# Paste and Thickened Tailings – a review

Dr Liam MacNamara
Vice President, EMEA
FLSmidth Non-Ferrous

# Overview

Development of Thickened Tailings Disposal

Key practitioners

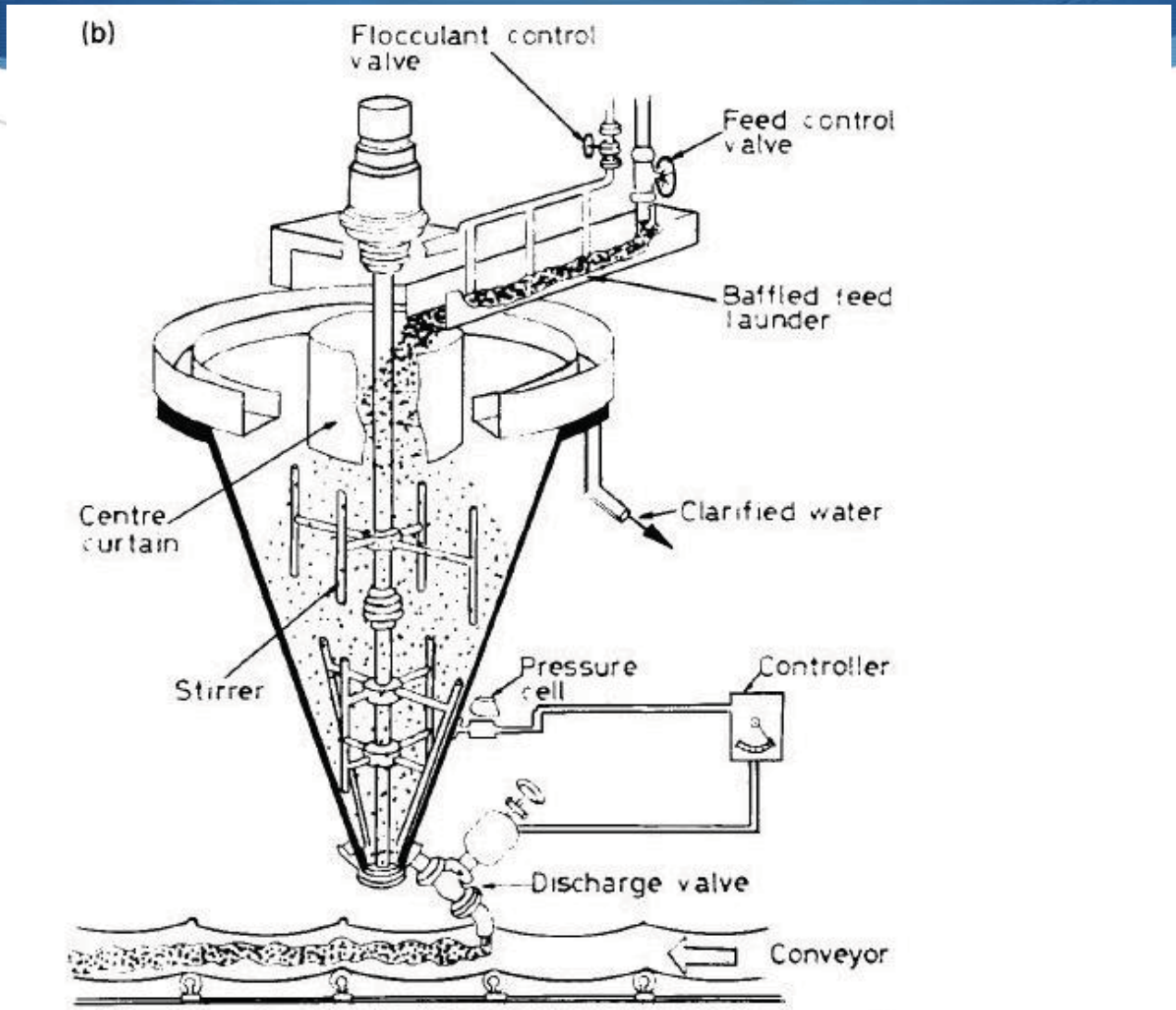
Milestones in development

Future challenges

# Why Paste?

- Maximum water recovery from a thickener (continuous)
- Co-disposal of fine and coarse waste (no slimes dam)
- The UK coal industry 1960's and 1970's

# NCB Deep Thickener



# What happened….?

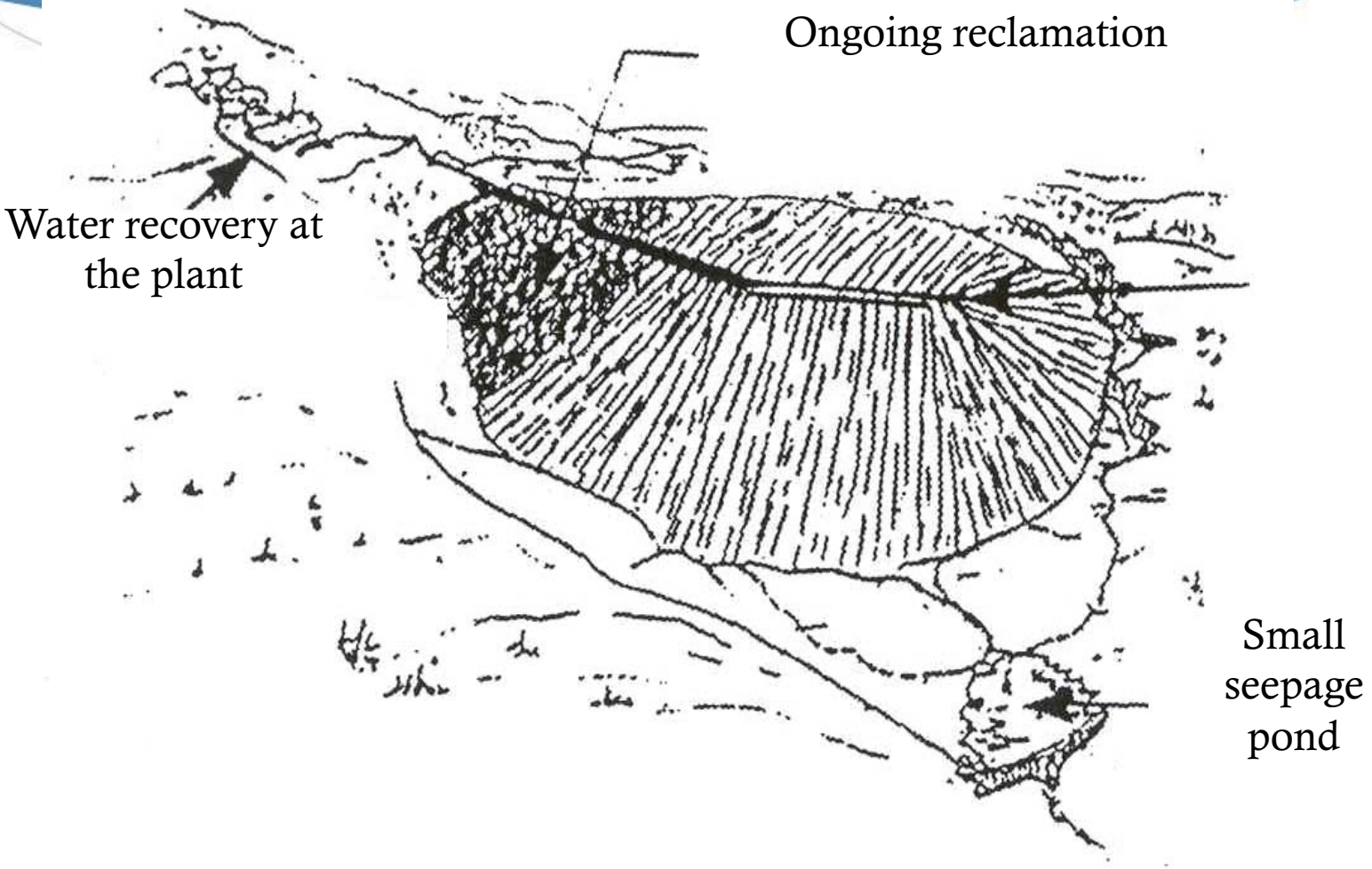
- Low feed rates
- Small units
- Poor control
- High flocculant consumption

- Replaced by filtration….

# Early Days (1970's)

- Concept – Eli Robinski
  - Kid Creek Mine (Canada)
  - Poor ground conditions prevented conventional dam construction (water retaining).
  - Idea to remove majority of the water BEFORE the tailings dam to reduce construction costs
  - Secondary benefit – reduced closure costs

# Thickened Tailings Disposal



# Implementation

- ATC Williams (Australia)
- Central Thickened Discharge Systems:
  - Peak Mine
  - Century Zinc
  - Sunrise Dam

# Early Days (1980's)

- Alcoa – Western Australia
  - Alumina refineries close to Perth
  - Undesirable seepage from traditional wet lake disposal systems
  - Dusting

  - Secondary benefit – increased recovery of process liquor (caustic solution)

# High Density Thickener

# Early Days (1980's)

- Alcan – Jamaica and Canada
  - Increased recovery of process liquor (caustic solution)
  - Picked up on

  - Secondary benefits
    - Fewer stages of settler / washers required
    - Improved availability of primary settlers as scaling was reduced

# Early Alcan Deep Thickeners

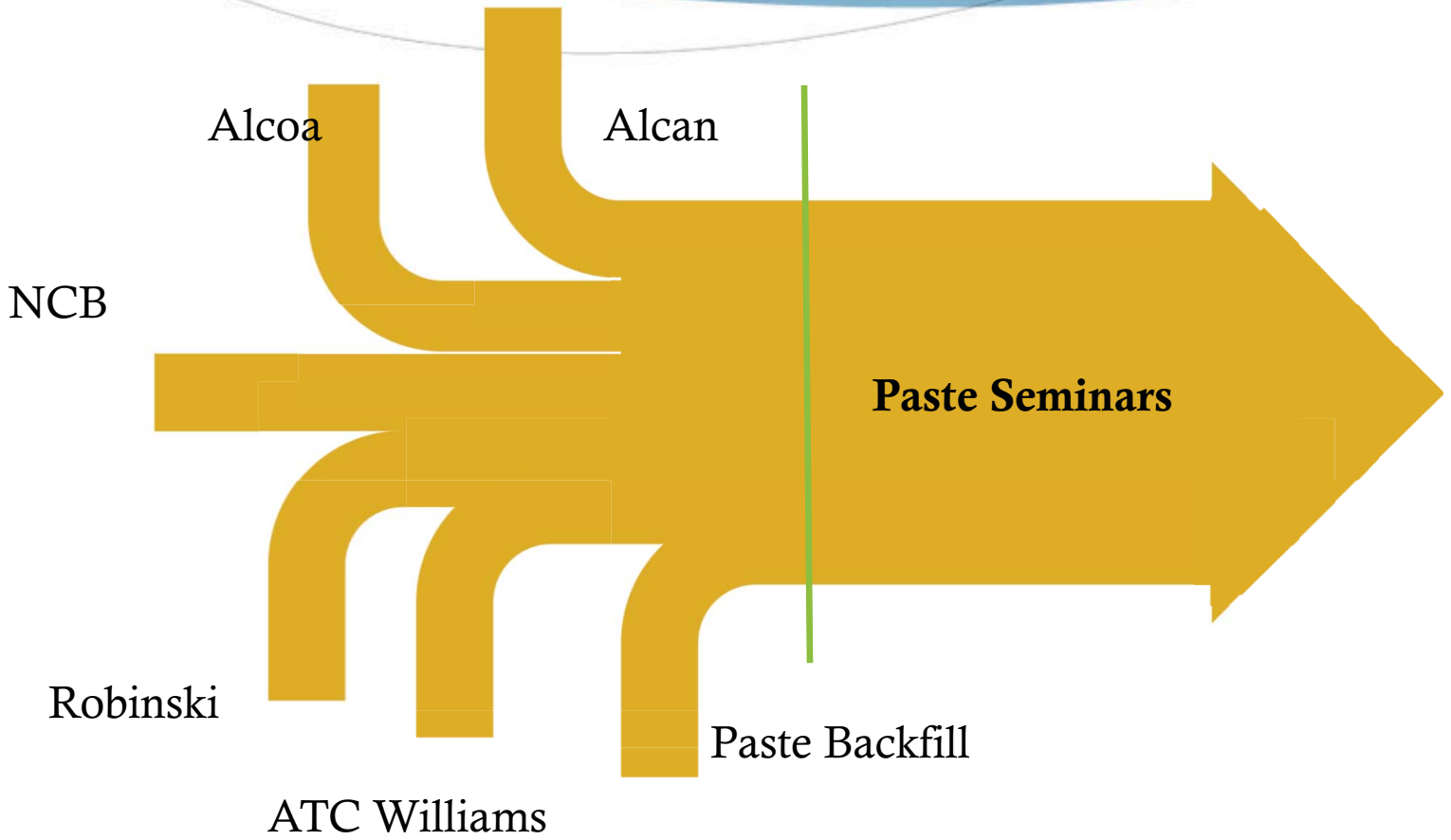
# Early Days (1990's)

- Mine backfill
  - Long been used as a means of extracting more from the orebody, but was typically classified. Paste backfill (total tailings) formed better fill and allowed more ore to be extracted.
  - Paste made with filter cake
  - Rheology and pipeline transport critical

  - Secondary benefit – less material placed in the tailings dam

# Paste Backfill

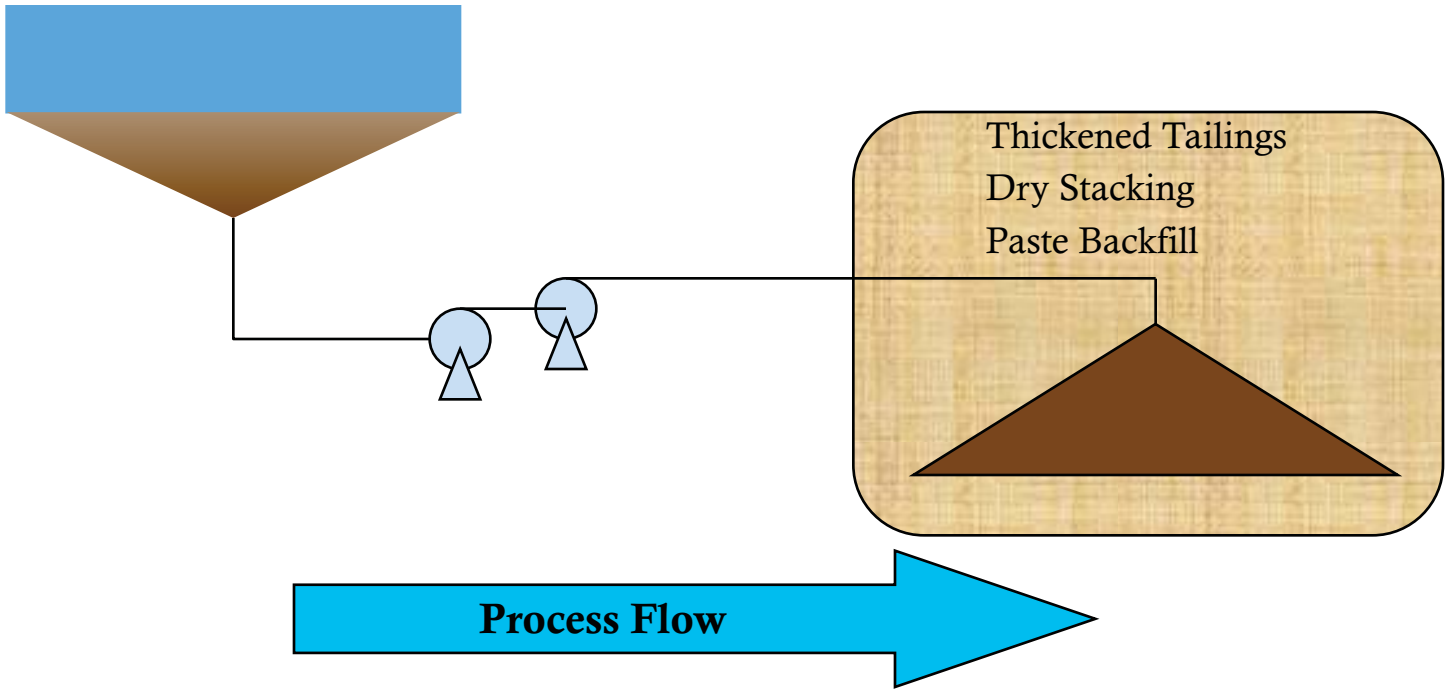

# Timeline


Alcoa
Alcan
NCB
Paste Seminars
Robinski
Paste Backfill
ATC Williams

# Early Days - Summary

- With the exception of the Alcoa plants, these new application was derived from a cost saving or production benefit.
- Parallel developments in different industries
- Until the “Paste and Thickened Tailings” seminars started there was no venue for people to meet.

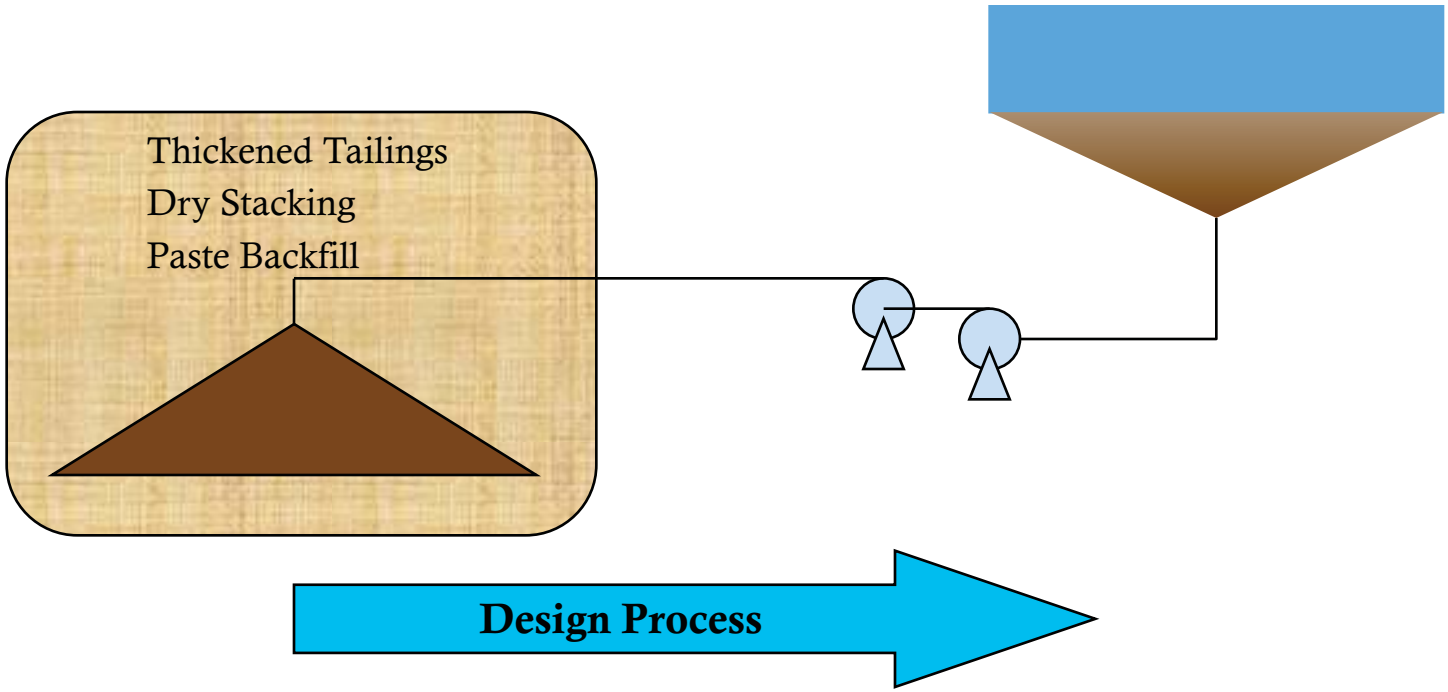
# Process Flowsheet



# Design for disposal

- "Environmental considerations dictate that we must manipulate tailings to fit a particular environment rather than manipulate the environment to contain the tailings."

# How we should think



# What do we want from the System

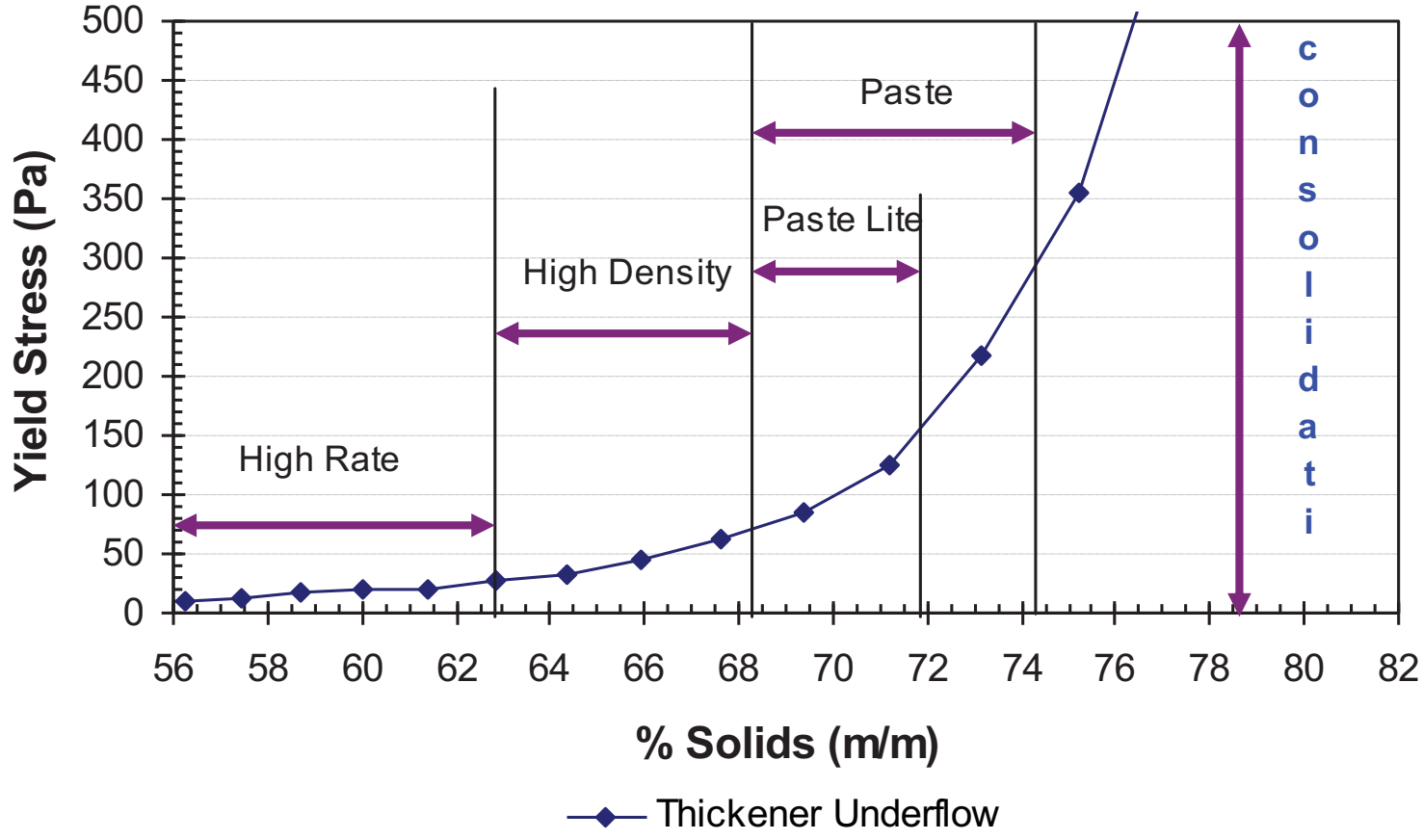
- Maximum water recovery
- Low lifetime cost
- Safe disposal system

# How do we get what we want?

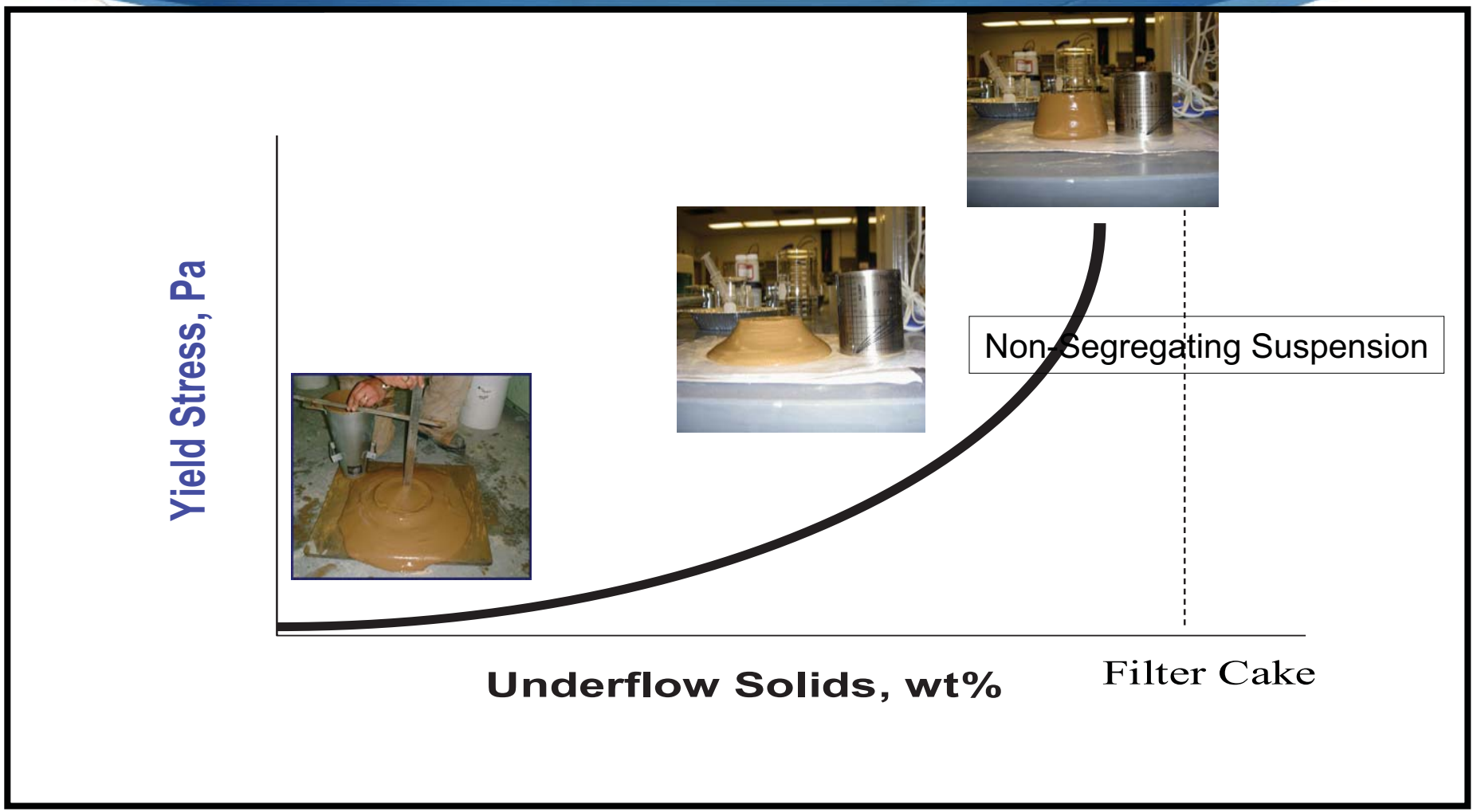
- Dewater the tailings to a homogenous, non segregating slurry
  - Reduces dam construction costs significantly
- Slurry is now Non-Newtonian (has Rheological properties)
  - Good (stacking angle)
  - Bad (pumping)

# Rheology

## Yield Stress Vs. Solid Concentration



# Rheology


Yield Stress, Pa
Non-Segregating Suspension
Underflow Solids, wt%
Filter Cake

# Ground breaking installations - Mine Backfill

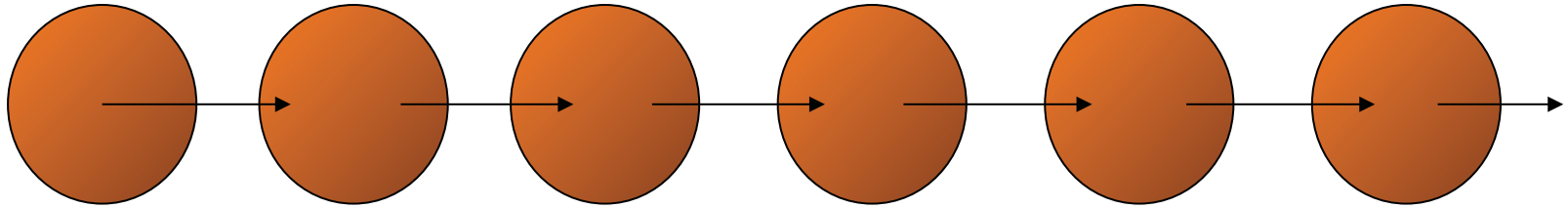
# Ground breaking installations - Sub-aqueous disposal

# High Efficiency CCD Circuits

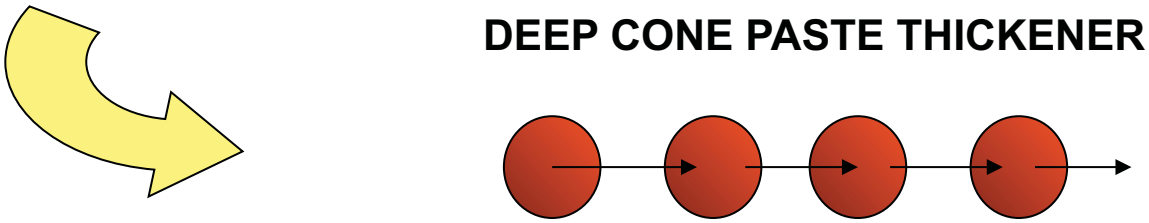
# Reduced CCD stages

**CONVENTIONAL THICKENERS**

**6 X 30 m Diameter Units.  4500 $m^2$ Total Settling Area**

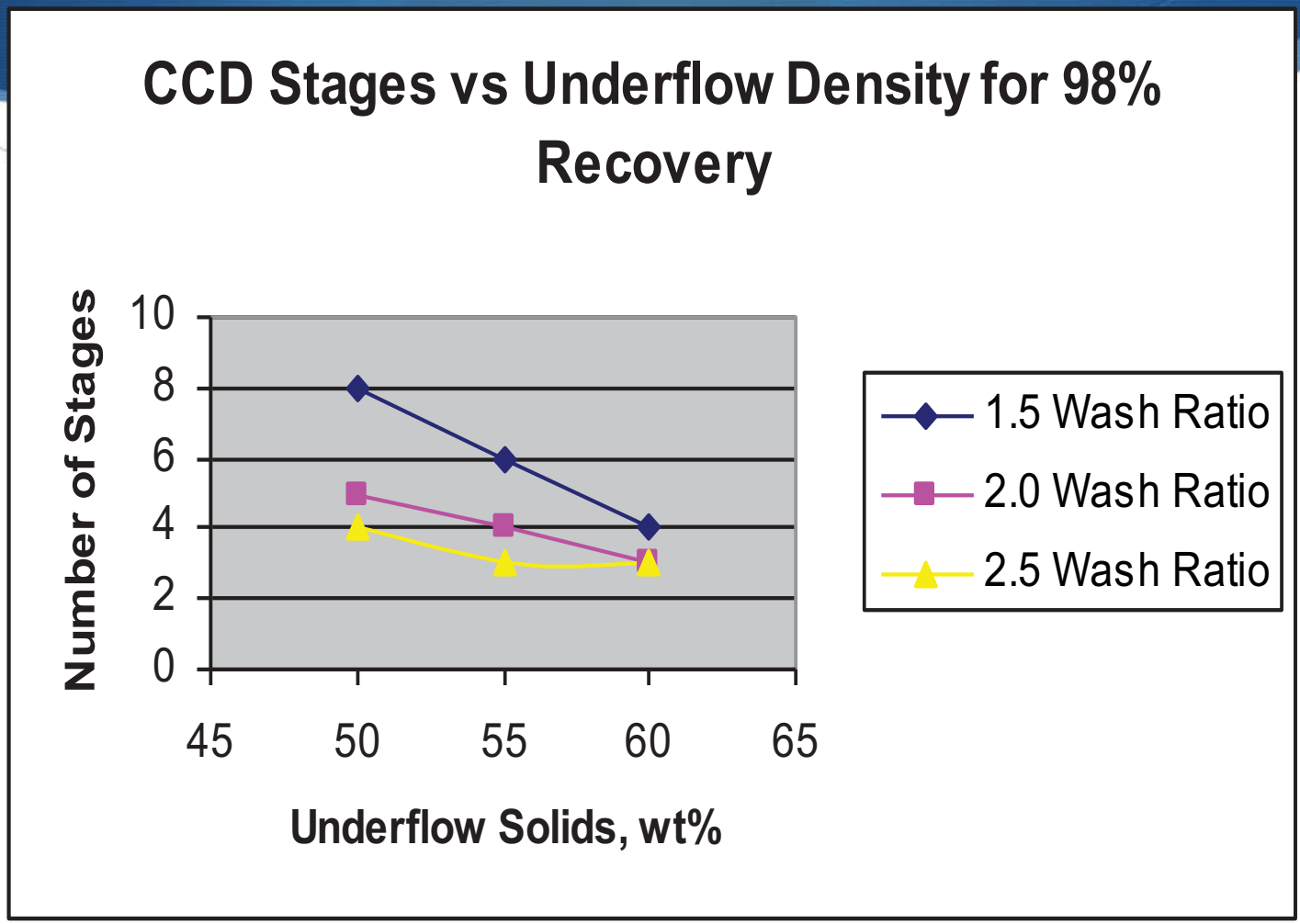


**DEEP CONE PASTE THICKENER**



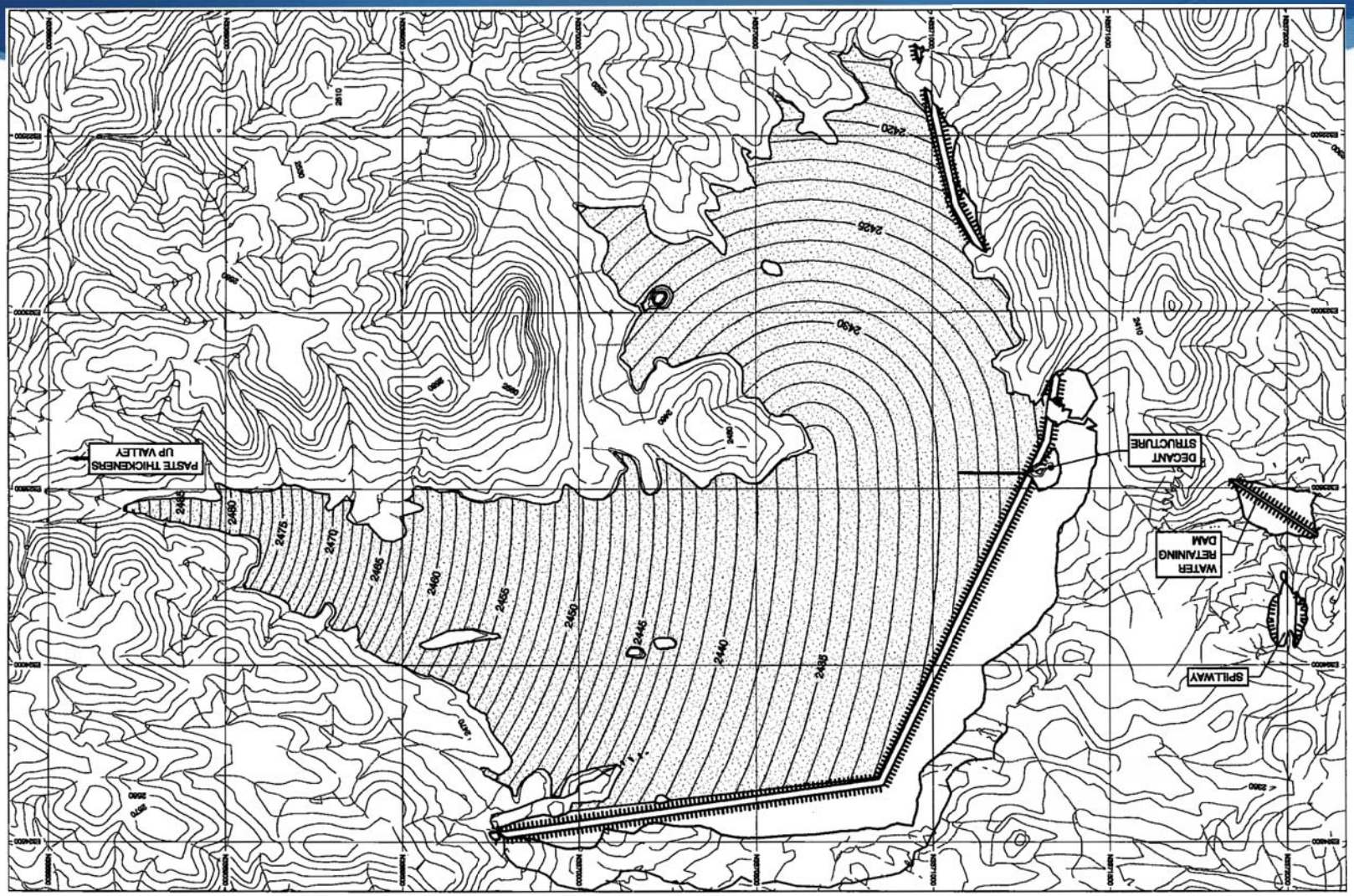
**4 x 12 m Diameter Units.  450 $m^2$ Total Settling Area**

# Improved CCD Efficiency



# Ground breaking installations – Down Valley discharge

# Miduk


PASTE THICKENERS
UP VALLEY
DECANT
STRUCTURE
WATER
RETAINING
DAM
SPILLWAY
2420
2425
2430
2435
2440
2445
2450
2455
2460
2465
2470
2475
2480
2485

# Ground breaking installations – In-Pit Disposal

# Ground breaking installations – Cement Kiln Feed

# Ground breaking installations – Autoclave Feed

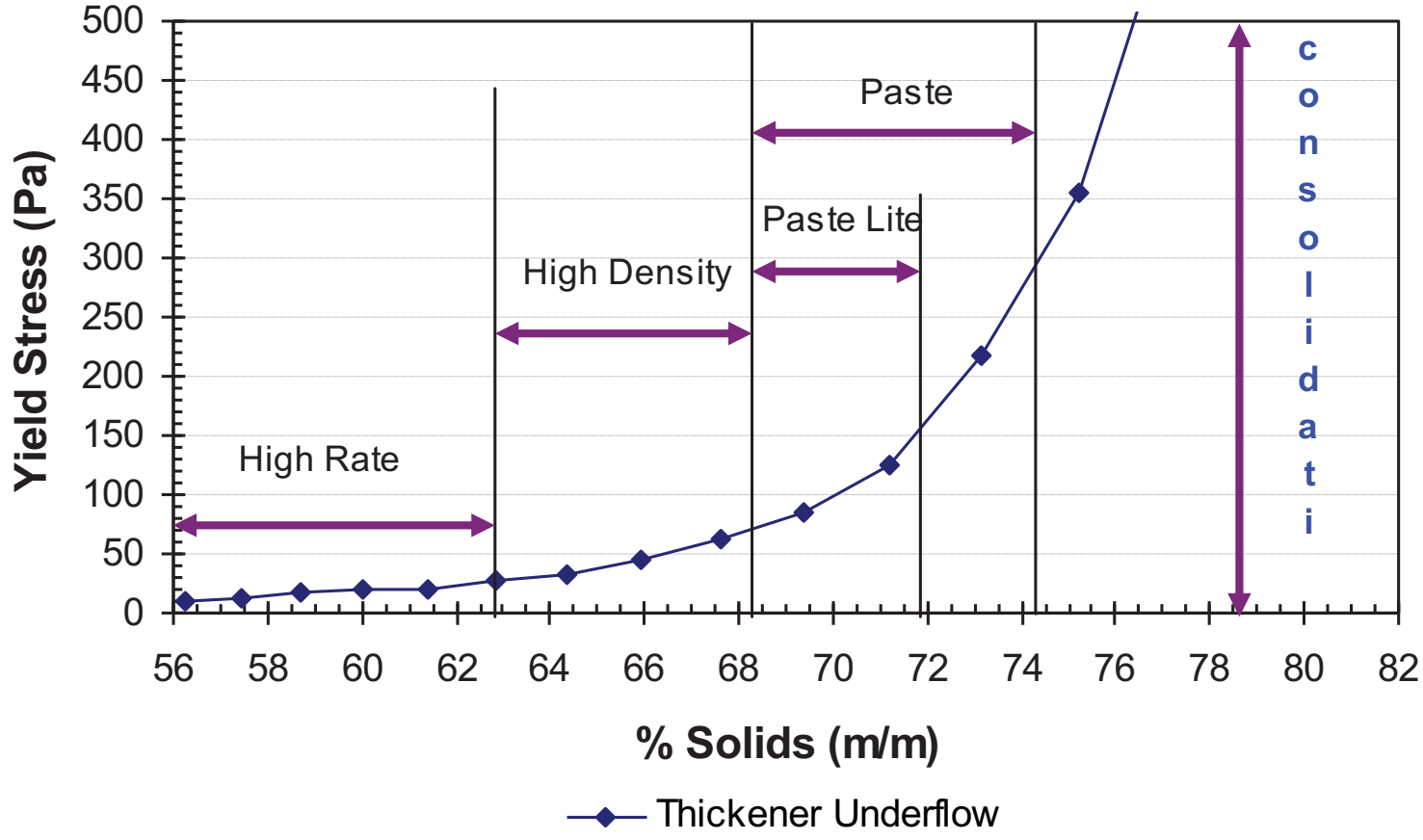
# Ground breaking installations – Prevention of AMD

# Factors that effect Yield Stress

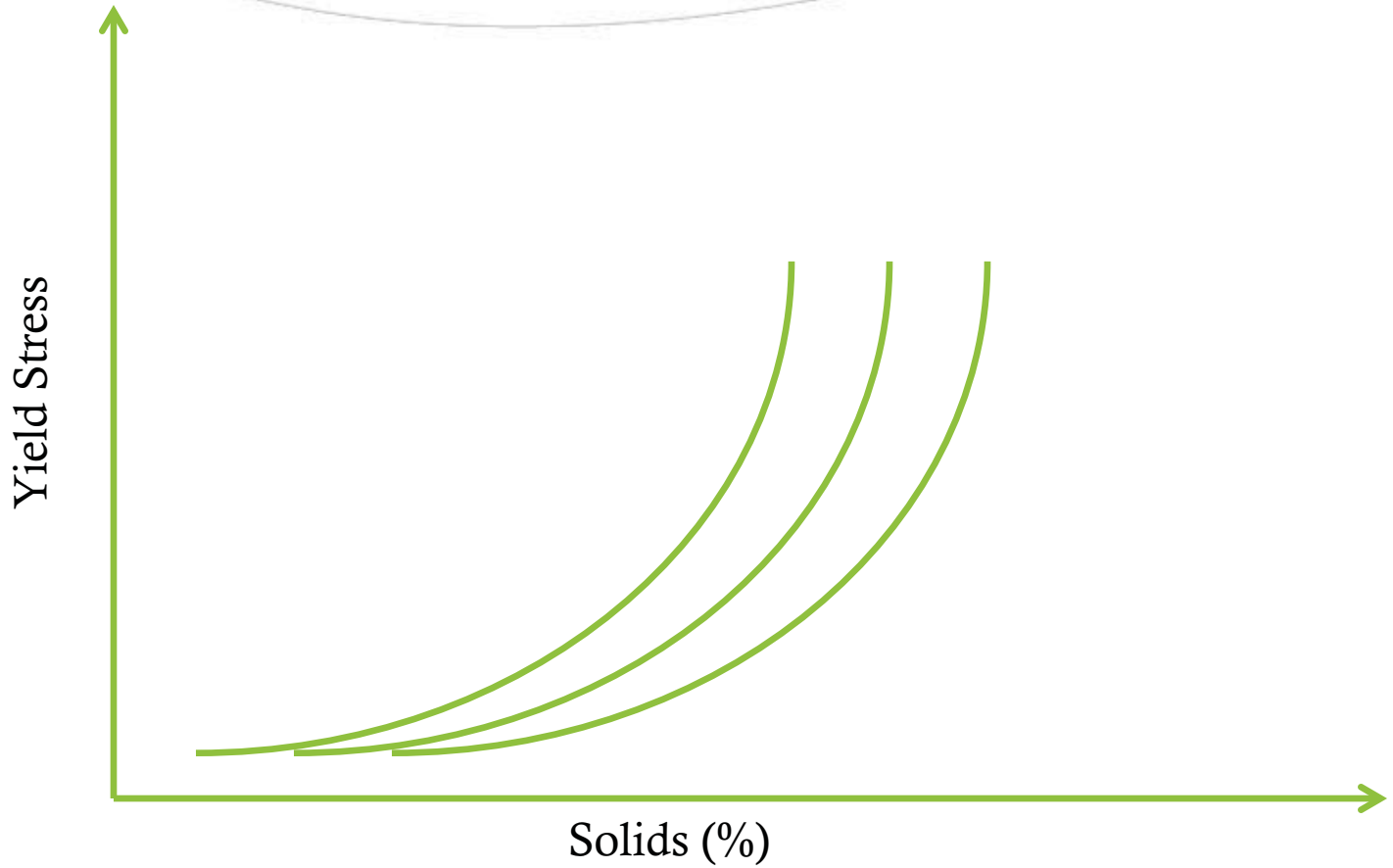
- Mineralogy
- Particle Size
- pH

# Rheology

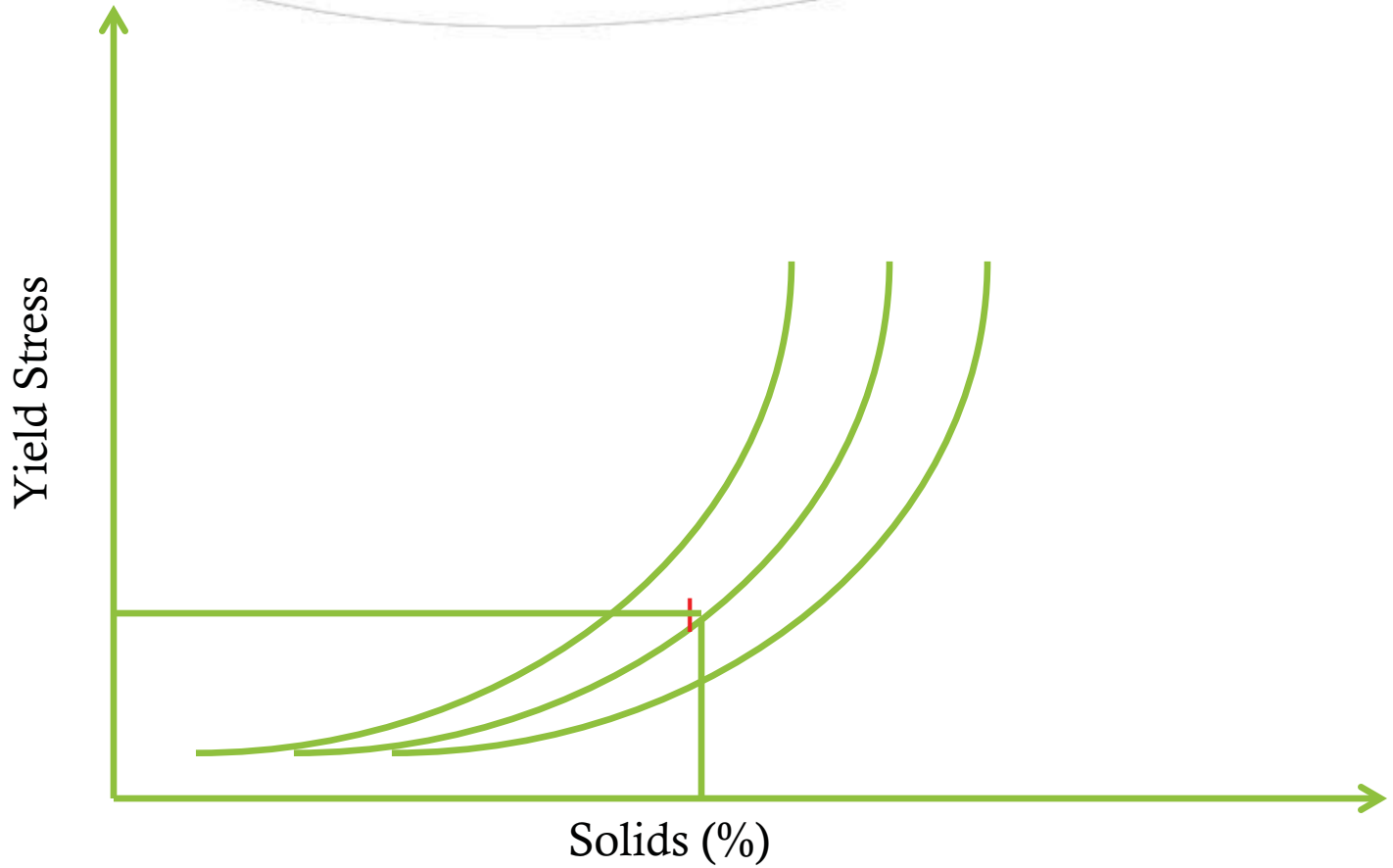
## Yield Stress Vs. Solid Concentration



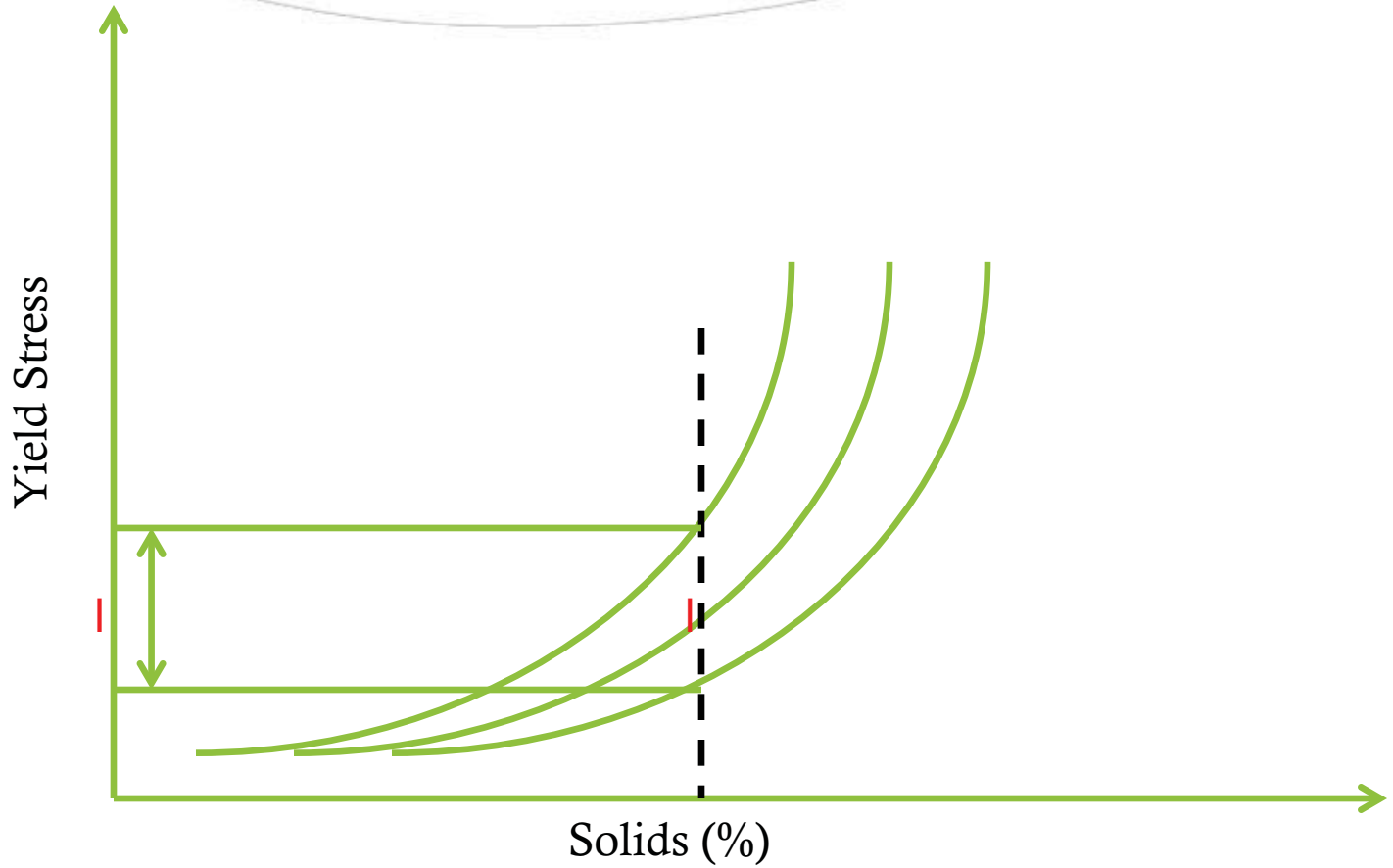
# Effect of ore on rheology



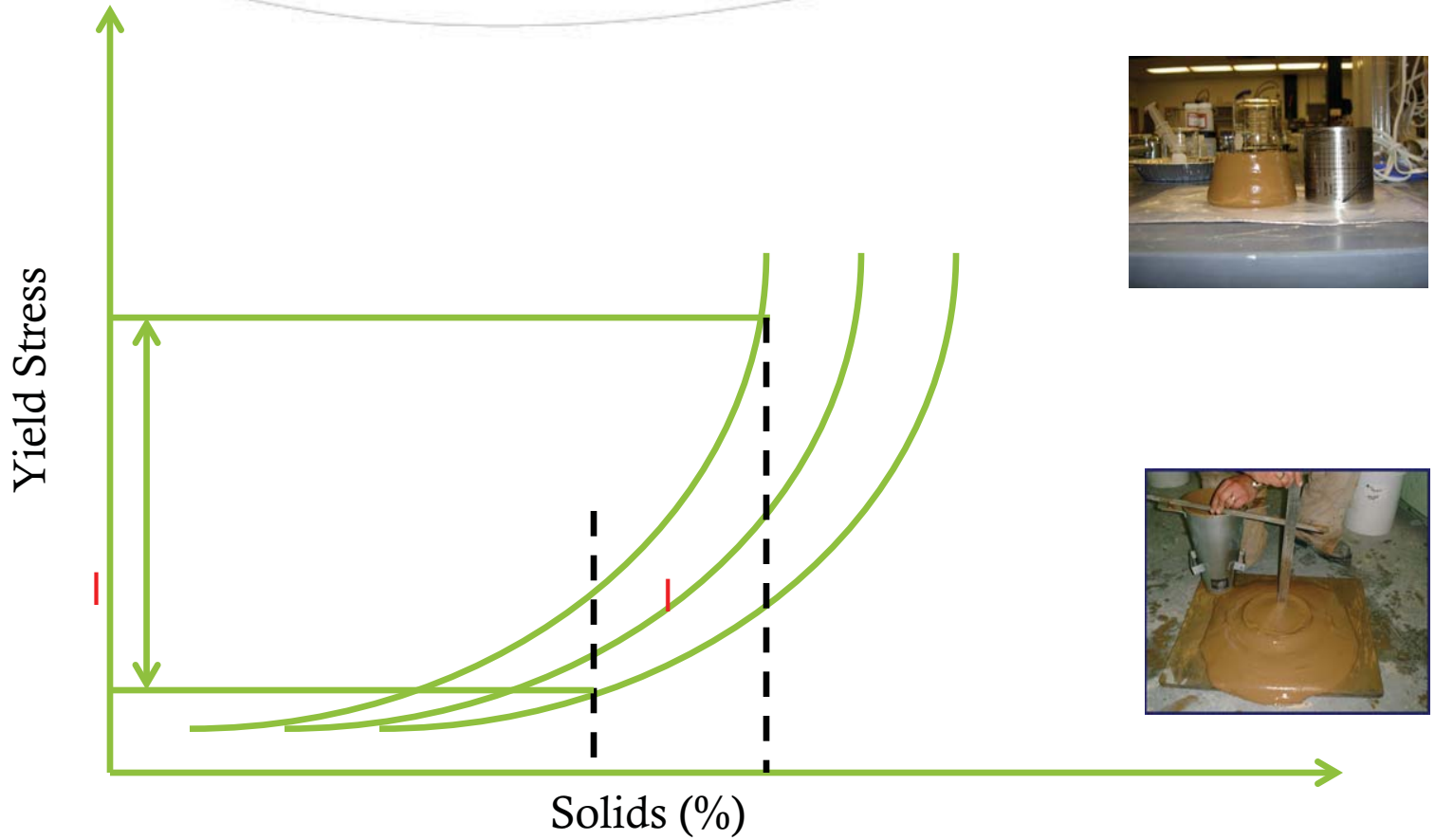
# Effect of ore on rheology



# Effect of ore on rheology



# Effect of ore on rheology



# Problems with operating on the edge

- Instrumentation can not differentiate between changes in the feed and changes in the operating conditions
- We should control to rheology but don't have the instruments
- Can't control what we can't measure

# TTD Requirements

- Should we push for “every last drop”
- More critically – should we *design* a system that relies on extracting every last drop

# Equipment Design

- Has to allow for wide range of conditions
- “Upside” is essential

# Current developments

- Larger equipment
- Prediction of beach slope
- “End of Pipe” flocculant addition

# What of the Future

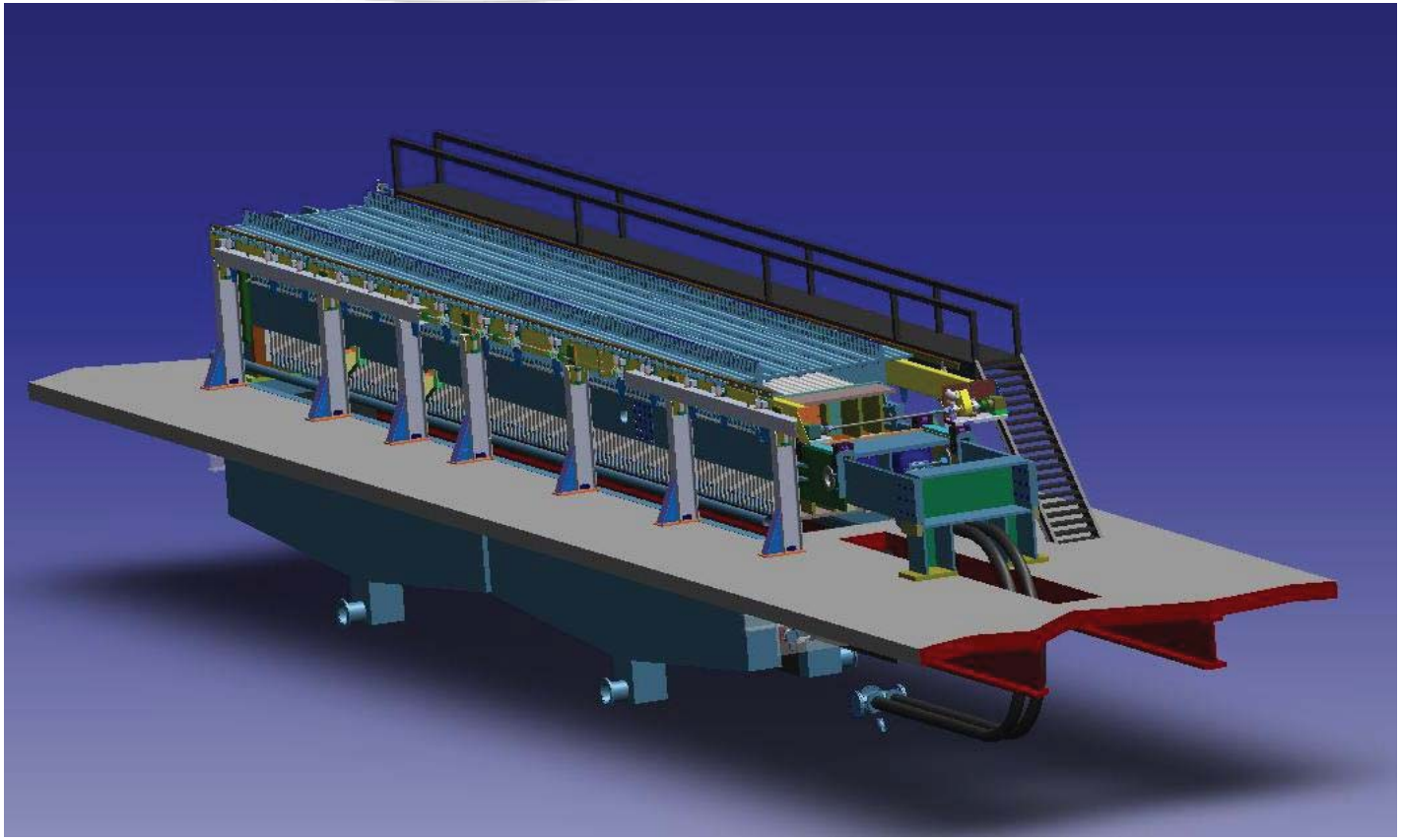
- Where are the next improvements?
  - Co-Disposal
  - Tailings Management
  - Further dewatering (filtration)

# Co-disposal

# Tailings Management

- Management of the tailings facility will increase.
- Performance of the facility will improve with increased management.

# Further dewatering



# Water Treatment

- Currently UV light (sunlight) breaks down Xanthate in the tailings dam
- Recycled water will recycle reagents
  - Possible effect on selectivity on flotation

# Advantages of Paste

- Paste Thickeners can generate significantly higher solids underflow than conventional thickeners

- Allows new applications where thickeners have not featured before