International Review of Soil Cover Design & Construction Practices

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"Challenges in the use of dry covers"
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Outline

- Background & Methodology
- Cover objectives – why are covers built?
- Cover design approach – how?
- Cover construction approach – how?
- Cover performance – do they work?
- Costs – how much do covers cost?
- Final word

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Background

- WISMUT is in process of closing 18 uranium waste rock piles in East Germany
- SRK was contracted to conduct a review of the current international practice with respect to the design and construction of soil covers over mine waste rock piles.
- This information was used to compare against current WISMUT cover practices.

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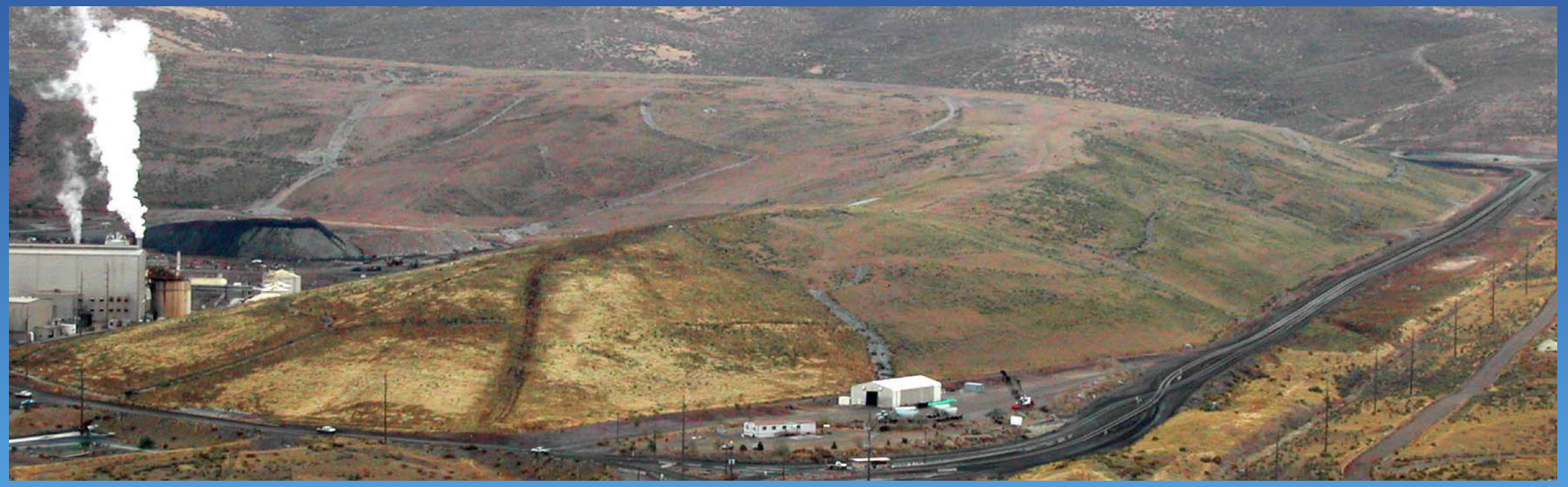
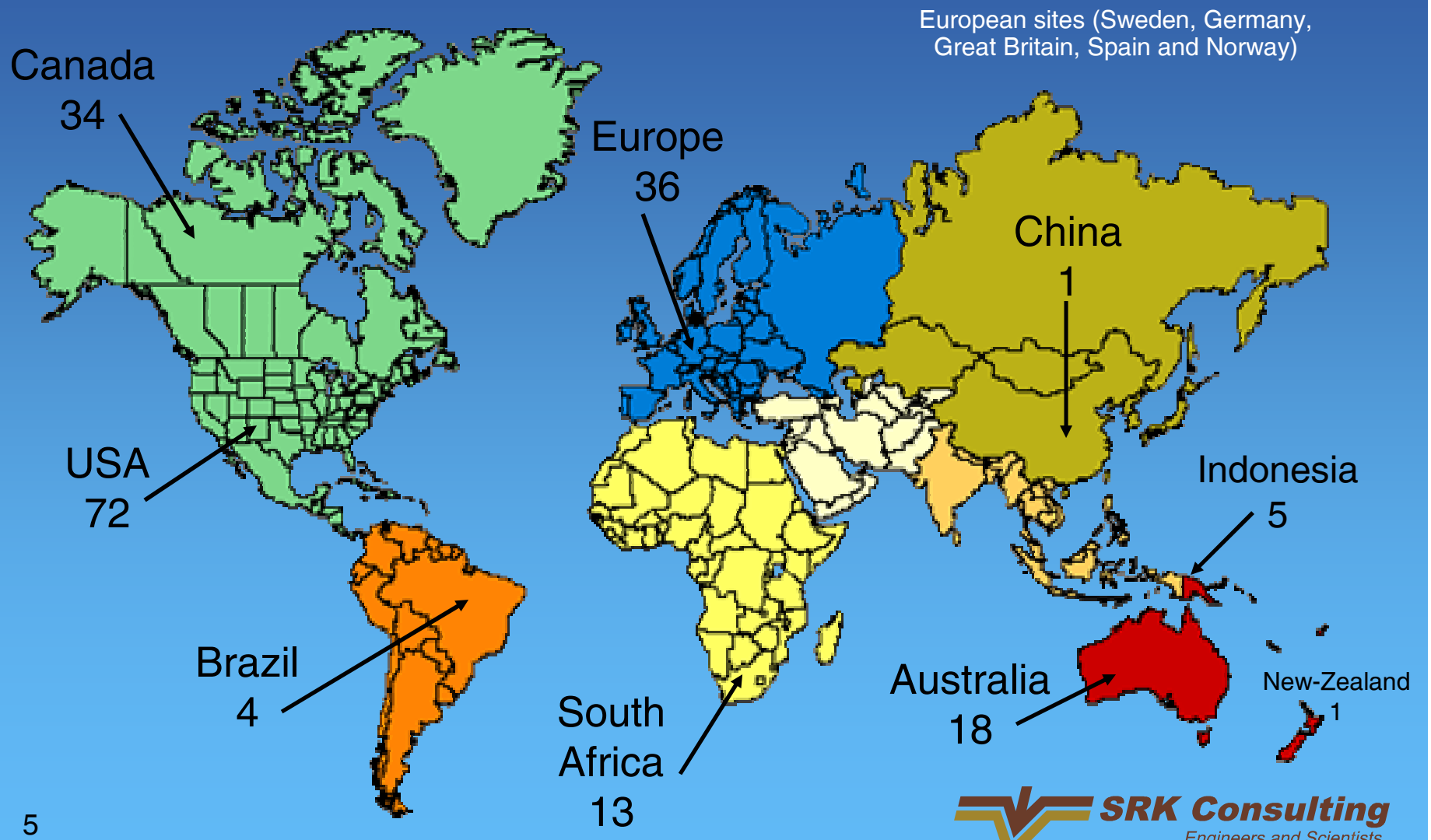
Methodology



- Information template to focus case study selection
- Preference given to waste rock pile covers, natural soil covers, continental climate zone & full-scale covers
- Other sites was not excluded, especially when evaluating construction practices
- Not intended to be an exhaustive list of all case studies!

184 Case Studies



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Why Build Soil Covers?

- Surprisingly few case studies has a definitive answer to this question
- Appears to be a disconnect between site closure goals and reason for using soil covers
- Suggest defining two separate terms;
  - Closure **OBJECTIVES**
  - Cover **FUNCTIONS**

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Defining Closure OBJECTIVES

Closure OBJECTIVES are the fundamental reasons/motivations for doing the work – they can include:

- Remove human/animal health/safety risks
- Prevent/remove/minimize environmental impacts
- Reclaim social/economic land value
- Regulatory compliance
- Release bonds
- Improve corporate image

Defining Cover FUNCTIONS

- A soil cover is one TOOL that can be used to achieve a Closure **OBJECTIVE**
- Soil cover **FUNCTION** is the "work" that the cover must perform in order to achieve part/all of the closure **OBJECTIVE**
- Typical soil cover **FUNCTIONS** include;
  - Radiation control
  - Waste stabilization (i.e. dust, erosion & freeze-thaw)
  - Seepage/leachate management (oxygen/infiltration control)
  - Physical stabilization (slope stability)
  - Thermal control (i.e. promote permafrost)
  - Promote vegetation
  - Access control (i.e. prevent direct contact with waste)

Finding: Cover FUNCTIONS

- From the 184 case studies it is evident that soil covers are primarily used for one of the following **FUNCTIONS**;
  - Promoting vegetation
  - Controlling erosion
  - Limiting infiltration
  - Limiting oxygen flux
  - Controlling radiation

- It is also clear that too often these **FUNCTIONS** are misinterpreted as the closure **OBJECTIVE**, leading to the perception that soil covers are always the answer – which is perhaps misleading!

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Cover Design Approach - How?

- Use of mine waste covers evolved from hazardous and municipal landfill liners
- Theory evolved from soil science
- No standard “recipes” for designing covers
- Site specific designs are promoted
- Designs predominantly influenced by climate & material availability
- Design life an open question

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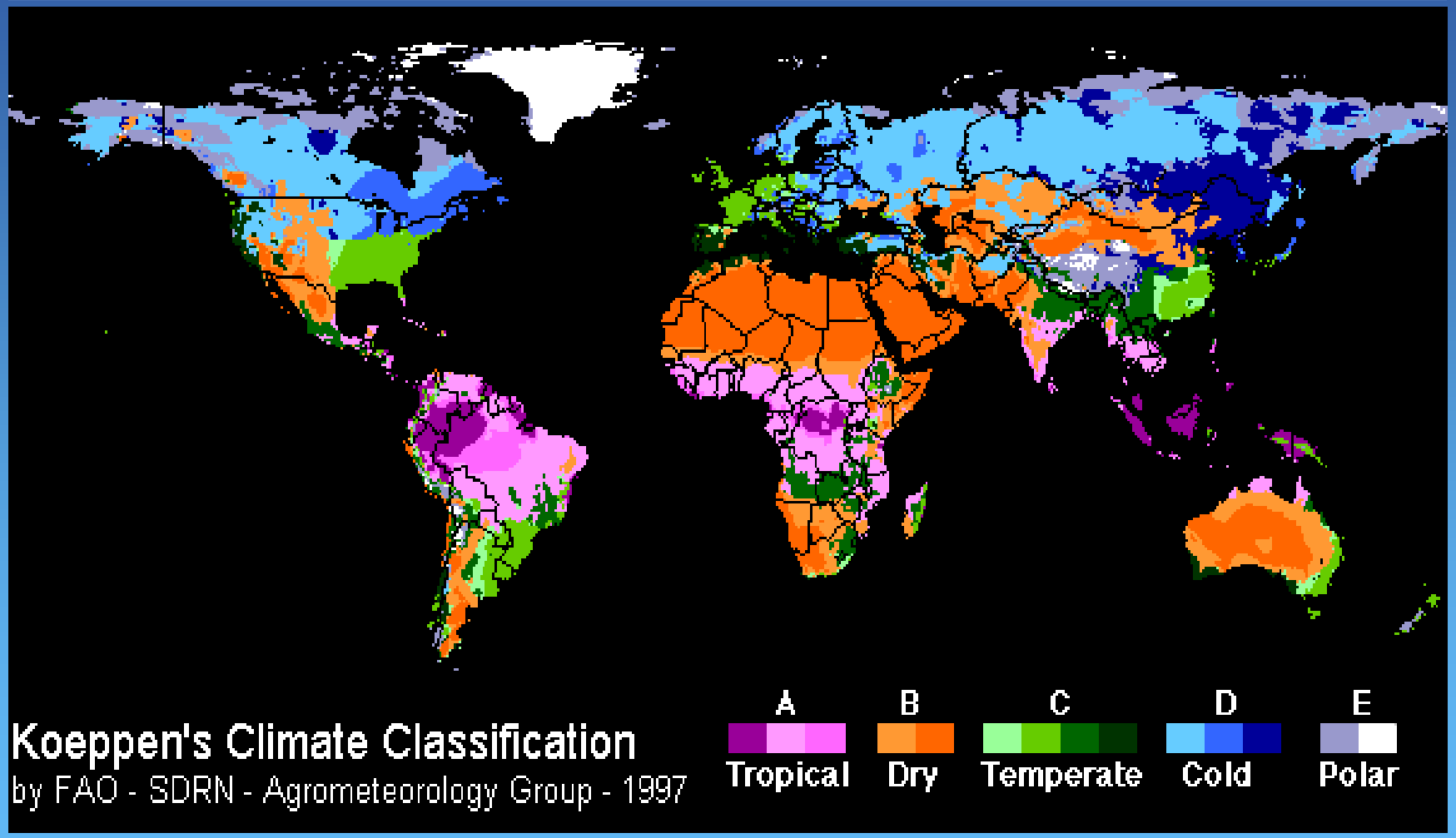
Designs not Zonal!



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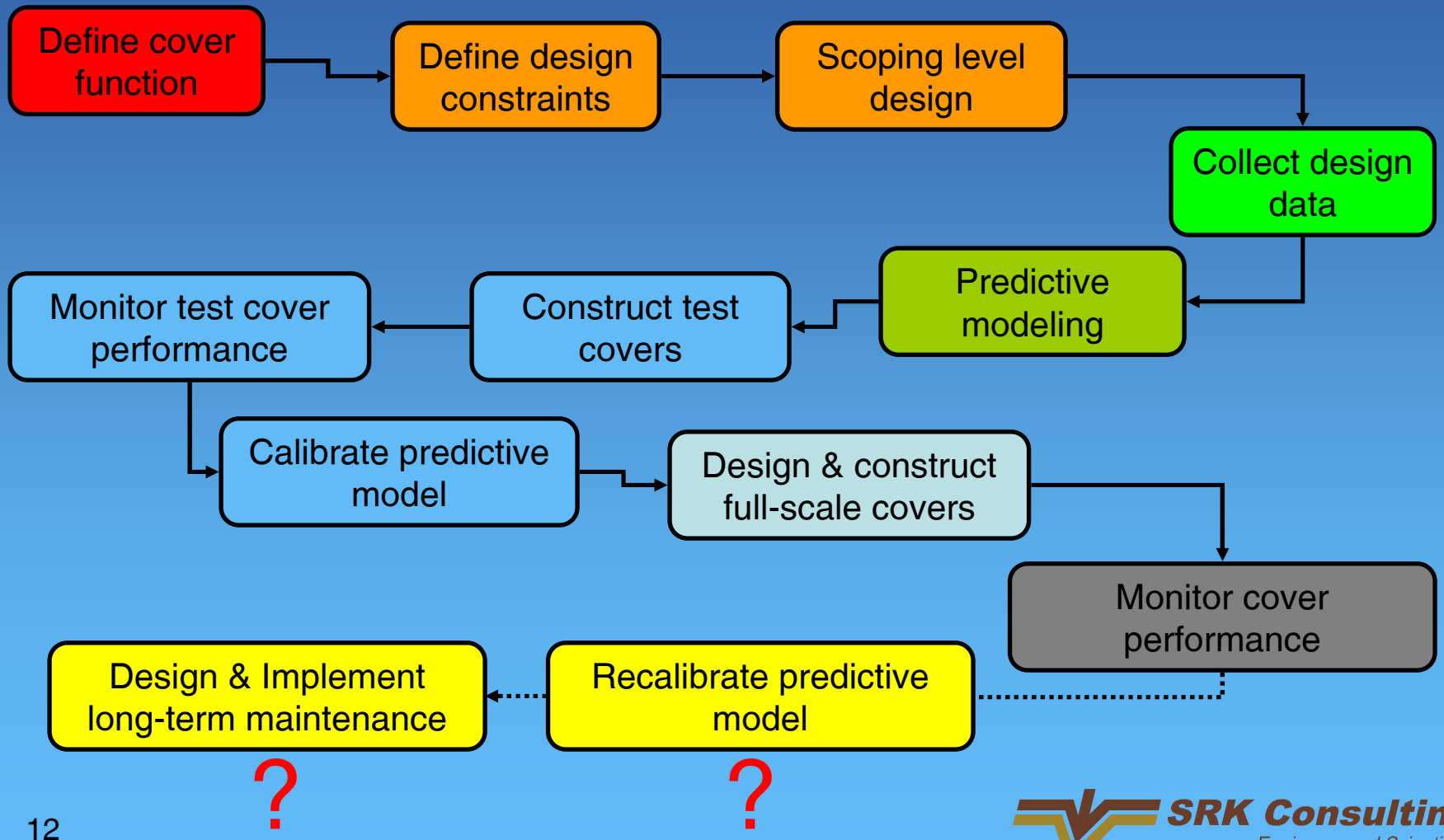
“Ideal” Cover Design Approach



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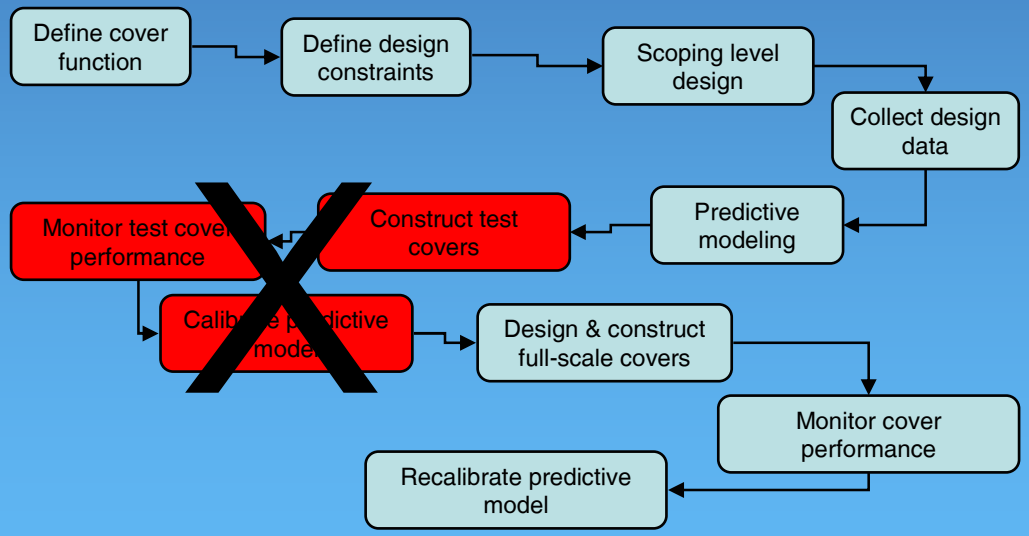
No Pilot Scale Work

- TVX Mineral Hill
- Golden Sunlight
- Equity Silver
- Rum Jungle



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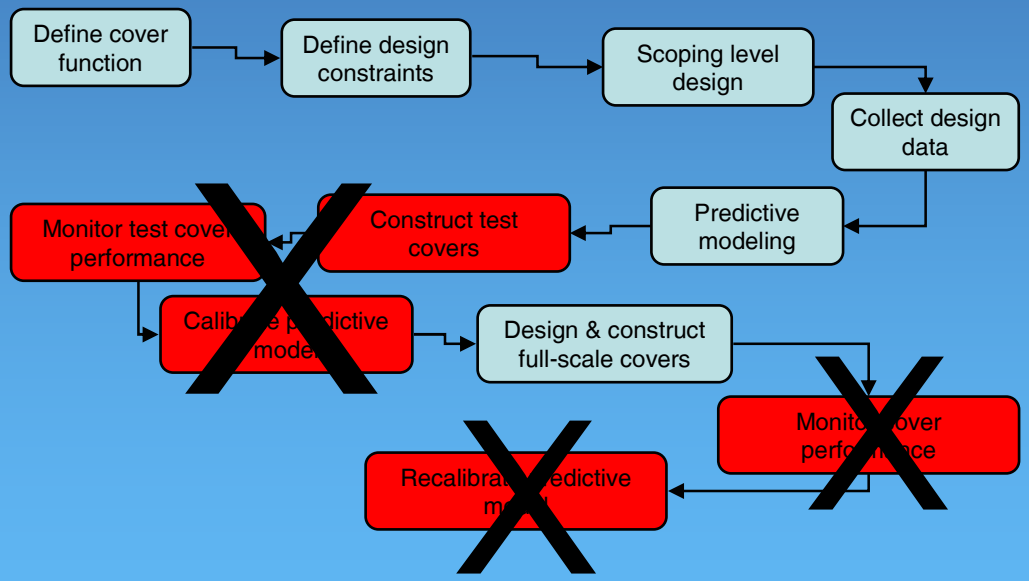
Uncalibrated Modeling Alone

- Majority of case studies done this way!



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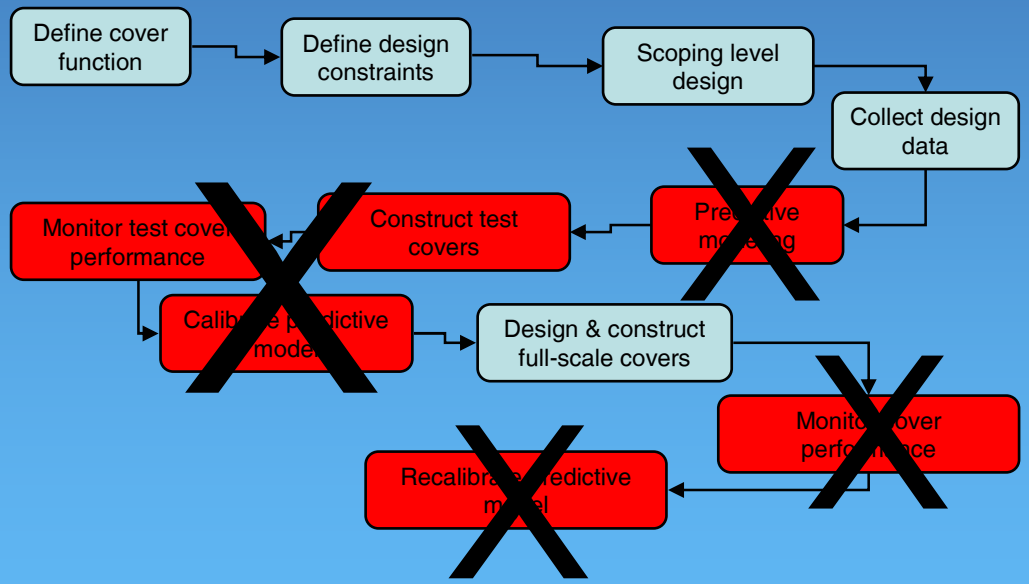
No Modeling – "Precedence"

- Large number of case studies done this way



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Regulatory Framework

- Limited prescriptive regulations that control the design of covers for mine waste facilities
- Numerous guideline documents with regard to mine waste covers
- Designs thus predominantly “performance” and/or “precedence” based

Prescriptive vs. Non-prescriptive

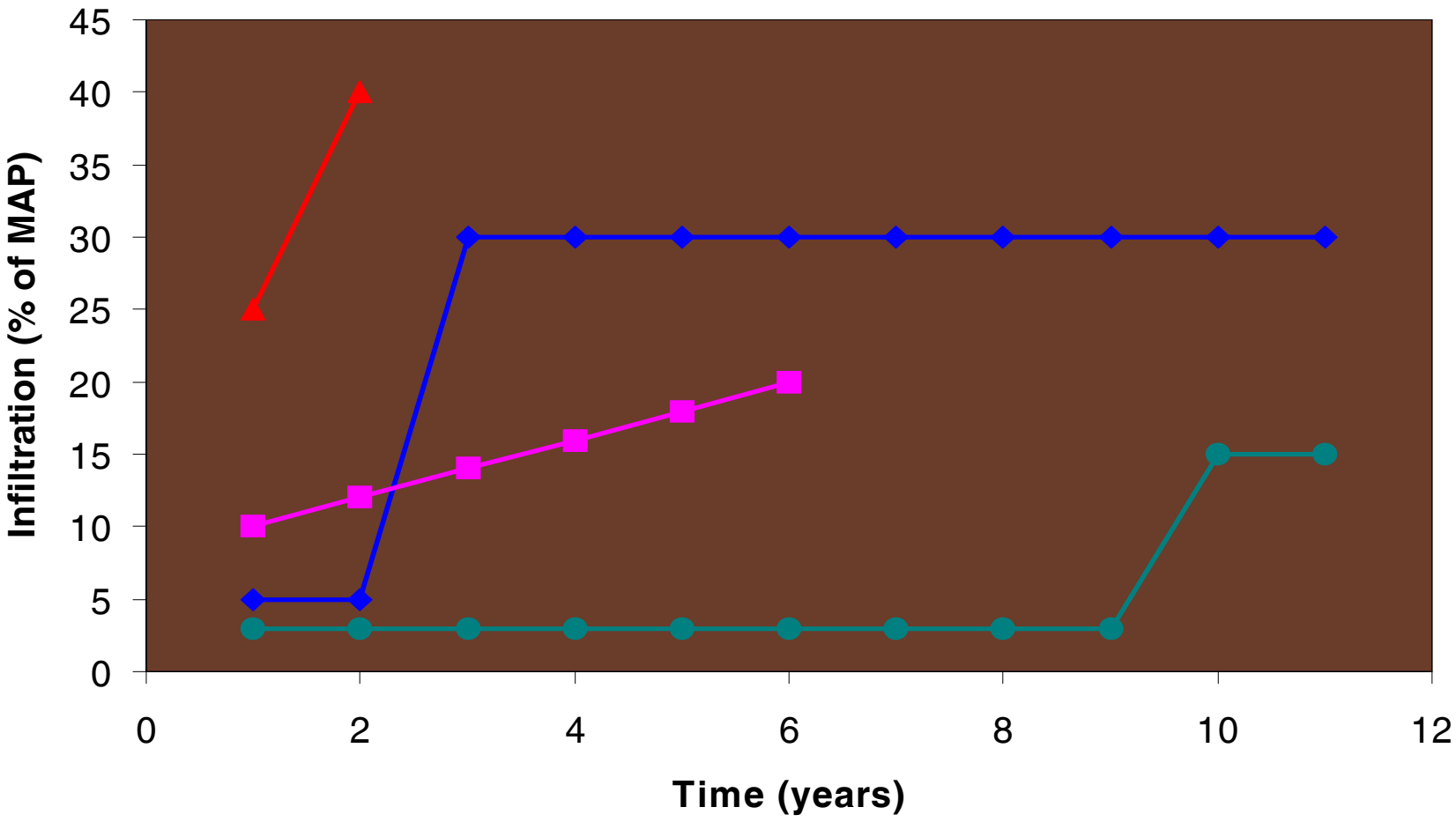
- **Prescriptive guidelines** make it easy for the industry to plan for what is expected upon closure; however, due to the site-specific nature of soil cover performance, prescriptive guidelines would have to be extremely conservative to ensure that all potential conditions are covered; this could lead substantially over-engineered covers.

- **Performance based cover design** based on site specific criteria leaves room for innovative ideas by the industry; however, the regulators are often reluctant to accept these ideas leading to shifting goalposts and conflicts between proponents and regulators.

Cover Construction Approach

Civil Earthworks	VS.	Soil Cover
• Specialist contractor		• Mine mostly does work
• Custom equipment		• Mining fleet
• Detailed engineering drawings		• Limited engineering drawings
• Strict specifications		• Limited specifications
• Strict QA/QC		• Limited QA/QC
• Design engineer representative oversees		• Operator representative oversees
• Impact of poor construction always seen as significant		• Impact of poor construction not seen as significant
• As-built reports required		• Limited as-built requirements

Increased Infiltration – Failure?



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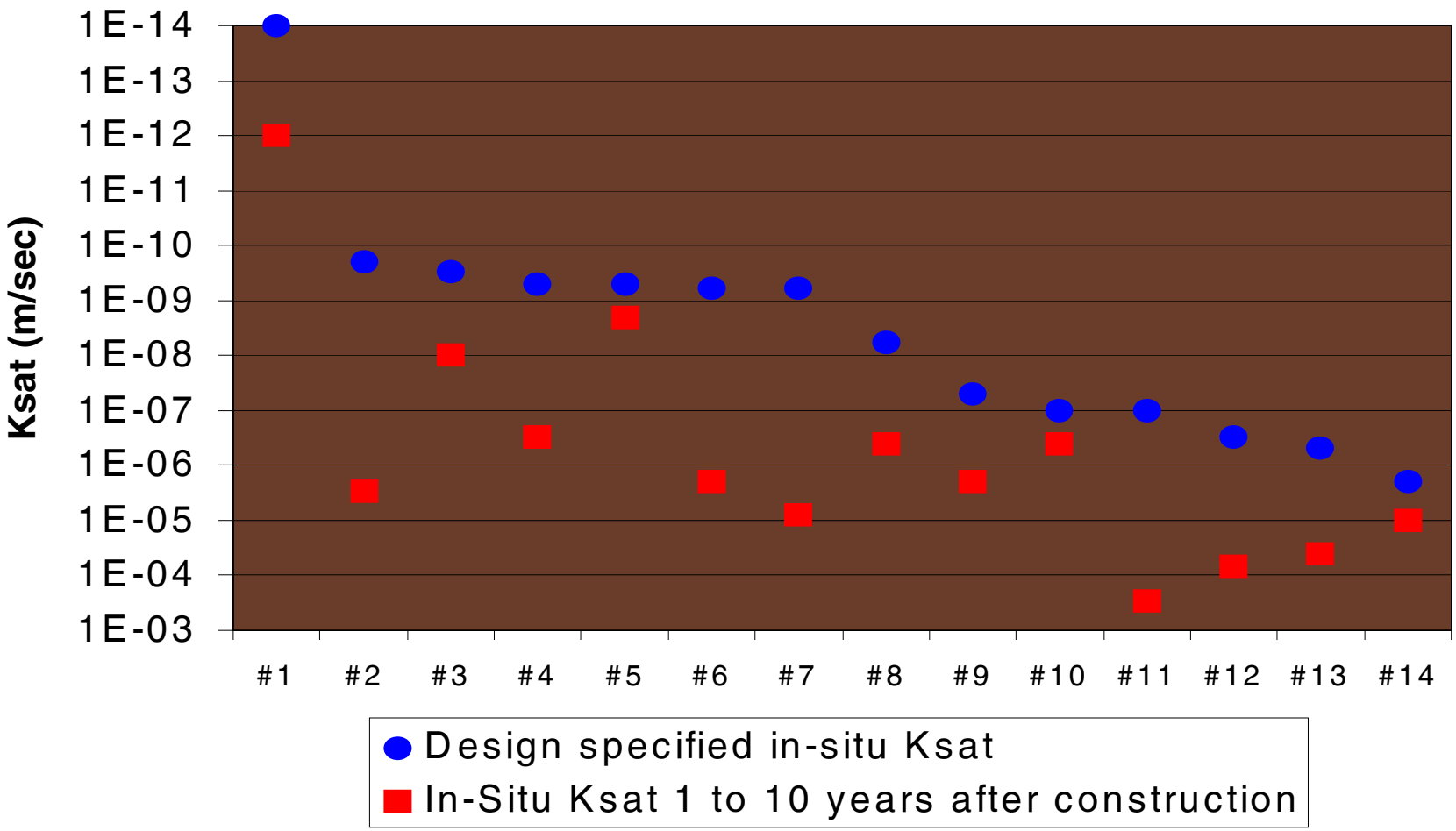
Cover Degradation – Failure?



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Other Failures?

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Cover Performance Monitoring

- Indirect monitoring
  - Seep surveys
  - Oxygen and temperature profiles
  - Observation
- Direct performance monitoring
  - Current state-of-the art technique
  - Complete water balance measurement
  - In-situ sampling & testing

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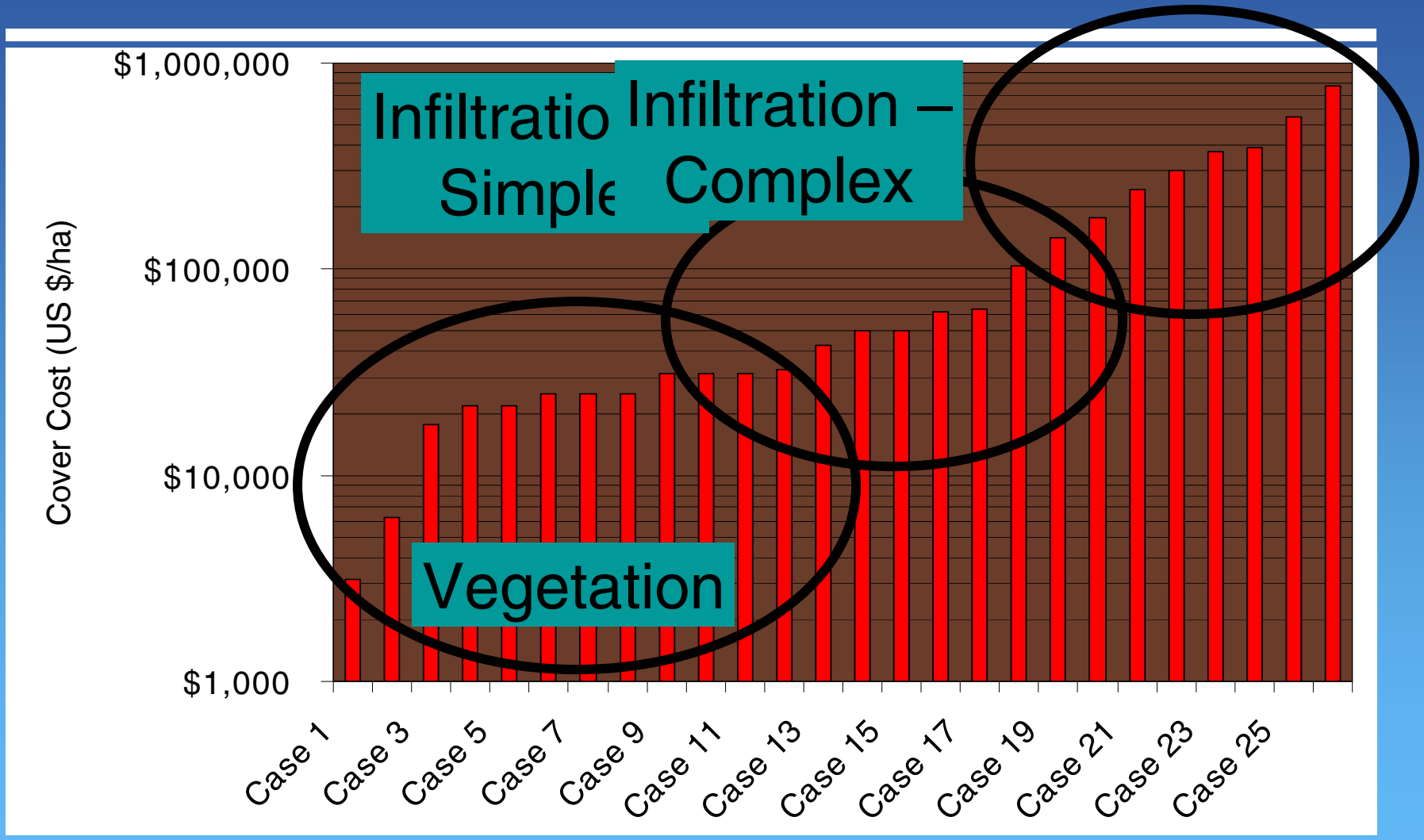
Cautionary Note on Monitoring

- Small instrumented test plots may not be representative of cover as whole
- Monitored components may be influenced by microstructure caused by instruments themselves
- Time-scale may be misleading

Long-Term Cover Maintenance

- As a rule there are no formal long-term maintenance plans for soil covers
- General maintenance approach; “deal with the problems when they occur”
- As a rule the only aspects that receive any consideration are erosion & vegetation
- Aspects that often require maintenance, but that are overlooked include sediment transport, settlement and physical degradation

Cover Construction Costs



Median Cost = US $60,000/ha

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Final Word

- There is a lot of valuable information out there in the form of case studies
- We need to change our approach to soil cover construction, to be consistent with civil earthworks
- We must start to agree on what constitutes a successful (or failed) cover
- We got to share our successes and failures, since the technology is still very much evolving