

# Urban Water Security Research Alliance



## ***N*-nitrosodimethylamine Formation Potential for South East Queensland Potable Water**

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**DBP Formation and Minimisation in Drinking Water**

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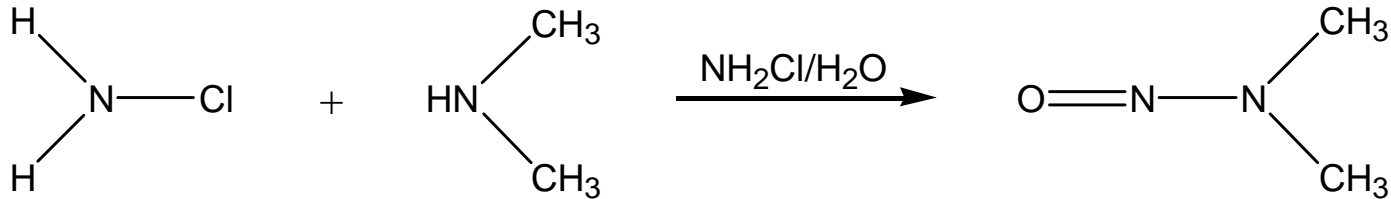


# Disinfection By-products

- Chlorination & chloramination are widely used in South East Queensland for potable water disinfection.
- Toxic disinfection by-products (DBPs) can form
  - Trihalomethanes (THMs)
  - Haloacetic acids (HAAs)
  - Nitrosamines (such as *N*-nitrosodimethylamine)

# N-nitrosodimethylamine (NDMA)

- Formed during chlorine or chloramine disinfection of water containing secondary amines such as dimethylamine.



- Potent carcinogen – WHO recommended guideline value in potable water is 10 ng/L.
  - Currently no Australian Drinking Water Guidelines for NDMA in Australia
- Light sensitive.

# Chlorination vs Chloramination

- Chlorination is generally accepted to form
  - Lower [NDMA] (dependent on nitrogen availability in source water)
  - Higher [THM]
- Chloramination can lead to high [NDMA]
  - can be decreased by WTP protocols ensuring monochloramine is predominant over more highly chlorinated amines.
- Higher residual concentration required for effective disinfection using chloramination.
  - 0.5 mg/L free chlorine
  - 1.5 mg/L monochloramine

# NDMA Formation Potential Experiments

- Form maximum NDMA possible with large excess of monochloramine or chlorine ( $\text{OCl}^-$ )
- Excess necessary to form detectable amount in 1 L sample (Method detection limit 5 ng/L)
- React 1 L sample for 7 days at pH 7 & room temperature, protected from light
- Extract into dichloromethane for analysis by GCMS (chemical ionisation)

# Mt Crosby Water Treatment Plant

- Pre-chlorinate at filters in most but not all cases.



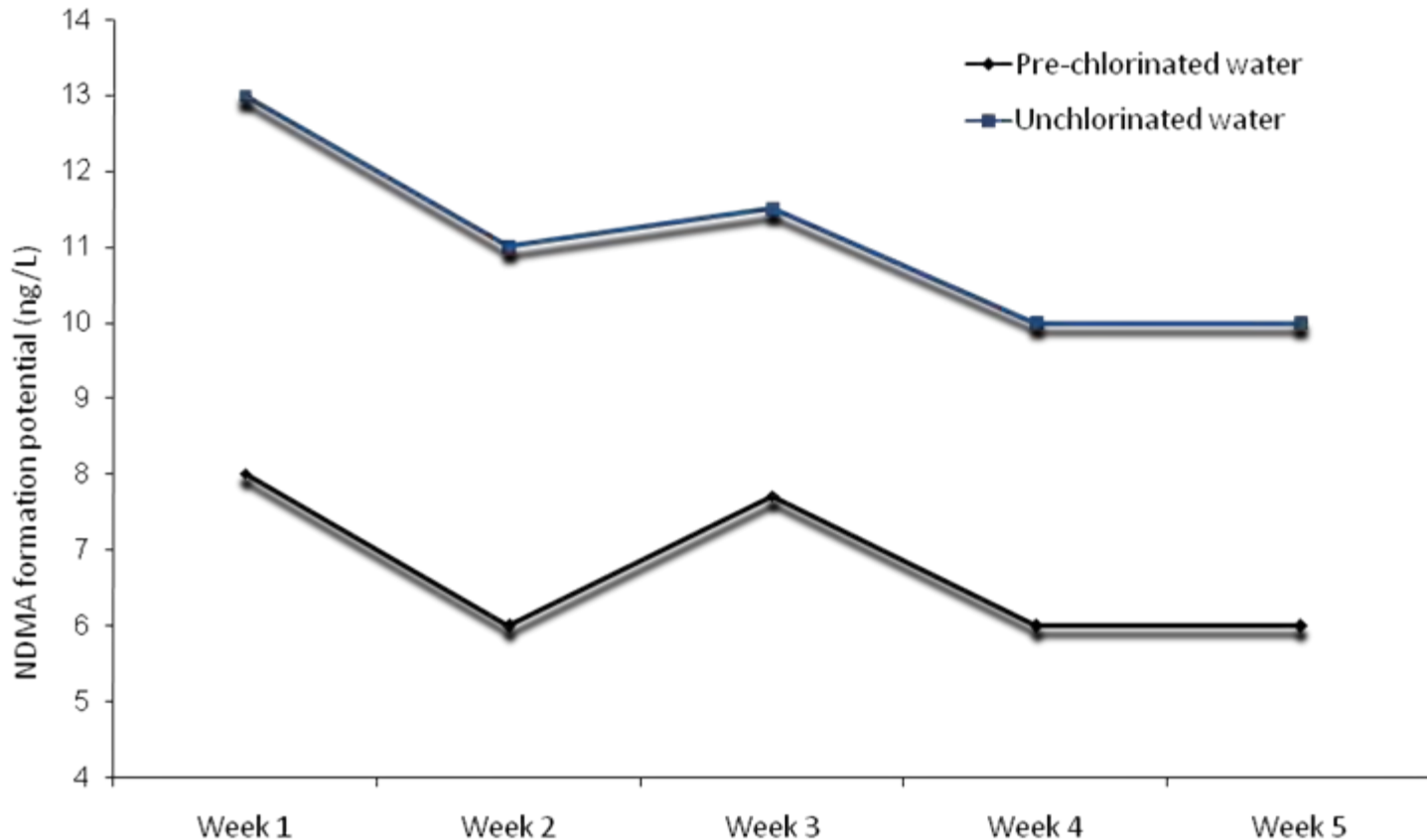
- Two plants
  - East & West bank

# Mt Crosby Water Treatment Plant

- Prechlorinate at most filters then chloraminate
  - Free chlorine contact time 2.5 – 23 hrs, average approx. 6 hrs.
- Actual [NDMA] immediately after chloramination below reporting limit (<5 ng/L).
- Actual [NDMA] at point of supply (QHSS labs, Coopers Plains) below reporting limit for 1<sup>st</sup> L fraction (<5 ng/L).

# Mt Crosby Water Treatment Plant

- Chlorine contact prior to chloramination
  - lower NDMA formation potential (data from West Bank, Mt Crosby WTP).



# North Pine Water Treatment Plant

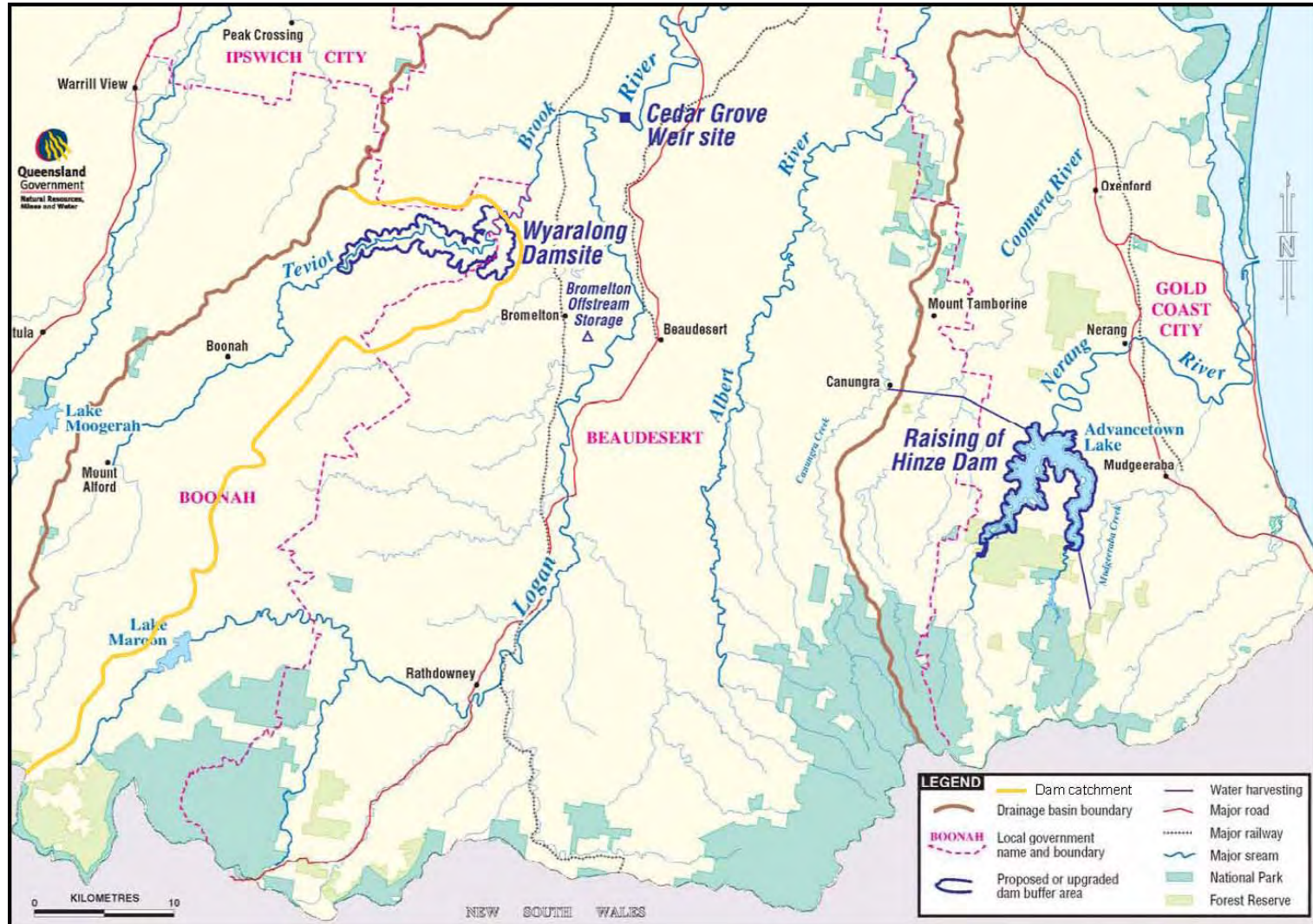
- Prechlorinate at filters then chloraminate
  - Free chlorine contact time 3 – 30 hrs, average approx. 6 hrs.



# North Pine Water Treatment Plant

- Maximum NDMA formation potential
  - *North Pine* – average 7.5 ng/L ( $\sigma = 1.1$  over 4 samples taken once weekly). Similar to pre-chlorinated water from Mt Crosby.
- Actual [NDMA] in chloraminated water leaving the plant
  - below the reporting limit (<5 ng/L)
- Actual [NDMA] at point of supply (Delan St, West Chermside)
  - below the reporting limit (<5 ng/L).

# Wyaralong Dam Site & Cedar Grove Weir

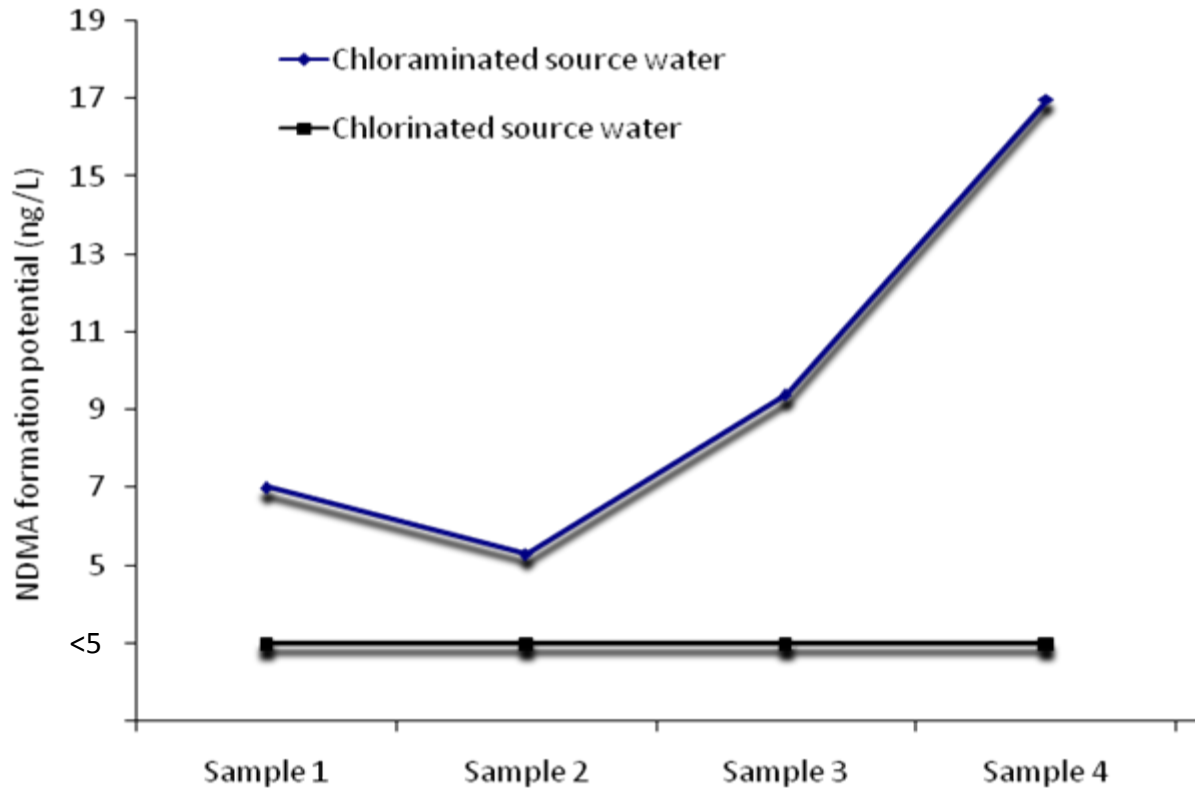


# Wyaralong Dam Site & Cedar Grove Weir



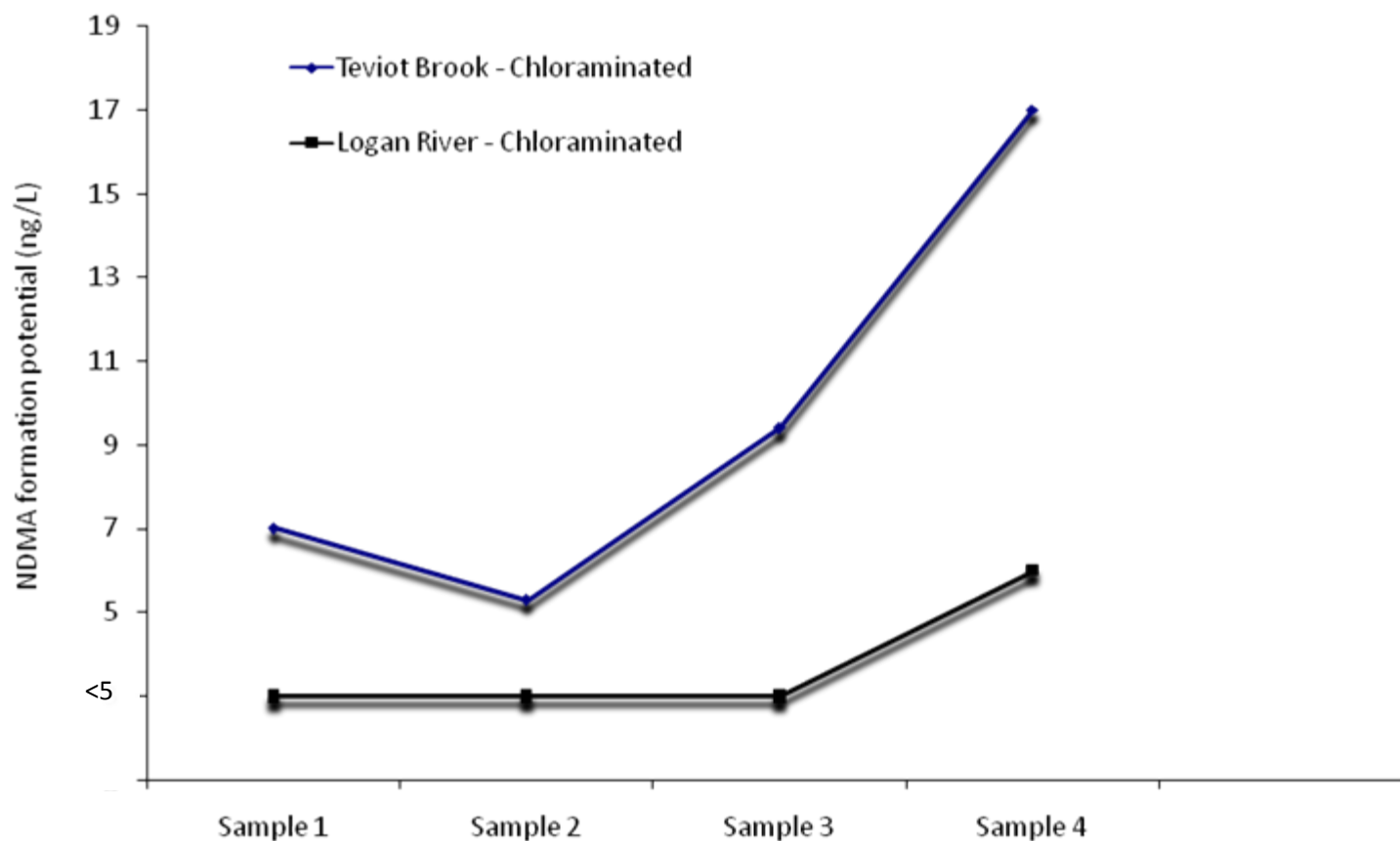
# Wyaralong Dam Site & Cedar Grove Weir

- Maximum NDMA formation potential for Teviot Brook source water using chlorination & chloramination.



# Wyaralong Dam Site & Cedar Grove Weir


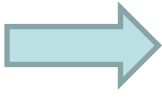
- Chloramination of Cedar Grove Weir (Upper Logan River) source water gives a lower NDMA formation potential than Wyaralong Dam region (Teviot Brook)
  - Teviot Brook generally has a higher DOC concentration than Cedar Grove Weir, which may account for the difference in NDMA formation potential.



# Wyaralong Dam Site & Mt Crosby WTP NDMA formation potentials



# Wyaralong Dam Site & Cedar Grove Weir

- NDMA maximum formation potentials below the WHO recommended guideline value (10 ng/L) 89% of times measured
- Approximate concentrations indicate:
  - Chlorination  NDMA formation
  - Chloramination  NDMA concentration <5 - 17 ng/L.

# NDMA formation in the distribution system

- Potable water samples taken from QHSS have had [NDMA] up to 17 ng/L.
- Highest concentrations were detected after a weekend (taps not in use).
- [NDMA] reaches a maximum at the 4<sup>th</sup> litre fraction then diminishes to <5ng/L after flushing pipeline.
- Establishing the source and extent of this is a suggested area for future research.

# ACKNOWLEDGEMENTS

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Thank you

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