# IMPACT OF BAUXITE MINING ON WATER YIELD

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## WATER

## ENVIRONMENTAL VALUES A

STREAMS, BIOTA, ECOSYSTEMS, TREES

## ECONOMIC VALUES

Domestic -\$ 1250-\$2500/ha/an (50-100 mmpa stream-flow) Some catchments have contributed for over 100 years

As a comparison- bauxite royalty \$ 100,000/ha as a once-off

- timber, possibly \$ 600/ha every 25 years
- irrigation, \$60-\$120/ha/an

#### 31 MILE BROOK IN EARLY AUGUST 2016, NO MINING

Average annual flow 1986-1998 was 150 mm, or 1.6 GL (DoW data). However, with mining there is an even greater change



#### BULLICH, DIED FROM DROUGHT IN SUMMER 2011, SUCKERING FROM BASE

Stream-zone located below bauxite pits



## A SHORT HISTORY- BAUXITE

- 1964, 4 ha/an, 400 ha in 100 years
- 2016, 600 ha/an, 25000 ha 50 years
- About 20-30 percent of each catchment is mined
- Therefore a much greater catchment area is impacted (75000 -125000 ha)
- Alcoa is considering direct export of bauxite. Area mined annually will increase substantially.

## Mining by Alcoa on water-supply catchments



Map credit-Alcoa

Mining processes

Outline of processes undertaken

Initial emphasis-Successful rehabilitation with trees/shrubs Self-sustaining ecosystem To prevent erosion

My current emphasis for this talk-Water yield and ecological health Original rehabilitation was clear-felled at age 35 and sold, area is now ready for sowing. Jarrahdale.



16 YEAR OLD PLOT REHABILITATED WITH NATIVE SPECIES 1800 stems/ha, 45 percent cover, leaf area index is 2, basal area 25m2/ha estimated volume of biomass 104 m3/ha or 6.5 m3/ha/an estimated water use 600-1200 m3/m3 of biomass- 6,000,000 litres/ha/an



Karri in bauxite pit planted at Jarrahdale about 36 years ago. Estimated biomass about 320 m3/ha. Total water used 290000 m3 Carbon Dioxide+Water+Energy= Biomass+ Oxygen+ Water vapour



#### Has rehabilitation been too successful?

#### Mining =

- + logging and regeneration,
- + rehabilitation of mine pits
- + dieback forest rehabilitation
- + a reduced level of prescribed burning
- Between 1989 and 2007, leaf areas have increased after mining (CSIRO), even as rainfall has fallen.
- More than half of the rehabilitated areas are now above the desired tree density (Alcoa, 2007)
- As leaf cover doubles (25 50 % crown cover, LAI 1-2) stream-yield falls by 80 percent (Schofield et al)

#### REDUCTIONS IN STREAMFLOW BETWEEN CATCHMENTS THAT HAVE BEEN MINED FOR BAUXITE AND AREAS THAT WERE NOT MINED

Catchment Name	Flow volume 2010-2015 as a percent of flow pre-2000 (DoW)	Area mined as a percentage of the catchment (Alcoa )	Influences that affect flow
Waterfall gully	30 percent	Nil	Rainfall, growth of native forest and understorey
Del Park	10 percent	32 percent	+ rehabilitation of mined area and of dieback
Seldom Seen	12 percent	34 percent	As above
More Seldom Seen	6 percent	62 percent	As above

- Alcoa have thinned their catchment twice to increase yield
- Funding is not available for water-supply and irrigation catchments

#### DECLINE IN STREAMFLOW ATTRIBUTABLE TO BAUXITE MINING

- The decline in stream-flow from 7 mined catchments was 66 percent and, over the same period, catchments that were not mined declined by 40 percent (CSIRO, based on DoW data)
- As the percentage mined increases, the reduction in flow also increases
- The decline in yield from catchments that were mined is 40-50mm greater than in the control (Alcoa 2007)
- On the 75000 ha affected by mining a loss of 50 mm would reduce yield by 37GI annually (if 125000 ha reduce by 62GI)
- To produce 37GI by desalination would cost the State \$ 90 million
- Bauxite royalty (Alcoa + S32, 2014/15) was \$82.5 million

### Alcoa Completion Criteria 2016 (MMPLG)

- The Completion Criteria cover many pages
- There is no criterion that specifically addresses water yield post mining-why not ?
- Aspirational targets are set for desirable tree density over time but
- There is no money for implementation of thinning programs
- Language is passive

#### Bauxite rehabilitation with jarrah dying in summer 2011



#### WHAT CAN BE DONE ? 30 yo rehab in bauxite pit thinned by Water Corporation in 2010 to 7 m2 (75% reduction) Photographed 2016



#### WHAT CAN BE DONE?

70 yo jarrah forest thinned by Water Corporation in 2007 to 11m2 (66 percent reduction) Photographed 2016 Silviculture and water enhancement are compatible



#### WHAT CAN BE DONE?

Rehabilitate 30 percent of pits with low understorey species



### WHAT CAN BE DONE?

More regular low-intensity burning



#### WHAT CAN BE ACHIEVED? A SELF-FUNDING SOLUTION?

- Water Corporation data (2012) show that if 6000 ha a year are managed appropriately on a 10 year recurring cycle (say 60000 ha in all) the estimated *annual increase* in yield would be 22GI in the first cycle and 45GI in subsequent cycles.
- This is equivalent to the production from the original desalination plant at Kwinana
- It costs about \$2.50 to produce a Kilolitre by desalination or \$
   2.5 million for each Gigalitre
- The additional annual water yield from forests would cost some \$55 to \$110 million to produce by desalination
- The cost of implementation is estimated at \$7 million pa
- Net present worth = \$132 million (at a 5 percent discount rate)
- There are additional benefits to streams, ecosystems, biota, trees, employment, forest products and biomass.

#### • THIS IS THE COMPLETE PACKAGE!!

## BUT

- Inertia partnerships; whole of Government
- Apathy
- Opposition
- Olitical concerns
- No action 1980, 1987, 1989, 2005 and it is now 2016 (when all is said and done.....)

# Deaths in rehabilitated area, summer 2011, Wungong (D Burt)





#### Jarrah thinned to 15 m2. Discovery forest 2016 (D Spriggins).



#### Basal area to generate stream-flows of 100 mm/yr for the HRZ, climate is the 2000-2012 repeated. (Croton et al 2014)



#### Streamflow 1965-2011. 62 percent of area was mined and rehabilitated 1975-1985.

