THE BRUKUNGA PYRITE MINE: A FIELD LABORATORY FOR ARD STUDIES

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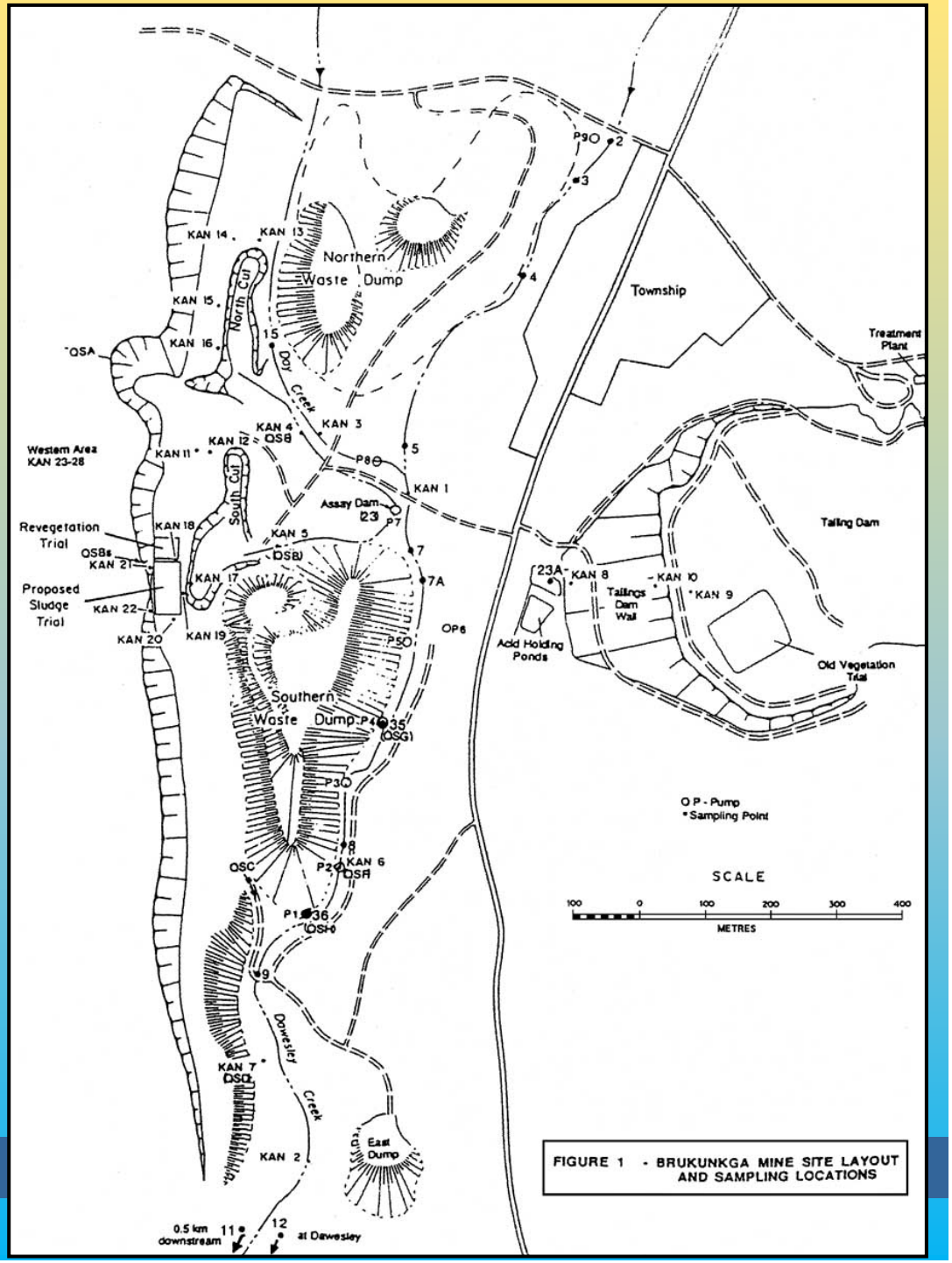
BRUKUNGA HISTORY

- Mine opened 1955
- Pyrite (pyrrhotite) concentrated on-site
- Transported to Port Adelaide for conversion to sulfuric acid
- Minewastes disposed of on-site
- Mine shut 1972
- Small township remains on site

BRUKUNGA GEOLOGY

- Talisker Calc-siltstone of Cambrian Kanmantoo Group
- Sulfide – rich bands in Nairne Pyrite Member over 100 km strike
- Three steeply E-dipping conformable lenses
- Each lens 15-30 m thick
- Iron sulfides in muscovite schists/gneisses
- Waste rock of quartz plagioclase granofels
- Pyrite, pyrrhotite, minor sphalerite, chalcopyrite, galena, arsenopyrite

Brukunga Mine Site layout and Sampling locations



MINING LEGACY

- Exposed quarry benches
- Diversion of Dawesley Creek
- Waste rock dumps
- Tailings storage facility
- Ponding on tailings surface

Quarry faces

Waste rock dumps

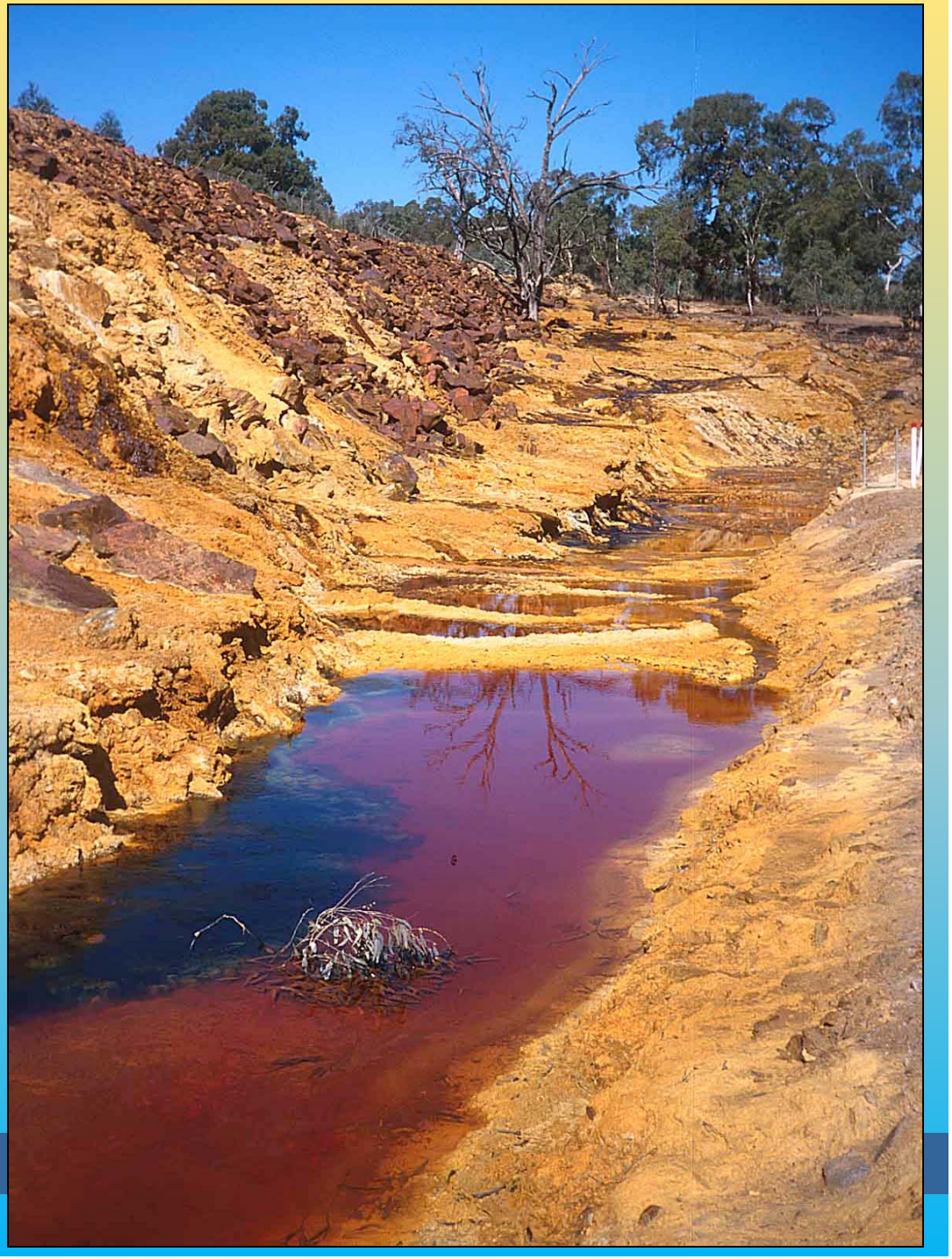
Wall of TSF and retention dams

Sludge dam

MINING LEGACY – cont.

- Water contamination
- Soil contamination
- Cover materials
- Noise, dust, odour
- Municipal impact

Seepage From TSF



Contamination of Dawesley Creek

Representative Water Quality from Mine Sources (range of values shown)

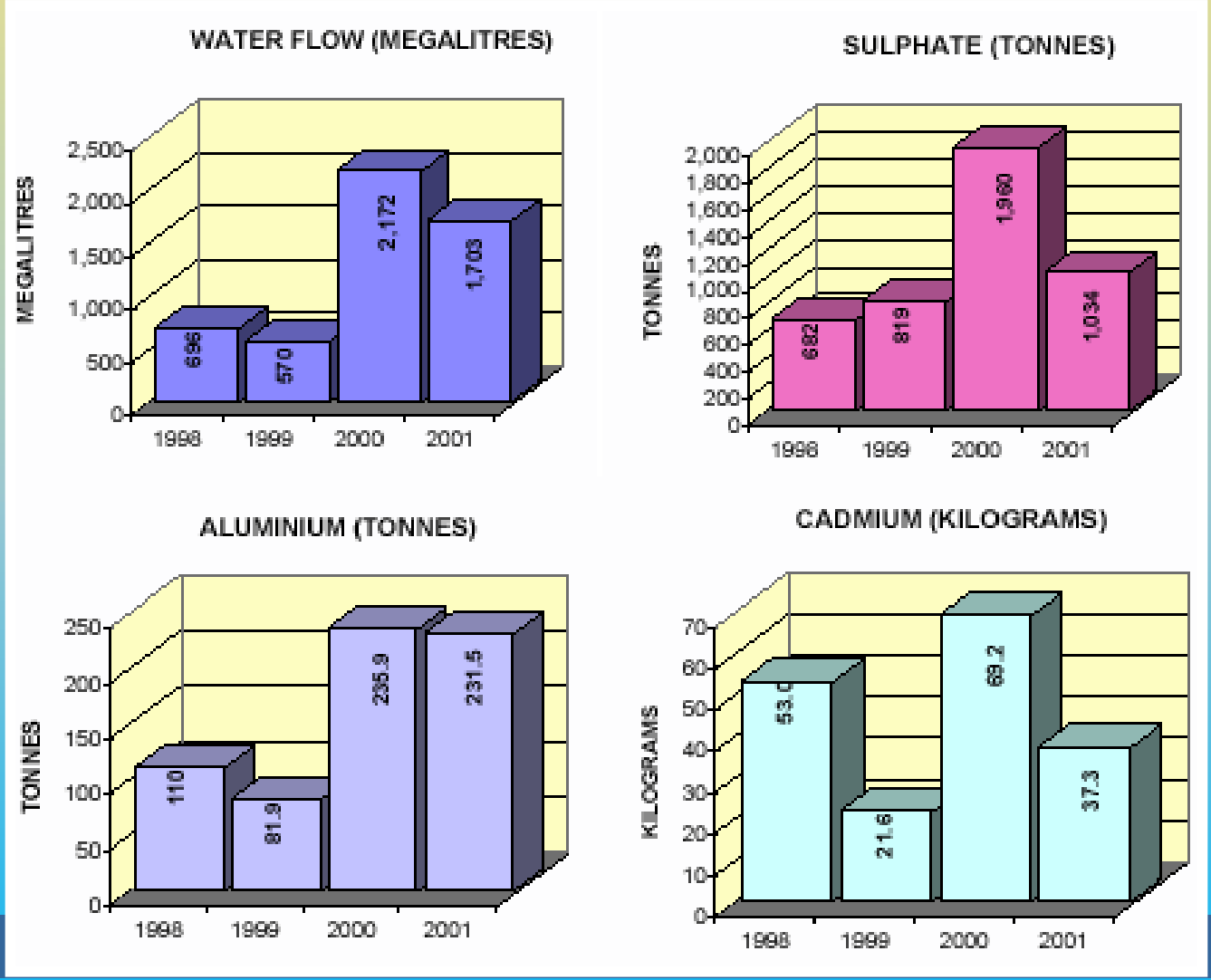
Parameter (mg/L) except pH	Mine Cuts	Tailings	Dawesleys u/s Peggy Buxton	Dawesley d/s (KAN 2)	Waste Dump R/O and Seep*
PH	2.5 3.0	2.3	7.5	3.0 4.5	2.5 3.0
Acidity#	4,000 8,000	7000	0	200 1,000	4,000 6,000
SO4	5,000 10,000	8000	80 100	1,000 2,000	6,000 9,000
Fe	1,000 2,500	4000	1.5	10 30	200 600
Al	400 800	50	<1	25 200	700 1,000
Cl	300 1,500	250	400	500	100 200
Ca	200 500	450	50 60	100 300	200 300
Mg	200 500	300	40 60	50 100	200 300
Na	200 1,200	200	450	300	100 400
Mn	20 40	150	0.1	5 20	30 50
Zn	30 50	15	0.005	15	20 50

BRUKUNGA - MONITORING

Required by EPA Site Licence No. 10577

- Annual and seasonal lodes of heavy metals entering Dawesley Creek
- Impact of mine on Dawesley Creek using biological monitoring every 3 months
- Determine spatial and temporal variations of pH and heavy metal concentrations in zone of impact – monthly program

Note: Chromium, Copper and Lead were not graphed because a high number of Samples are recorded as being below the detection limits of the analysis technique. Using this data can result in high calculated loads that are not real.



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Calculated annual load of contaminants in Dawesley

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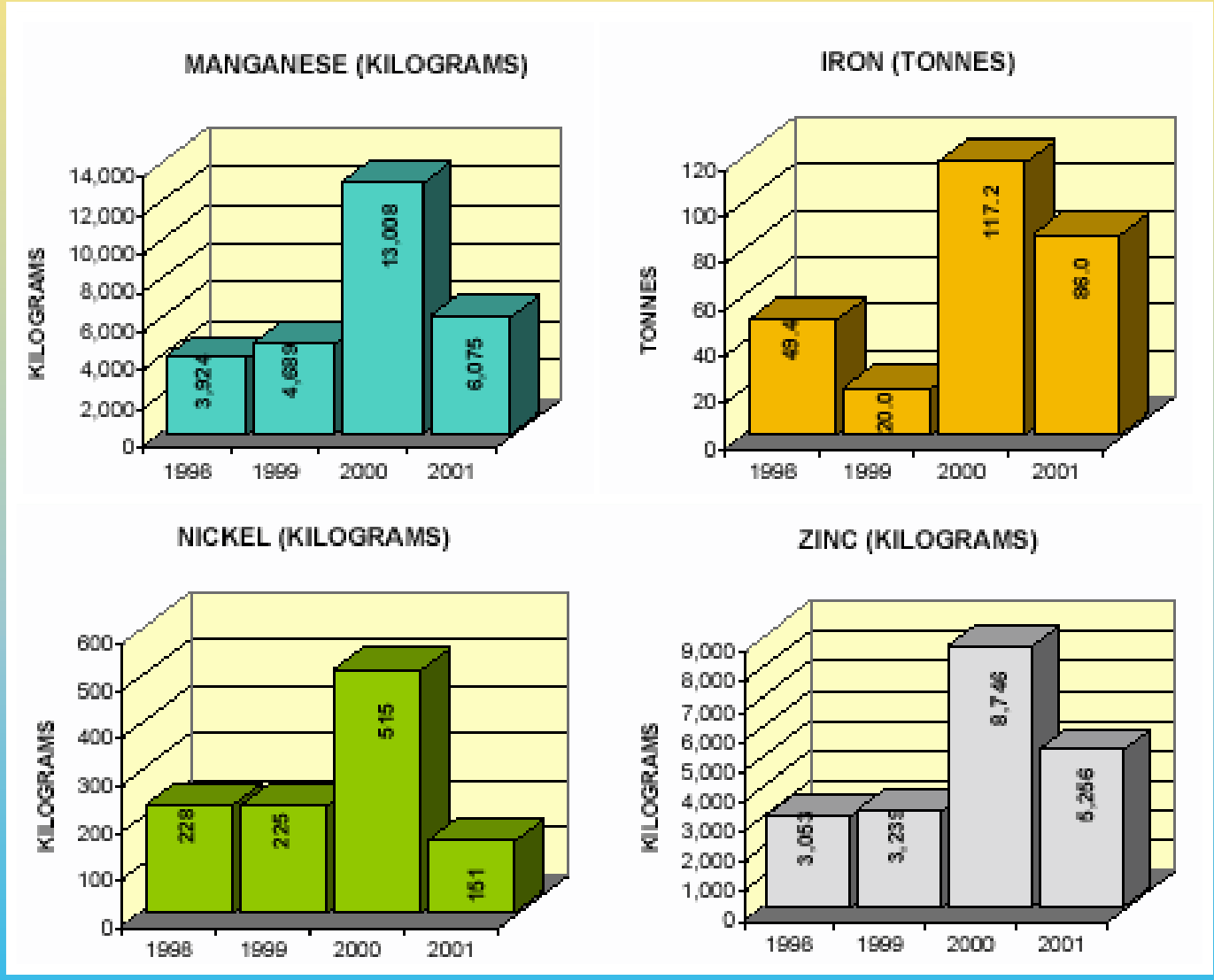
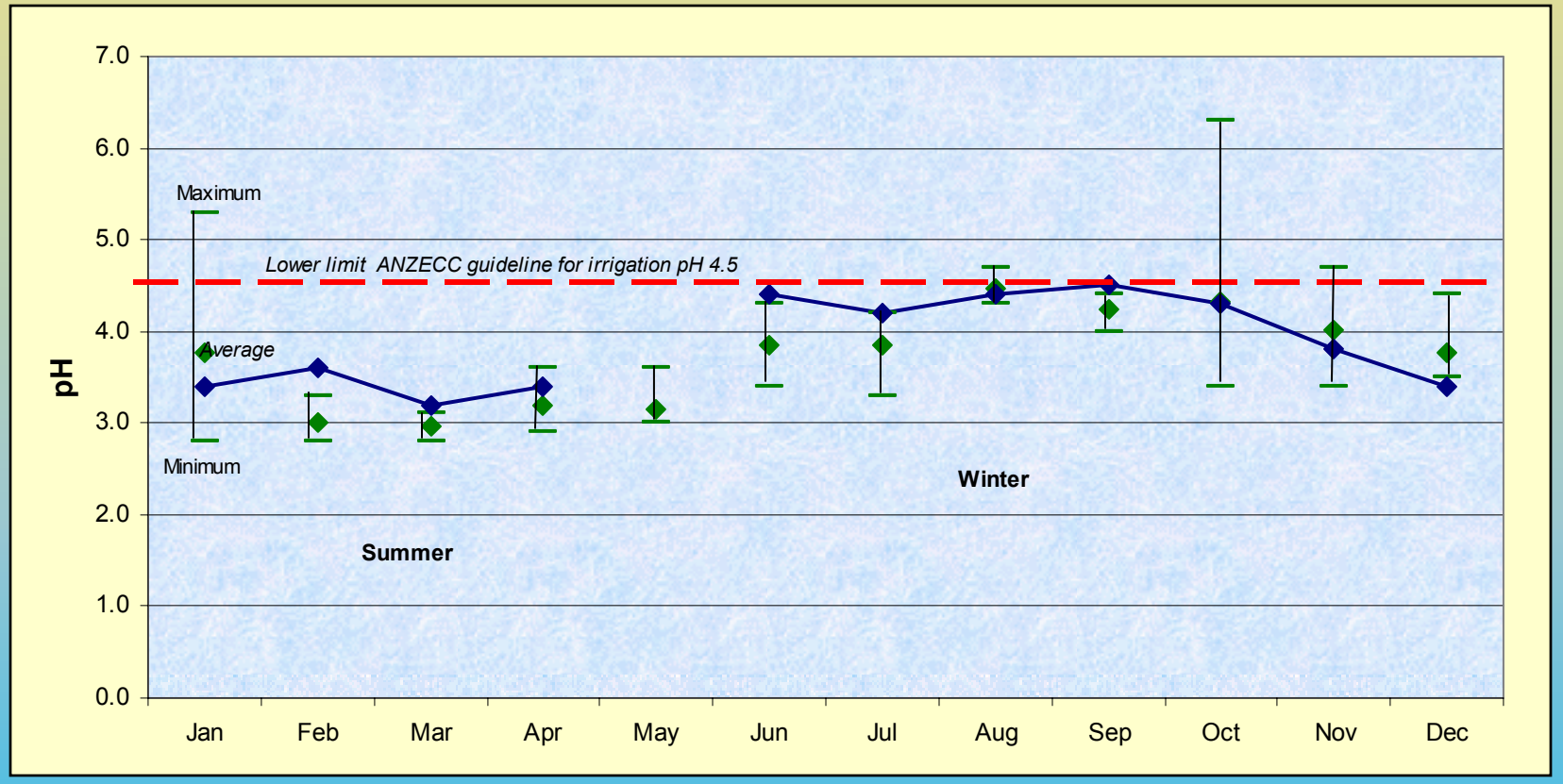

MANGANESE (KILOGRAMS)
KILOGRAMS
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
3,924
4,689
13,008
6,075
1998
1999
2000
2001
IRON (TONNES)
TONNES
120
100
80
60
40
20
0
49.4
20.0
117.2
88.0
1998
1999
2000
2001
NICKEL (KILOGRAMS)
KILOGRAMS
600
500
400
300
200
100
0
228
225
515
151
1998
1999
2000
2001
ZINC (KILOGRAMS)
KILOGRAMS
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
3,051
3,235
8,746
5,256
1998
1999
2000
2001

BRUKUNGA – WATER QUALITY

- Sampled at 8 localities
- Analysed for pH, TDS, conductivity
  Cu, Fe, Pb, Mn, Al, Ni, Cd, Zn, Cr, SO_4^{2-}
- Ecosystem impact - macroinverterbrates

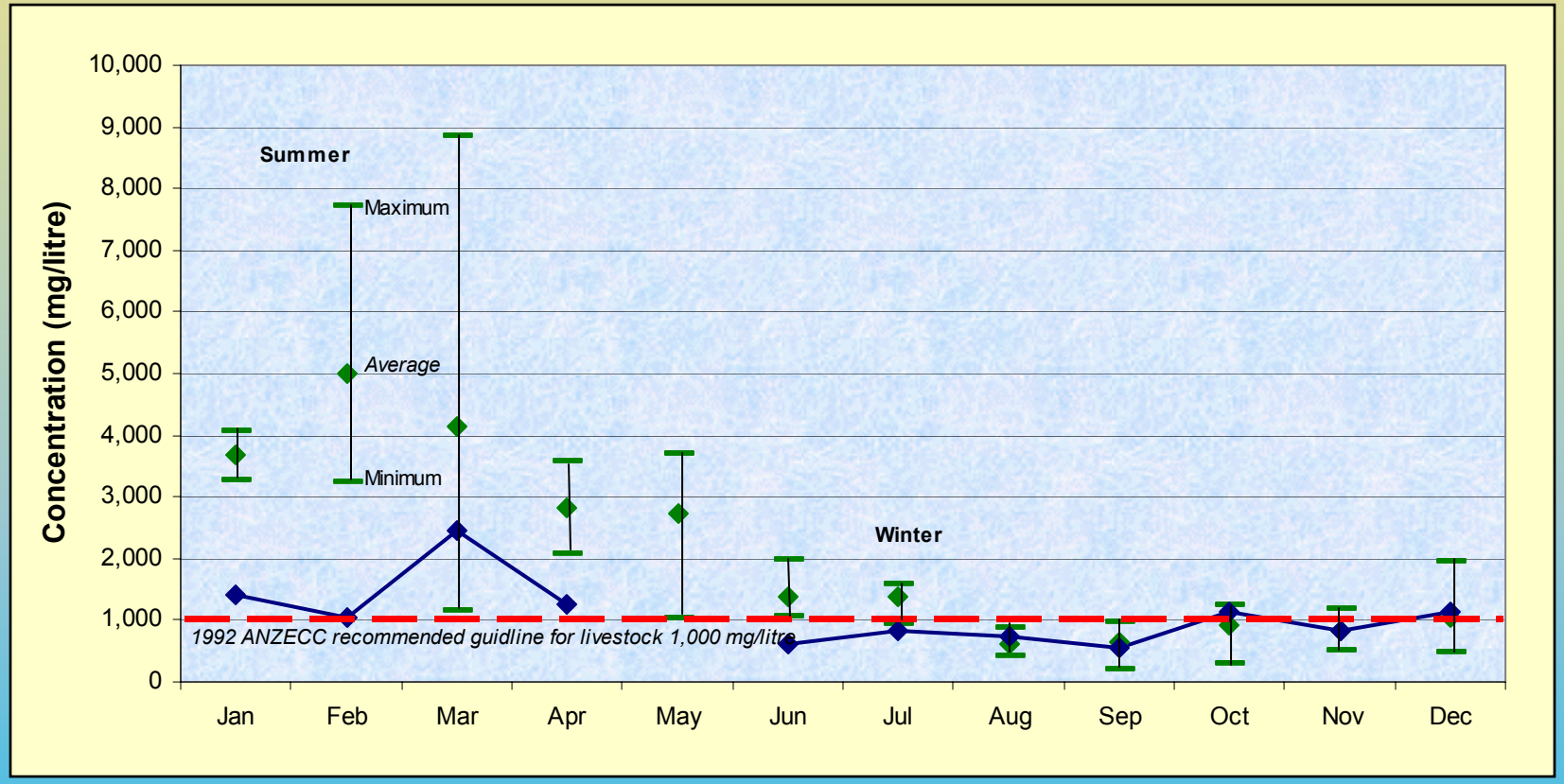
2002 pH results

against four year average Dawesley Creek as it leaves the Brukunga Mine site



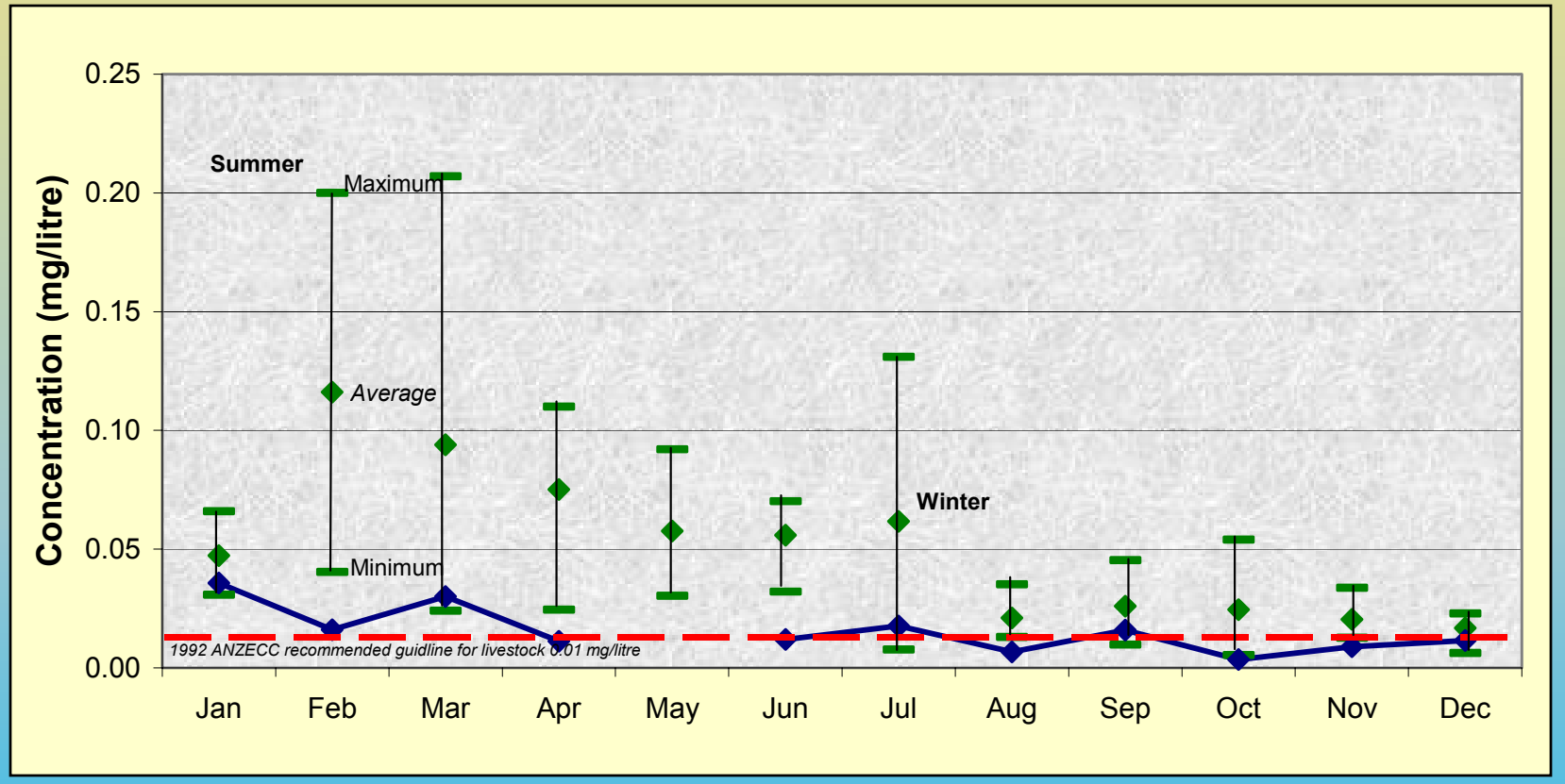
2002 Sulphate results

against four year average Dawesley Creek water as it leaves the Brukunga Mine site



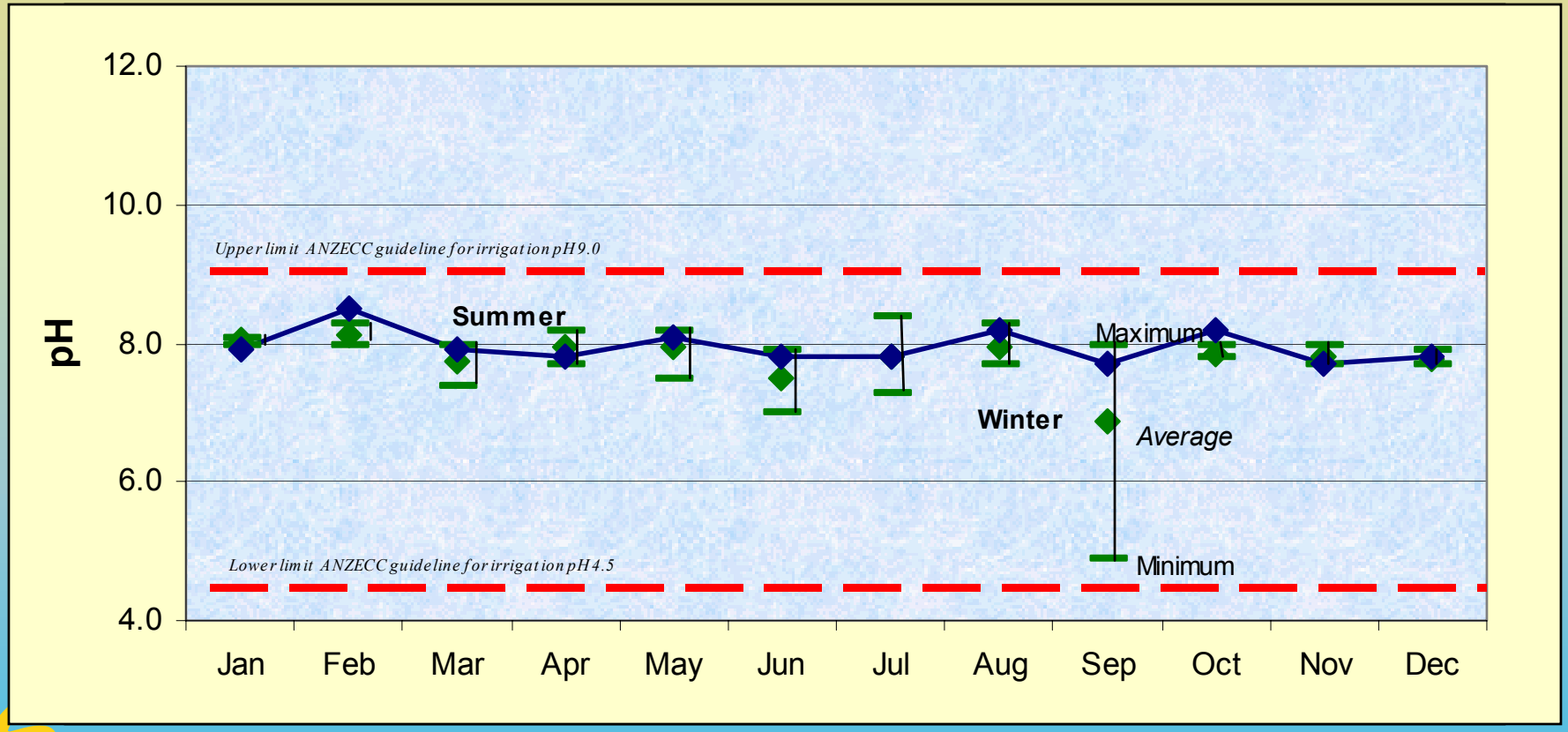
2002 Cadmium results

against four year average Dawesley Creek water as it leaves the Brukunga Mine site



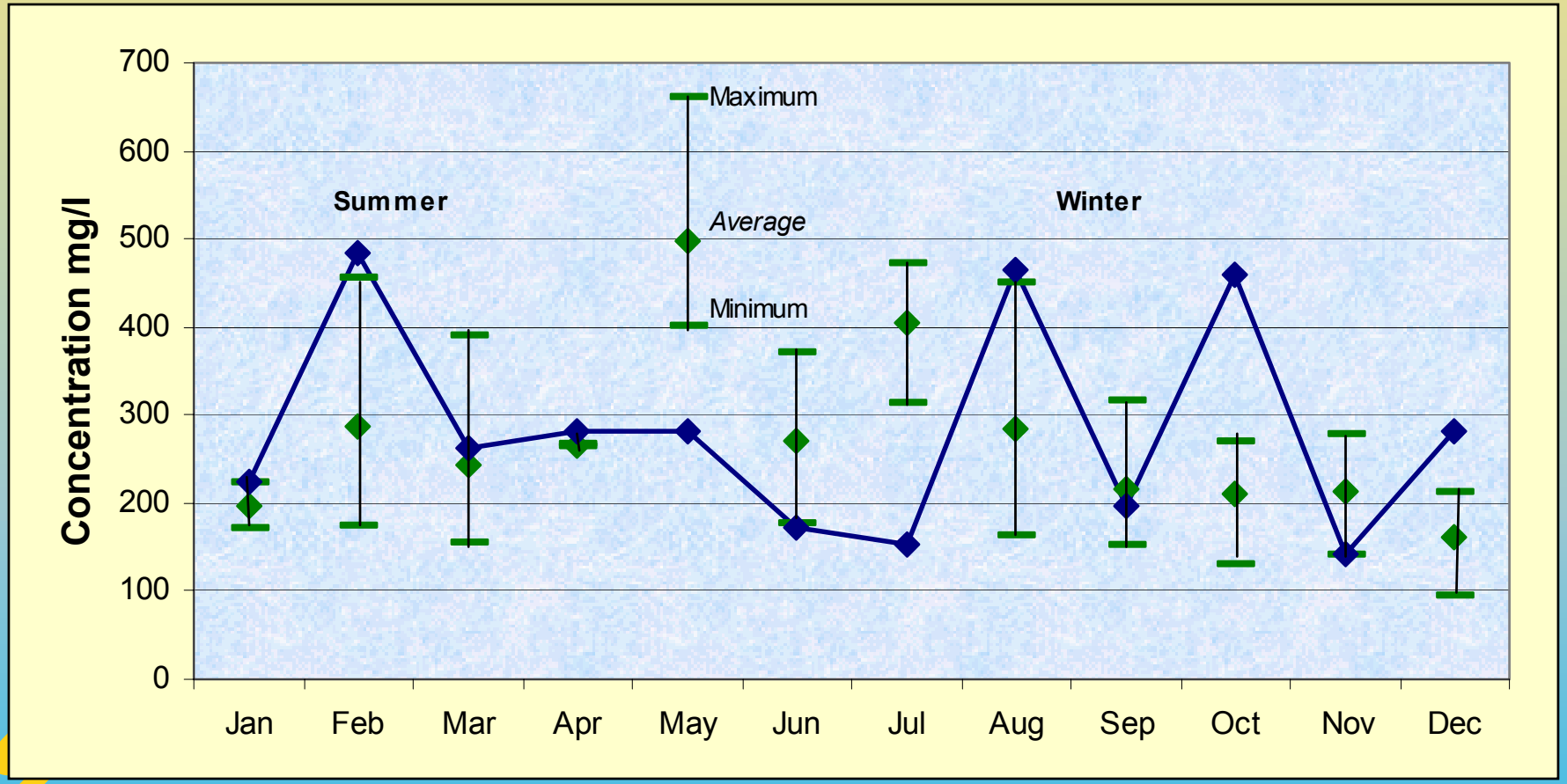
2002 pH results

against four year average Mt Barker water downstream of the Brukunga Mine site



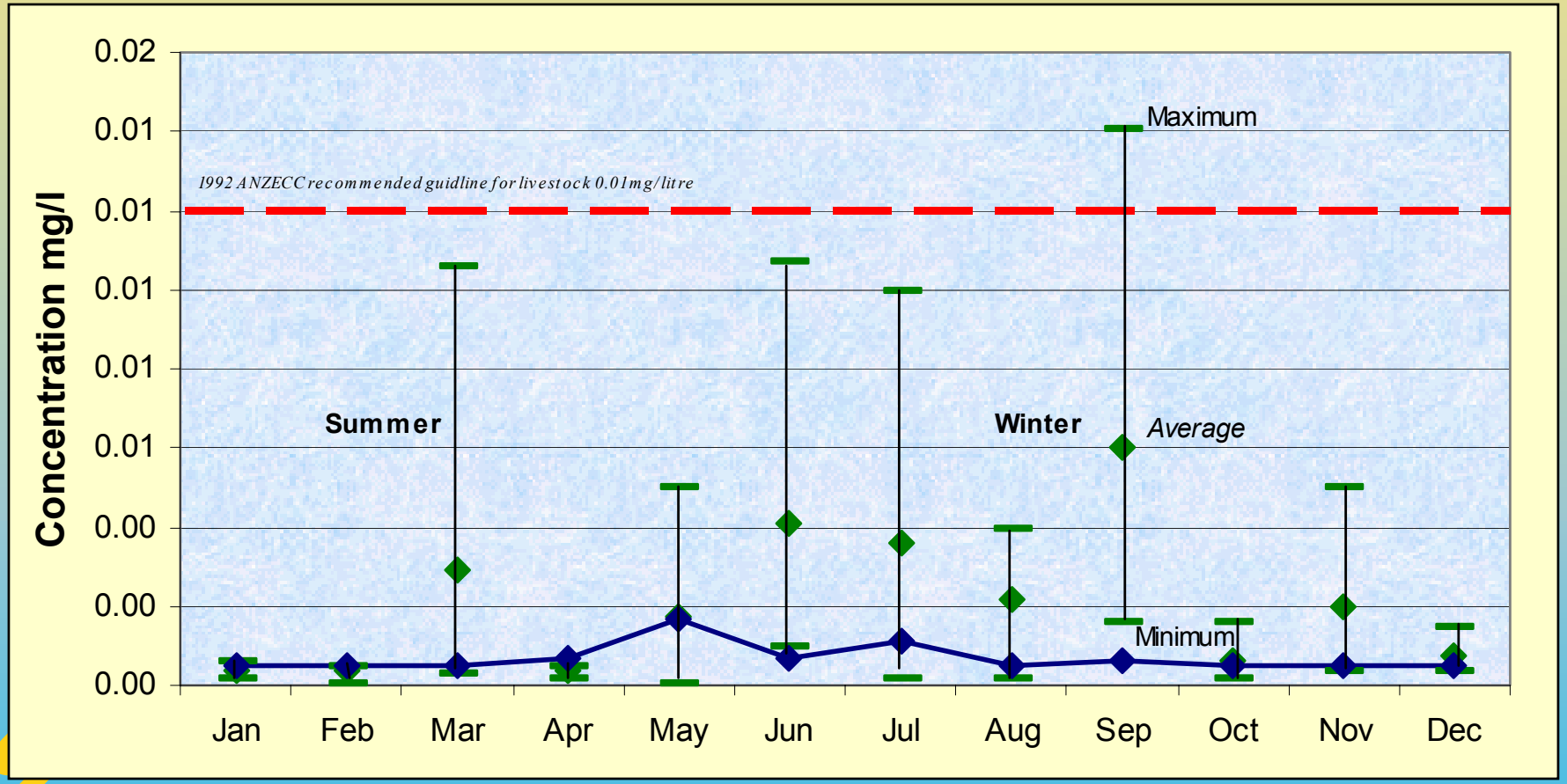
2002 Sulphate results

against four year average Mt Barker water downstream of the Brukunga Mine site

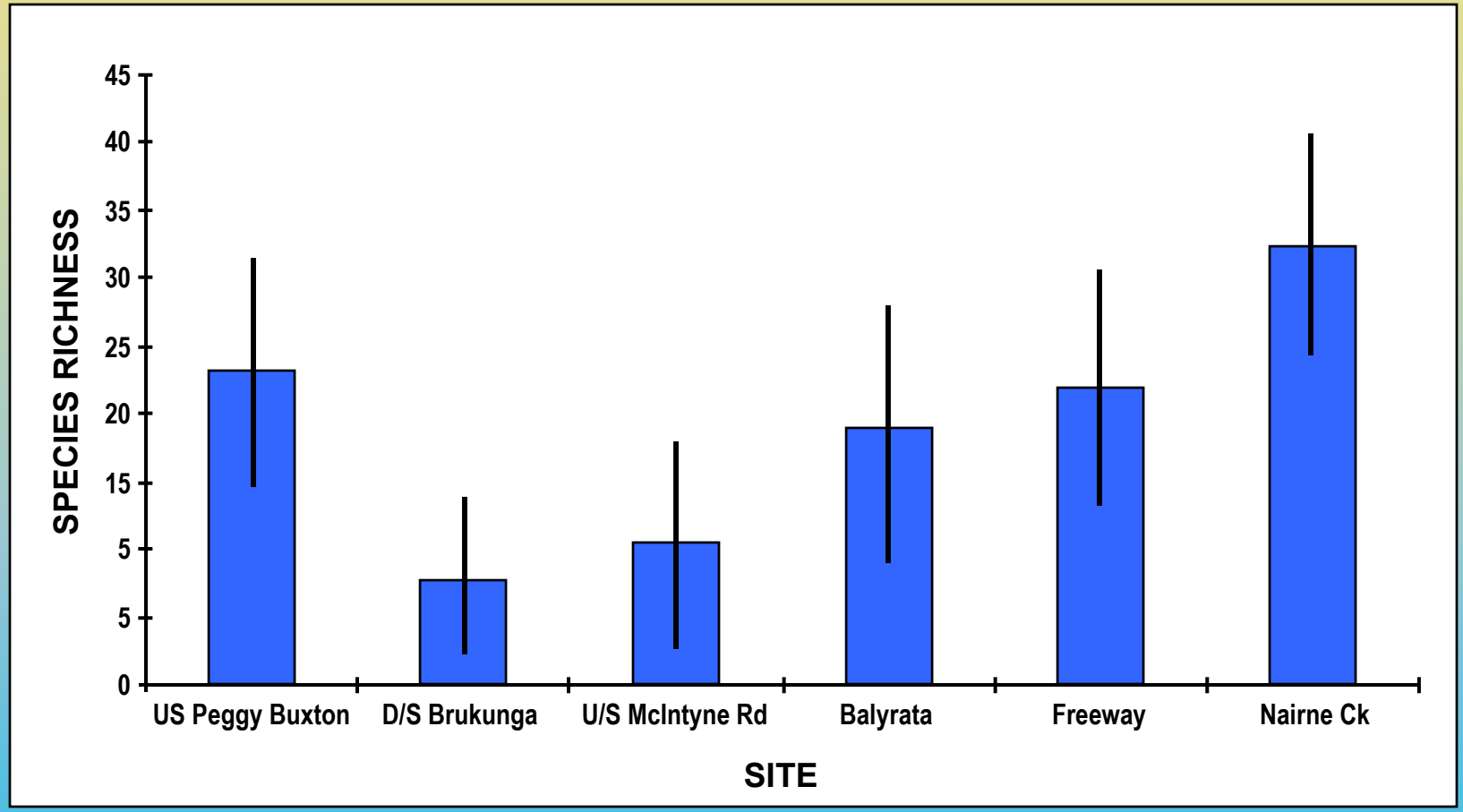


2002 Cadmium results

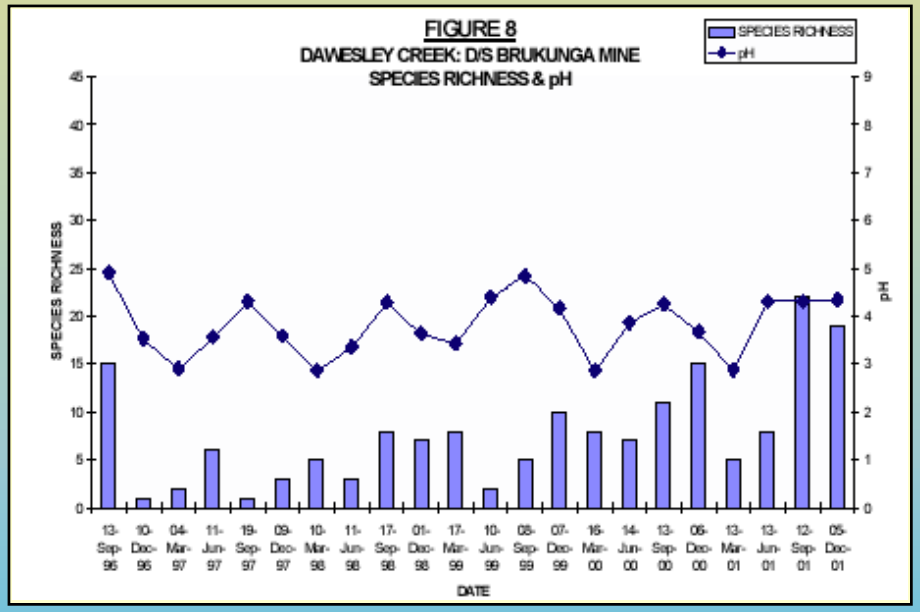
against four year average Mt Barker water downstream of the Brukunga Mine site

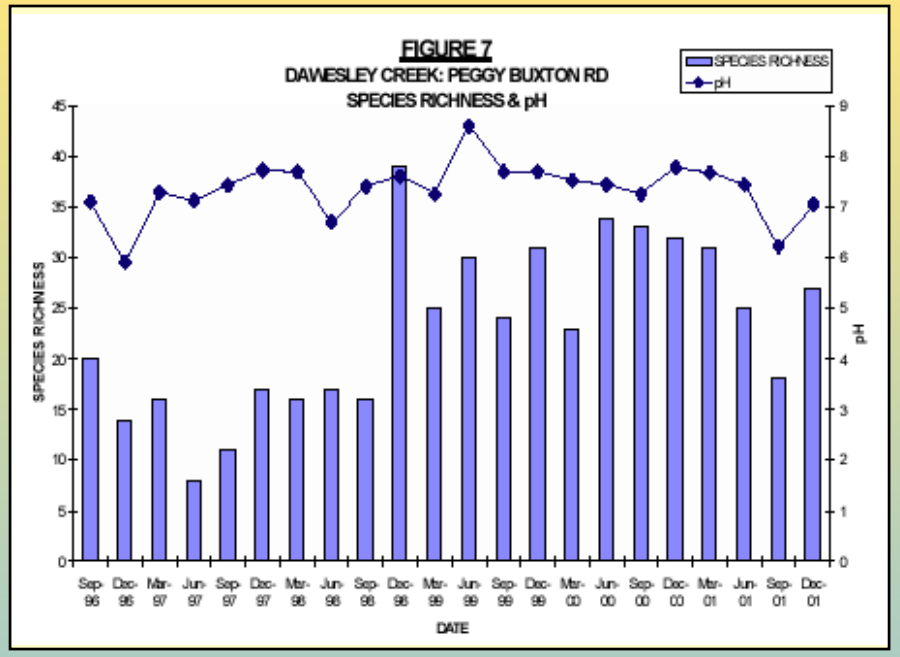


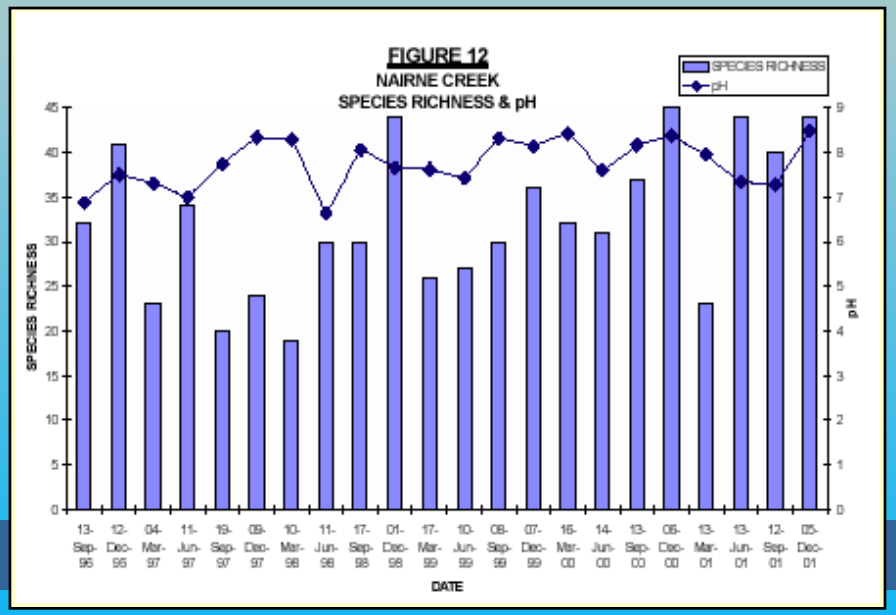
Dawsley Creek system-mean & Standard deviation species riches six sites: 1996-2001



Species richness and pH







BRUKUNGA - MONITORING

- Depth to water table in TSF
- Ecology –
  - algal activity
  - benthic diatoms
  - freshwater shrimp
  - aquatic fungi
  - microbial communities
- Groundwater hydrology
- Soils and stream sediments
- Oxidation rates

BRUKUNGA – ENVIRONMENTAL MANAGEMENT

- Water collection
- Neutralisation plant
- Rehabilitation of TSF
- Rehabilitation of waste rock dumps
- Rehabilitation of quarry faces

BRUKUNGA RESEARCH

By ANSTO, CSIRO, AWT, AWQC and tertiary institutions

- **impact of biosoloids and neutralisation sludge**
- **oxidation rates**
- **development of ecological risk assessment protocol**
- **Cd/Zn contamination in soils**
- **aquatic ecosystems**

... cont.

BRUKUNGA RESEARCH - cont.

By ANSTO, CSIRO, AWT, AWQC and tertiary institutions

- **microbiological reduction of AMD**
- **hardpan / cement formation**
- **porous reactive wall to remove contaminants**
- **ecotoxicology**
- **hyperspectral remote sensing**

BRUKUNGA – ENVIRONMENTAL IMPROVEMENT PLAN

- Diversion of Dawesley Creek
- Additional lime treatment capacity
- Relocation of rock dumps
- Community consultation
- BMSR Board – activities
- Informal liaison
- Aboriginal heritage

BRUKUNGA – MAINTENANCE COSTS

Total = $650,000 (2001 – 02)

- Salaries ($150,000)
- EPA Licence ($12,900)
- Monitoring program ($67,300)
- Power ($25,200)
- Lime and flocculant ($77,800)
- Relocation of neutralisation sludge ($85,700)
- Overall maintenance ($205,300)

BRUKUNGA – CONCLUSIONS

- A legacy of poor practices
- Contamination of Dawesley Creek
- “Band-aid” treatment to date
- Concerted effort by PIRSA to fix problems
- Community consultation
- Good example of attitude changes during last 20 - 30 years

ACKNOWLEDGEMENTS

- PIRSA for permission to publish
- Peter Grindley for continued insight
- Members of the BMSR Board
- All those who made data available