NEWMONT

Micro and Macro Scale Design and Performance of Dry Covers - Waihi, New Zealand

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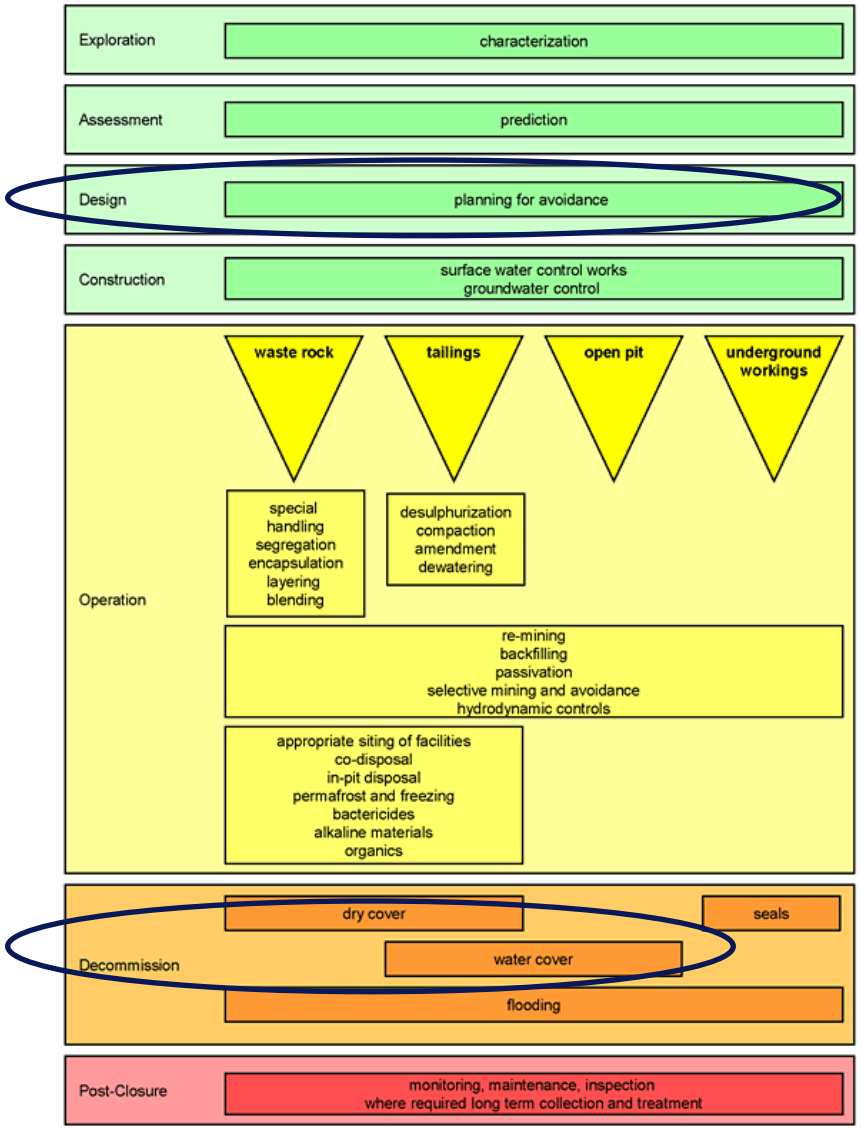
Prevention & Mitigation of ARD -

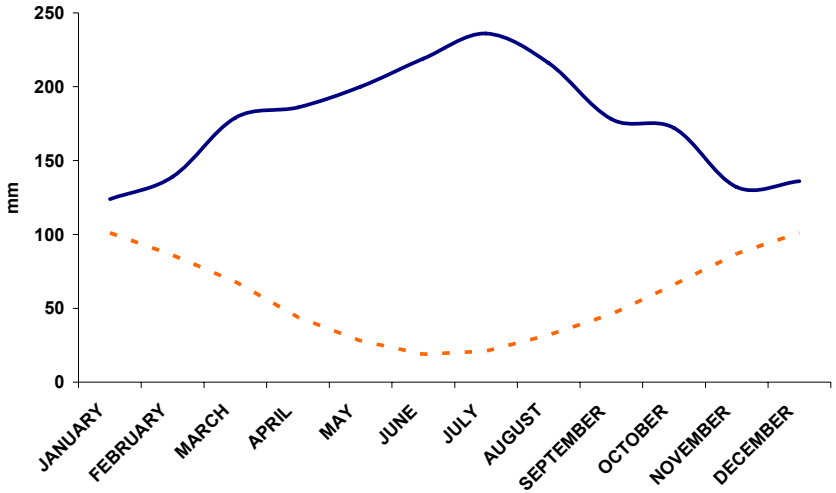
Summary of methods for the prevention of mine drainage

(Ref. Global ARD Guide)



Waihi Climate

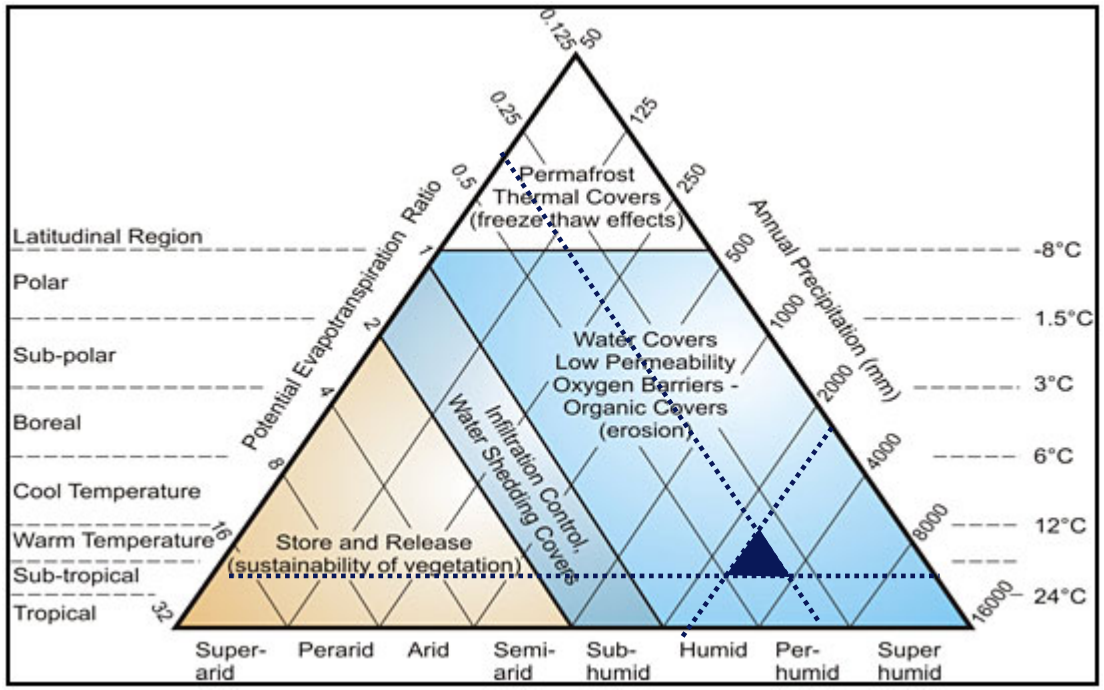
Air temperature	-5° to 28° C
Rainfall:	2100 mm a^{-1}
ET:	700 mm a^{-1}



Cover and Climate Types

General guidance on appropriate cover types

(Ref. Global ARD Guide)



Waihi – New Zealand

Waihi Tailing Storage Facility

Storage 2 rehabilitation

Storage 2 rehab cover and land use

Embankment cover design

Objectives:

1. Restriction on generation of acid drainage in the short and long term
2. Rehabilitation of the downstream shoulder to pasture and native plantings
3. Surface water control to prevent ponding, infiltration and erosion

Achieved by:

Multi-layered cover system

1. Sealing layer - oxidation control and geochemical security
2. Soil layer – insulation & vegetation growth medium

Slope geometry – surface runoff and erosion control

Geochemical objectives & targets

Objectives - minimise risk of adverse water quality effects
- minimum after-care and long term geochemical security

Targets

Mn – receiving water quality standard in consents is 2 g/m^3

Reduction in underdrainage flows rates < 1 L/s

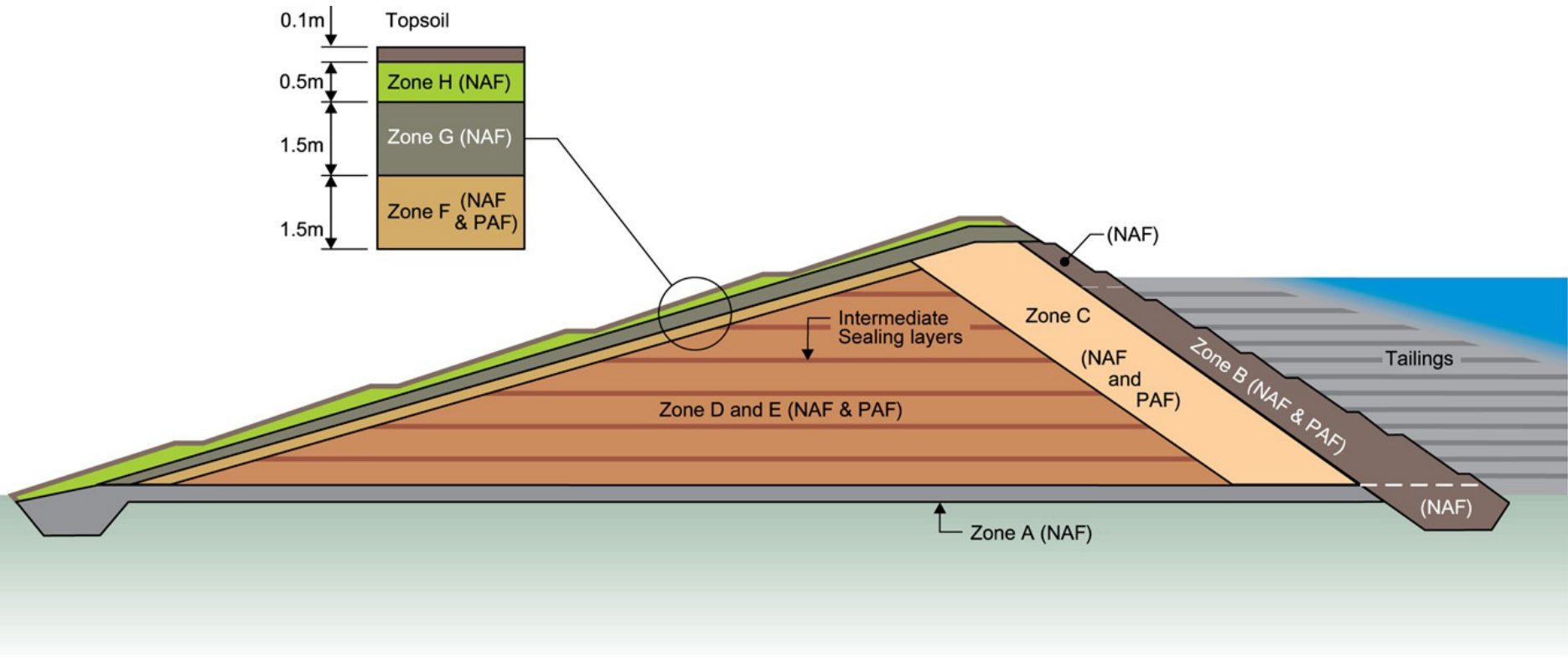
pH = 6 for minimising Mn release and control of Al and Cu

SO_4 – 250 g/m^3 recommended at closure (c. 10 kg/ha/d = double worst case estimate)

Primary method to achieve these targets is limestone addition to the waste rock

Sealing layer will reduce leachate flow rates

Cover design



Storage 2 cover assessment

ANSTO study in 1994 – oxygen, temperature, and diffusion on waste rock and covers

Diffusion is the dominant O_2 transport mechanism in WRD

- No advection or convection

Oxygen concentration < 1% at 2m depth from surface

- No O_2 below 5m depth even in areas not covered
- No oxidation at depth
- Pyrite oxidation is not significant below 1-2m depth in uncovered areas
- Some heating during construction of PAF waste areas

Sealing layer diffusion coefficients < 2.1 x 10^{-8} m^2/s

- 2-orders of magnitude lower than bulk waste rock
- Important oxygen barrier

Sulphate generation rate - 93-99.5% reduction (to 5.5 kg/ha/d) with use of cover

ANSTO = Australian Nuclear Science & Technology Organisation

Zone G – sealing cover specifications

Diffusion coefficient is the critical factor determining the performance of zone G

De - function of moisture content or degree of saturation

90% degree of saturation (81-100% range) @ De = 2.1 x 10^{-8} m^2/s

zone G permeability < 1 x 10^{-8} m/s

Embankment design and material specifications

Construction control - compact waste rock in 250mm thick layers – zone G

Field saturation levels – 85% minimum, 90% median

Construction Monitoring

Geotechnical testing of foundations and placed embankment fill

- Dry Density
- Air Voids
- Degree of saturation
- Scala Penetrometer
- Shear vane
- Particle Size Distribution
- Permeability – Triaxial Cell – zone G sealing layer
- Solid Density of Soil Particles

Failed tests result in re-compaction of finished areas and retesting

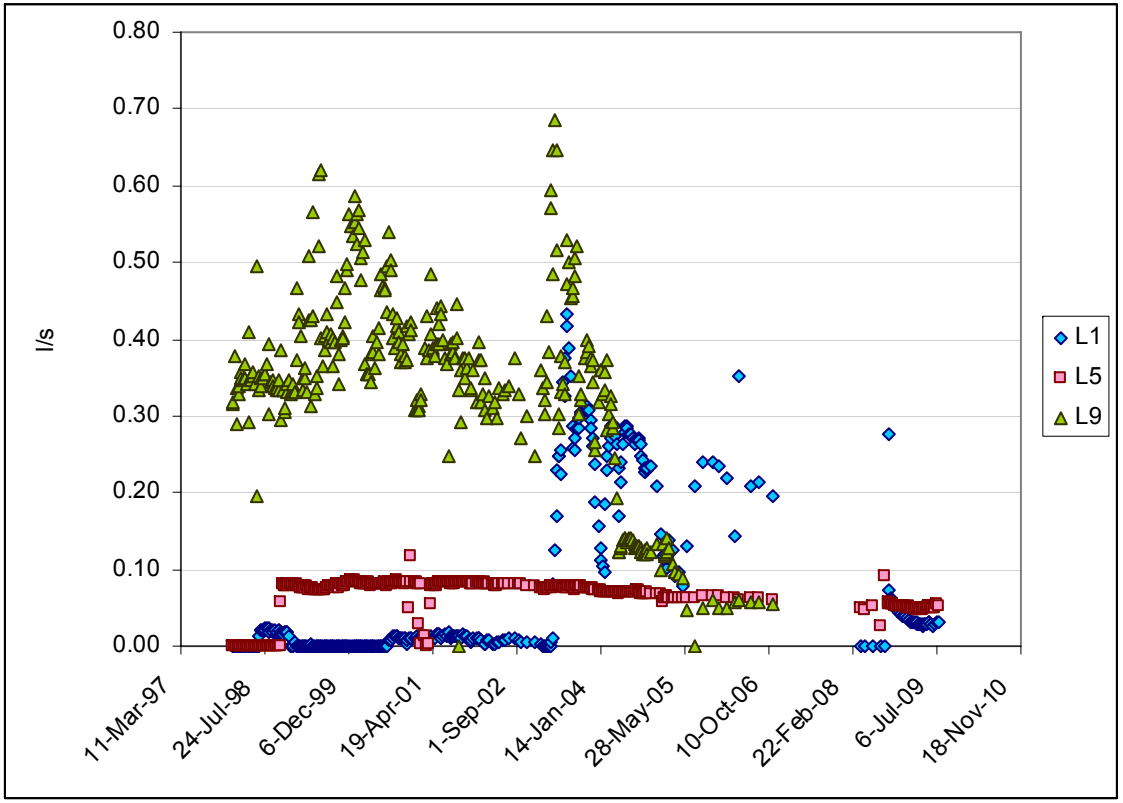
Storage 2 zone G – performance

Sealing layer reduces leachate flows

Prevention of water ingress

- Zone B – tails upstream barrier
- Zone G – embankment cover

Graph shows performance for Storage 2 – L9 had the highest flows



Expected flows less than 0.25 L/s

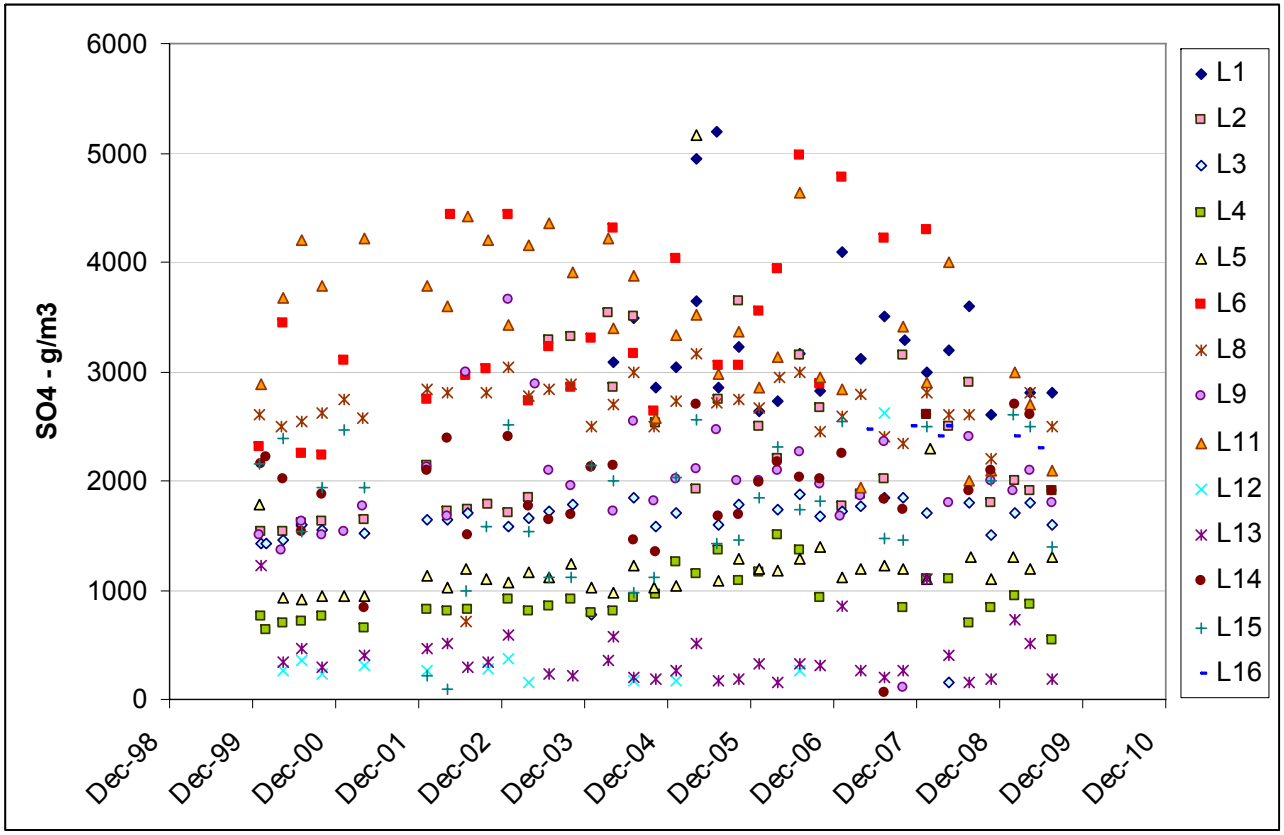
Zone G – performance

Sulphate trends

250 g/m^3 recommended at closure

Equiv. 10 kg/ha/d

= double worst case estimate



Storage 1A – slope geometry

Slopes

- 4:1 to 3.2:1 (horiz:vert)
- 10 m berms - reverse & longitudinal fall
- collector sumps and subsoil drainage

Pasture Productivity

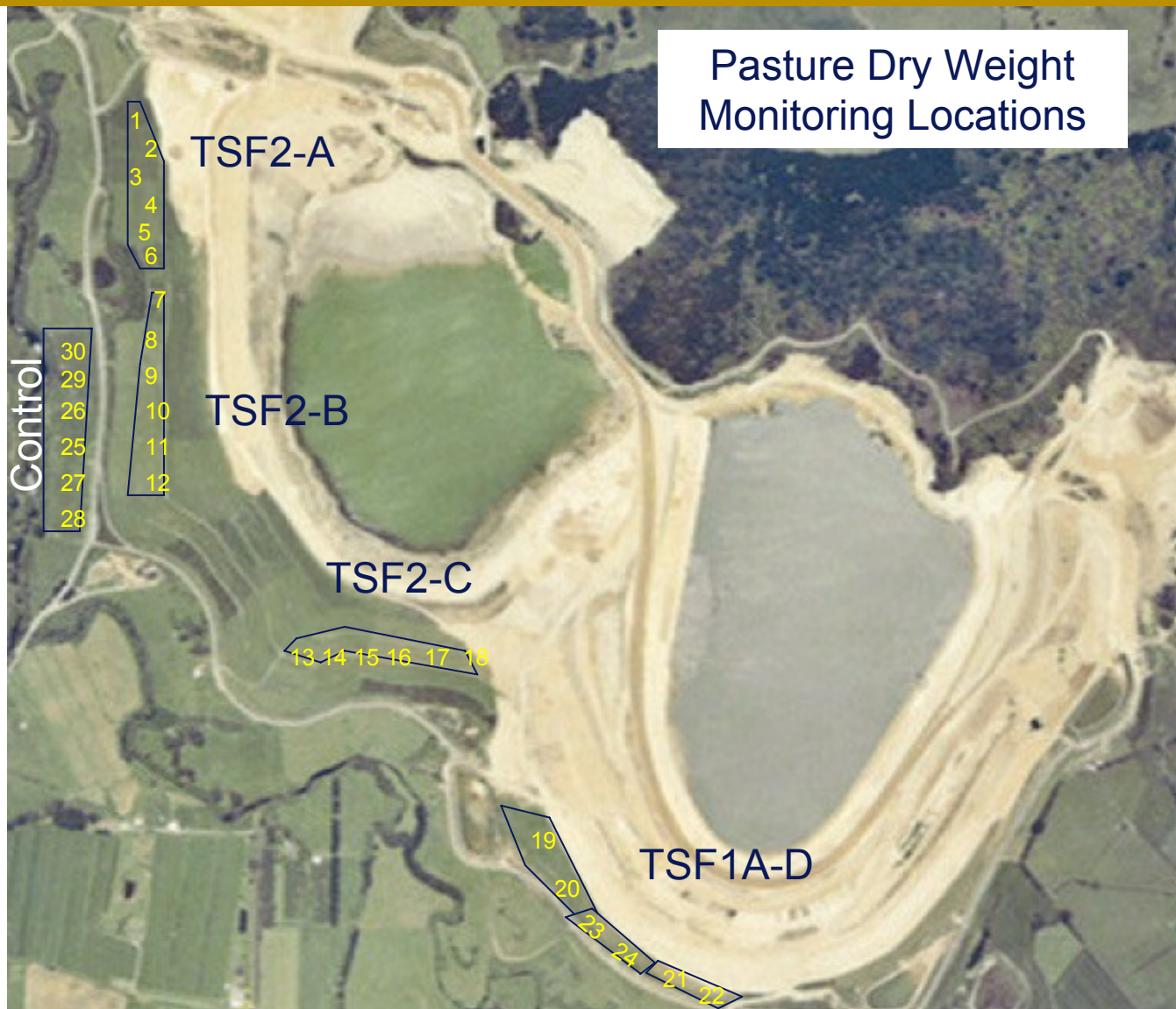
Storage 2
dry matter (grass) production

18 embankment sites

6 control sites
-flat alluvials

Average = 15 kg/ha/d
(range 9-23 kg/ha/d)

Performance target
80% - met in 2008



Successful Closure

Monitoring & inspection

Peer review

Receiving water quality standards for discharge & no adverse effects

Contributors

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