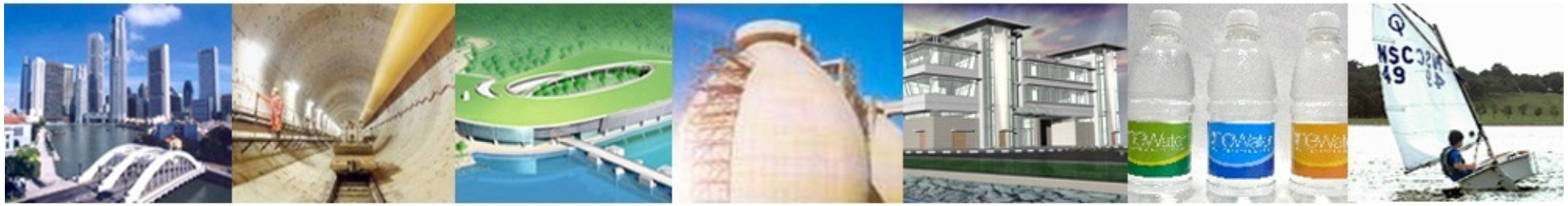
Water for All
Conserve, Value, Enjoy
PUB



Managing Operations of PPP Contracts
Case Study: SingSpring Desalination Plant

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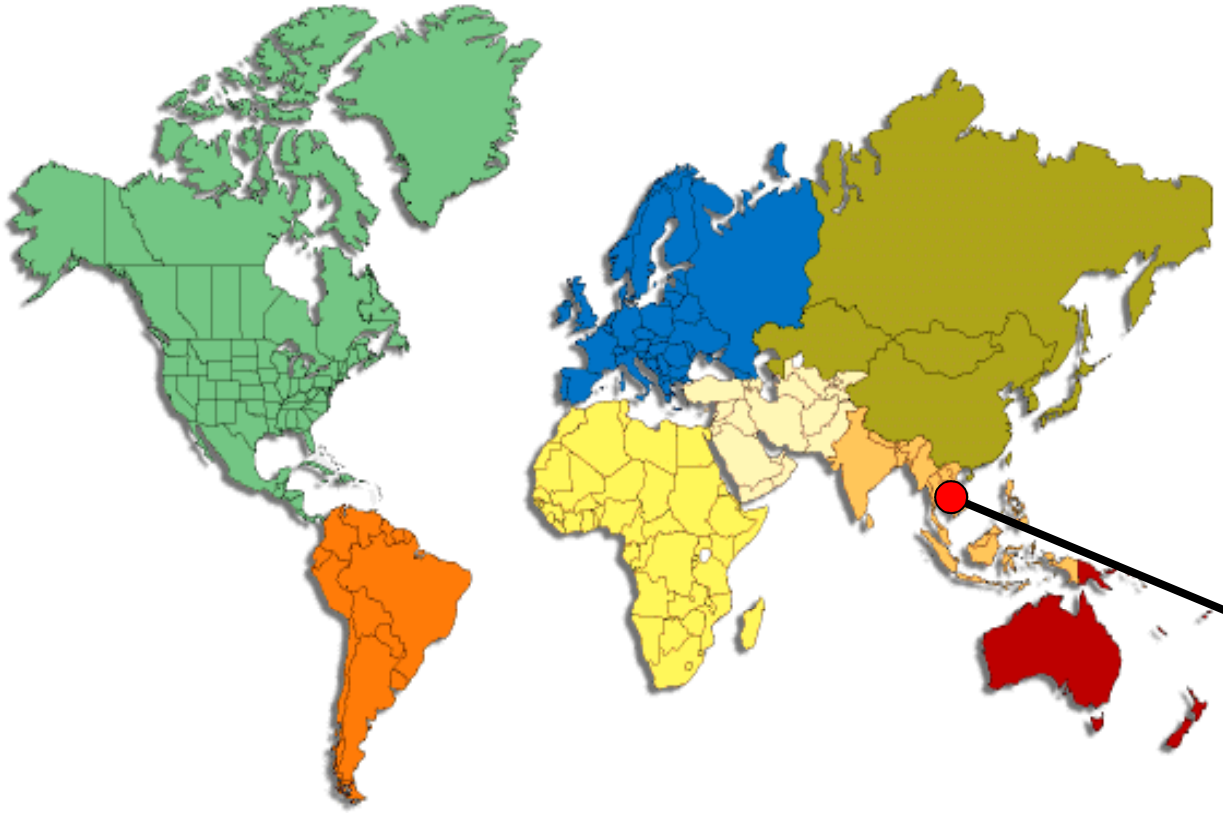
2 Nov 2012

Outline

- Introduction
- Project Details
- Desalination Processes
- Desalinated Water Quality
- Price Structure
- Managing the Performance of PPP contractor
- Overcoming Difficulties

Introduction



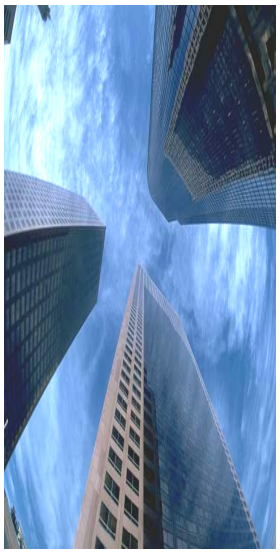


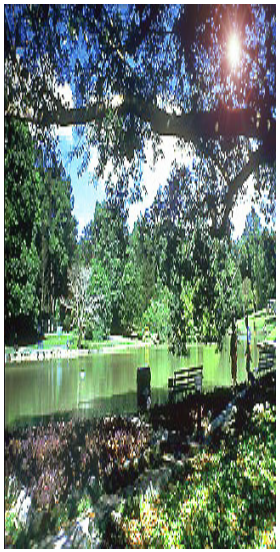


About Singapore

Land Area	712 km^2
Population	5.18 mil
Average Annual Rainfall	2,400 mm
Average Water Demand	1.7 mil m^3/day

Introduction






Ministry of the Environment and Water Resources

"To deliver and sustain a clean and healthy environment and water resources for all in Singapore."

National Environment Agency

"To ensure a sustainable quality environment in Singapore"

- ***Clean Land***
- ***Clean Air***
- ***Public Health***

PUB

Water for All: Conserve, Value, Enjoy

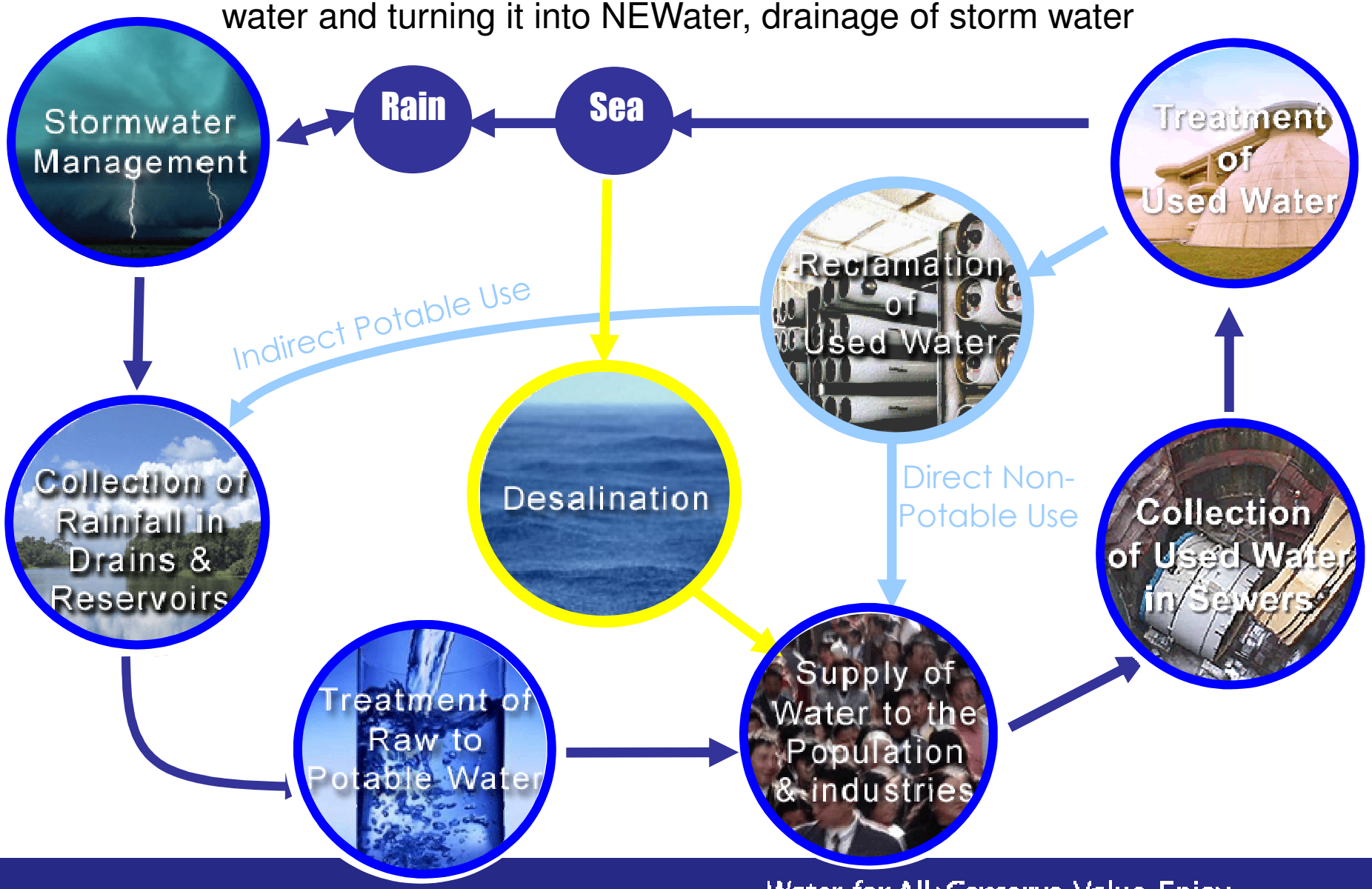
"To ensure an efficient, adequate & sustainable supply of water"

- ***Clean Water***

A Statutory Board constituted under the Public Utilities Act 2001 to provide integrated water supply, sewerage and drainage services

PUB Manages the Complete Water Cycle

From sourcing, collection, purification and supply of drinking water, to treatment of used water and turning it into NEWater, drainage of storm water



Managing Operations of PPP Contracts
Project Details

- Supply of desalinated water over a period of 20 years

- SingSpring Desalination Plant
  - Design-Build-Own-Operate project by Hyflux Pte Ltd
  - Capacity: 136,380m^3/day or 30 MGD
  - Cost: S$200 million
  - 10% of Singapore's daily needs for potable water



Project Details

- One of the largest seawater RO desalination plant in the tropics when it was built
- One of the largest single RO trains in the world
- Largest in-filter DAFF in the world
- One of the most energy efficient desalination plant in the world



Desalination Processes

- In-take Screening
- Dissolved Air Flotation & Gravity Sand Filtration
- Cartridge Guard Filter
- 1st Pass Reverse Osmosis
- 2nd Pass Reverse Osmosis
- Post Treatment
  - ✓Lime
  - ✓Carbon dioxide
  - ✓Fluoride
  - ✓Chlorine
  - ✓Ammonium sulphate



Desalination Processes
Pre-treatment

- 30m long submerged seawater intake culvert and intake screen - feed water supply and debris removal
- Dissolved Air Flotation Filtration (DAFF) units – remove oil, grease and suspended solids via coagulation and flotation process
- Sand filtration - remove finer suspended solids and silt



Seawater intake



Integrated DAFF and sand filtration units resulting in smaller footprint

Desalination Processes
Reverse Osmosis (RO)

- 2-pass RO system
- 1st pass through Seawater RO (SWRO) - 10 trains of single stage RO membranes (1,239 elements/train)
- 2nd pass through Brackish Water (BWRO) – 5 trains of 2-stage RO (910 membrane elements/train)
- Recovery Rate: 45% for 1st pass SWRO, 90% for 2nd pass BWRO



1st pass SWRO



2nd pass BWRO

Desalination Processes Post-Treatment

- Re-mineralization of treated water including addition of fluoride to protect against tooth decay and pH adjustment to meet WHO drinking water quality standards
- Storage at product water tank and pumped to service reservoir to distribute desalinated water to PUB potable water network



Post-treatment Chemical Building

Desalinated Water Quality Online Monitoring at PUB

- Fluoride: (Limit: 0.40 - 0.70 mg/l)
- Turbidity: (Limit: ≤ 3.0 ntu)
- pH: (Limit: ≤ 9.0)
- TDS: (Limit: ≤250.0 mg/l)
- Conductivity: (Limit: ≤ 378.0 µS/cm)
- Total Residual Chlorine: (Limit: 0.50 - 2.00 mg/l)
- Free Residual Chlorine: (Limit : ≤0.12 mg/l)
- Chlorine Combined (Monochloramine) Residual: (Limit: 0.80 - 2.00 mg/l)
- Temperature: max. 40°C

Desalinated Water Quality

(Non-conformance necessitating immediate ceasing of water dispatch)

Parameters	Non-Conformance Level
Monochloramine	<0.80 mg/l or >2.00 mg/l
Chlorine	<0.50 or >2.00 mg/l
Total Dissolved Solids	> 250 mg/l (max)
Turbidity	> 3 ntu (max)

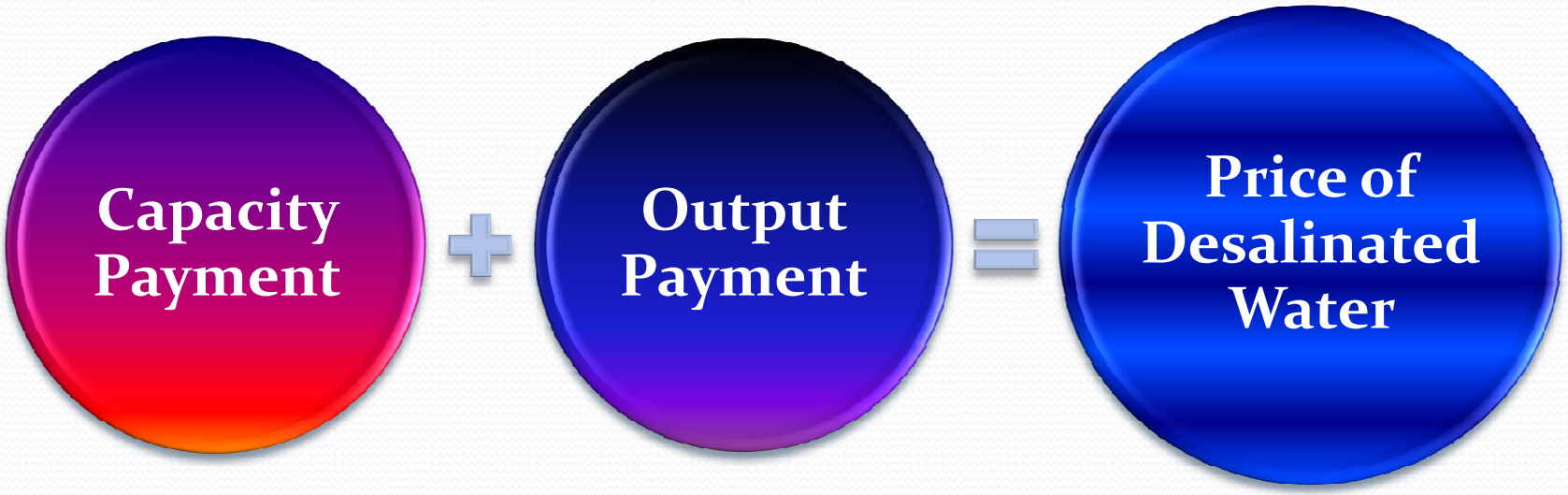
Seawater Quality – Threshold Level

(Plant shutdown if exceeded)

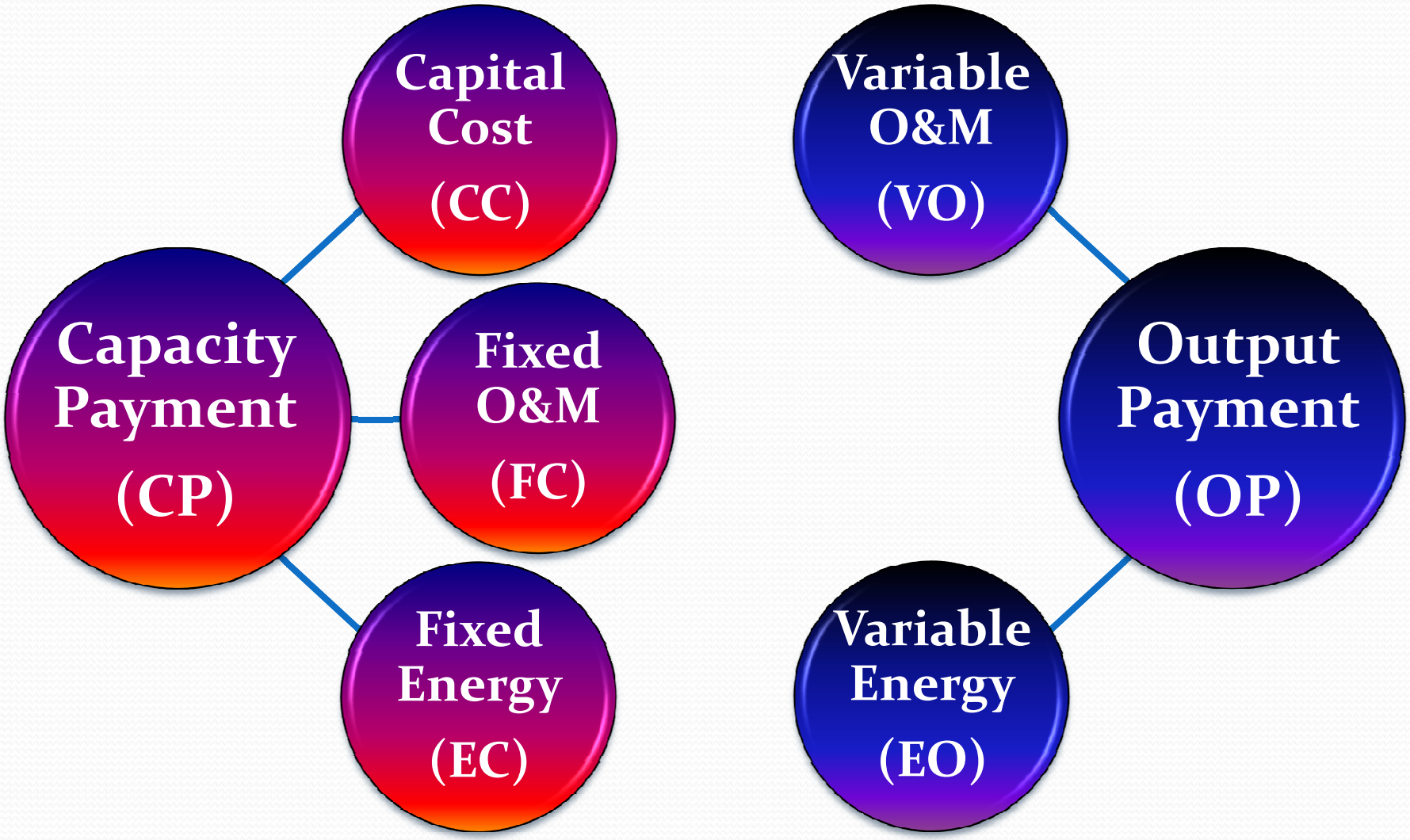
Parameters	Non-Conformance Level
Oil / Hydrocarbons	10 mg/l
Salinity	3.5 %
Total Suspended Solids	60 mg/l
Boron	5.0 mg/l

Price Structure

- 1st year price of S$0.78/$m^3$
- 2nd year onwards – applicable formula with adjustment for fuel price & price indexation



Desalinated Water Cost Components



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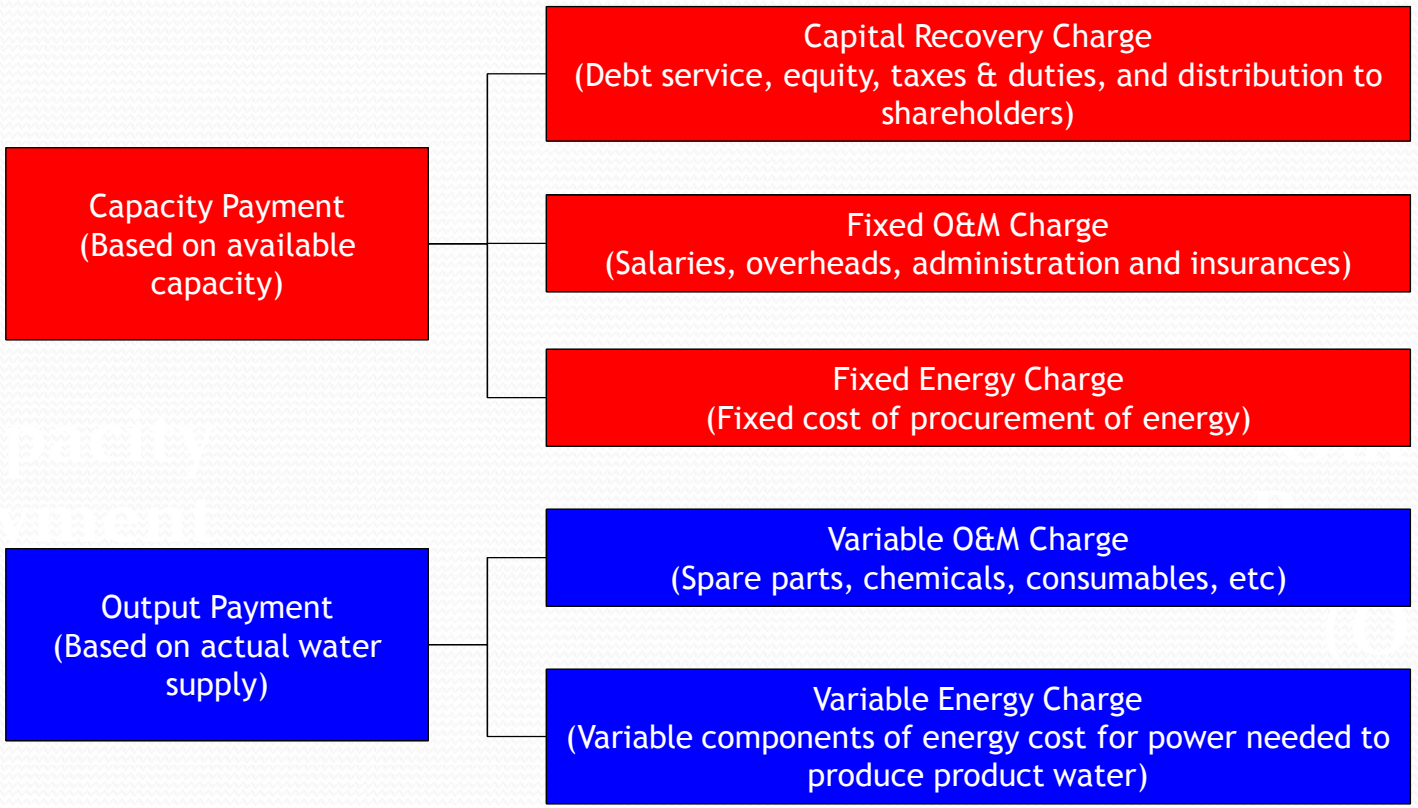

Index/ Adjustment Rate	Cost Components
USD to SGD Exchange Rate	• **Capital Cost** • **Fixed & Variable O&M** • **Fixed Energy** • **Variable Energy (part subjected to indexation & adjustment)**
Singapore Consumer Price Index (SCPI)	• **Fixed & Variable O&M (Local Portion Only)** • **Fixed Energy (Local Portion Only)**
US Producer Price Index (PPIUS)	• **Fixed & Variable O&M (Foreign Portion Only)** • **Fixed Energy (Foreign Portion Only)**
Fuel Price Index (FIP)*	• **Variable Energy (part subjected to indexation & adjustment)**

*Based on Singapore Cargo Price for HSFO 180cSt as published in Platt's Oilgram Report

Managing the Performance of PPP contractor

- Day-to-day monitoring of performance
  - Water quality by linking the plant's on-line water quality monitoring system to PUB's central monitoring system
  - Daily water sampling for analysis by PUB's laboratory/accredited laboratory
  - Daily dispatch
- Regular management meetings
- Regular operations meetings to review:
  - plant maintenance and performance such as differential pressures of RO membrane, conductivity and boron
  - security arrangements
  - accuracy and calibration of on-line instruments
  - accuracy and calibration of output flowmeters
- Annual Net Dependable Capacity Test
  - Plant capacity (24 hour sustainable run)
  - Water quality (full range of quality parameters)

Overcoming Difficulties

- **Proactive Management and Close Partnership**

  - championed at the top level of both PUB and the private sector partner in reaching a win-win implementation of the project. Such close working relations have so far ensured the smooth delivery and operation of the DBOO project.

  - much engineering involved in the design and construction of the plant to produce water satisfactorily. It is very difficult for legal/contractual documents to capture all the engineering requirements fully. When problems arise, both parties must come together and try to understand each other's points to arrive at a technical solution. Taking a strictly contractual/legalistic approach may lead to failures of PPP project – eg Tampa Bay.

Thank You