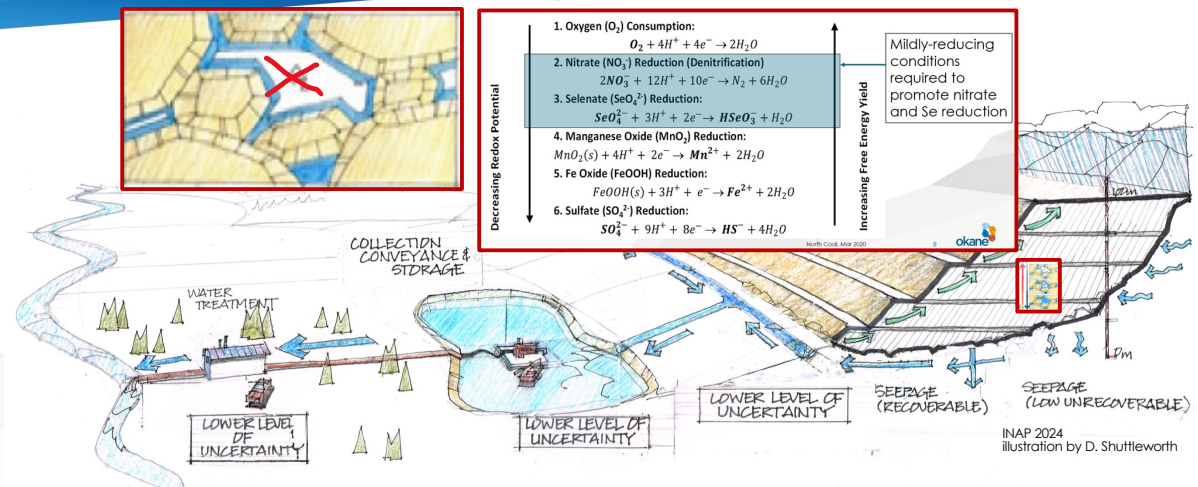
## Mine Rock Stockpile Stored Acidity over Time



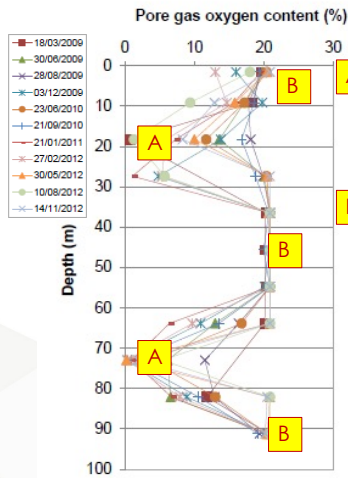
O'Kane and Sawyer – BC ML-ARD Workshop 2025



## ...a focus on Source Control ...large-scale suboxia



## ...a focus on Source Control ...large-scale suboxia



**Zones of suboxia are observed:**

- *Extent and consistency are a function of time of year, MRS structure, material texture, material reactivity, and location*

**Zones of large-scale oxic conditions are observed**

- *as above*

**Seepage water quality:**

- **Higher  $\text{NO}_3$  and Se concentration**

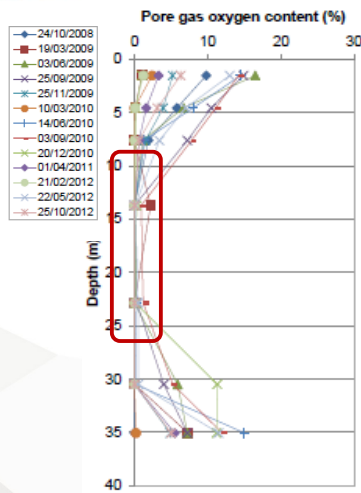
Dockery et al. 2015

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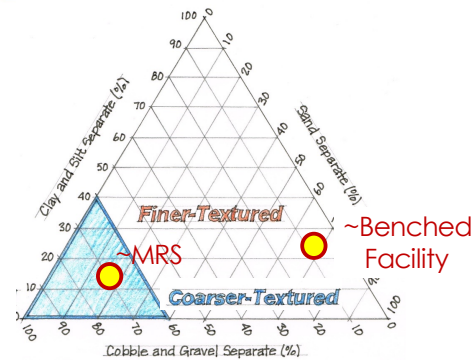


## ...a focus on Source Control ...large-scale suboxia



Dockery et al. 2015

O'Kane and Sawyer – BC ML-ARD Workshop 2025



### Large-Scale zone of consistent suboxia:

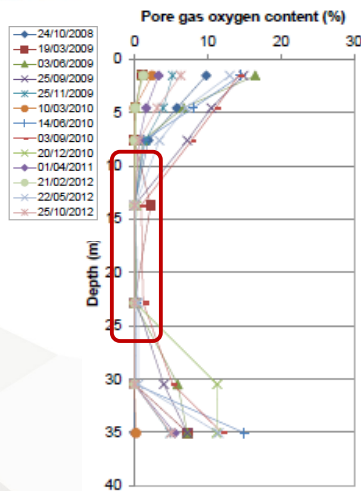
- Despite same climate conditions
- At monitoring points, consumption of pore of pore-gas exceeds consumption
- **WHY?**

50



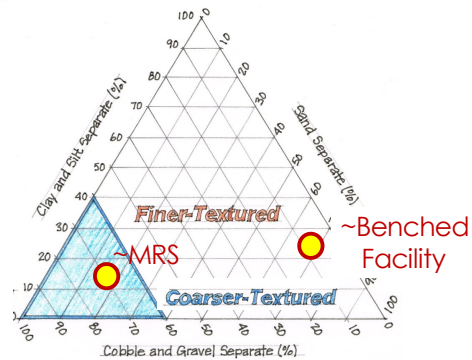


## ...a focus on Source Control ...large-scale suboxia



Dockery et al. 2015

O'Kane and Sawyer – BC ML-ARD Workshop 2025



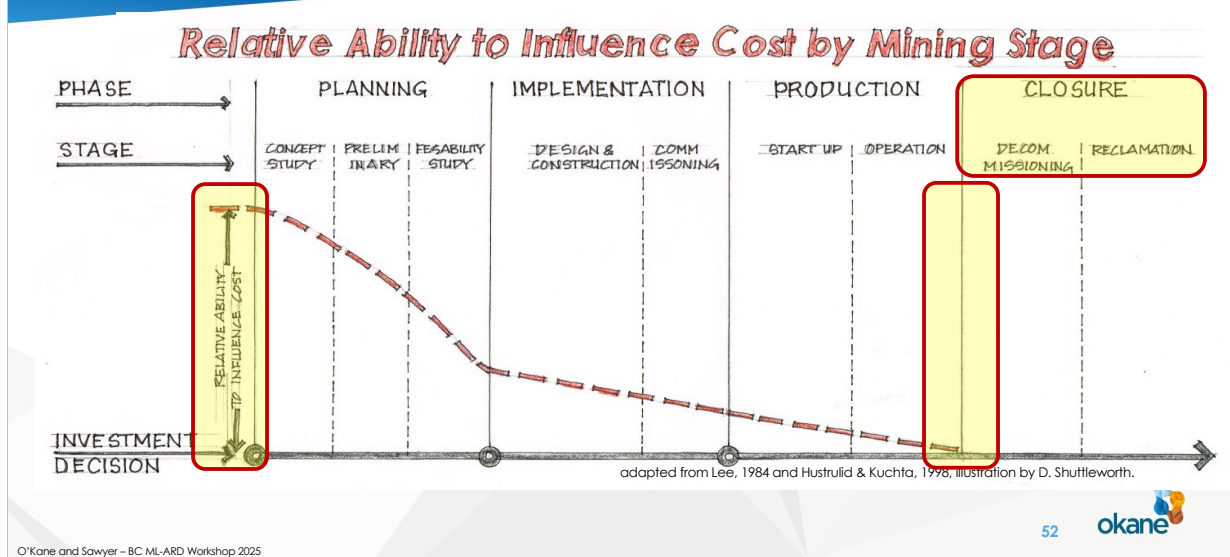
**Seepage water quality:**

➤ **Lower  $\text{NO}_3$  and Se concentration**

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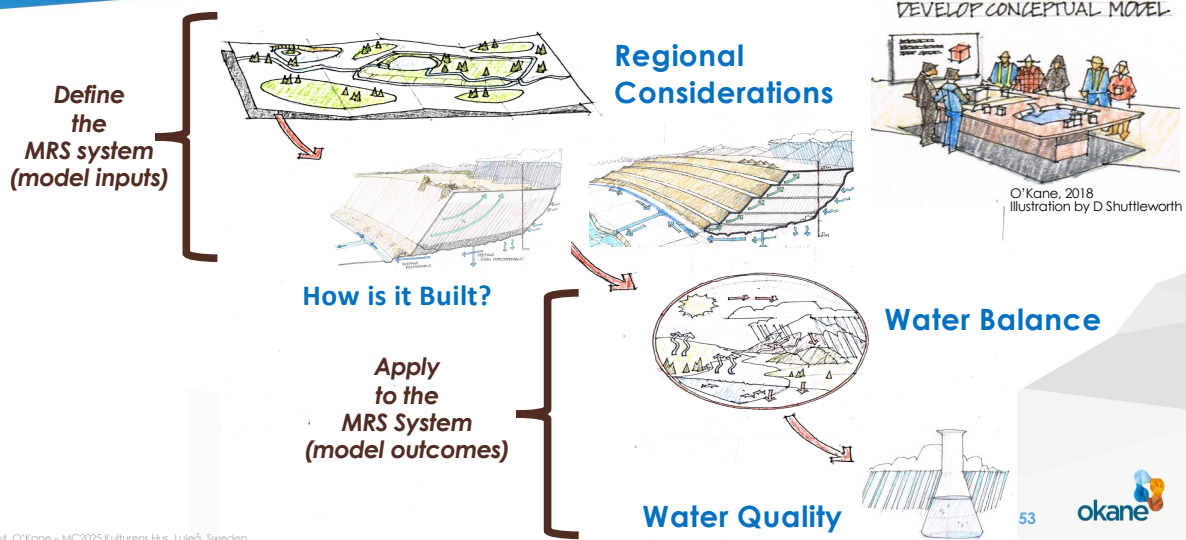


...speaking to the folks at the start...

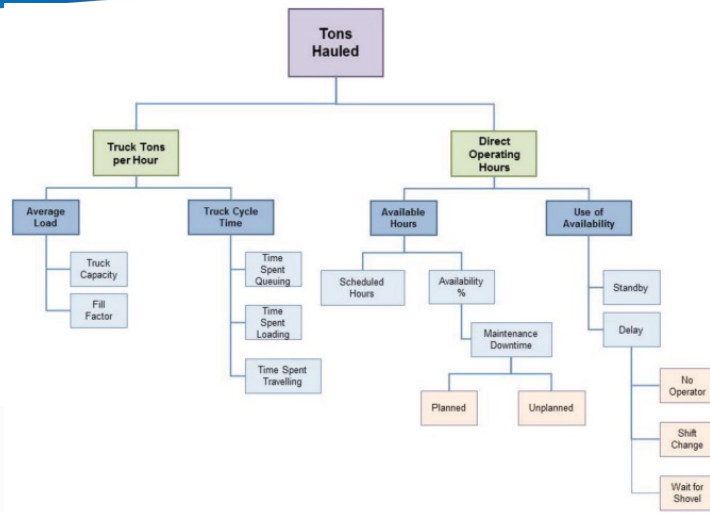


The Final Investment Decision—or FID—happens after a detailed Feasibility Study. This is the last major decision point before construction begins. And it's where mine closure, if not embedded early, becomes very challenging to influence.

## ... better at developing “...informed simplicity...”



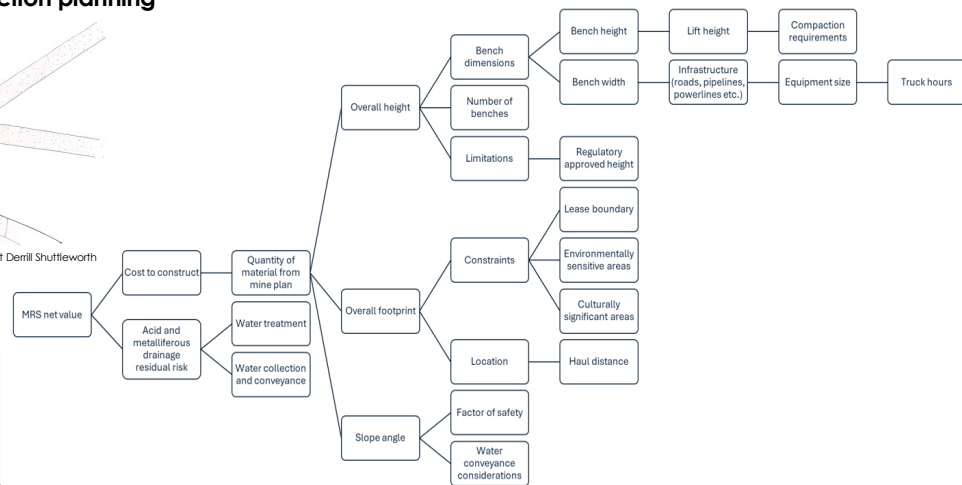
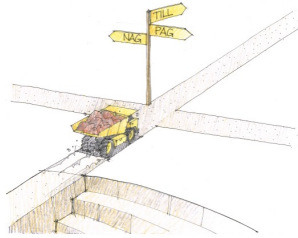
# Value Driver Tree



G.R. LANE and B. WYLIE, Cyst Corporation, Case study: a value driver tree as a means of integrating value drivers across disciplines and activities  
<https://www.platinum.org.za/P2014/Papers/143Lane.pdf>

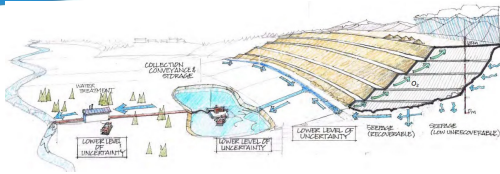
# Value Driver Tree – Application to an MRS

## Conventional mine rock stockpile (MRS) design and construction planning

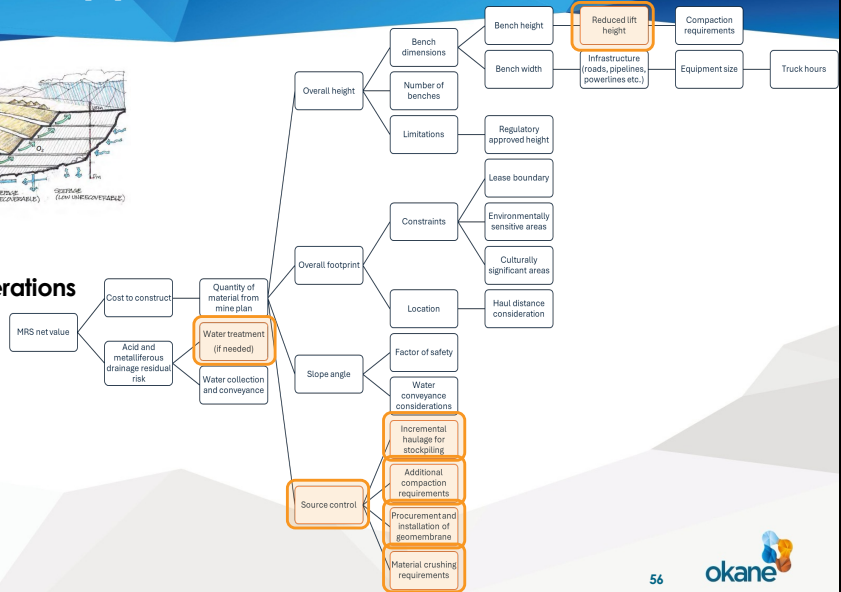


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# Value Driver Tree – Application to an MRS



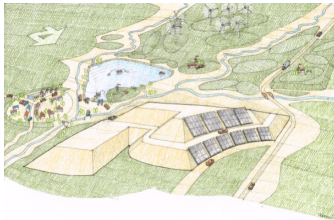
## Mine Rock stockpile Design with Source Control (orange) considerations



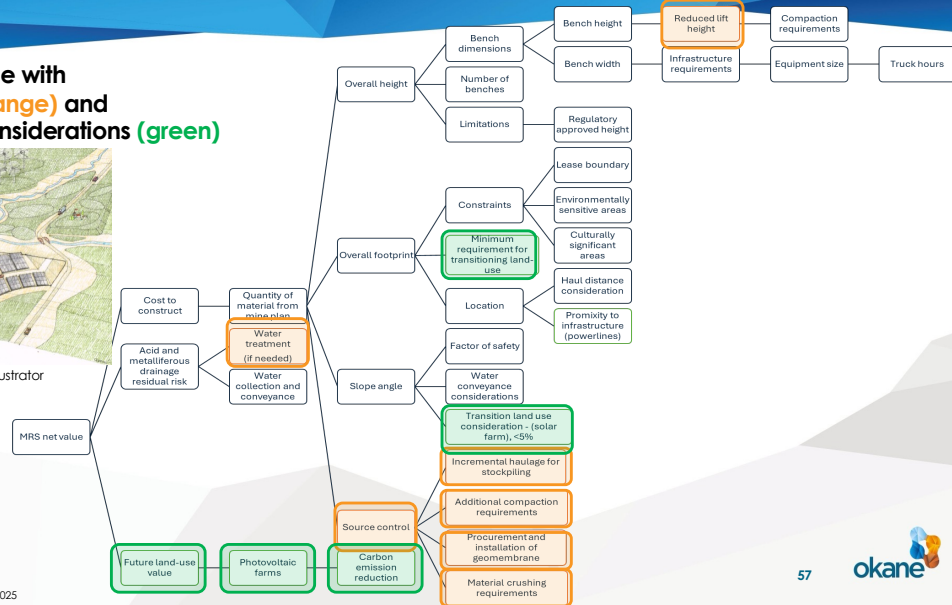


# Value Driver Tree – Application to an MRS

## Mine Rock Stockpile with Source Control (orange) and Future Land Use considerations (green)



O'Kane and Sawyer – BC ML-ARD Workshop 2025

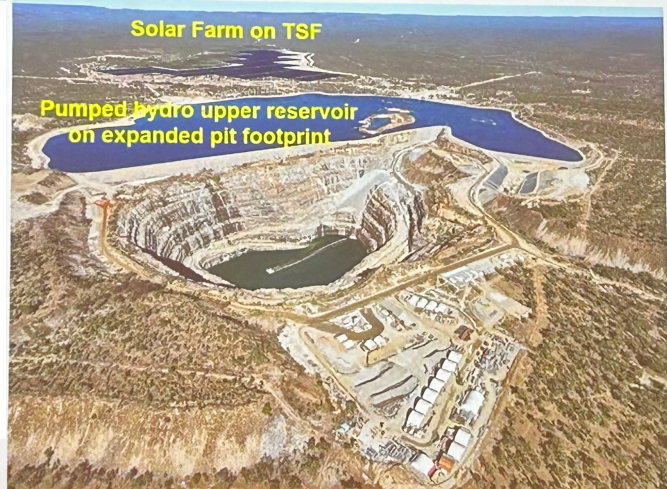


## ... its about the Land... and Land Transition

### Kidston Gold Mine

From Wikipedia, the free encyclopedia

- **Gold first discovered around 1907**
- **Open cut mining had commenced from 1921**
- **Kidston applied to restart modern open cut mining in 1979**
- **Mining continued from 1985**
- **Until it was again closed in 2001**

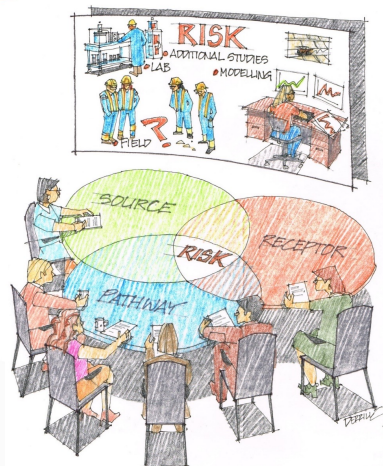


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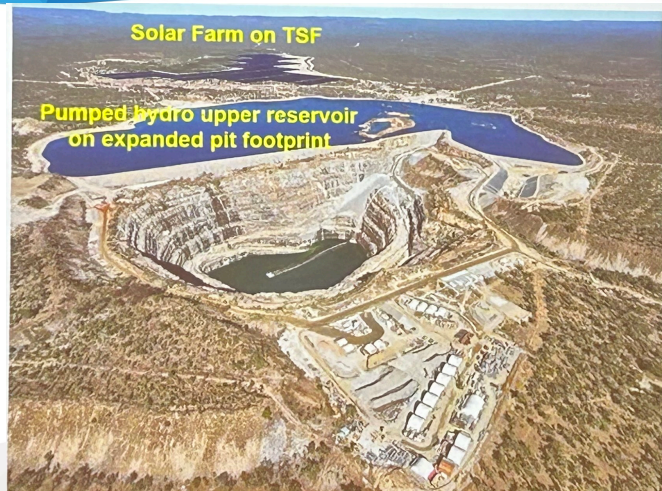
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O'Kane, 2019 Derrill Shuttleworth, illustrator



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