SD07 A CLIMATE FOR CHANGE
Sustainable Development Conference

Minerals Council of Australia

URS

SKM

bp

Geordie McMillan

Environmental Earth Sciences

Production of process water during drought – treatment of AMD using soil chemistry: a case study – Ardlethan, NSW

ENVIRONMENTAL EARTH SCIENCES
THE KNOW AND THE HOW

What did the project opportunity present?

- Multiple issues
- Very limited resources available
- Space and time constraints for mine operator
- Non-standard approach
- Progressive education for stakeholders in developing innovative solution for water use, water conservation and site rehabilitation

Site and operation background

- Alluvial clay tin mine approx 400 km W-SW of Sydney
- Agricultural setting of cropping and beef/dairy farms, 4 km outside of township of Ardlethan
- Two distinct aspects to operation:
  - current alluvial clay ore deposits
  - Historic mined out open cut pits, waste rock dumps, tailings dams, mill & evaporation dams
- Water within historic storages highly acidic (pH 2.2-3.6), high TDS, sulfate, dissolved heavy metals (Al, Mn, Zn)

Site and operation background

Site and operation background

- Typical ‘Mediterranean’ climate with 485 mm rainfall & 1850 mm evaporation per year
- Little to no groundwater (“aquifuge”)
- Very strict & limited allocation of pipeline water from Murrumbidgee River tributary over 50 km away

Site and operation background

- Separate scraping of ore and overburden
- Continual backfilling of mine voids with tailings
- Scrubber-trommel, gravity separator and spiral plant used to 90% Sn concentrate
- Thickener with alum additive to dispose tailings into voids

Previous tailings disposal practice

Issues faced

- Maintaining a ‘thirsty’ operation during drought
- Highly dispersive clay ore (ESP ~25%)
- Very low recovery rates of decant water (up to 18 months)
- Very low tails density → poor consolidation → spatial constraints

Issues faced

- High processing costs (alum)
- Lack of progressive rehabilitation
- Unavailable extra allocation of pipeline water
- Environmental liability of historic mine workings and waste disposal areas

Previous 'traditional' approaches

- Dosage of liquid alum in thickener to increase settling of sediment & decant water
  - Very low efficacy
  - Increased costs made it economically unviable
- Treatment trial using hydrated lime slurry to neutralise AMD water
  - Aim to supplement mine water supply
  - Economically unviable due to calcium hydroxide costs and infrastructure requirements

Problem solving process

- Based on company principle
  - To develop groundwater, water, soils and rocks as a resource using simple science based techniques
- Characterise the waste streams, characterise the natural environment, determine the interaction between these
  - Mineralogical and inorganic chemical analysis of ore
  - Chemical analysis of all waste and water storages and sources

Conceptual solution

- Mixing of AMD water with sediment-laden process water
- High dissolved Al^{3+} and low pH in AMD water to remove sediment
- Ore sufficiently alkaline to neutralise residual acidity of mixed water
- Increase potential for water re-use
- Reduce pressure on allocation from pipeline water

Importance of stakeholder engagement

- Early series of discussions on proposed conceptual solution
- Mine operator & consultant greater understanding of regulators' requirements for addressing AMD issues & water management
- Knowledge sharing partnership
- Chance to educate regulators and stakeholders of advantage in using unconventional method
- Development of 'mixing trials' to calibrate the conceptual solution

Mixing trial concepts

- Trial aim:
  - Treat large amounts of AMD water
  - Increased flocculation of sediment in tailings
  - Supplement mine process water supply
- Three methods developed:
  - Neutralise AMD water with NaOH and/or $Ca(OH)_2$ to precipitate metals and produce clarified decant water
  - Theoretical calculations of mixing ratios between AMD and sediment-laden process water (accounting for ANC, salinity, CEC, etc)
  - Development of field and laboratory mixing trials using pipeline water, AMD water & ore feedstock

Mixing trial results - neutralisation

- Chemically simple to calculate
- Not considered viable
- Did not address process water (tailings) flocculation/re-use, only AMD water
- Addition of NaOH likely increase dispersion of ore feedstock & site soils
- $CaCO_3$ precipitate would form when adding $Ca(OH)_2$, reducing neutralising efficiency & clogging infrastructure

Mixing trial results - calculations

- Various scenarios based on theory
- Assumed all buffered acidity removed by neutralisation, absorption & dilution and only [H^+] acidity corrected by lime
  - In reality, acidity also controlled by Al, Fe
- Assumed chemistry (particularly ANC) of ore was homogeneous → required testing through field and laboratory trials

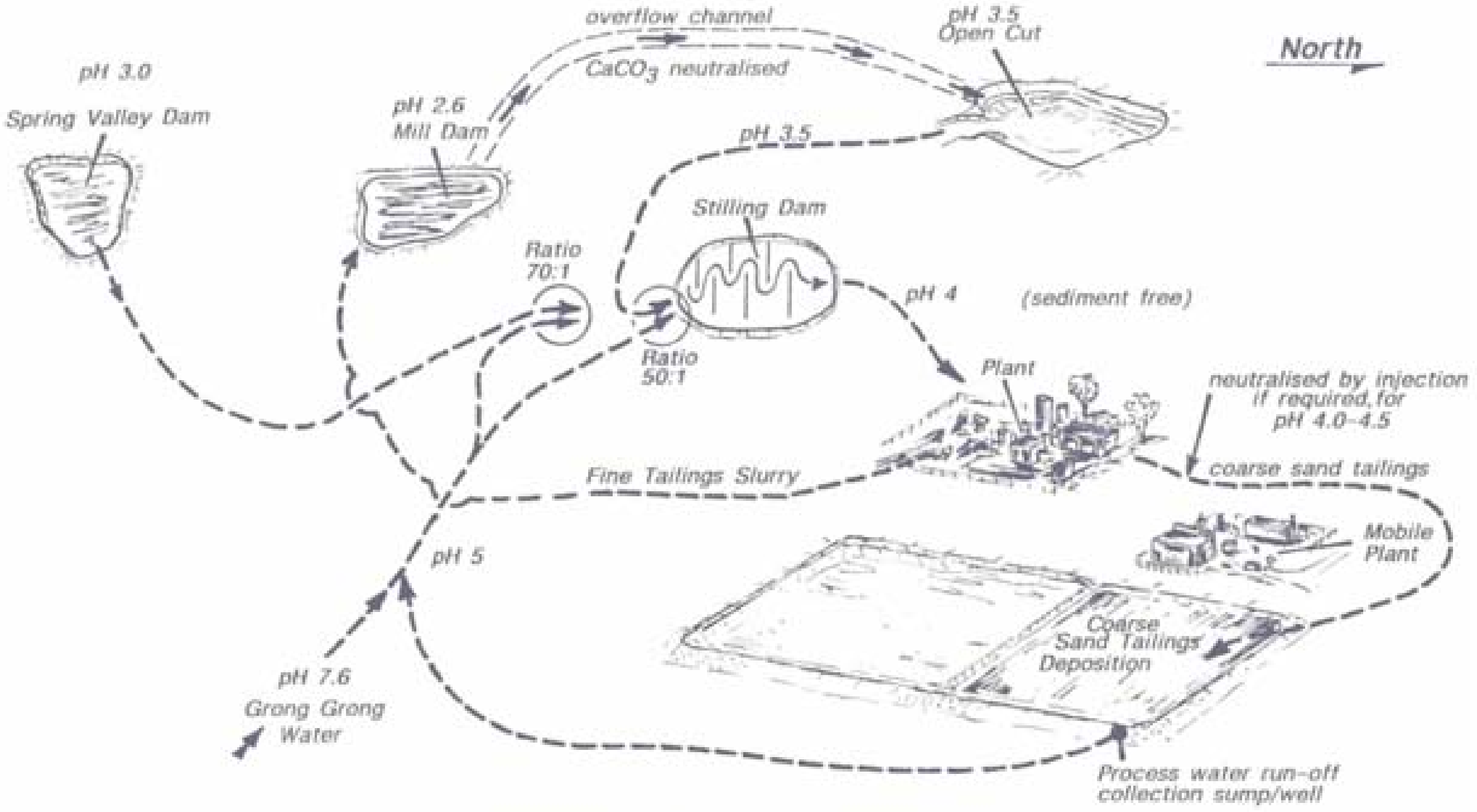
Mixing trial results – field/lab trials

- 10 week test to simulate cycling acid water through plant with ore feedstock & pipeline water
- Rapid modifications required to theoretical calculations due to underestimation of ore buffering capacity
- Theoretical mix – 1:500 AMD to process water
- Trial mix – 1:1 AMD to ore feedstock & pipeline water
- Rapid flocculation of tailings, clear decant solution of pH 6.2 produced for re-use in plant
- Stakeholder approval for next stage

From trial to implementation

- Whole of mine water budget to size stilling dam
- Sustainable extraction rates from AMD storages
- Wholly dependent on precipitation & evaporation due to lack of groundwater
- Fortunate topographical location, AMD catchment boundaries within site

Conceptual model of new process



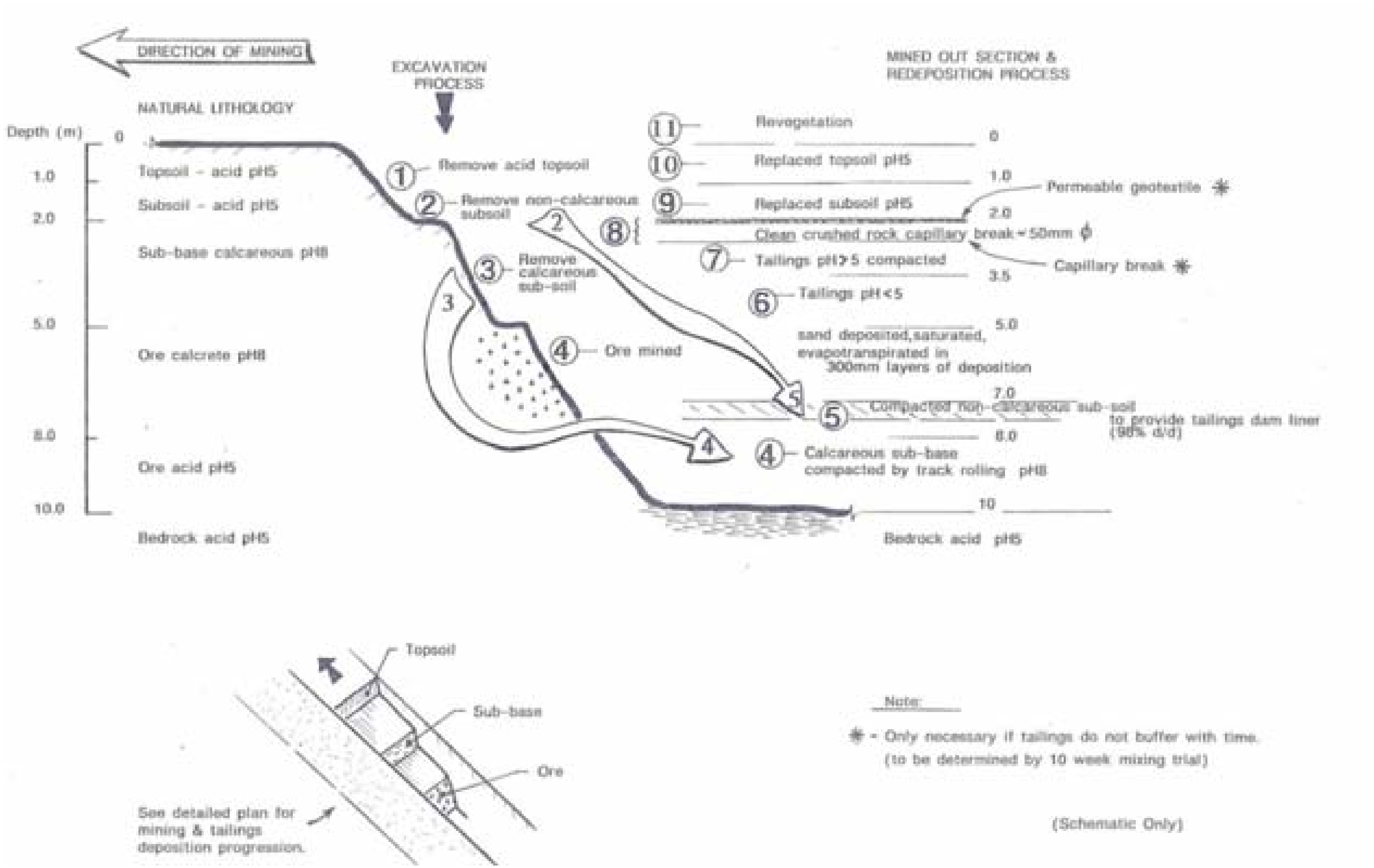
Conceptual Model of Alluvial Mining Water Use Process

(Schematic)

New process, new rehabilitation strategy

- Changes to ore processing required changes to waste disposal & rehabilitation strategy
- Opportunity to ‘mimic’ natural soil profile based on earlier characterisation
- Increased consolidation of sediments allowed greater progressive rehabilitation
- Use of AMD water to treat voids where consolidation of sediment was slow

Conceptual mining and rehabilitation process




35

Conclusions

- “Three-pronged” environmental benefit for mine and wider area
  - Treated historic AMD issues, reducing environmental liability
  - Increased consolidation of tailings, thereby maximising space for waste disposal
  - Created near-neutral pH, clear decant water able to be quickly re-used in plant, reducing pressure on pipeline supply
- “Necessity is mother of invention”… and innovation
- Principal factor in record Sn concentrate production in one quarter by operator

Lessons learnt

- Solutions for water use & environment are often at or near site
- Simple, innovative, cost-effective, net environmental & social benefit
- Adequate and accurate geochemical and hydro(geo)chemical characterisation of ore(s), overburden, wastes and the natural environmental is critical…
- Why?
- Implications across all facets of mine/facility operations
  - Water re-use, water conservation, rehabilitation, impacts on the environment, size and financial constraints.