



Topsoil Handling for Mine Rehabilitation

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Structure of Presentation

- Quick description of Alcoa's rehab process
- Why use topsoil?
- Optimum handling methods
- Operational issues
- Soil movement plans
- Problem topsoil

Alcoa's Rehabilitation Process

MINE REHABILITATION OBJECTIVE

To restore a self-sustaining jarrah forest ecosystem, planned to enhance or maintain water, timber, recreation and conservation values.















APPLIED SEED

3 T in 2004

50-80 spp

~20 km radius
provenance zone
each mine

~\$500,000



Eucalypt seeds

No treatment



Acacia seeds

boiling



Grevillea wilsonii

smoke



Ripping and Seeding



PLANTING

Loxocarya cinerea

Resprouter

Tissue culture

24,000 in 2002



Adenanthos
barbiger

Common in forest

Moderate return in
direct return pits

Absent from stockpiled
pits

Cannot obtain seed
cuttings

39,000 in 2002







Plant Numbers, Recalcitrant Plantings all Mines

Year	plants	spp	per ha
■ 1997	2000 (exptl.)	7	5
■ 1998	14,190	14	31
■ 1999	67,600	15	170
■ 2000	184,552	16	229
■ 2001	213,678	19	230
■ 2002	229,757	28	385
■ 2003	184,000	23	354
■ 2004	166,660	21	341
■ 2005	133,000	20	301
■ 2006	118,000	24	295
■ 2007	230,000	28	400





Fertilising





6 months



2 years



4 years



13 years

Why Use Topsoil?

Topsoil Benefits

- Texture and Physical properties
- Nutrients and Nutrient Holding capacity
- Biological Attributes

Properties Jarrah forest soils

■ Topsoil

- Hydraulic conductivity
3000-20,000 mm/day
- Plant Available Water
0.04-0.1 mm³/mm³
- Total N
0.05-0.2%
- Organic C
0.5-4.0%

■ Pit floor

- Hydraulic conductivity
5-100 mm/day
- Plant Available water
0.1-0.3 mm³/mm³
- Total N
0.001-0.01%
- Organic C
0-0.1%

Biological Properties

- Seeds
- Microbes
- Nutrient Cycling, binding and release

Seed storage strategies in Western Australia

Vegetation Community	Canopy seed store (m^{-2})	Soil seed store (m^{-2})
jarrah forest	7	767
heath	363	155
Kalbarri heath	716	1647
Kalbarri heath	303	1641
wheatbelt	1121	not measured

ORIGIN OF SPECIES in 4000m² sampling area

<u>Source of plants</u>	<u>No. of species</u>
topsoil	137
applied seed	52
planting	25

Seed in Topsoil Studies (Jarrah Forest)

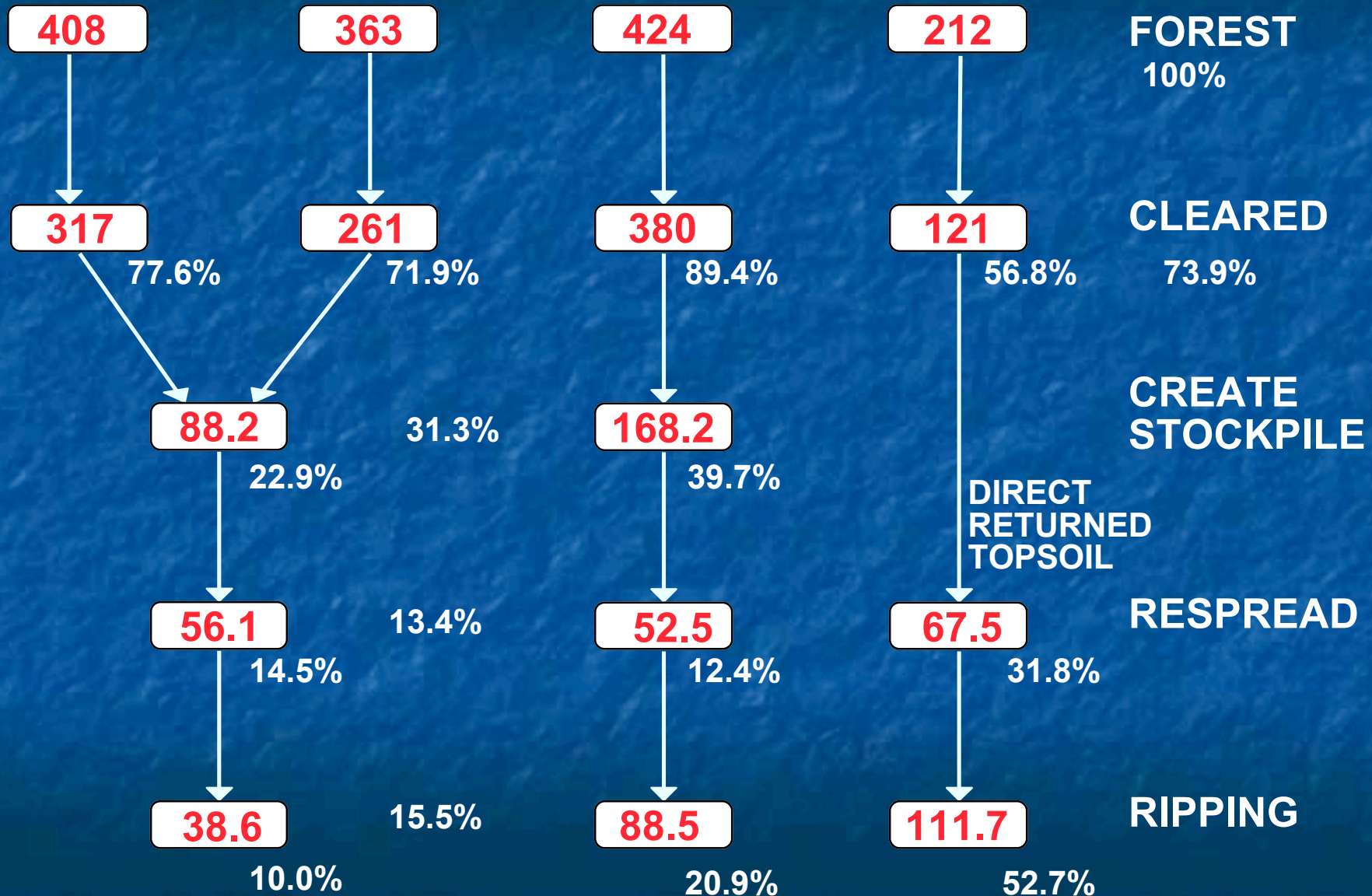
- Tacey & Glossop 1980 Jarrahdale 0-10cm 301 / m²
- Vlahos & Bell 1986 Huntly 0-3cm 767 / m²
- Koch *et al* 1996 Huntly 0-10cm 352 / m²
- Ward *et al* 1997 Huntly 0-5cm 535 / m²
Jarrahdale 240 / m²
Willowdale 529 / m²
- Martin Smith *et al* 2000 Jarrahdale 0-10cm 1605 / m²
- Esther Cromer 2003 Huntly 0-10cm **128 / m²**
- Venicia Giannasi 2004 Willowdale 0-5cm **168 / m²**
- Koch *et al* 2007 Huntly 0-5cm 471 / m²

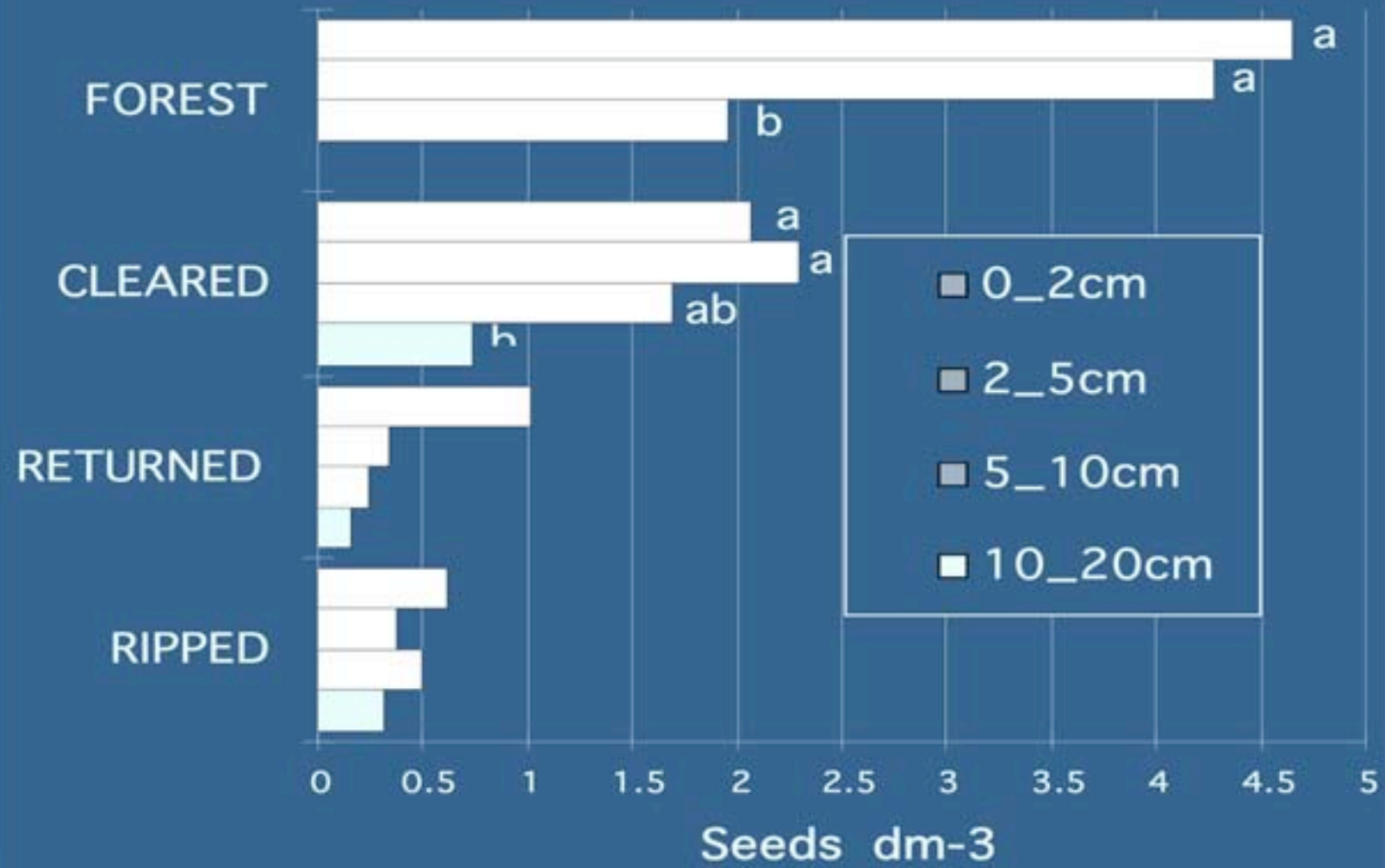
Optimal Handling

Seed Stores in the Topsoil (0-5cm)

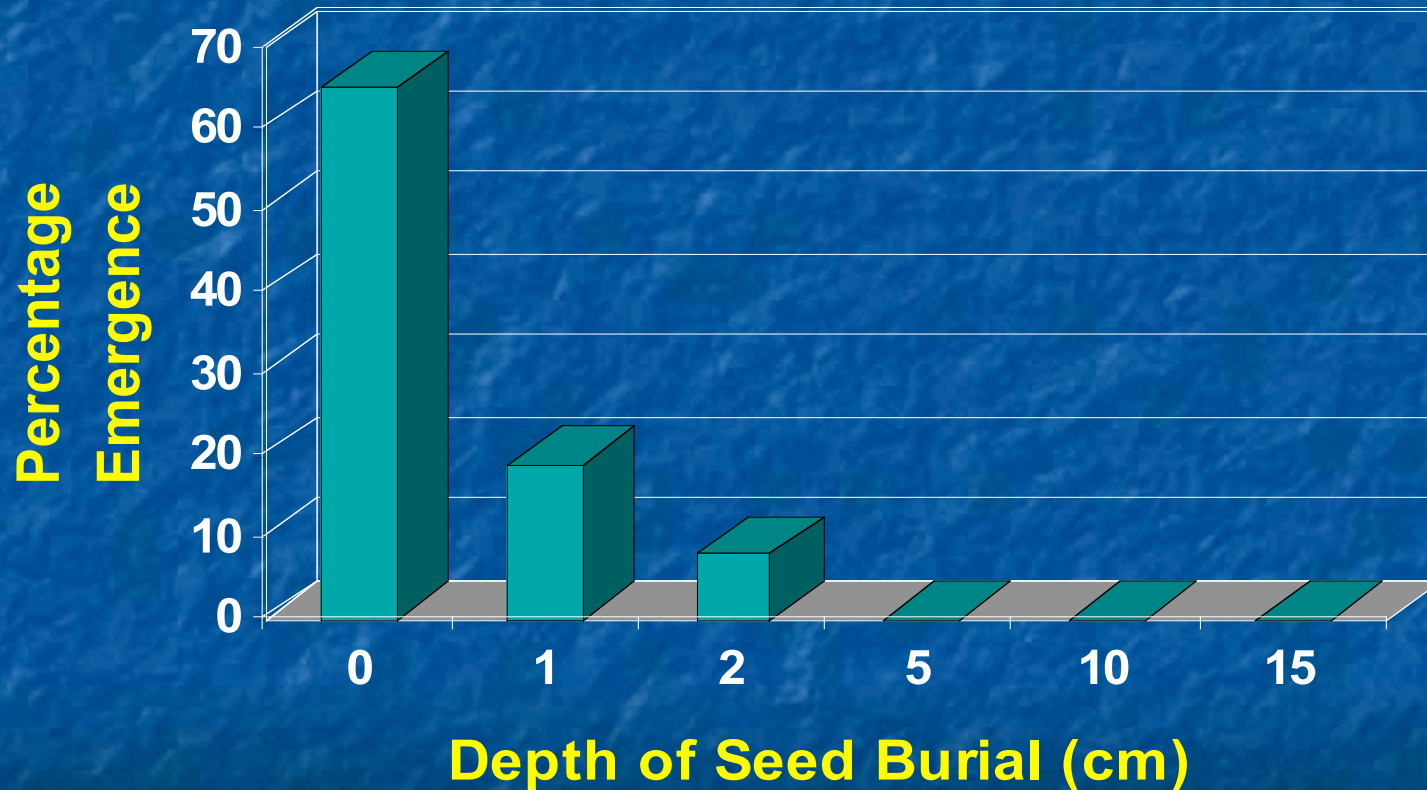
SEASON	GERMINABLE SEEDS M ⁻²	SEM
Summer	435	(72)
Autumn	265	(49)
Winter	207	(39)
Spring	261	(56)

Seed Losses During Mining and Rehabilitation

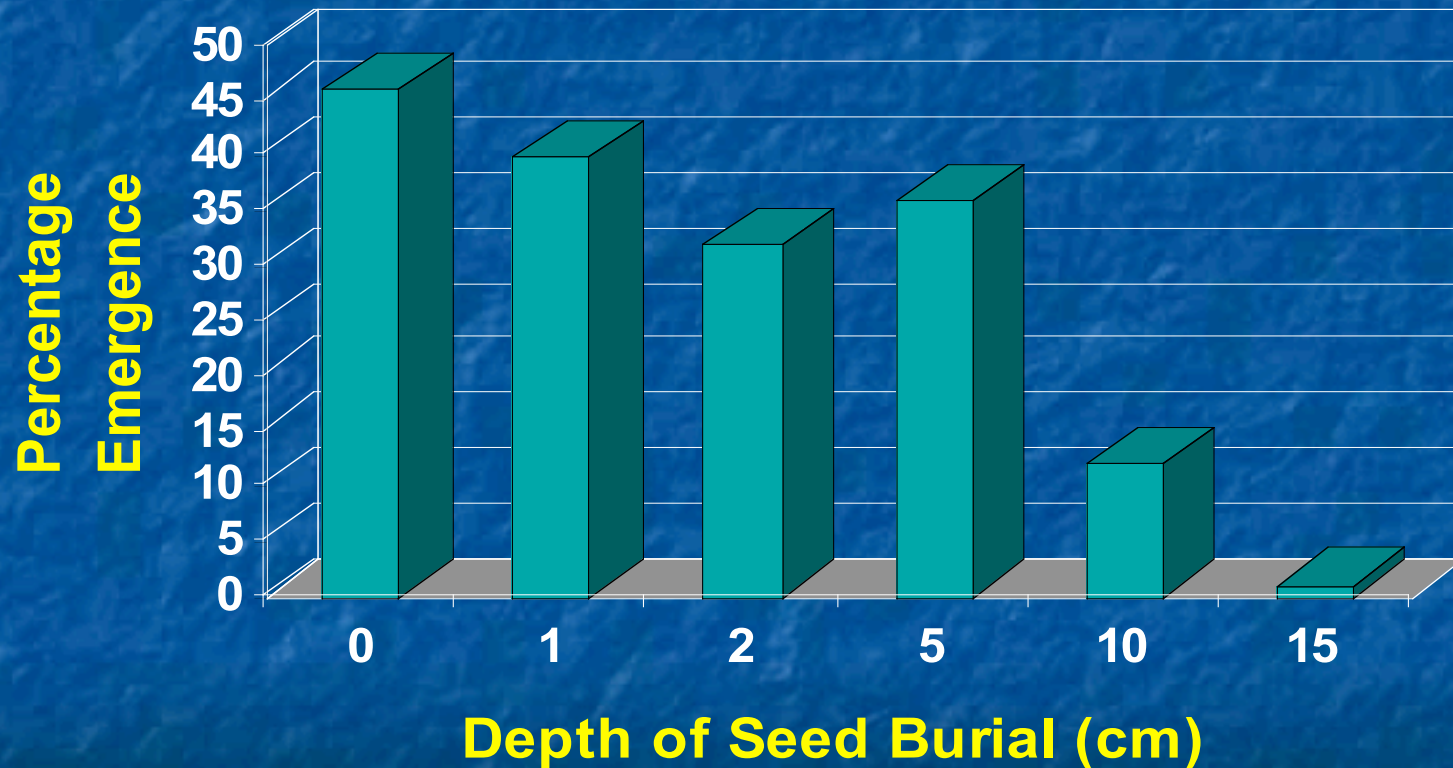




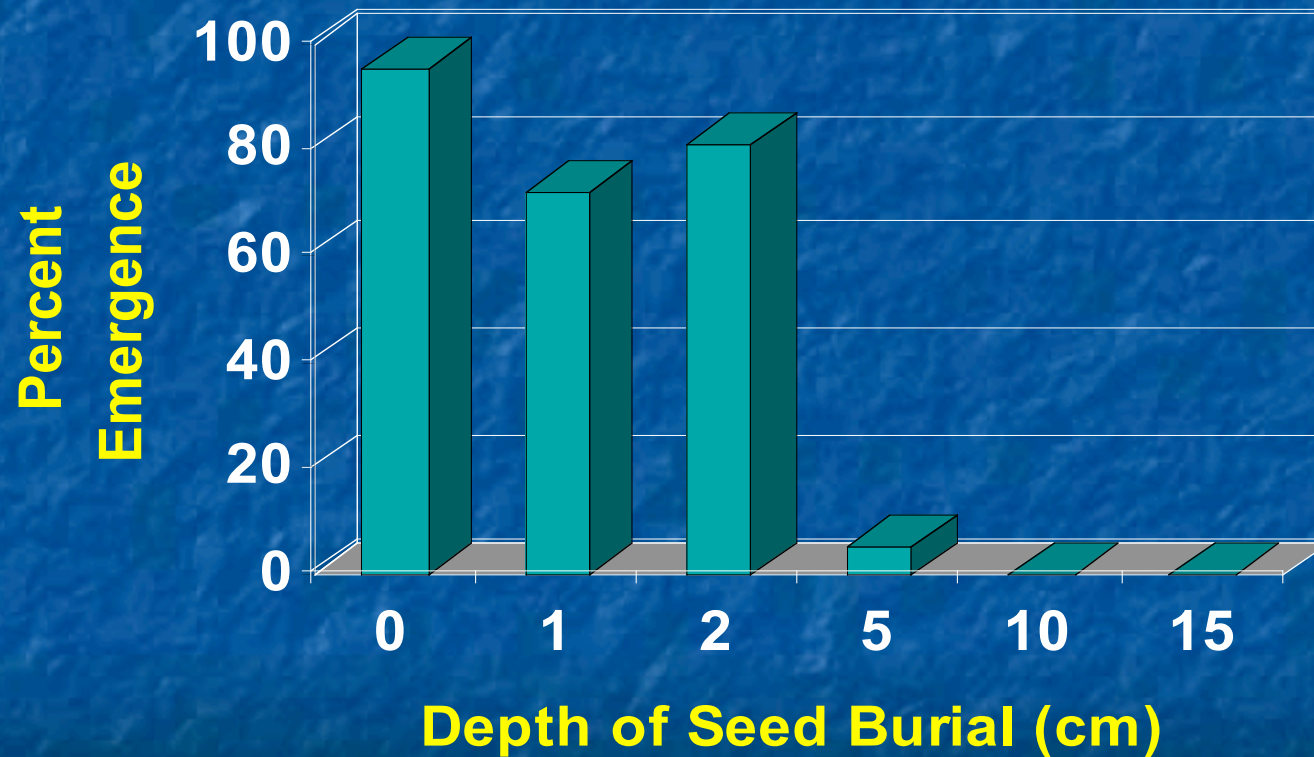
Emergence of *Stylidium calcaratum*



Emergence of *Acacia pulchella*



Emergence of *Hakea amplexicaulis*



Effect of Ripping Date on Seedling Establishment



To Optimise Topsoil Seed (our research has shown)

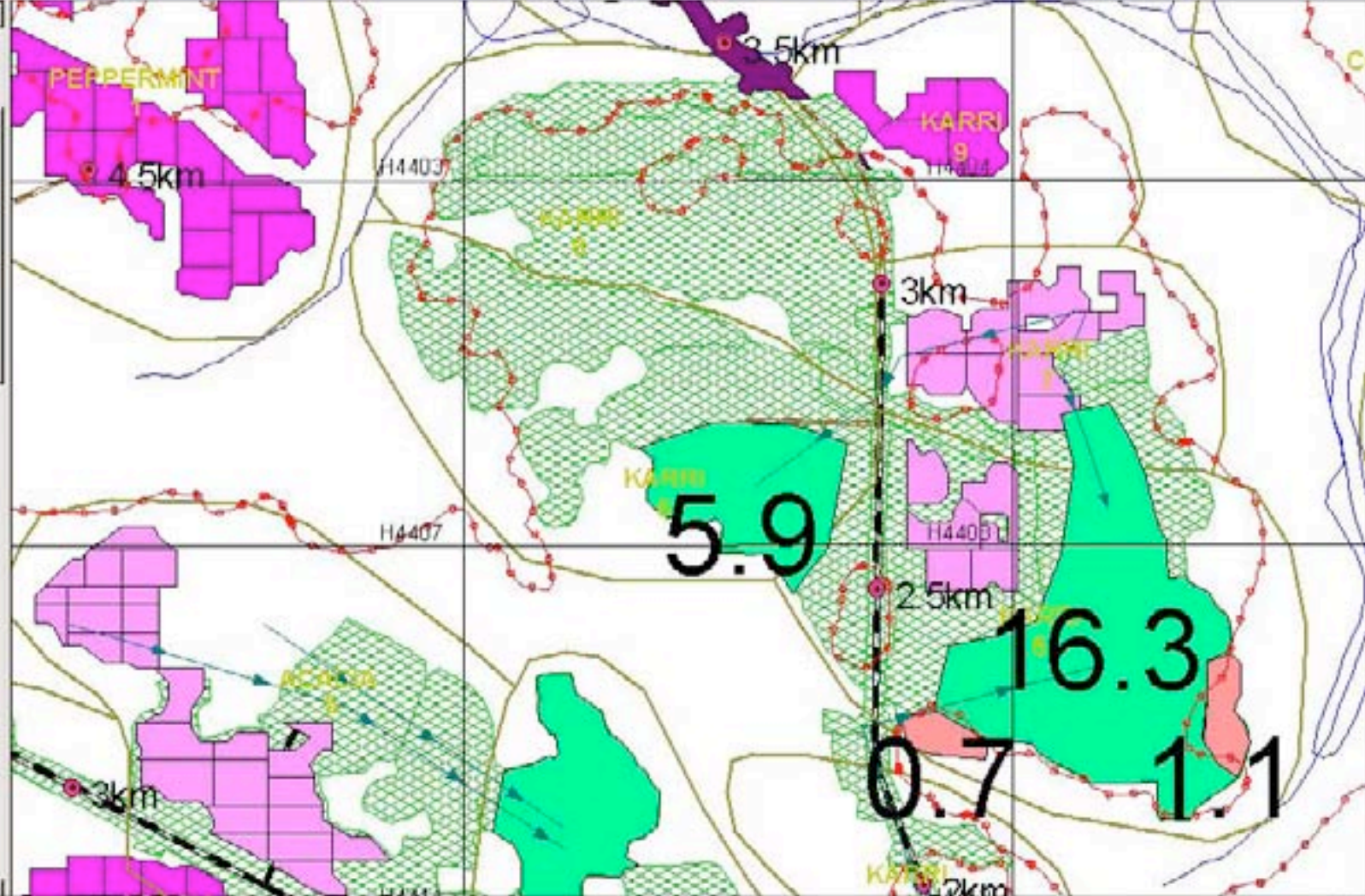
- Strip and return in dry season (summer-autumn)
- Direct return (don't stockpile)
- Rip in dry season (summer-autumn)
- Keep the top layers on the top (double strip)
- Can take out some of the inert gravel fraction and use the 'concentrated seed fraction'



Operational issues

- Distance
- Planning ahead
- Cost
- Availability
- Seasonal issues
- Dieback (for Alcoa)
- Communication and Education

- Operational Dieback
- Haul Distance
- Sieve Soil
- Donor Sites (NEW)
 - Spring
 - Summer
- DRT
 - DB
 - DB/DBF
 - DBF
- Production Areas
- Future Mining
 - RESID H1
 - Q306
 - Q406
 - Q107
 - Q207
 - Q307
 - Q407
 - Q108
 - Q208
 - Q308
 - Q408
- Useby
- Desired Stream Vegetat
- Donor Soil (OLD)
 - Winter
 - Summer
- Rta Stream Hierarchy



Problem Topsoil

- Weed seeds – solution, bury top layers if possible. Most weed seed in top 10cm, virtually none below 20cm.
- Toxic or pyritic materials – solution, bury the soil and use benign materials near surface.