Avoiding impacts of the aquatic ecosystem

Barry N Noller

EnTOX

National Research Centre for Environmental Toxicology

The University of Queensland,QLD 4108, Australia.

Introduction

- Location and mining
- “Top End” region north of 15°S
- Pine Creek Geosyncline
- Review waste water management practices at mine sites in the Northern Territory

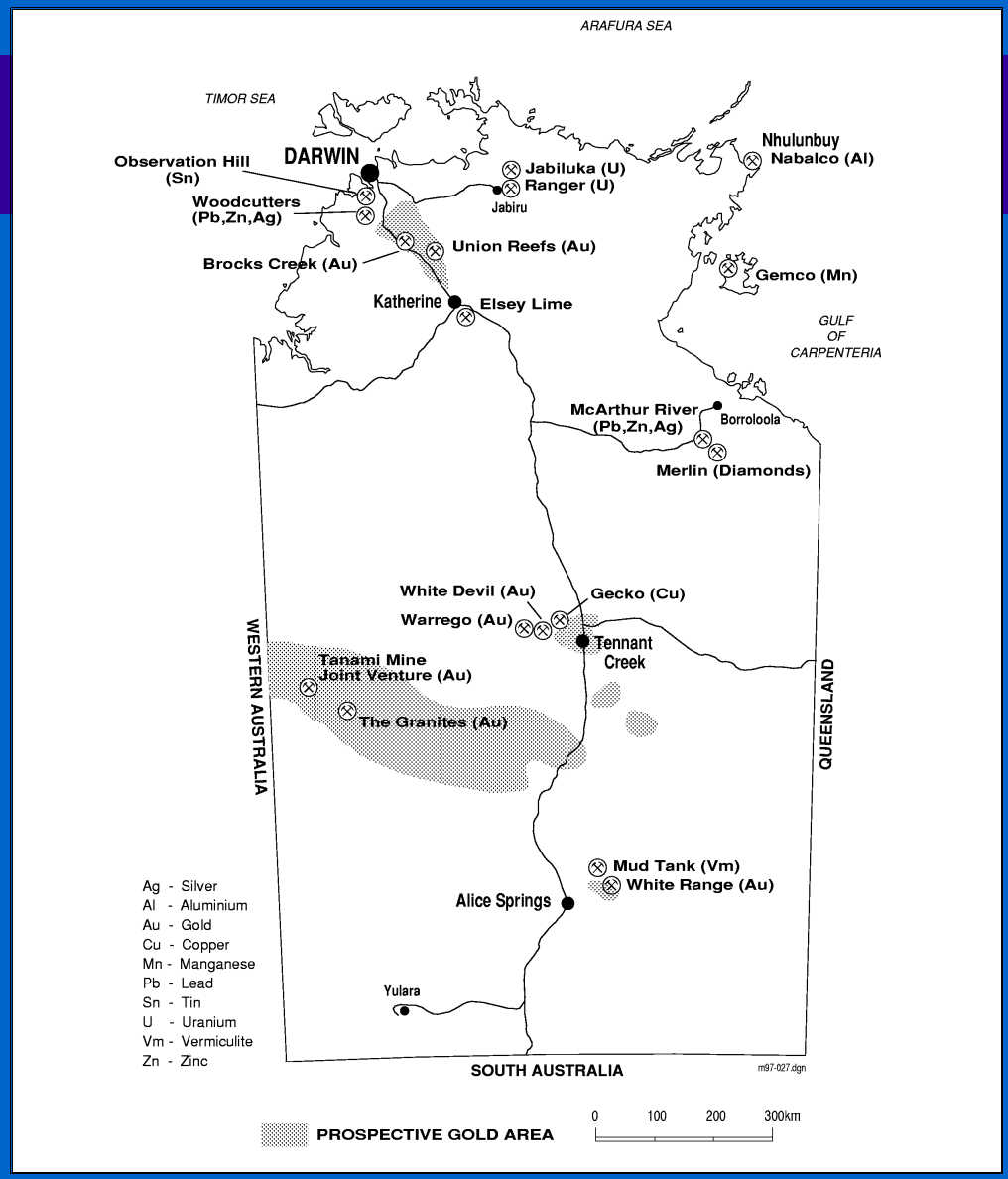

Figure 2 Major mines and commodities in the Northern Territory.

Climate

- “Top End” of Northern Territory lies within the tropical monsoonal zone
- Maximum average of 21 rain days in January
- Minimum average near zero in August

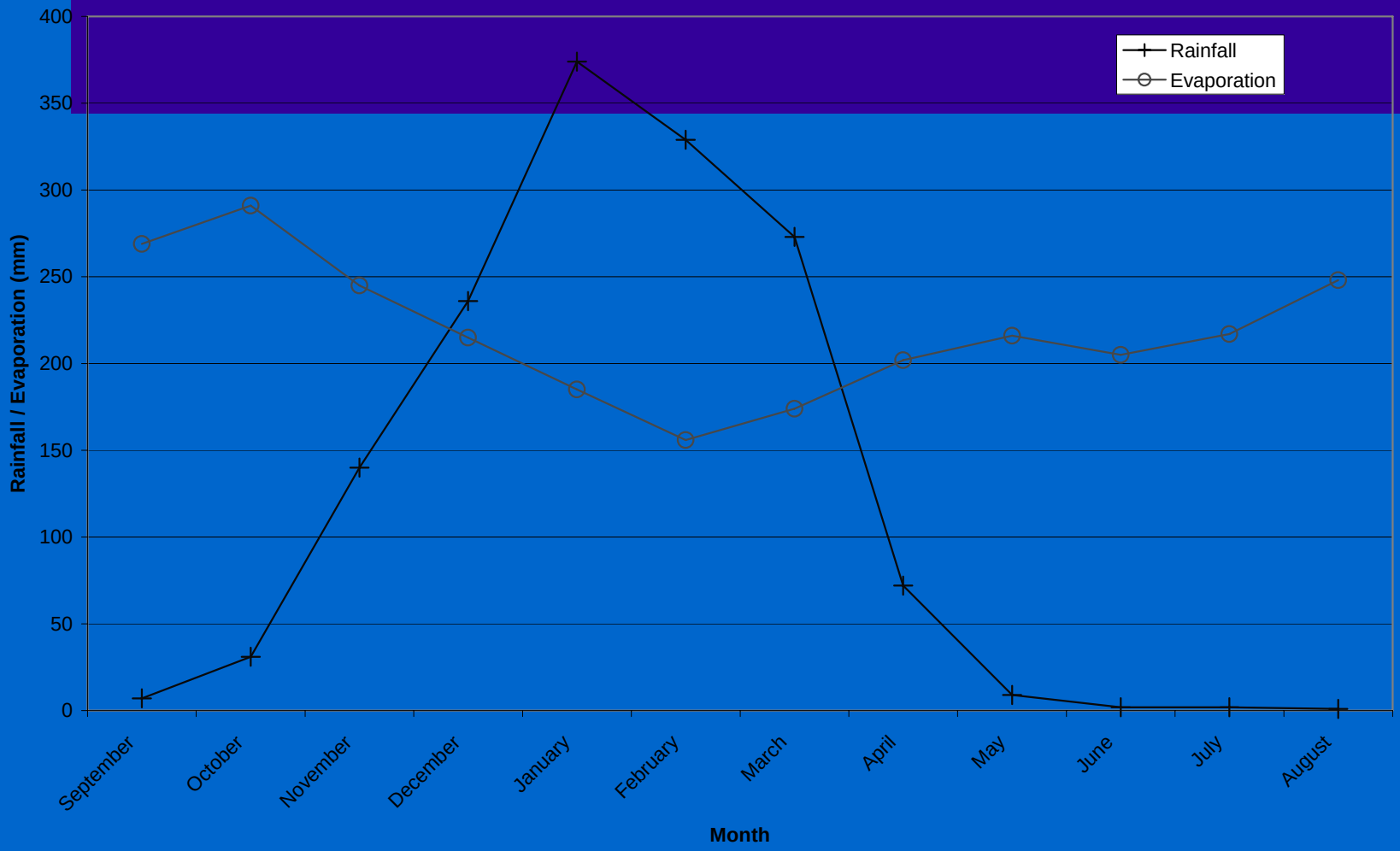

Figure 1 Average monthly rainfall and evaporation (mm) at Jabiru Airstrip.

Sources of contaminated water on mine sites

- Pit and underground dewatering
- Process water storage
- Seepage or overflow
- Pits

Waste water and its impact

- Acidic waters
- Circumneutral waters
- Slightly alkaline waters

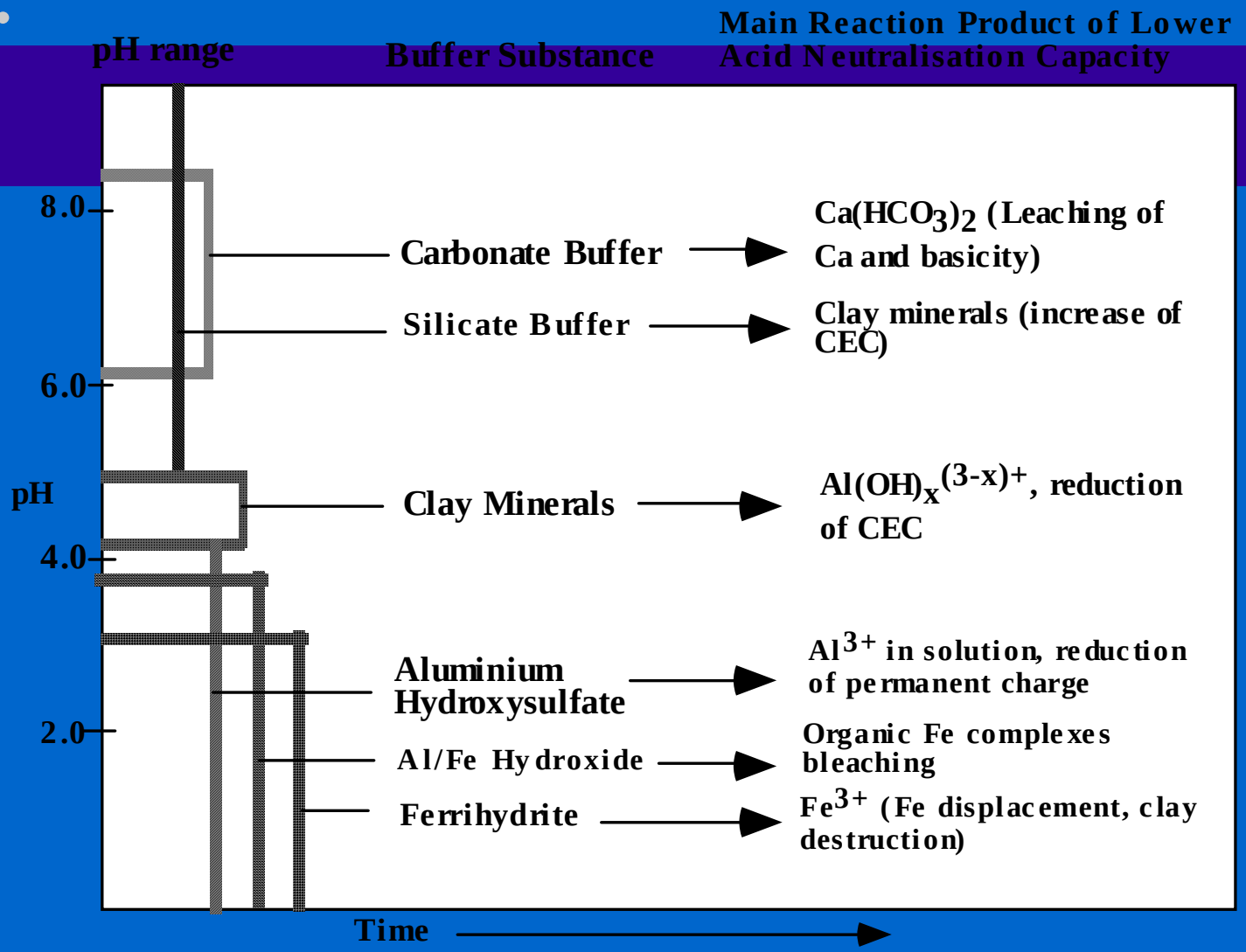

Figure 3 Buffer zones in natural waters, and products of buffer reactions.

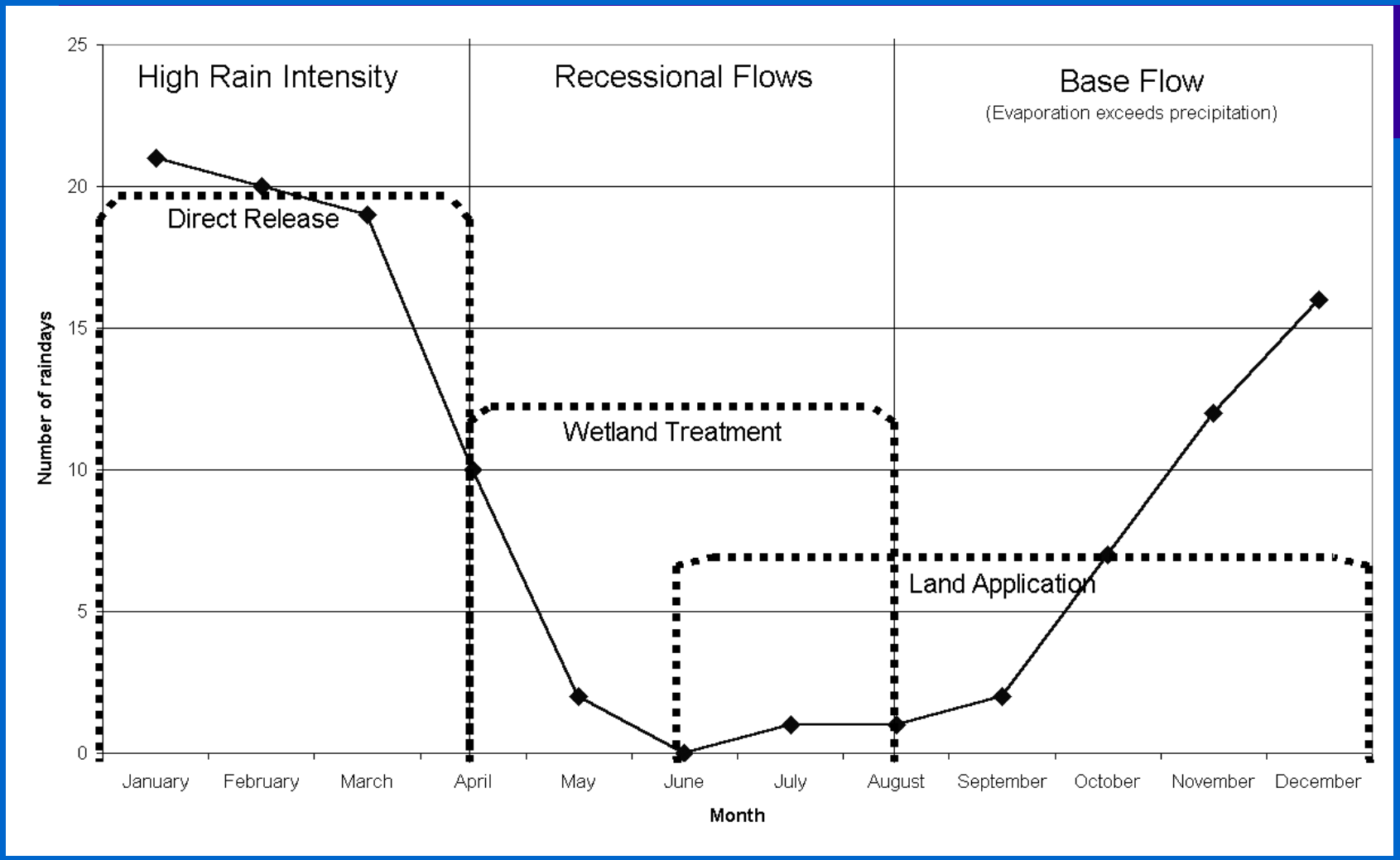

Figure 4 Plot of average number of raindays per month and best times for water release.

Reducing the amount of accumulated water

- Methods and timing
- Legislation

Northern Territory Water Act

The NT Water Act (1998) states:

"A person shall not, unless authorised to do so by or under this or any other law in force in the Territory and in accordance with that authorisation, wilfully cause, either directly or indirectly -

(a) waste to come into contact with water; or

(b) water to be polluted,

causing serious environmental harm."

NT Water Act Cont

to pollute means *"directly or indirectly to alter the physical, thermal, chemical, biological or radioactive properties of the water so as to render it less fit for a prescribed beneficial use for which it is or may reasonably be used, or to cause a condition which is hazardous or potentially hazardous to - (a) public health, safety or welfare; (b) animals, birds, fish or aquatic life or other organisms; or (c) plants;"*.

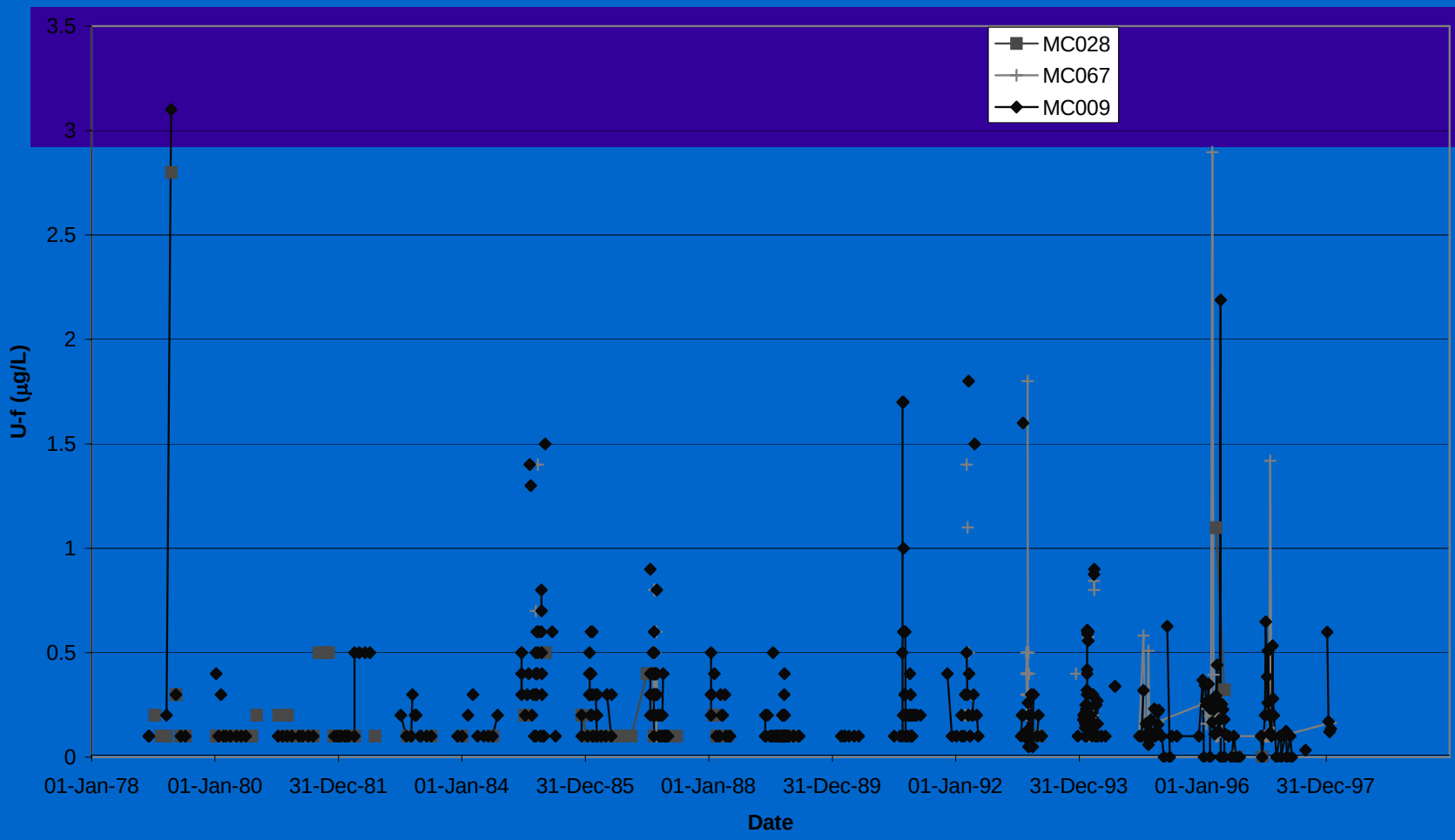

Figure 5 Filterable uranium concentrations (µg/L) in Magela Creek (MG028 and MG067 upstream of mine operations and MG009 downstream of mine operations).

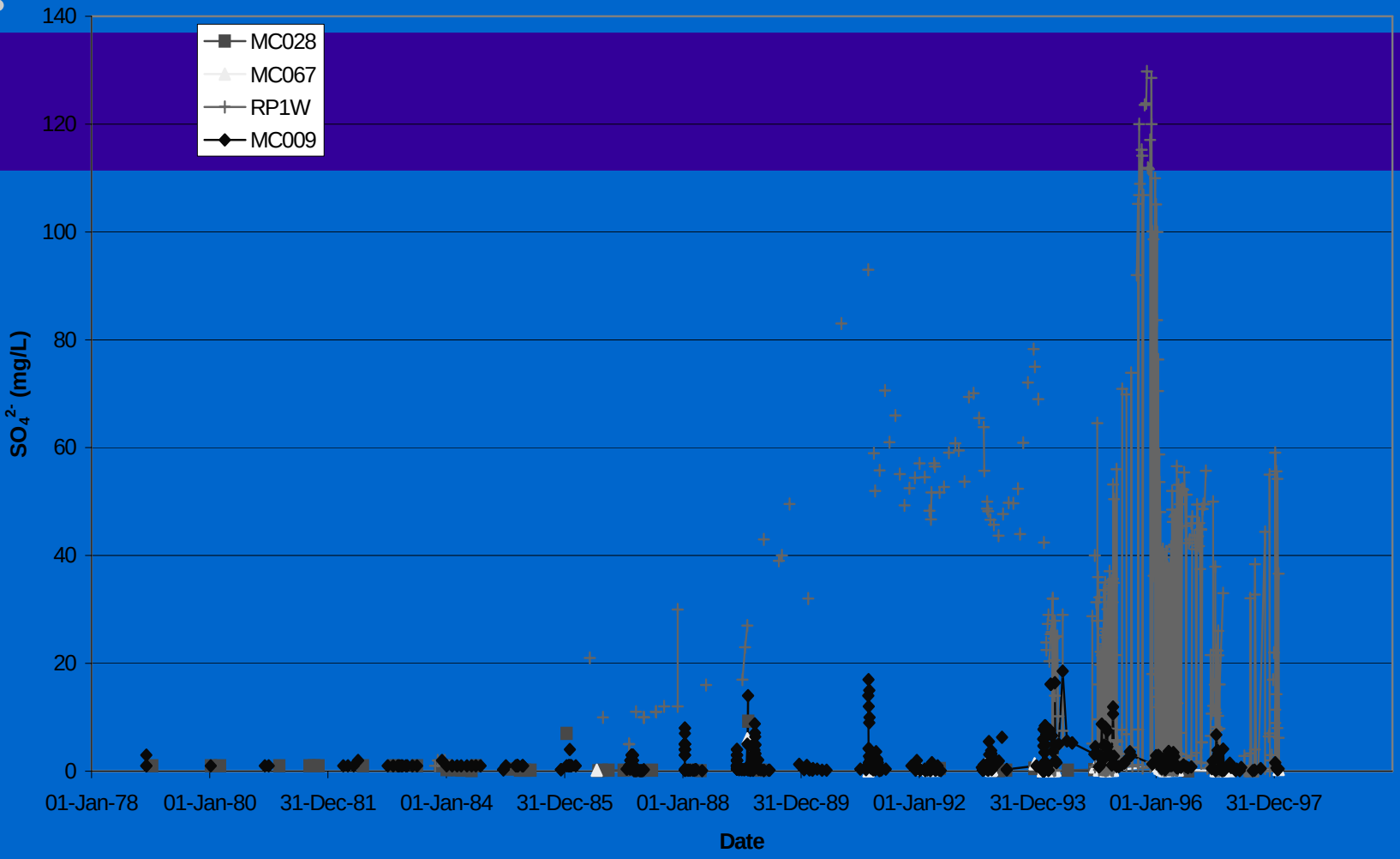

Figure 6 Sulfate concentrations (mg/L) in Magela Creek and RP1 (MG028 and MG067 upstream of mine operations and MG009 downstream of mine operations).

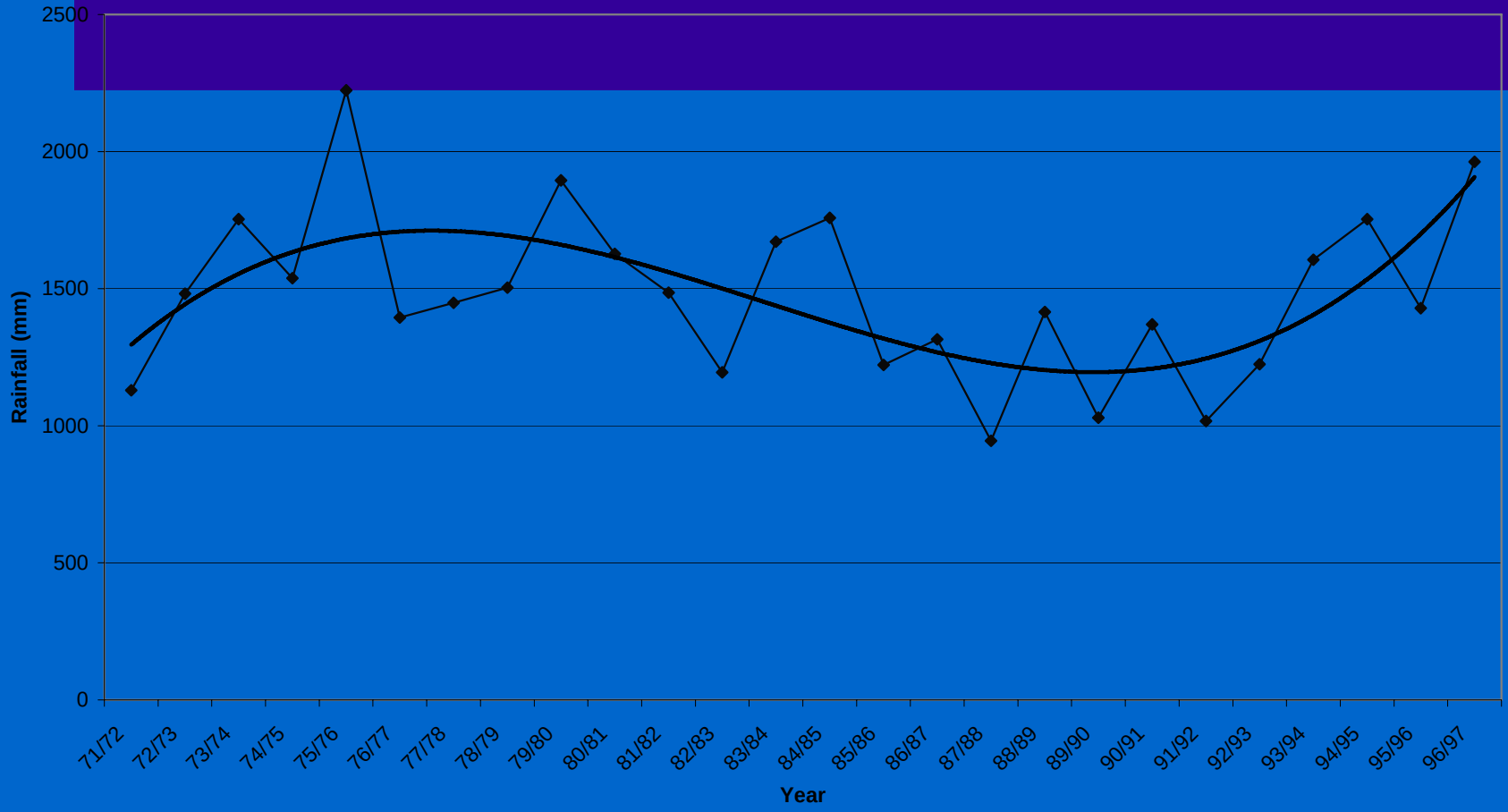

Figure 7 Annual rainfall (and trend line) at Jabiru Airstrip.

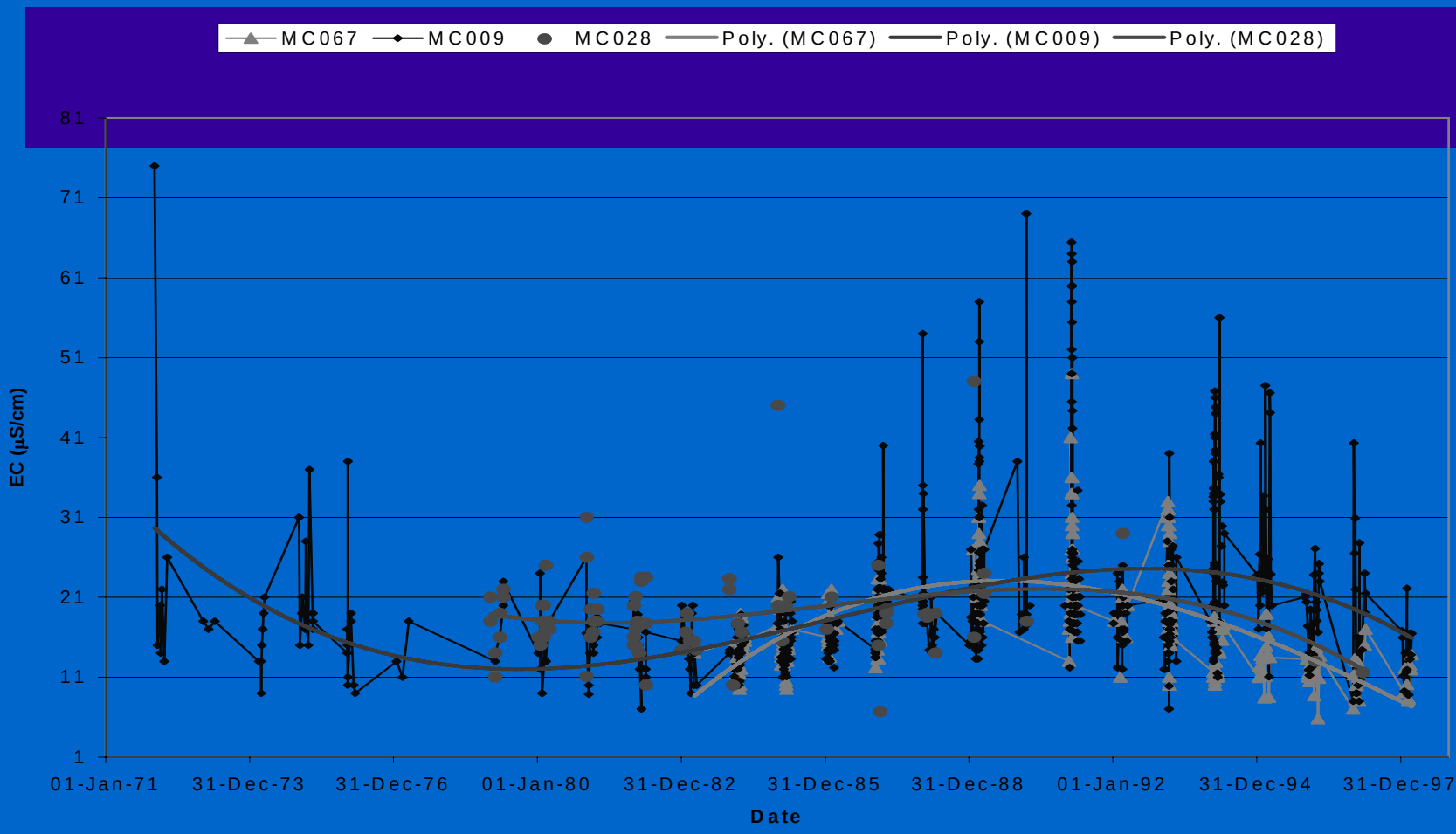

Figure 8 Electrical Conductivity (µS/cm) and trendlines in Magela Creek (MG028 and MG067 upstream of mine operations and MG009 downstream of mine operations).

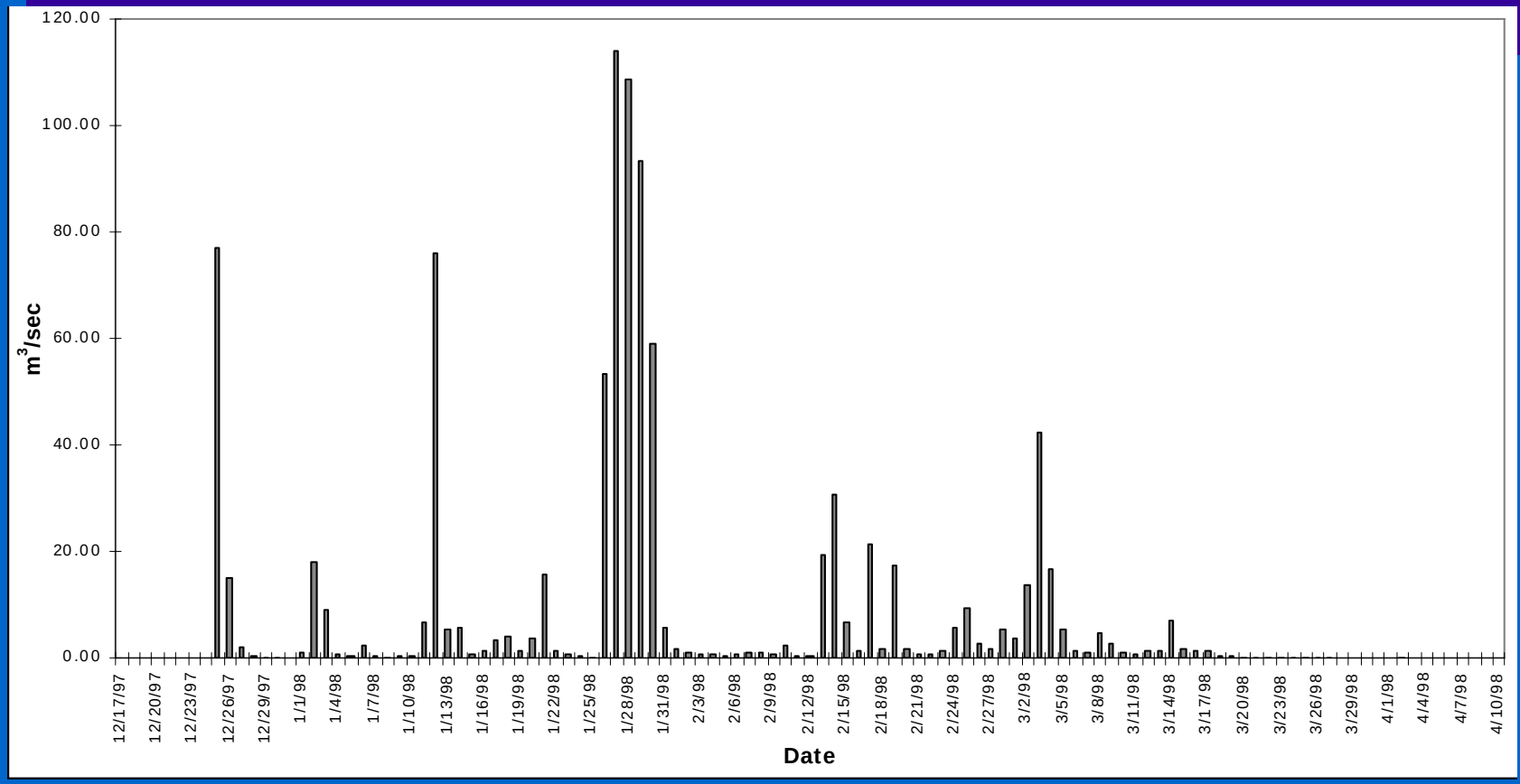

Figure 9 1997/98 flow data in Howley Creek

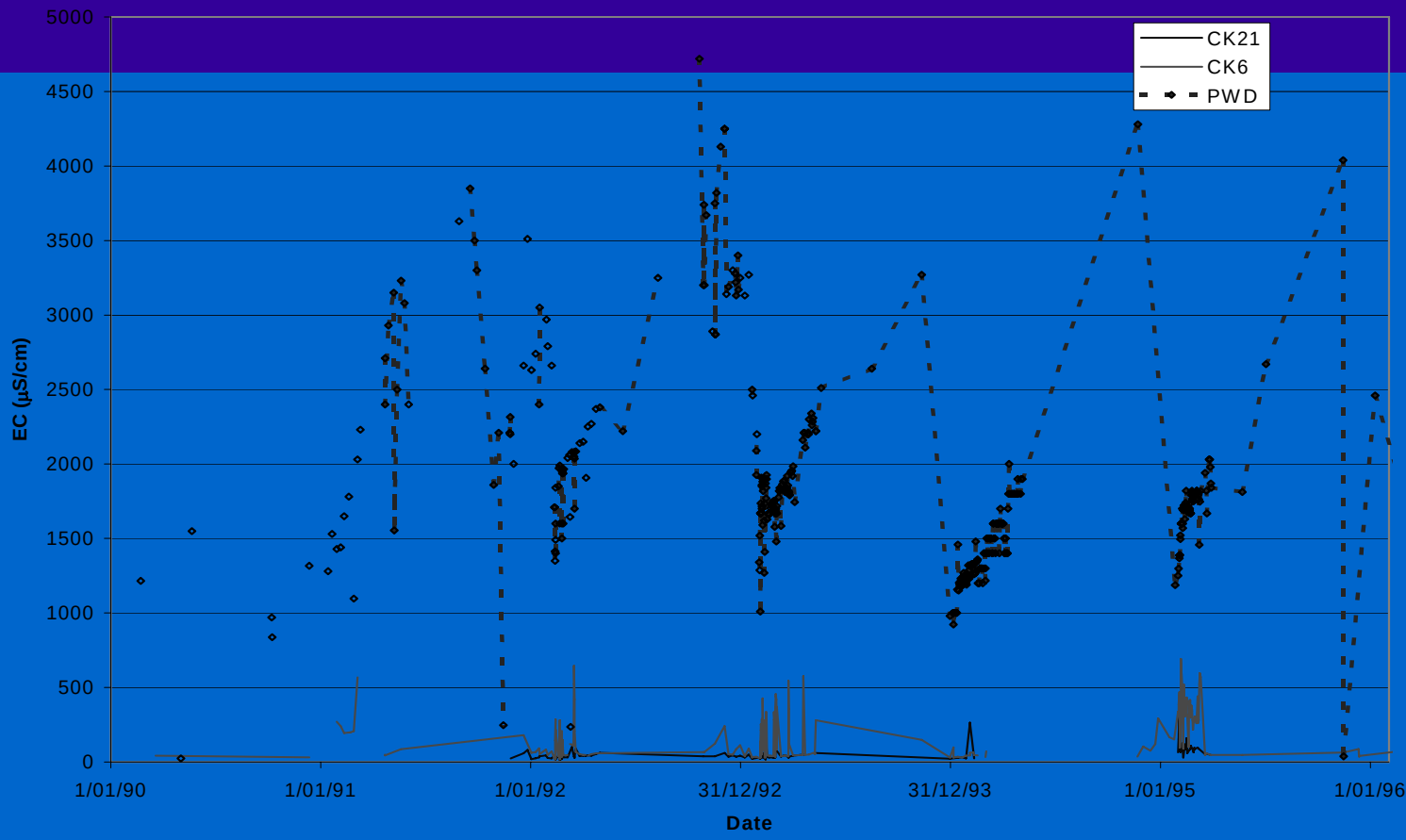

Figure 10 Electrical Conductivity in the Pine Creek Gold Mine Process Water Dam (PWD), and downstream, Copperfield Creek.

Water release in practice
Issues to consider

- Beneficial use of downstream waters is determined
- ANZECC guidelines were revised in 2000
- Tropical surface waters may have very little buffering

Biological pre-release testing of waste water at Ranger Mine

- Water Flea (*Moinodaphnia macleayi*); a microcrustacean – Reproduction
- Green Hydra (*Hydra viridissima*), a cniderian – Population growth
- Chequered Rainbowfish (*Melanotaenia splendida inornata*), a fish – Embryo mortality

Nature of floods

Methods of water release (use of spillways)

- Stream flow: stream gauging needs to be undertaken and flow measured
- Meteorological data: rainfall and evaporation
- Precise catchment delineation
- Other sources of water (ie. groundwater ingress etc.)
- Catchment runoff coefficients

Revised ANZECC 2000 guidelines

Concept of management framework

- Strategy
- Environmental values (replacing beneficial uses)
- Environmental goals
- Water quality guidelines
- Water quality management strategies
- The use of water quality prediction models

Revised ANZECC 2000 Guidelines

Guideline Applications

- Primary considerations
- Cooperative best management
- Water resource management
- Guidelines for site-specific conditions
- Derivation of guidelines

Revised ANZECC 2000 Guidelines

Guideline Principles

- Achieving ESD involves the application of two core principles :
  - Inter-generational equity
  - Conservation of biological diversity

Revised ANZECC 2000Guidelines

Three further principles

- Involve all spheres of government, community, local and indigenous groups and the private sector
- Link to the National Strategies for ESD, Wetlands and Biological Diversity
- Ongoing research into ecosystem wellbeing

Aquatic ecosystems

Classification into 3 broad categories

- Geographical (inland, estuarine, coastal/marine);
- Climatic (tropical, temperate, arid); and
- A combination of geography and/or climate coupled with various key physical factors (eg salinity, hydrodynamics, hydrology etc.)

Aquatic ecosystems

Division of freshwater and marine systems

- Freshwater (flowing or standing);
- Lakes and reservoirs (with or without wetlands);
- Estuarine and drowned river valleys; and
- Coastal and marine (barrier lagoons or embayments and open coasts)

Concept of level of protection 3 Ecosystem Conditions

* high conservation/ecological value systems;
* substantially natural systems; and
* highly modified systems.

Aquatic Ecosystems
Selection of level of protection

(i) Maintenance of the current ecosystem condition

(ii) Enhancing a modified ecosystem by adopting the most appropriate conditions

Water discharge under ANZECC 2000

- Go through ANZECC process and determine Environmental values
- Determine suitable sampling sites
- Acquire baseline data sets

Following the commencement of mining

- Characterise waste water (ICP MS scan)
- Undertake detailed catchment modelling
- Undertake pre-release toxicity testing
- Undertake aquatic assemblages survey
- Undertake bio-accumulation studies with organisms

Conclusions

- Water release at tropical locations has been haphazard but showing positive development
- The ANZECC 2000 criteria aim to provide better approach, adapting to local conditions
- Water discharge in the tropics requires attention to the end of flow phase as well as event-based release