Wastewater Recycling in Singapore by EDR

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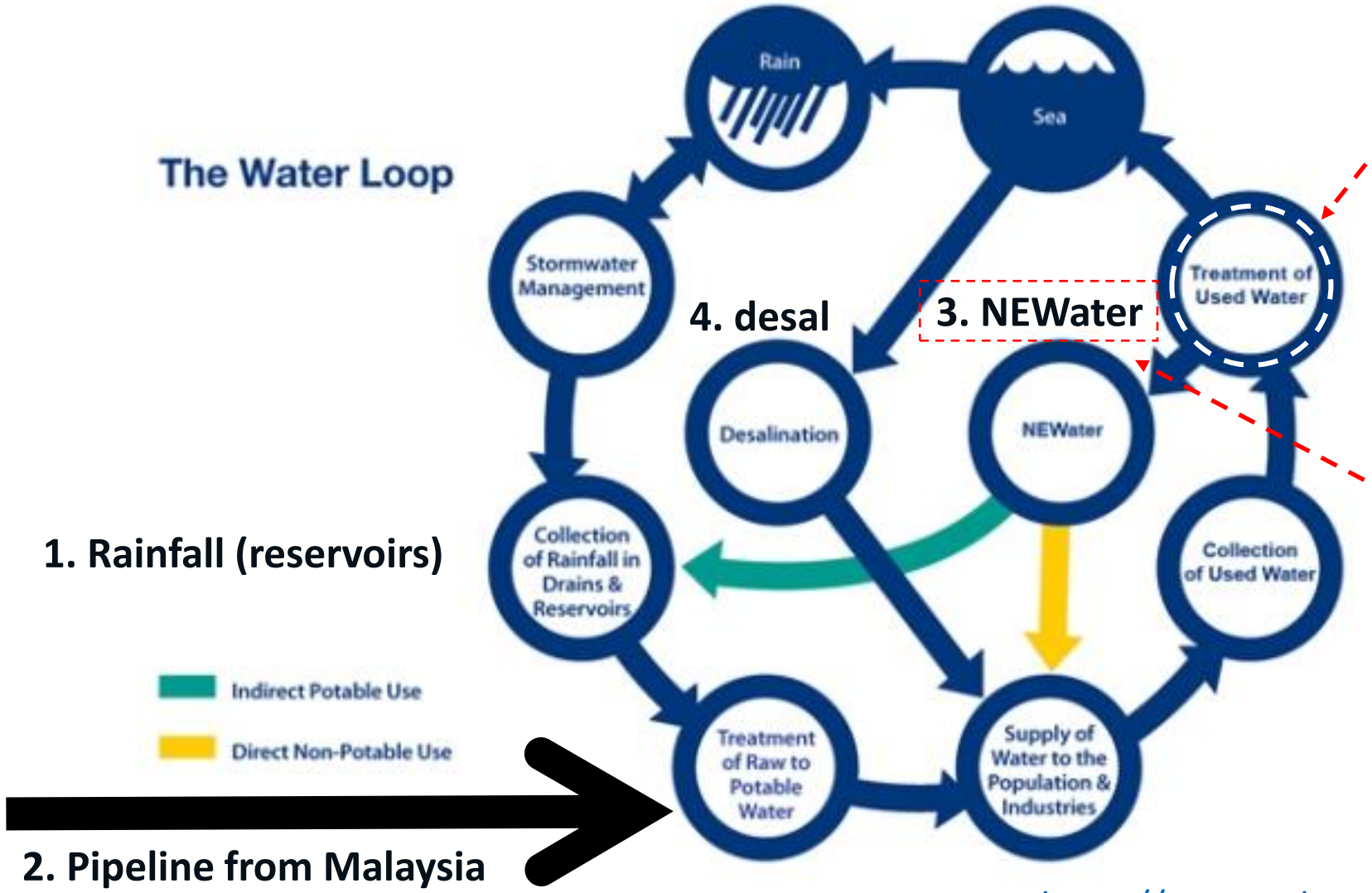
SUEZ WTS

Water independence = national security

"… every other policy has to bend at the knees for our water security."

PM Lee Kuan Yew

Singapore PUB: 4 national taps and water loop



Domestic wastewater recycling

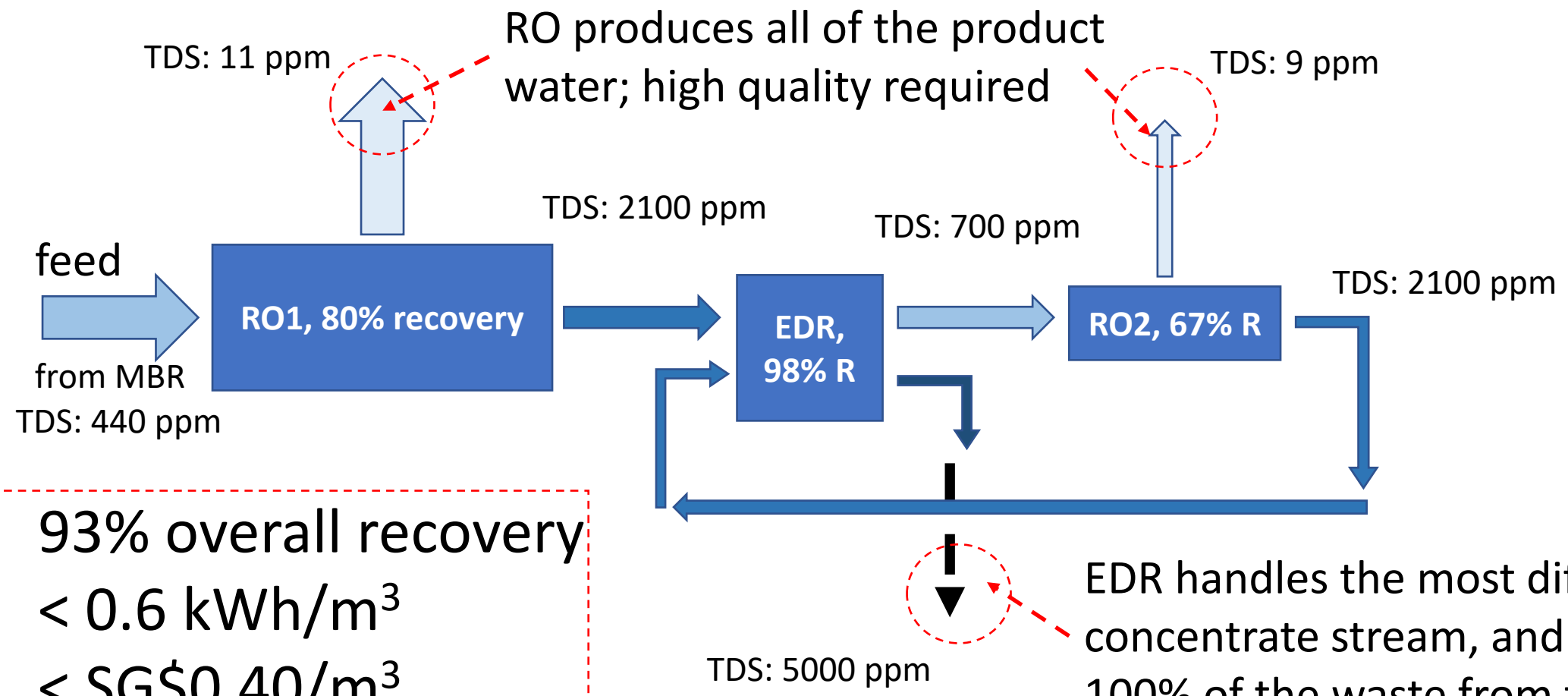
Five NEWater plants, supplying up to 40% of Singapore's daily water demand

MBR – RO + UV

75-80% recovery

https://www.pub.gov.sg/watersupply/fournationaltaps/newater

NEWater with high recovery SUEZ concept



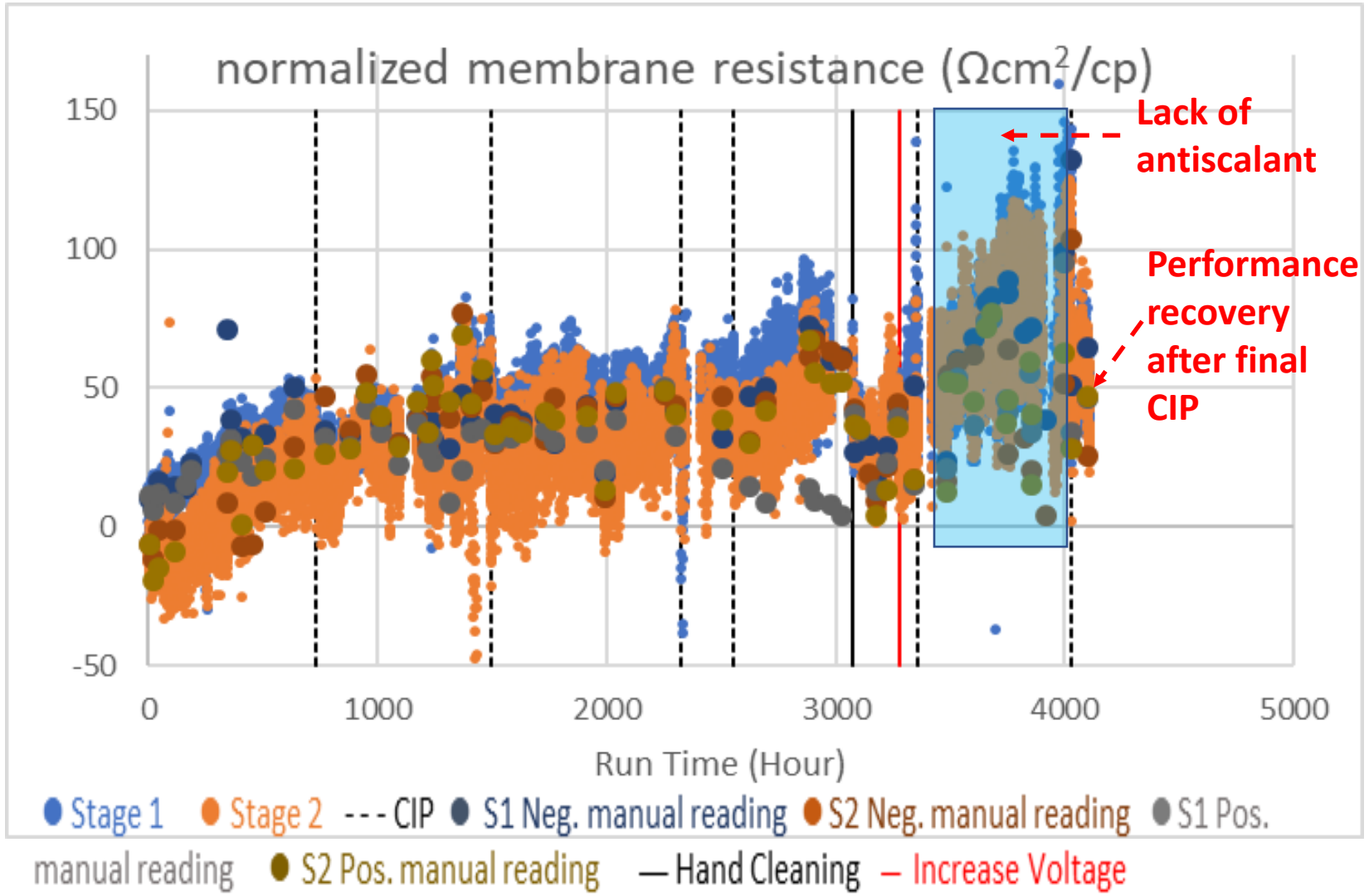
- 93% overall recovery
- < 0.6 kWh/m^3
- < SG$0.40/$m^3$

Pilot site at Ulu Pandan WRP

RO1 feed flow rate = 50 gpm

5 experimental phases, 2015-2020

Stable EDR performance



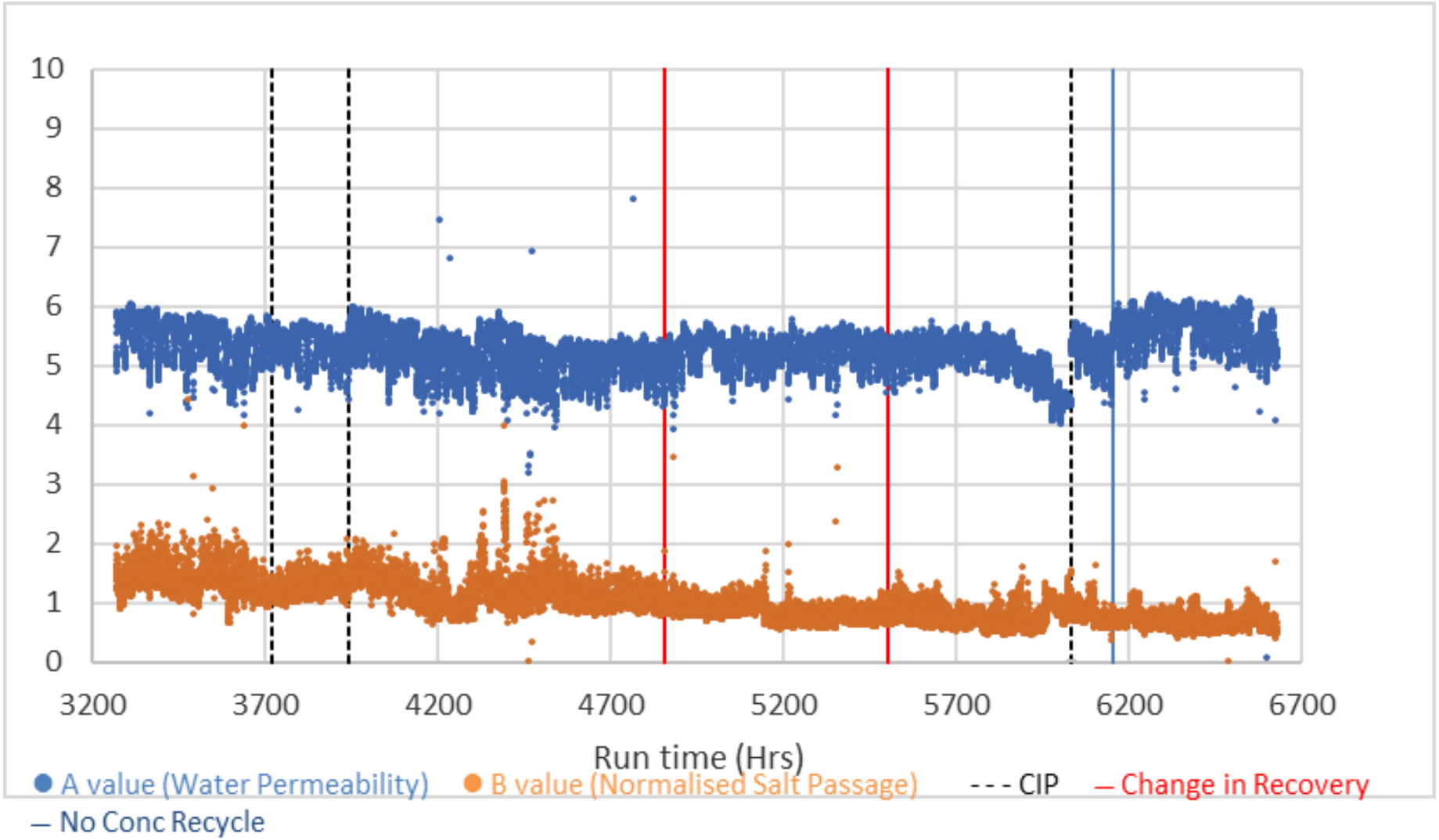
EDR removes

- 50-75% of conductivity
- 80-95% of hardness
- 0-15% of TOC

How to do EDR data normalization:

Moe, N.E., Barber, J. (2019) Making sense of electrodialysis reversal (EDR) plant operating data, IDA World Congress, Dubai, October 20-24.

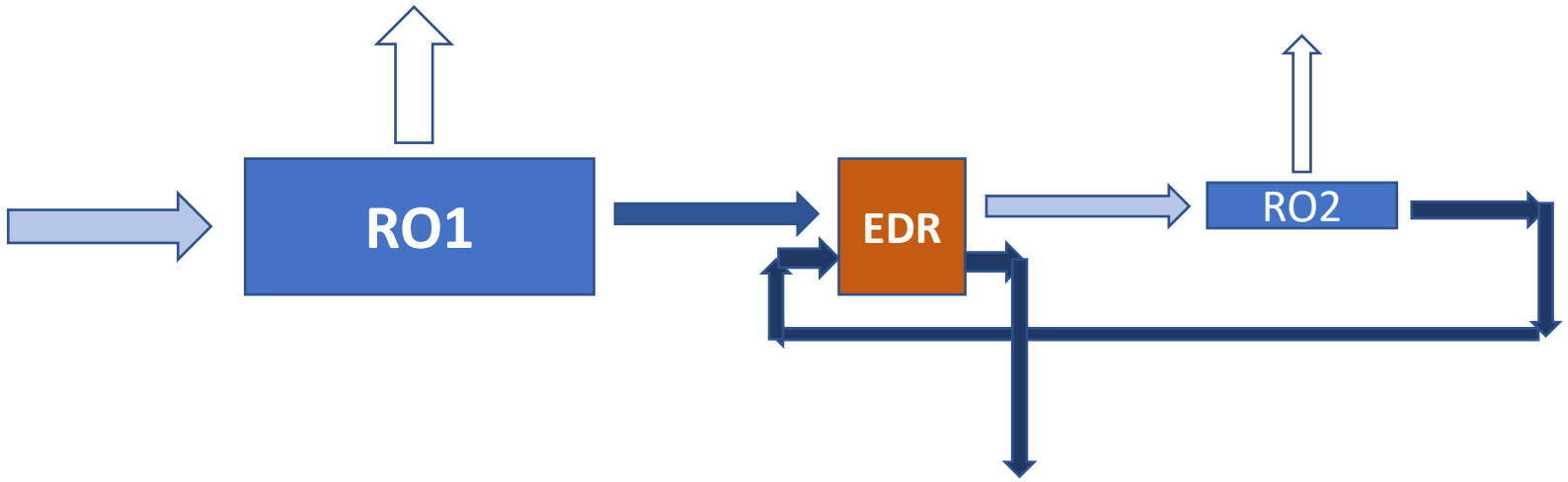
Stable RO2 performance



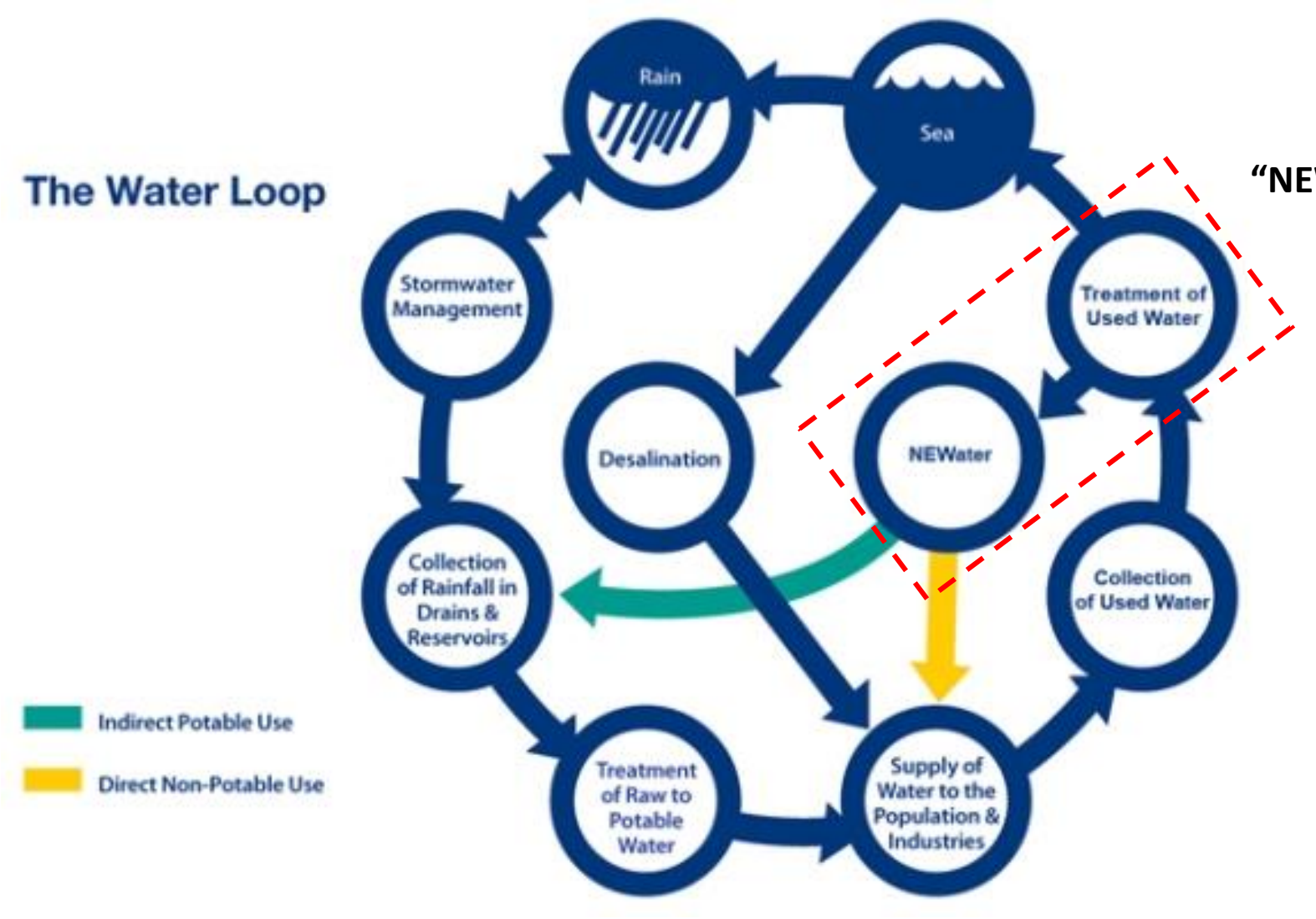
- RO2 elements not changed since 2015 (~13,000 operating hours)
- Starting A-Value around 8 (2015)
- 50 ppb permeate TOC
- 300 ppb permeate silica

Why does this high recovery combination work?

- EDR processes the most concentrated stream and is more fouling resistant than RO
- EDR removes “something” that enables RO2 to run smoothly
- RO capable of very high rejections



Introducing industrial WW recycling



"NEWater" = municipal wastewater recycling

- High end industrial
- Reservoir recharge

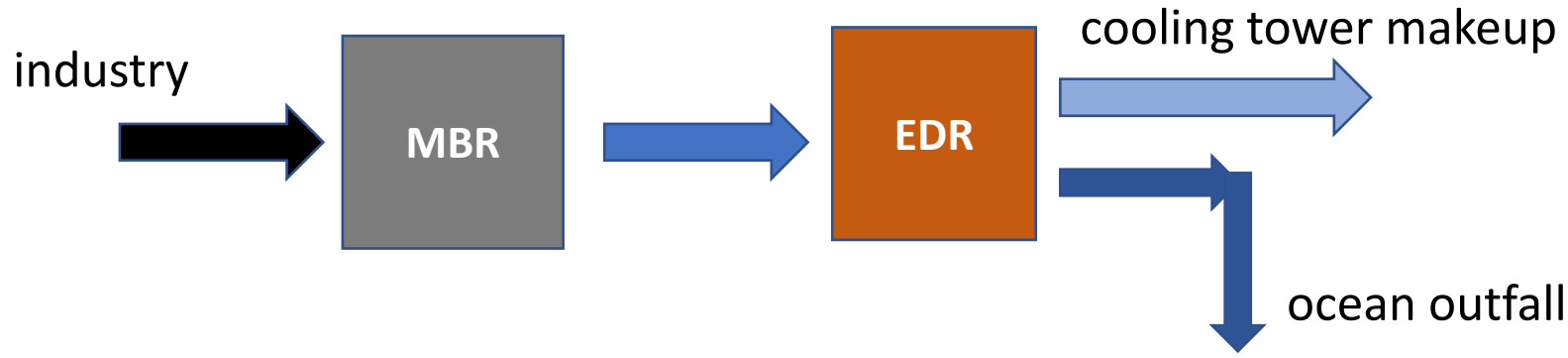
"XXX" = industrial wastewater recycling

- Not for human consumption
- Not for semiconductors
- Low end industrial -> cooling tower makeup

Treatment goals and proposed process

Feed conductivity = 2500-3500 µS/cm → Product conductivity < 1600 µS/cm

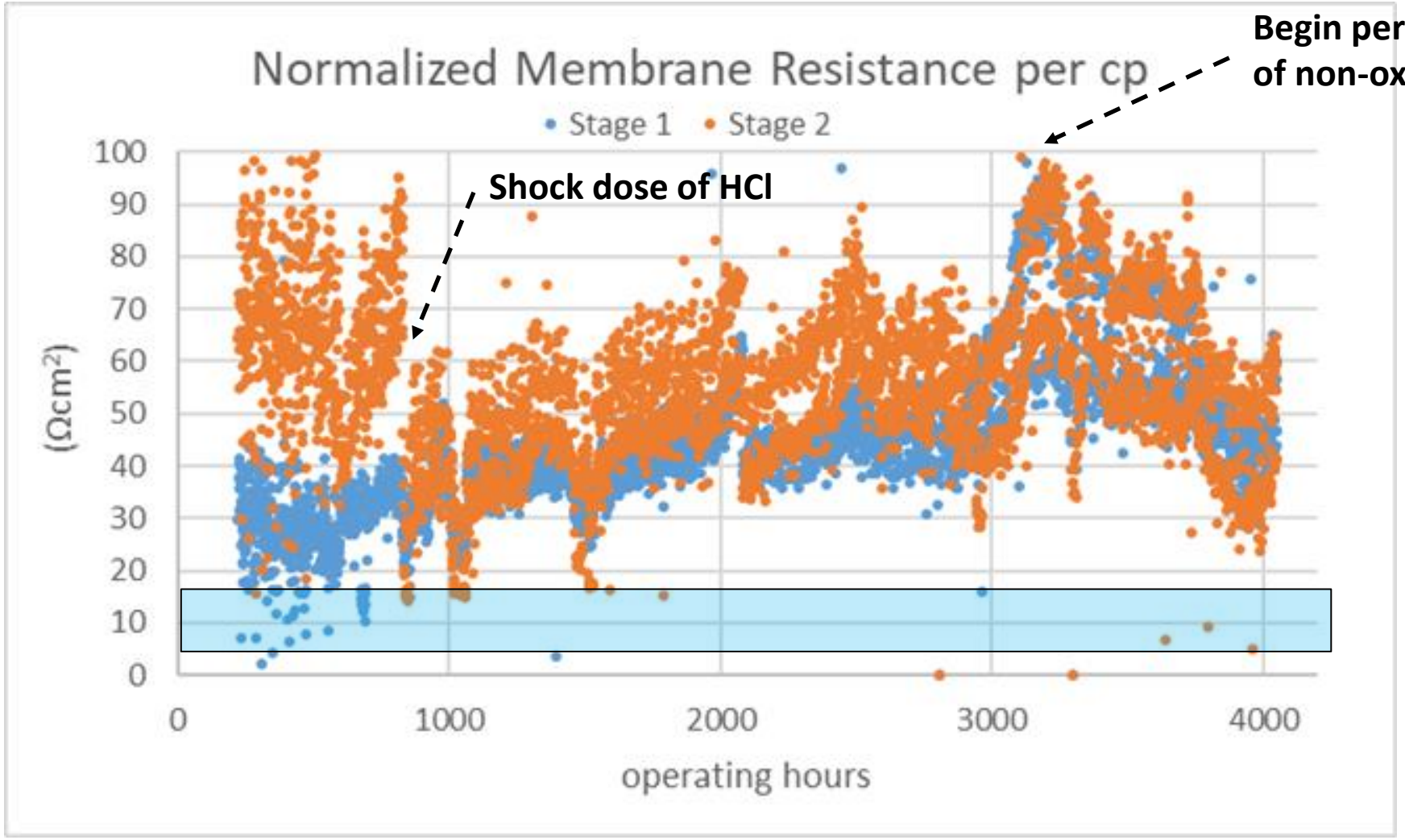
Recovery = 80%



Pilot location: Jurong WRP

(RO struggles to achieve 50-60% recovery)

Stable EDR performance



- No CIP performed
- Product conductivity of 500-1000 µS/cm achieved at constant voltage.

Why is EDR successful in this application?

- EDR removal of TOC is only 15% (typical for WW applications)
- EDR removal of silica is 0% (it is uncharged)
- Polarity reversal helps, too

Although IWW has 3-5x conductivity, TOC, silica, phosphate … than MWW, treatment of this IWW was less challenging because:

- Recovery is lower (80% vs 93%)
- Removal of silica and TOC is minor compared to RO
- TDS removal is much less (50% vs 97.5%)