

AN OVERVIEW OF PUB SINGAPORE & OUR WATER QUALITY CHALLENGES

Puah Aik Num

Chief Engineer, Water Supply (Plants) Department

MacRitchie Reservoir

Presentation Overview

1. Brief overview of Singapore & PUB
2. Brief overview of Choa Chu Kang Waterworks
3. Our water quality challenges
4. Feasibility study of the SIX[®] technology

About Singapore & PUB



MacRitchie Reservoir

Singapore



Land Area

~719 km²

Population

5.6 mil

Average Annual Rainfall

2.328m

Average Water Demand

430MGD (1.95mil m³/day)

Our Key Strategies



**Capture every
drop of water**



**Reuse water
endlessly**

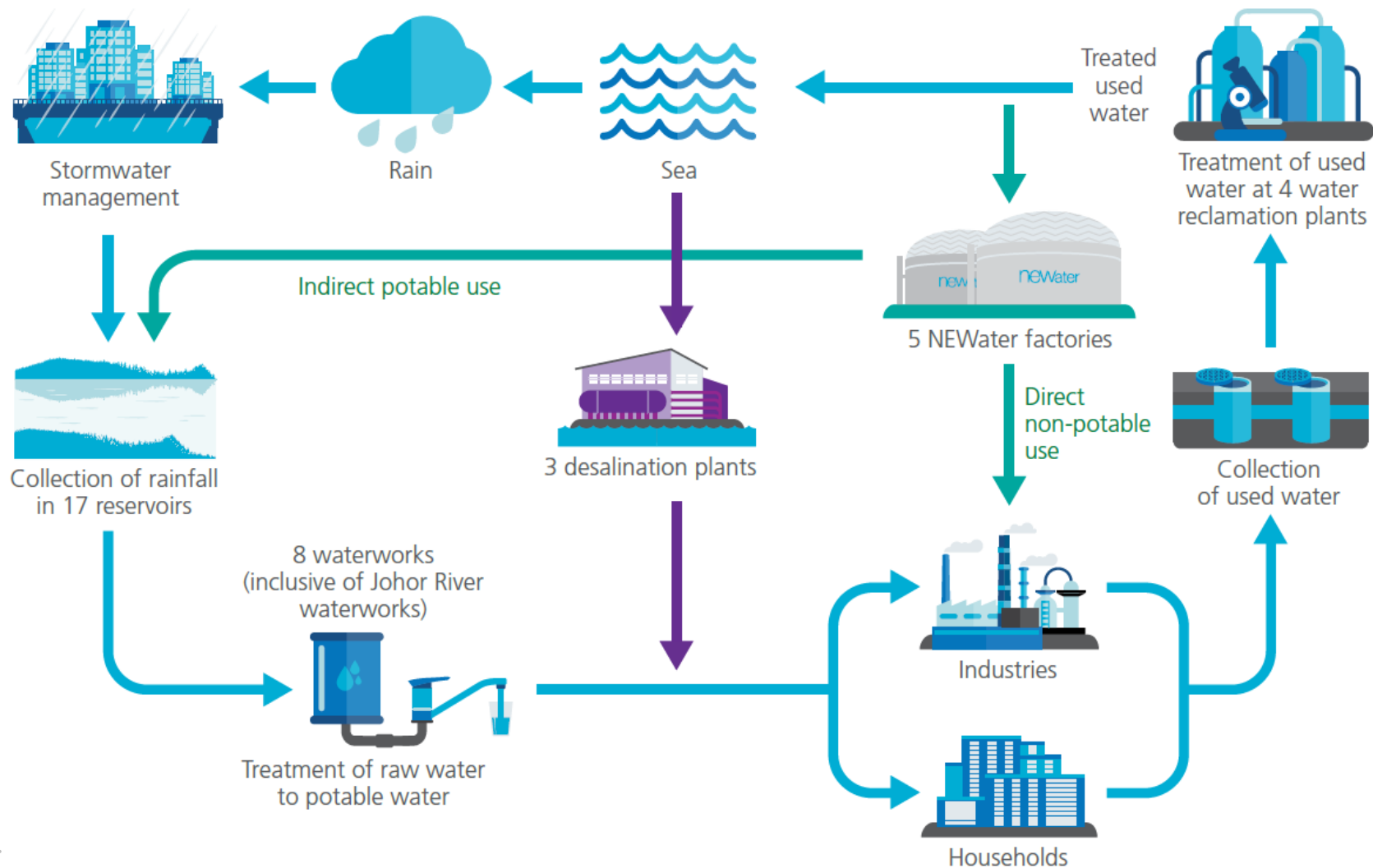


**Desalinate
seawater**

Technology & Innovation



Our Closed Water Loop



Our Four National Taps



**WATER FROM
LOCAL CATCHMENT**



**IMPORTED
WATER**

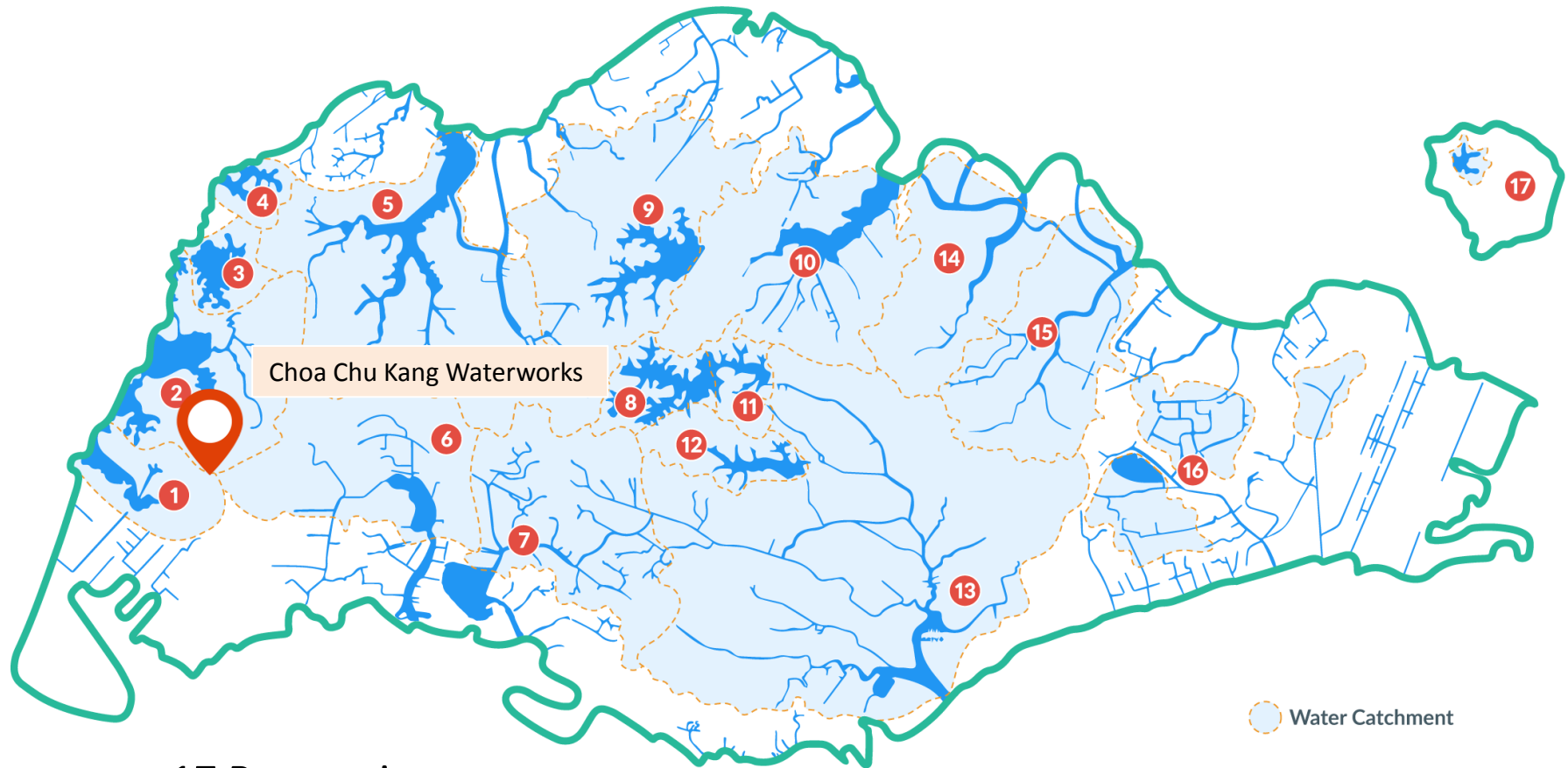


NEWATER



**DESALINATED
WATER**

Local Catchment



- 17 Reservoirs
- 2/3 Catchment Area
- 8 Waterworks (including Johor River Waterworks)

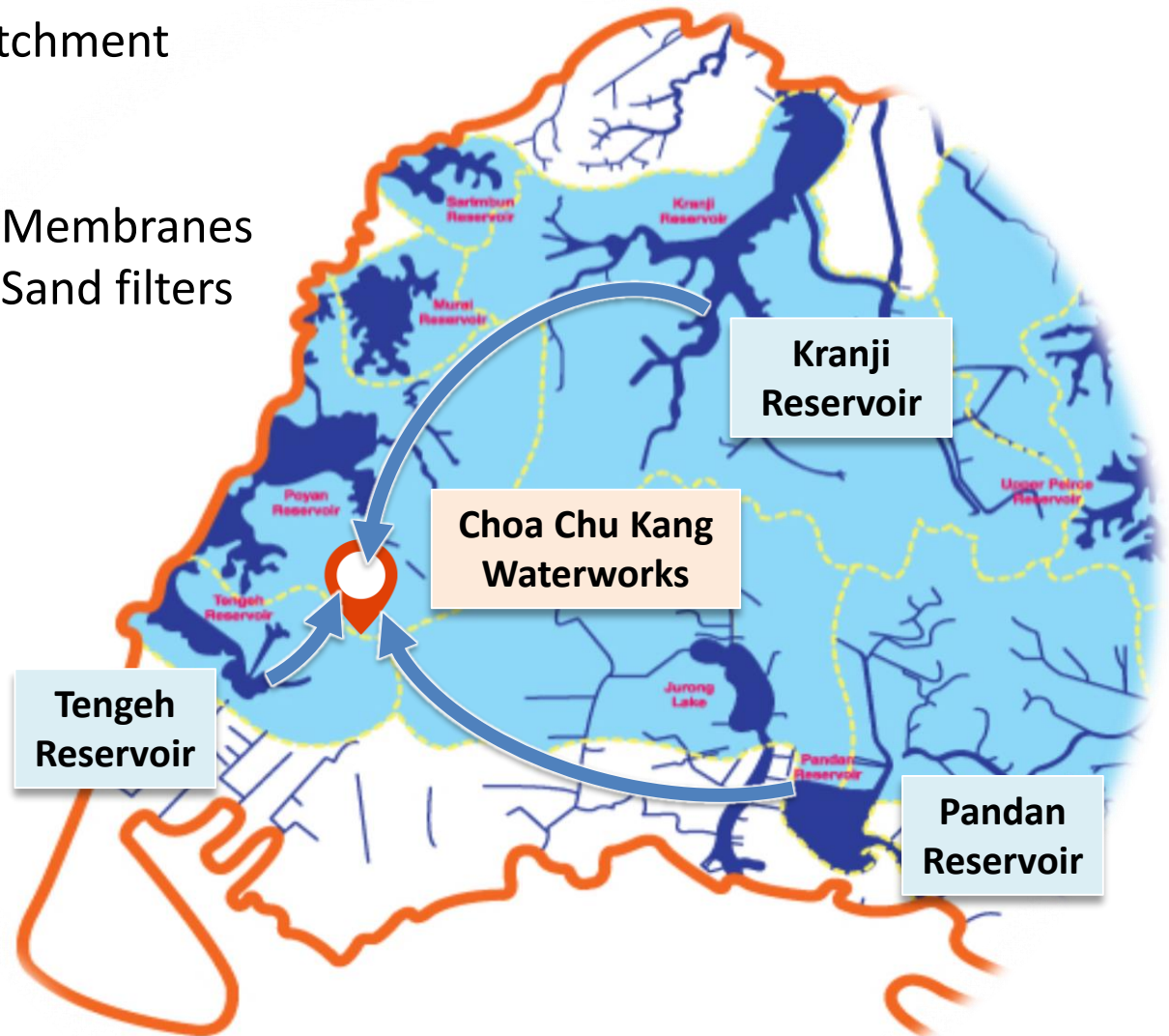
Choa Chu Kang Waterworks

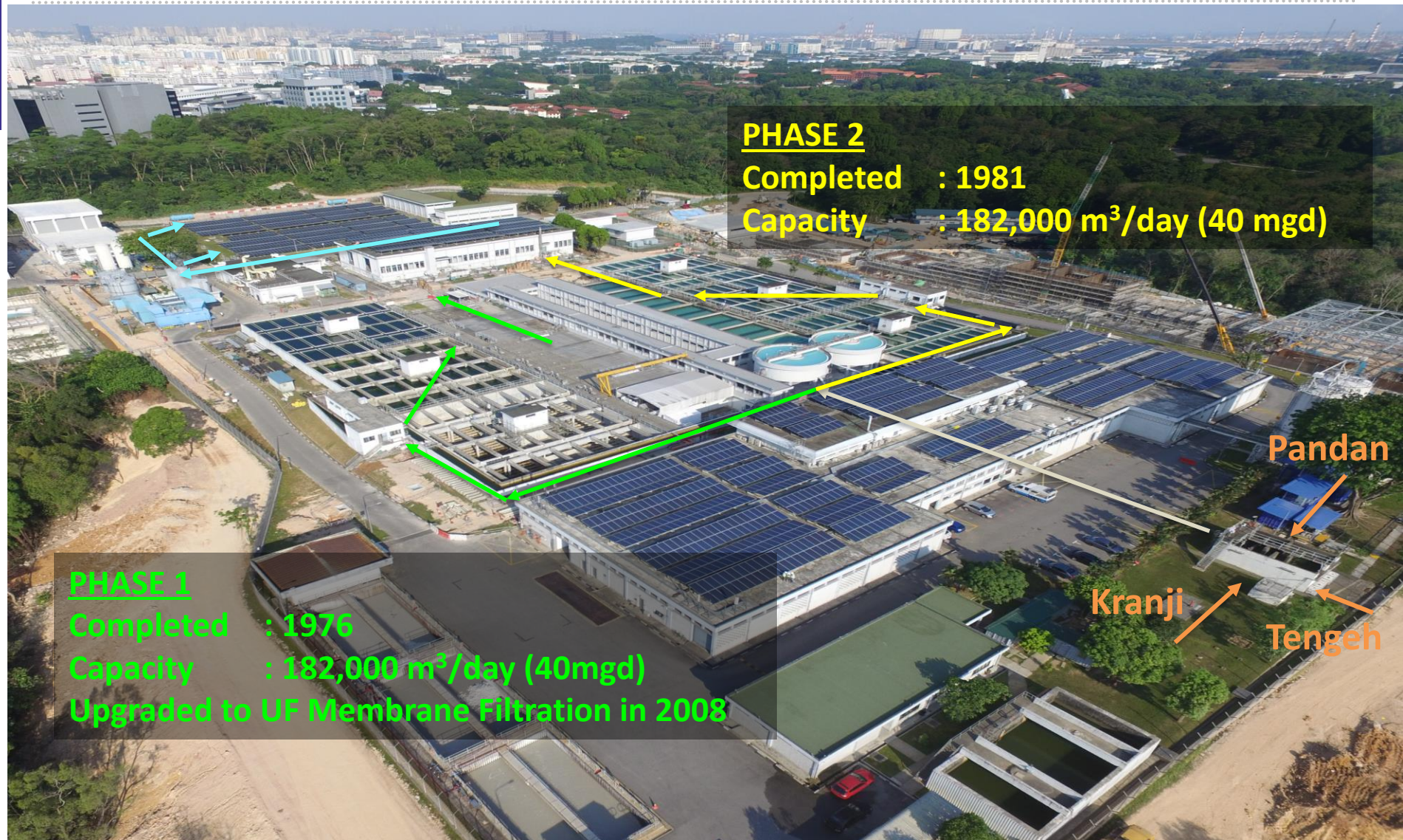


MacRitchie Reservoir

Choa Chu Kang Waterworks

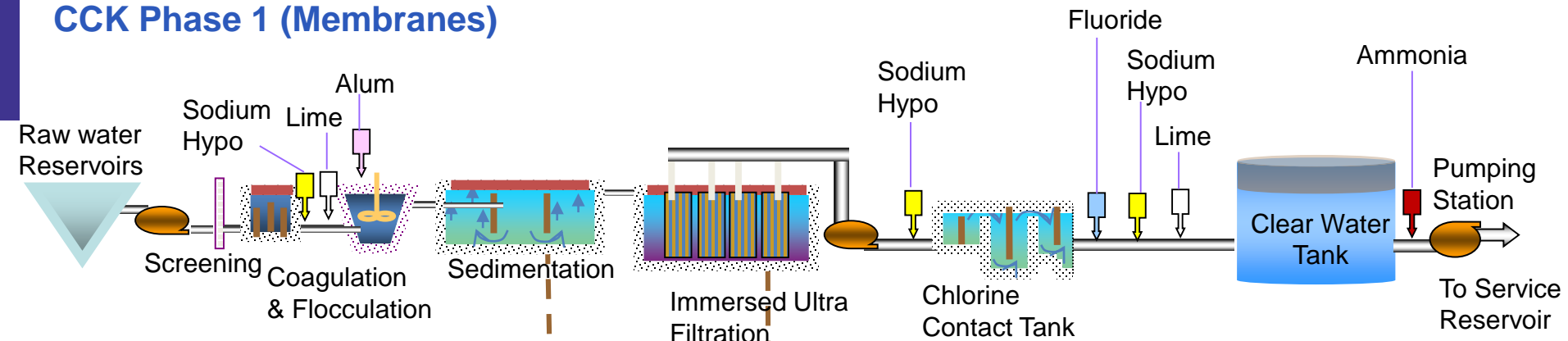
- Serves the western catchment
- 3 raw water sources
- Capacity of 80 MGD
 - 40 MGD Phase 1: Membranes
 - 40 MGD Phase 2: Sand filters



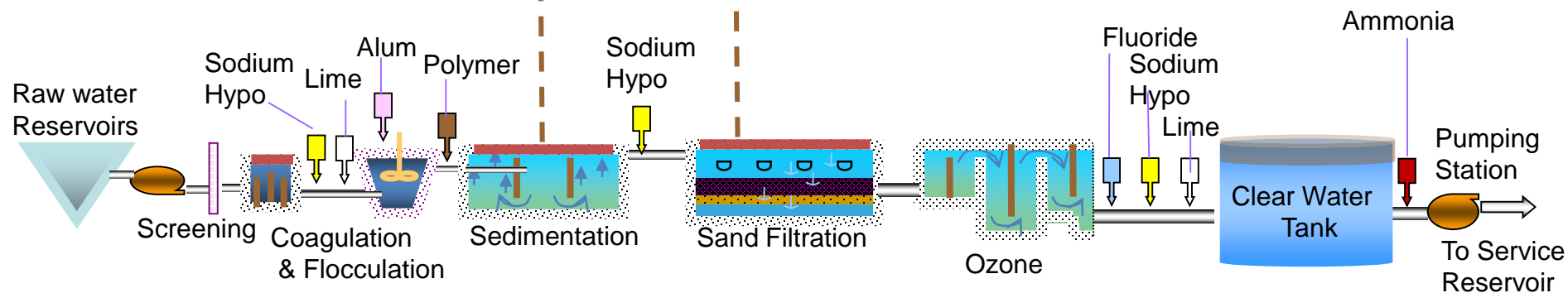


Treatment Process

CCK Phase 1 (Membranes)



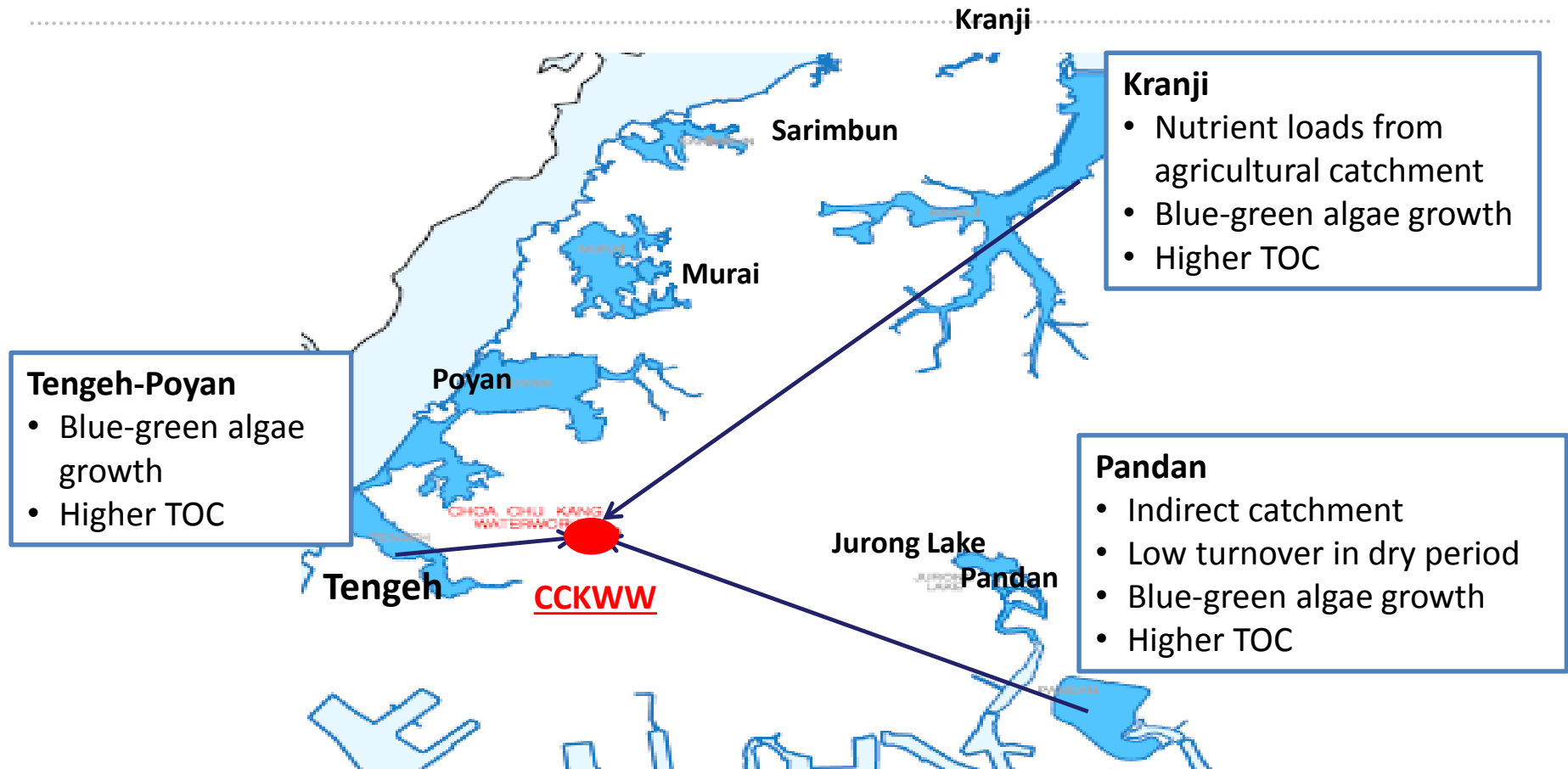
CCK Phase 2 (Sand Filters)



Our Water Quality Challenges

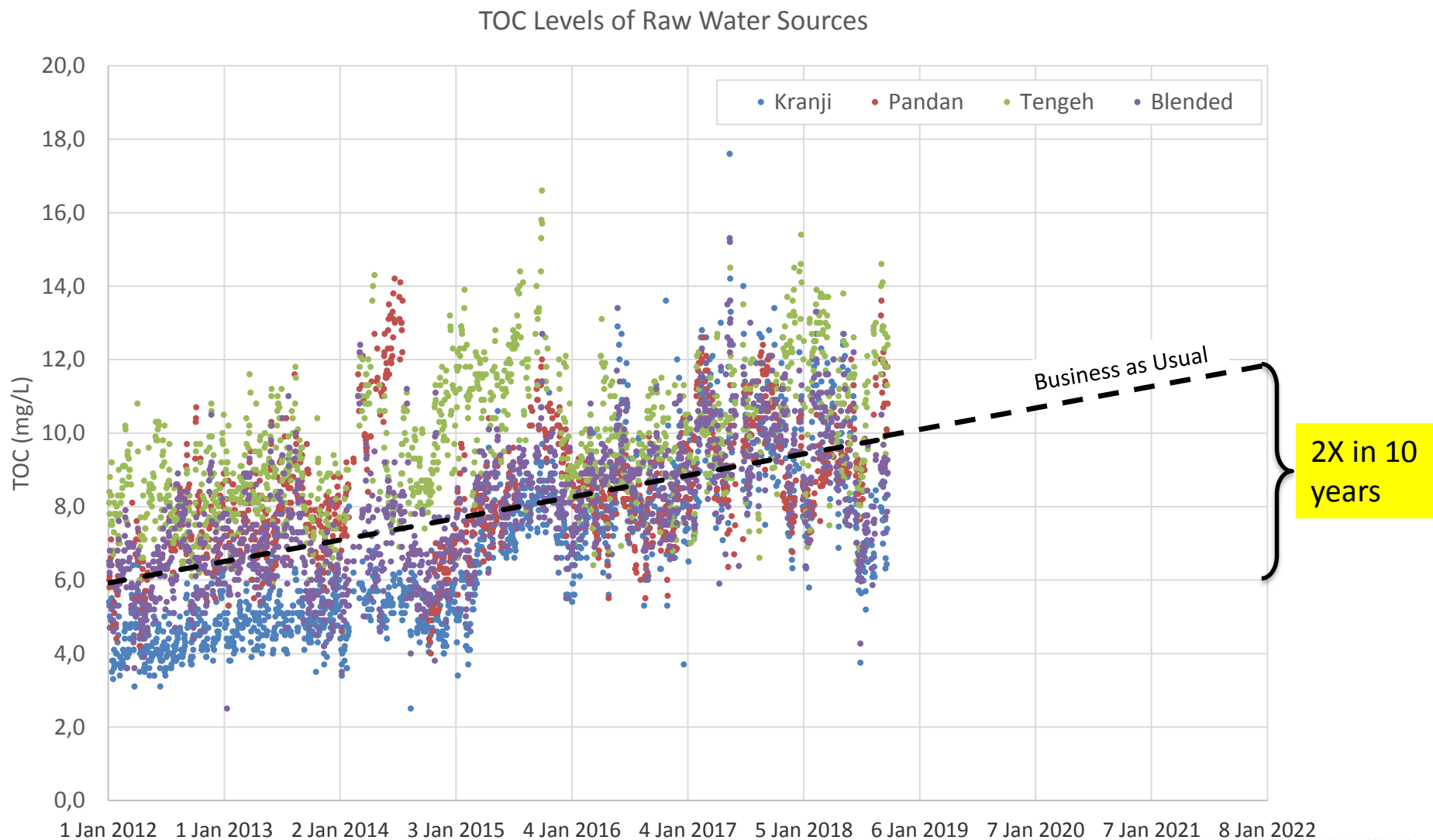
MacRitchie Reservoir

Reservoir Water Quality Challenges

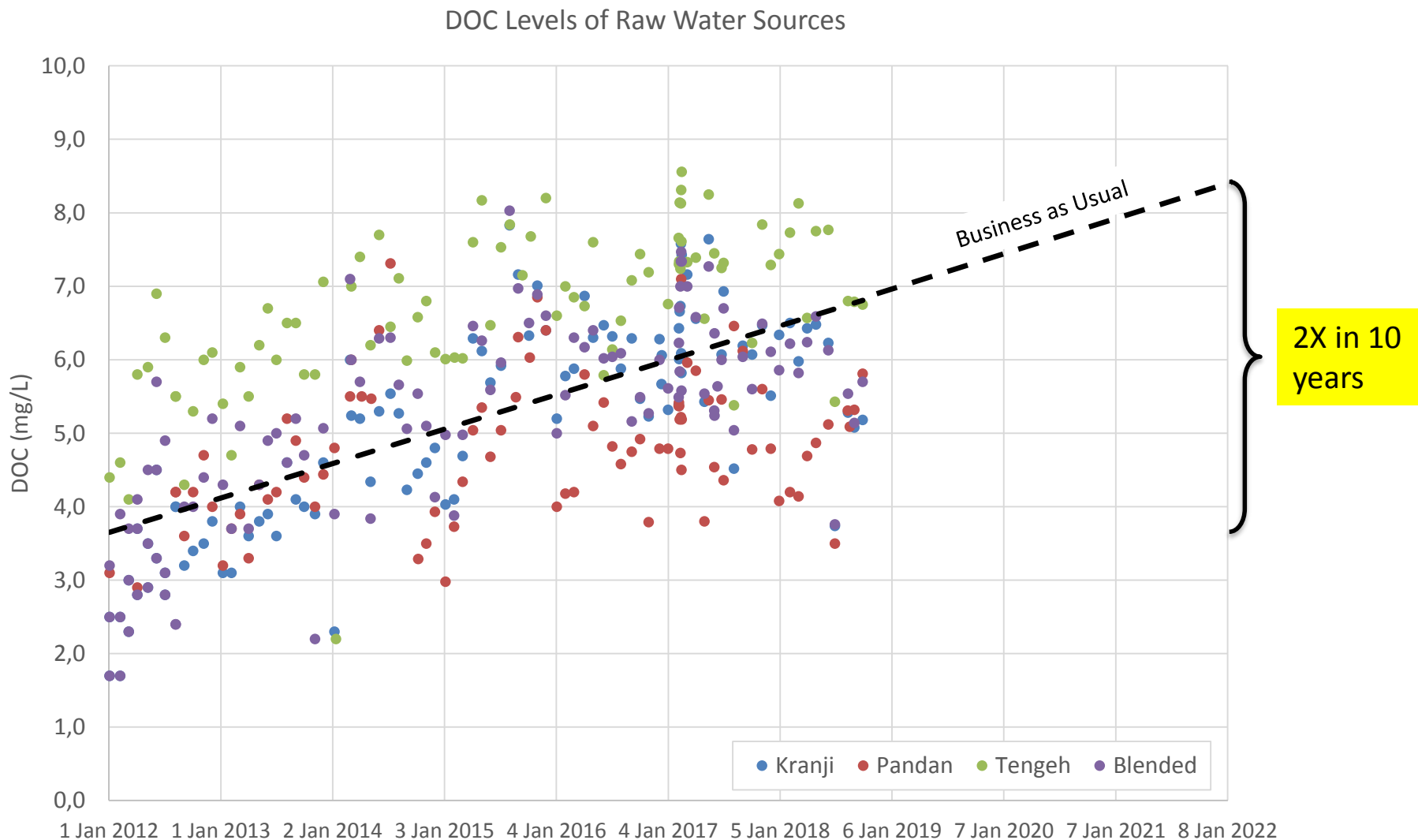


- High TOC in raw water risks the formation of Disinfection By-products
- High algae counts, particularly blue-green algae counts, can result in aesthetic issues, e.g. visual impact (algal scum) and undesirable taste and odour compounds (MIB & geosmin)

Increasing TOC Levels of our Raw Waters

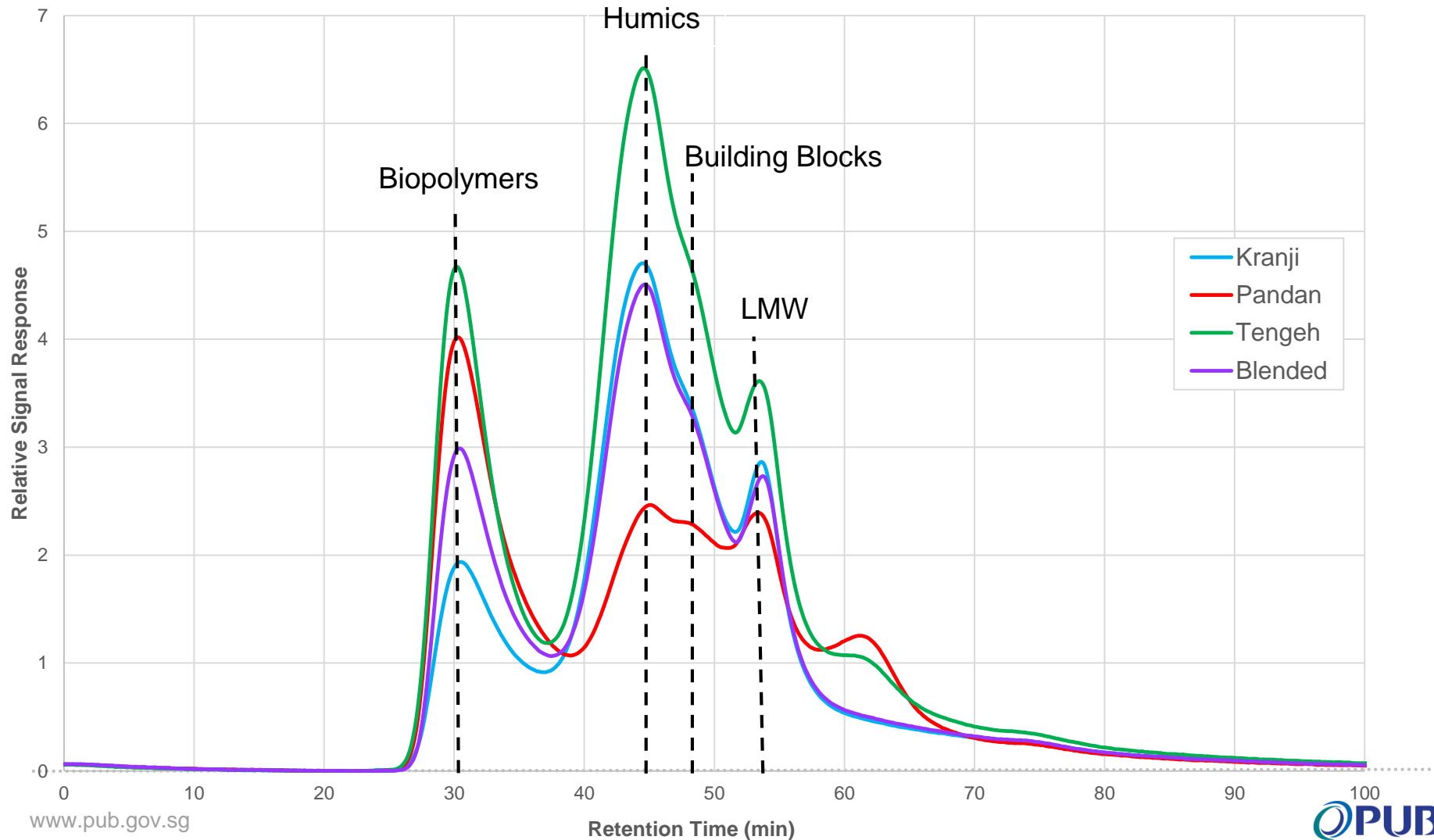


Increasing DOC Levels of our Raw Waters



Varying Quality of Raw Waters

Unique DOC profiles for each water source



Impact of DOCs on CCKWW

- Increase chlorine demand
- Increase membrane fouling
- Increase DBP / TTHM formation potential
- Higher nitrification potential in distribution network

Current Control Measures

- Operational tweaks
 - For e.g. changing blending ratios, enhanced coagulation, maintaining a narrow band for residual chlorine levels, etc.
- Process upgrading to enhance DOC removal
 - Including upgrading of sand filters to ceramic membranes, and a new BAC and ozone process

Feasibility Study of SIX®

MacRitchie Reservoir

Feasibility of SIX® at CCKWW

DOC removal by SIX®

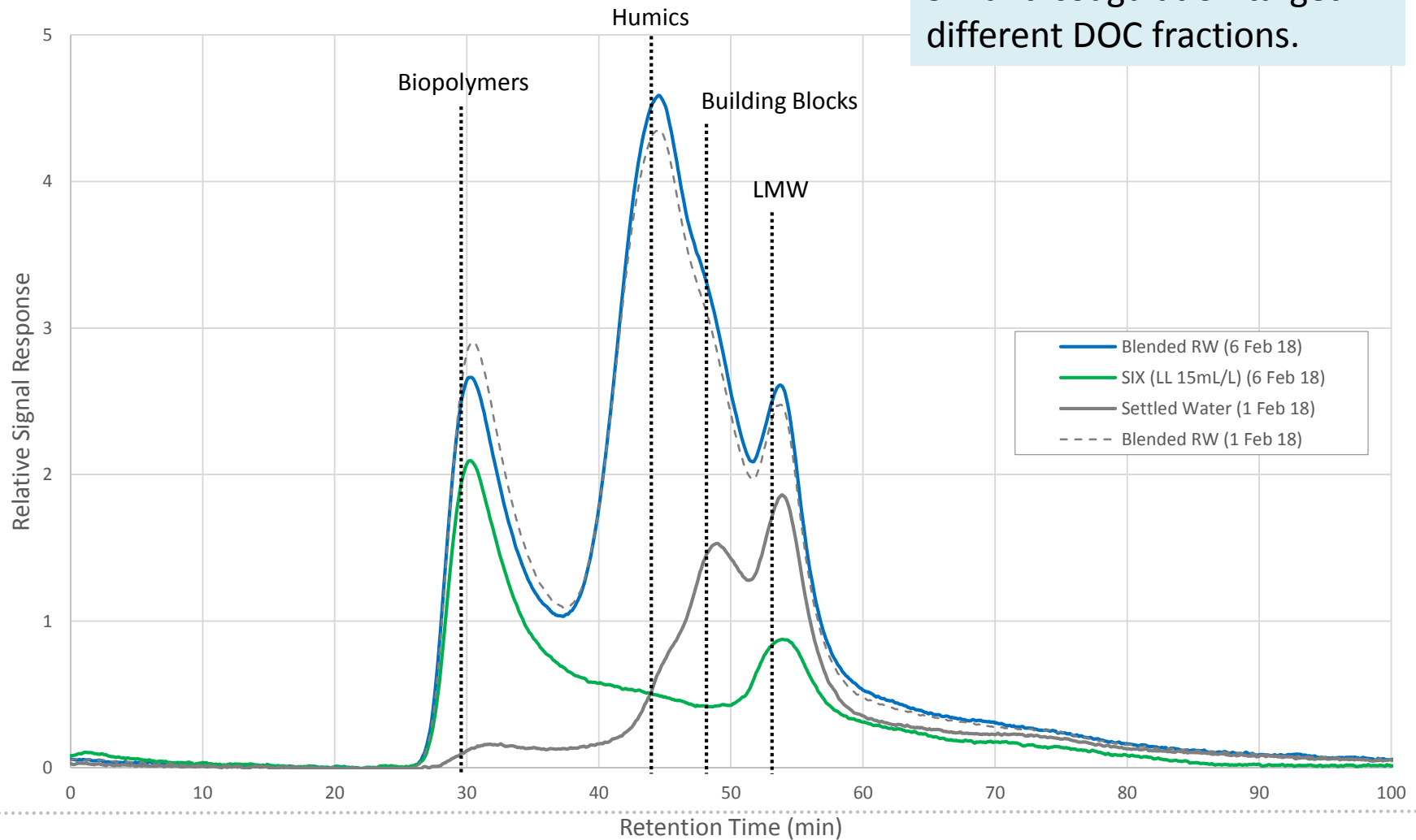
- A 6-month bench-scale trial of SIX® was done in CCKWW (Dec 2017 to Jun 2018)
- Results showed the following optimal operating conditions:

Resin concentration	15 – 20 mL/L
Contact time	30 minutes
DOC removal	42% for blended water
UVT increase	17.6% for blended water

LC-OCD Sample Analysis

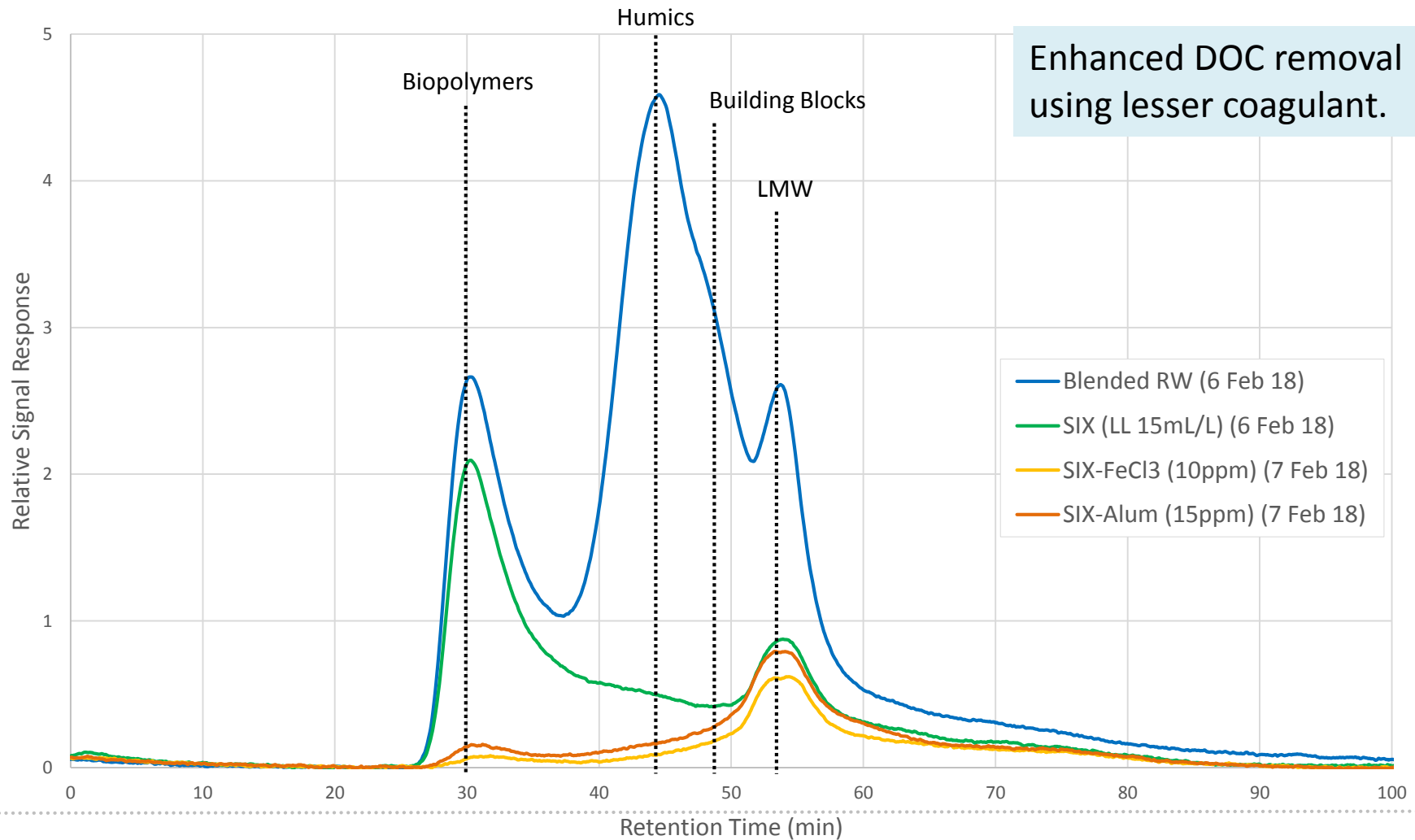
DOC removal by SIX® vs coagulation

SIX and coagulation target different DOC fractions.



LC-OCD Sample Analysis

Further DOC removal using coagulation after SIX®



Feasibility of SIX® at CCKWW

Brine challenges

- The regeneration process requires ~30 g/L NaCl solution
- A waste brine is generated:

Amount of salt required	70 tonnes/day
Total amount of brine waste:	~2,346 m ³ /day
Chloride in the brine waste	6,150 ppm
TDS in the brine waste	>6,150 ppm

Sewer discharge limits in Singapore:

- TDS < 3,000 ppm
- Cl- < 1,000 ppm

**Values based on calculations for 80 MGD*

Feasibility of SIX® at CCKWW

Brine management options?

- Blending of brine with other waste streams
- On-site treatment of brine
- Discharging of brine into sea
- Injection into the ground



IDEAS?

designed by  freepik.com

Thank you

MacRitchie Reservoir