South Australia's Environment Protection Authority
Inland Desalination
Wednesday 29th February 2012

Tony Sliuzas
tony.sliuzas@epa.sa.gov.au

EPA
South Australia

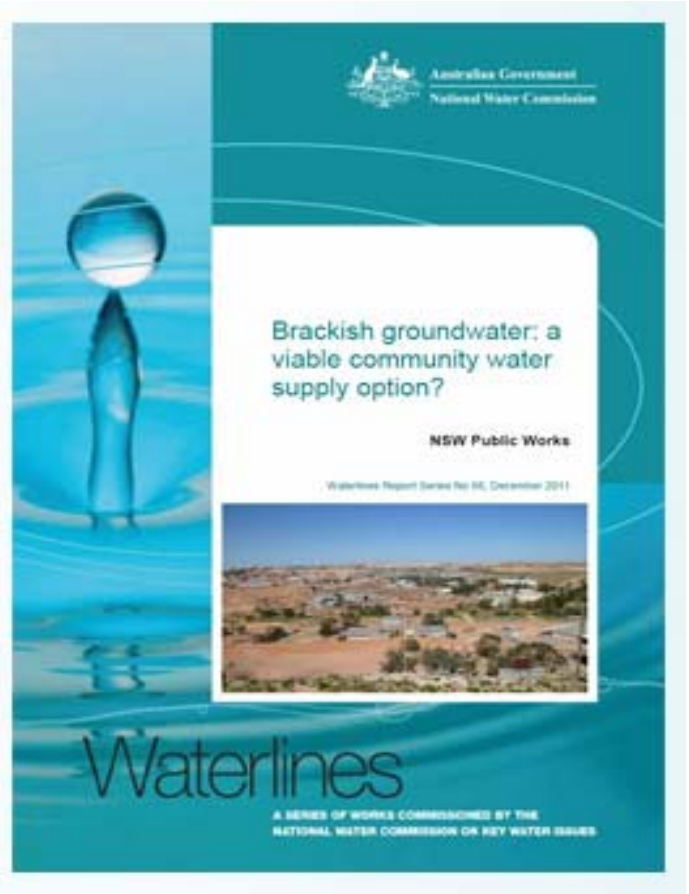
Inland Desalination

- I will be borrowing from:

  "Australian Government, National Water Commission on Key Water Issues, Brackish groundwater: a viable community water supply option? Waterlines Report Series No 66, December 2011"

- at this site http://nwc.gov.au/publications/waterlines/brackish-groundwater-a-viable-community-water-supply-option

- and a bit of anecdotal and personal experience



Inland Desalination

Table 1–1: Definitions and uses of saline waters

Description	TDS (mg/L)	Potential use of water
Fresh	<500	All purposes, limit of ADWG
Brackish	500–1500	Most purposes, objectionable taste if used for drinking
	1500–5000	Livestock, limited irrigation
	5000–7000	Most livestock
	7000–14,000	Some livestock (beef, cattle, sheep)
	14 000–30 000	Limited industrial uses, ore processing
Saline	30 000–50 000	Limited industrial uses, ore processing
Hypersaline	50 000–100 000	Limited industrial uses, ore processing
	>100 000	Brine production, ore processing

Source: Adapted from multiple sources, largely Australian Water Resources Council 1988

Inland Desalination

- Volumes required:
  - Average = 7000 KL/yr
  - Minimum = 2500 KL/yr = 7 KL/day
  - Maximum = 200 000 KL/yr = 550 KL/day, but unsure wether this is total daily demand or daily desalinated demand
- Fit for purpose – a term I use a lot when talking about the treatment of wastewater but just as applicable here as the desalinated water is very pure & needs salts added to it to be useable ∴ shandy it back into the source water to make it to the salinity you require (differences in salinity are for maintenance, good growth & lactating animals – seek agronomic advice)

Inland Desalination

Table 1–2: Relationship between TDS and conductivity for some common salts

Salt (0.01 mol/L)	TDS (mg/L)	Conductivity (µS/cm)	TDS factor (TDS/cond.)
NaCl	584	1155	0.51
$CaCl_2$	1110	2310	0.48
$NaHCO_3$	840	865	0.97

- The salt composition of the water is important to understand as there is variation in the electrical conductivity of the various ions, so an EC meter reading may be misleading
- More importantly is the composition of those salts likely to cause scale problems in any treatment plant eg. Fe, Si, Ca, Mg, Na, Ba, S & sparingly soluble $CaCO_3$ & $CaSO_4$ & HCO_3^-

Inland Desalination

- Organics eg. algae from water stored in dams, cause other filtration issues
- May need post-desalination treatment

- NB: withdrawing groundwater may cause a cone of depression below the well head & this may cause water to flow in from other geologic features & change the chemical composition of the water

- To overcome this problem, don’t rely on only 1 analysed water sample – redo it

Inland Desalination

- When analysis is repeated, get your supplier back to optimise the plant for maximum efficiency – get more product water & less in wastewater stream

- To recap: scale, pre-treatment and filtering requirements are essential elements to be understood – find a competent, experienced (ask for details of other similar customers) desalination plant supplier & seek advice

Inland Desalination

- What is a likely suitable technology:
  - Distillation:
    - Simple solar
    - Emerging technology
    - Farmer’s ingenuity
  - Membrane processes:
    - Reverse Osmosis
    - In situ membranes (down hole)

Inland Desalination

- What is an un-likely, un-suitable technology:
  - **Complex Distillation** – solar
    - Parabolic reflector
    - Linear Fresnel flat plate reflector – 12.4 MW Hunter Valley power generation

    - Multistage flash – used in the sugar industry
    - Multiple-effect distillation
    - Vapour compression
- Why? – very complex, expensive & requires specialist training to operate

Inland Desalination

- What is an un-likely, un-suitable technology:
  - **Membrane processes**
    - electro-dialysis reversal – water quality requirements
    - HERO – high efficiency RO – 90-98% recovery
- Why – again it's cost & training

Inland Desalination

Distillation: Simple solar

John Ward

F -cubed

Limited production volumes & cost effectiveness is questionable

Inland Desalination

Distillation:

- Emerging technology – NCED testing new methods currently (Research Roadmap - http://desalination.edu.au/wp-content/uploads/2010/02/NCEDA-Research-Roadmap-2011.pdf)
- Farmer's ingenuity - In 1950's CSIRO developed a simple solar distillation process to supply Coober Pedy with fresh water. This comprised a black plastic trough on the ground with a small glass house above it. The sun heated the saline water in the trough and the vapour condensed on the bottom of the glass and was collected in a channel. (acknowledgment - Cliff Hignett)

Inland Desalination

Membrane processes: Reverse Osmosis

Inland Desalination

Membrane processes: Reverse Osmosis

- Reliable
- Pretty much stand alone
- Relatively cheap (don't forget the cost of brine disposal)
- Small or large
- Used in many industrial and commercial applications
- Wide range of salinity

Inland Desalination

Membrane processes: In situ membranes (down hole)

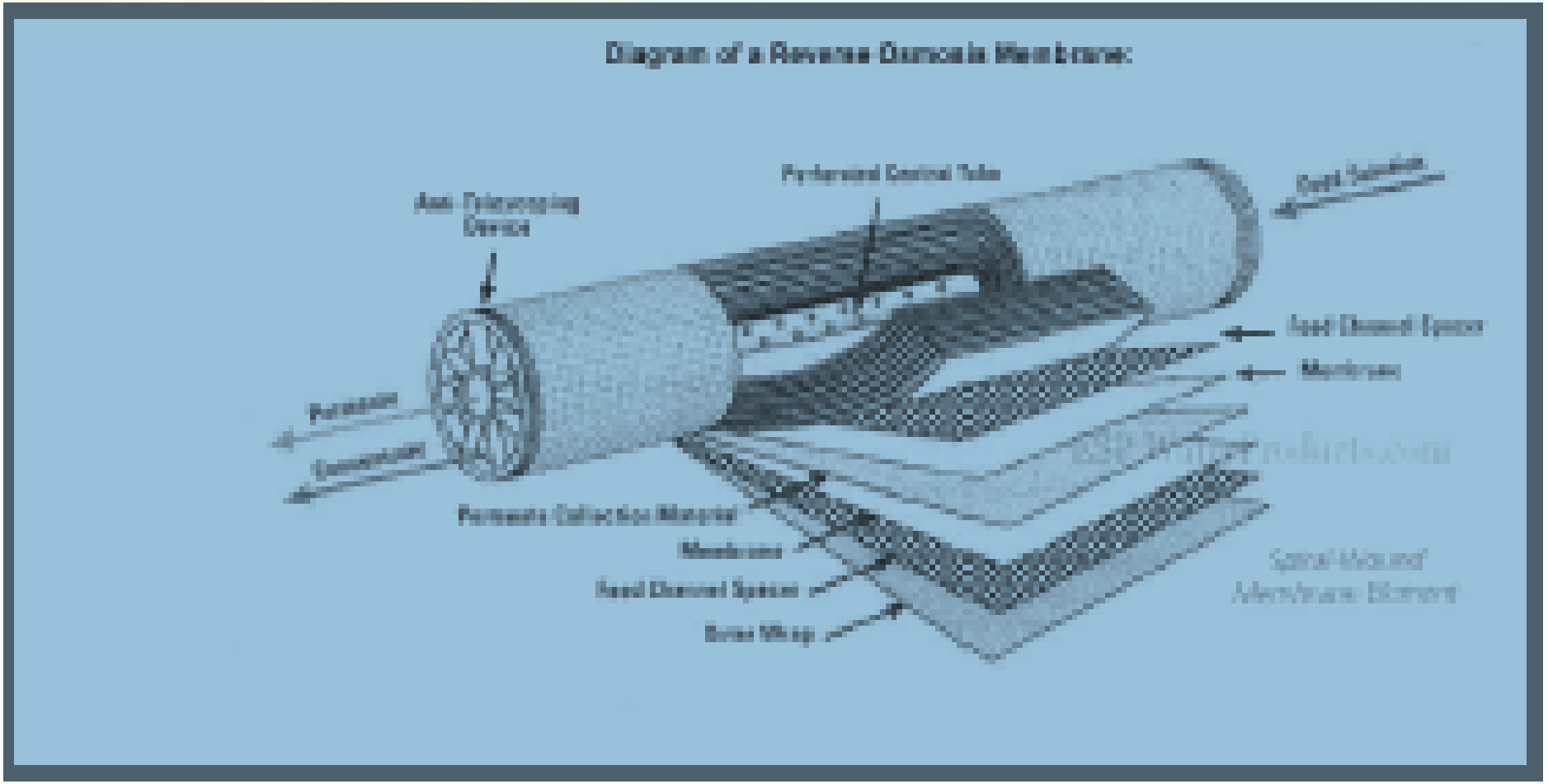
RO plant installed in a well with low recovery efficiency (so scales are flushed off the membrane)

Brine is discharged back to the groundwater and it sinks due to its higher Specific Gravity

Only suits some aquifers & sites

Prerequisite: expensive & time consuming rigorous hydro-geological assessment

Inland Desalination



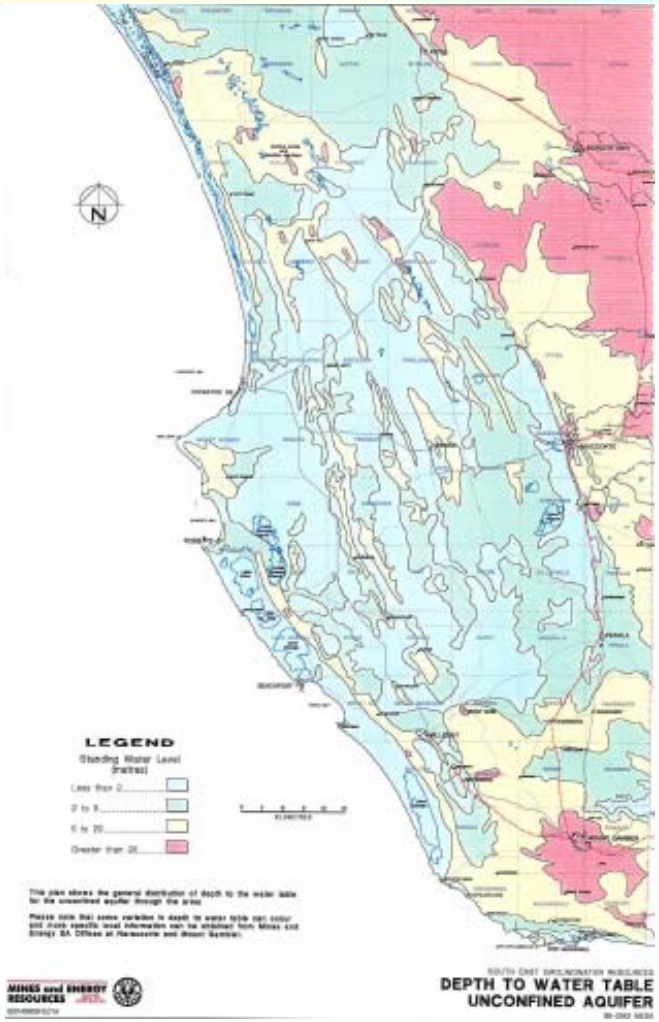
Inland Desalination

- Brine wastewater
  - Salts in the brine (& anti-scalants & any other chemical additives) are concentrated up, depending on efficiency
    - <10 000 EC = 75-90% efficiency = 5+ X concentration
    - <20 000 EC = 50% efficiency = at least doubled
    - ~ 35 000 EC = seawater = ~45% efficiency
    - Salt pan = ~ 200 000 to 300 000 EC before crystallisation of different salts
  - Also concentrates other salts in source water eg Selenium has been implicated in bird breeding problems at <0.1 mg/L (egg damage)
  - EPA stands up for the brine shrimp (sea monkeys)

Inland Desalination

- Brine disposal – EPA's risk assessment process – we look at:
  - Water resources:
    - if good, bad or indifferent, its environmental value & depth or distance to it
    - groundwater type – Karstic, fractured rock, gravels & sand lenses, aquitards
  - Soils – salinity, SAR (sodicity), type - sand, loam, clay
  - Vegetation & landscape
  - Habitat/Biota values
  - Neighbours
  - & take account of public perception

Inland Desalination

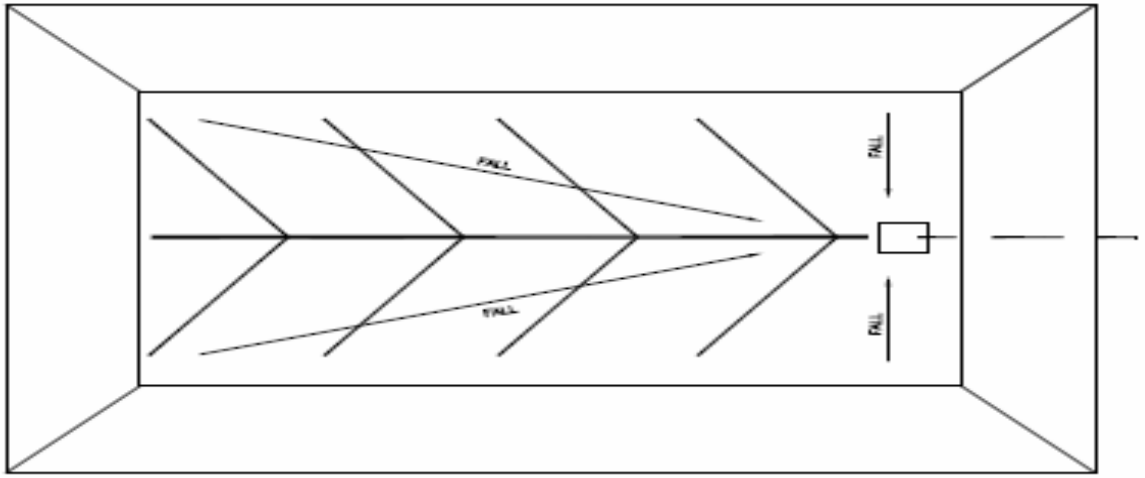


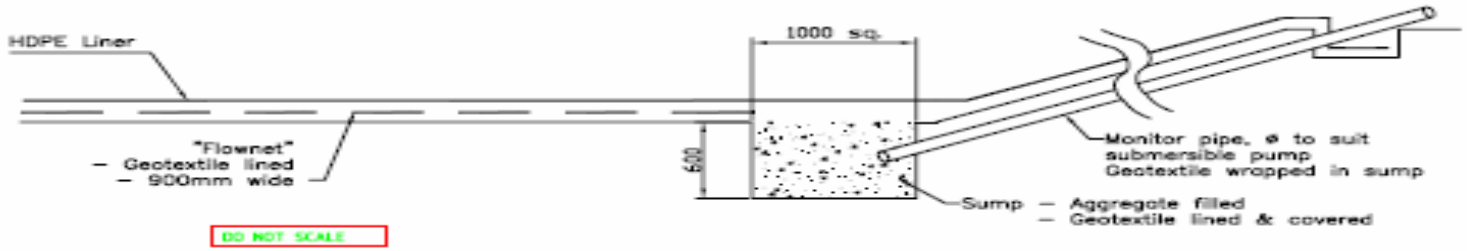
Inland Desalination

- Brine disposal options
  - Irrigation – if source water is low salinity – hydroponics & olives
  - Deep well injection – hydro-geologic assessment required
  - Dust suppression – in the right environment (Mercury)
  - Storage & evaporation – need to manage risk

Inland Desalination

Leak detection





Inland Desalination

- Crystallisation brine disposal options

Brine concentrate disposal method	Key issues
Evap ponds/mist sprays	Land availability & cost Climate applicability Construction & maintenance Salt drift Potential g/water contamination Habitat Disposal of salt Excavating salt without damage
Wind aided intensified evap	Wind availability Small footprint Low energy costs Suitable for high evap areas
Forced circulation crystalliser	Complexity of equipment Mechanically intensive Energy requirements More suitable for industrial applications
Farmer's ingenuity	Coober Pedy/CSIRO experience

Inland Desalination

- Brackish groundwater publication
  - Also contains:
    - Case studies
    - Operating costs

Inland Desalination

- EPA
  - Proposed regulation – adding to list of Scheduled activities along with abattoirs, feedlots, piggeries, wineries – all producing a waste
  - Will likely require Development Application & EPA will have power of direction over Council
  - Will attract a licence fee – approx $2500 pa, $1200 if HDPE
  - This will happen within about a year

Inland Desalination

Questions?