CaribDA 2014 Conference & Exposition

*"Drought-Proofing the Caribbean"*

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# SANTA BARBARA, CURACAO DESALINATION PLANT EXPANSION USING NANOH$_2$O THIN FILM NANOCOMPOSITE (TFN) SWRO MEMBRANE

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**NanoH$_2$O**

# About Nano$H_2O$

**Mission**

- **Lower the cost of desalination by leveraging nanotechnology to advance reverse osmosis (RO) membrane performance**

**Quick Facts**

- **Licensed original technology in 2005 from University of California, Los Angeles**
- **Intellectual property includes over 8 patents and patent applications**
- **Headquarters, manufacturing and R&D facility located in Los Angeles, California, USA**
- **Approximately 150 employees**
- **Nano$H_2O$ membranes are installed in over 150 commercial sites across 6 continents, representing over 300,000 cubic meters per day**
- **On April 30, 2014, NanoH2O was acquired by LG Chem**

# Thin-Film Nanocomposite Membrane Technology

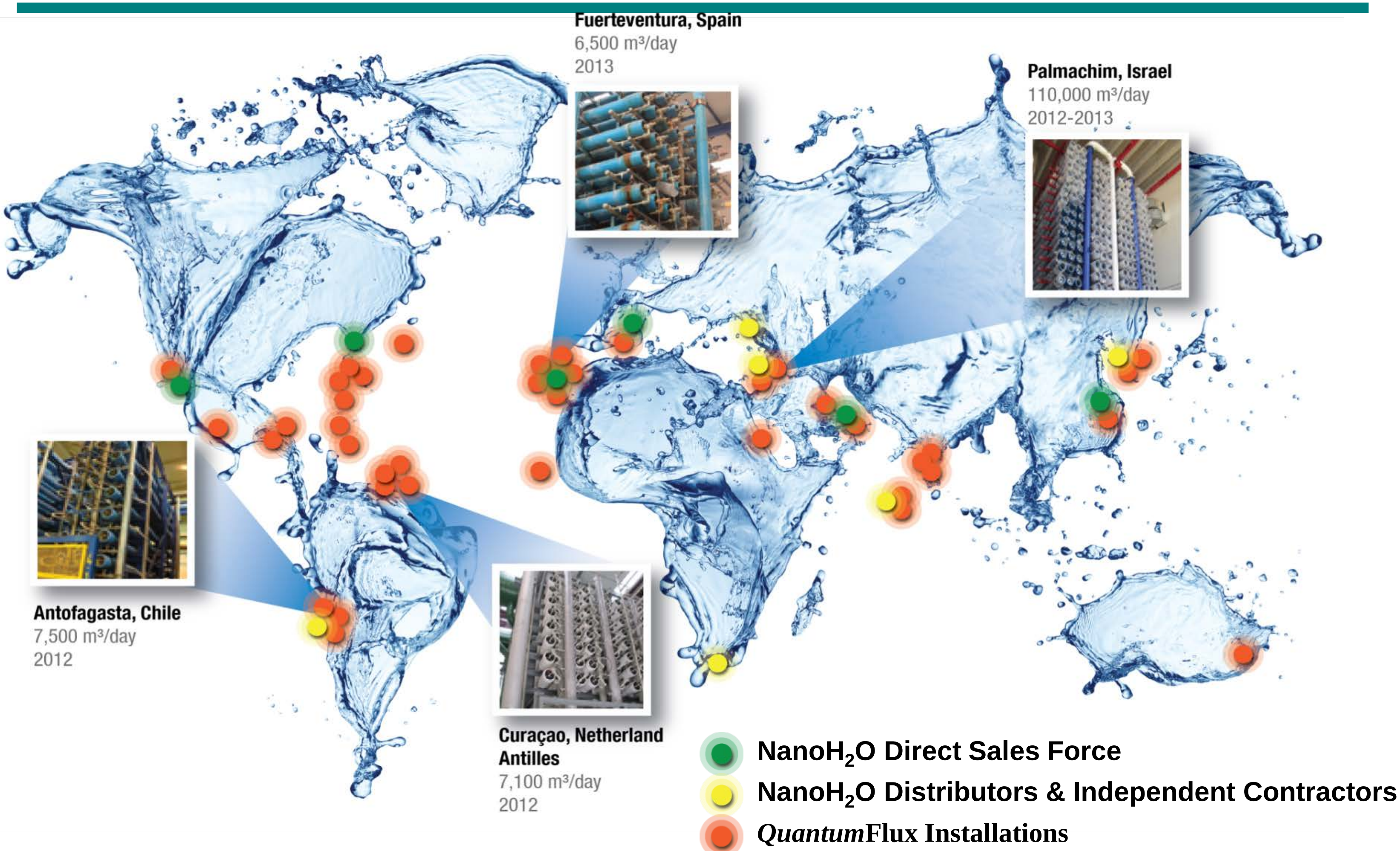

- **50-100% more permeable than existing polymer technology**
- **Improves best-in-class salt rejection by 25%**
- **Drop-in replacement for existing membranes**
- **5 Patents / 3 Applications in 11 Countries**

# Product Line Specifications

| **400 $ft^2$ elements** | **Qfx SW 400 ES** | **Qfx SW 400 R** | **Qfx SW 400 SR** |
|---|---|---|---|
| Permeate Flow Rate, $m^3/d$ (gpd) | **52 (13,750)** | 34 (9,000) | 24.6 (6,500) |
| Minimum NaCl Rejection, % | 99.7 | 99.75 | 99.75 |
| Stabilized NaCl Rejection, % | 99.8 | **99.85** | **99.85** |
| Active Membrane Area, $m^2$ ($ft^2$) | 37 (400) | 37 (400) | 37 (400) |
| Feed Spacer, mil | 28 | 28 | 28 |
| Stabilized Boron Rejection: % | 89 | 93 | 93 |

| **440 $ft^2$ elements** | **Qfx SW 440 ES** | **Qfx SW 440 R** | **Qfx SW 440 SR** |
|---|---|---|---|
| Permeate Flow Rate, $m^3/d$ (gpd) | **57 (15,070)** | 37 (9,900) | 27 (7,150) |
| Minimum NaCl Rejection, % | 99.7 | 99.75 | 99.75 |
| Stabilized NaCl Rejection, % | 99.8 | **99.85** | **99.85** |
| Active Membrane Area, $m^2$ ($ft^2$) | 41 (440) | 41 (440) | 41 (440) |
| Stabilized Boron Rejection: % | 89 | 93 | 93 |

# Global Installations



# Hybrid Design

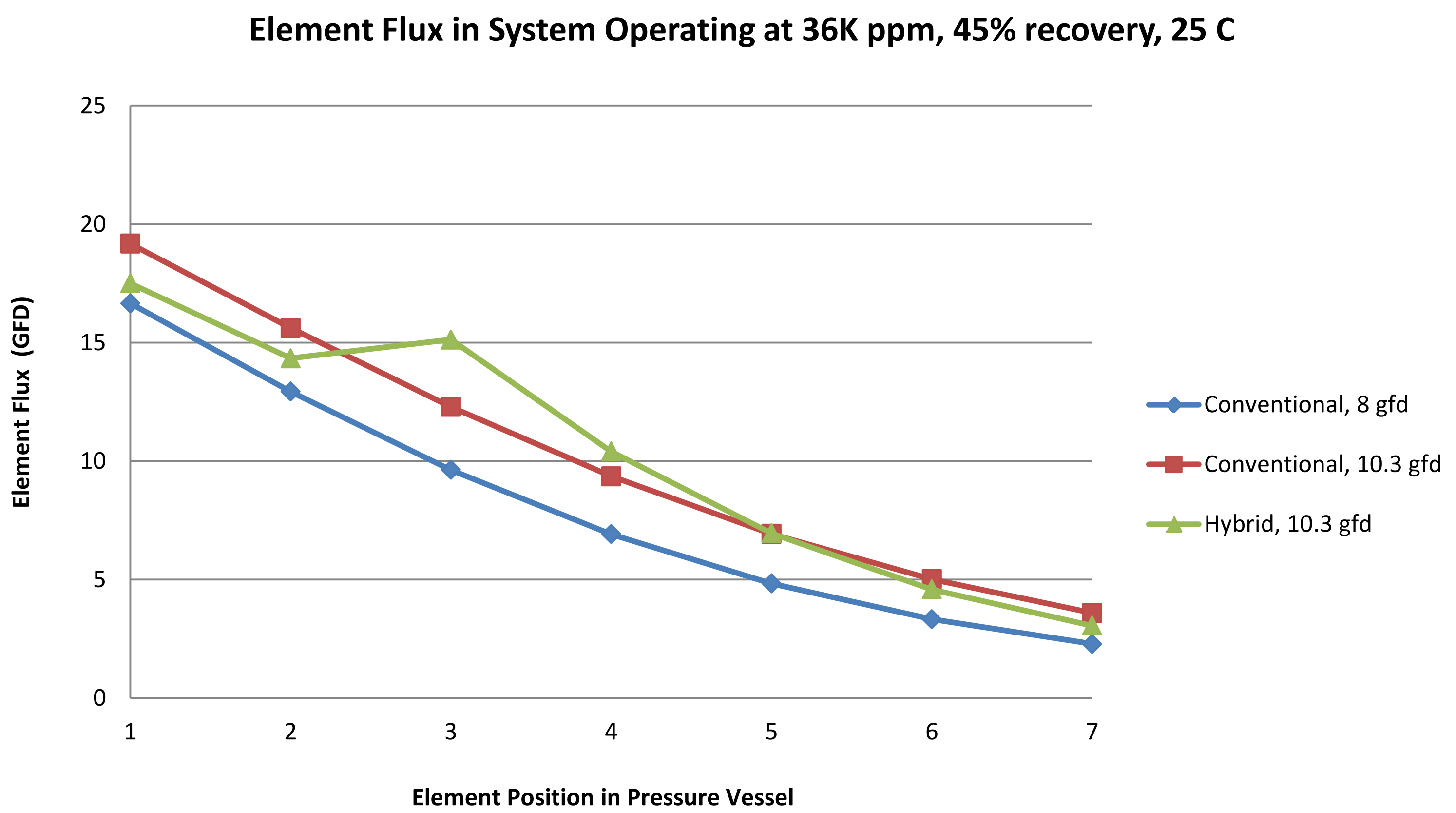
**Definition:**

The concept involves the internal staging of different RO element models, with different specification characteristics, within the pressure vessel to optimize system performance. The typical configuration consists of placing low flux elements in the lead positions of the pressure vessel and higher flux ones in the rear.

**Benefits:**

- Increase the production capacity
- Reduce the number of elements and pressure vessels used in a system
- Lower the feed pressure and energy consumption
- Reduce the risk of fouling

# Hybrid Design (2)



# Island of Curacao, West Indies

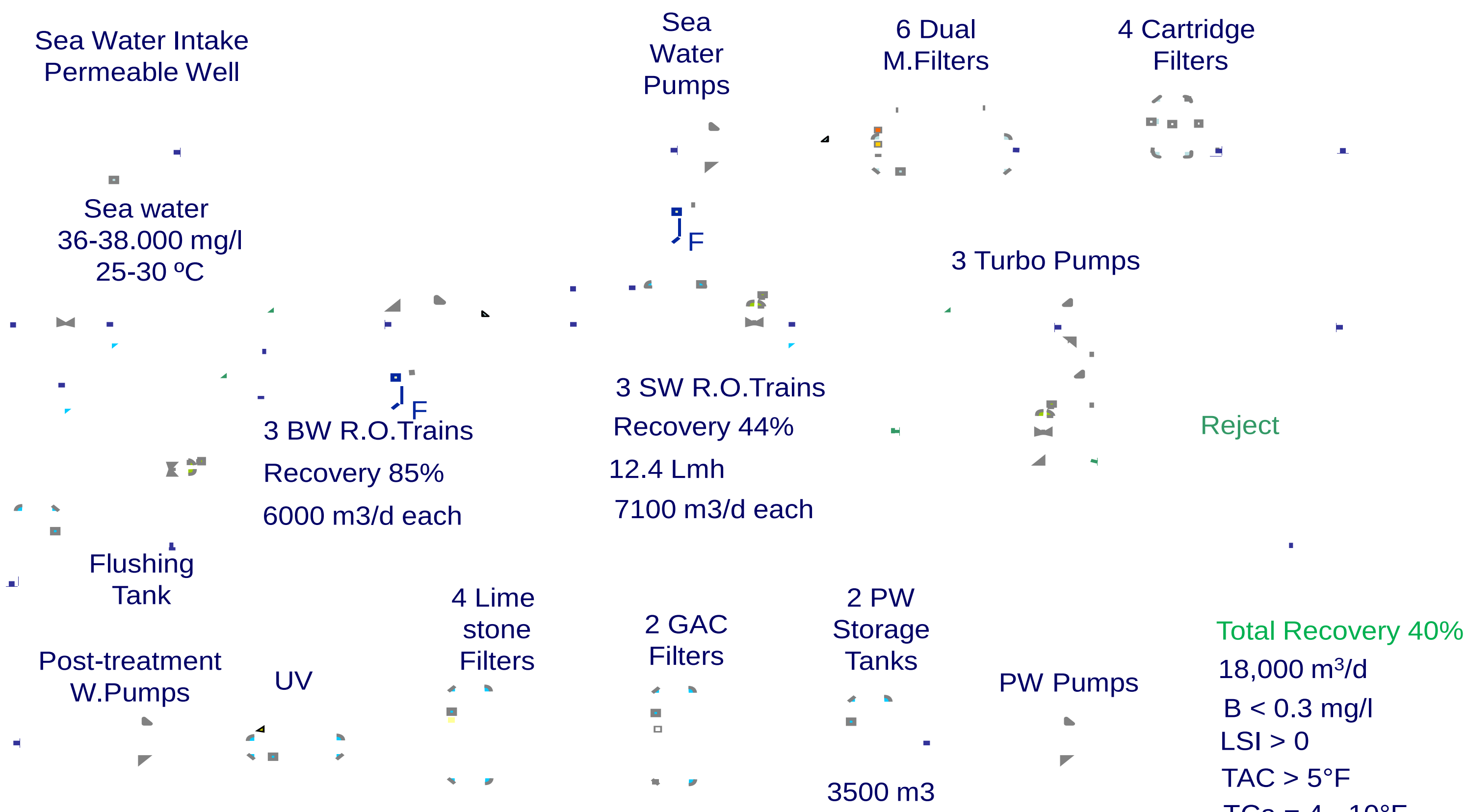

- Most populous island in the Netherland Antilles, West Indies
- Major Industry: oil refining, tourism, and ship repairing
- Desalination using thermal method started in the 1930's
- The use of Reverse Osmosis technology was decided in 2003 by Aquaelectra

# Santa Barbara SWRO Plant

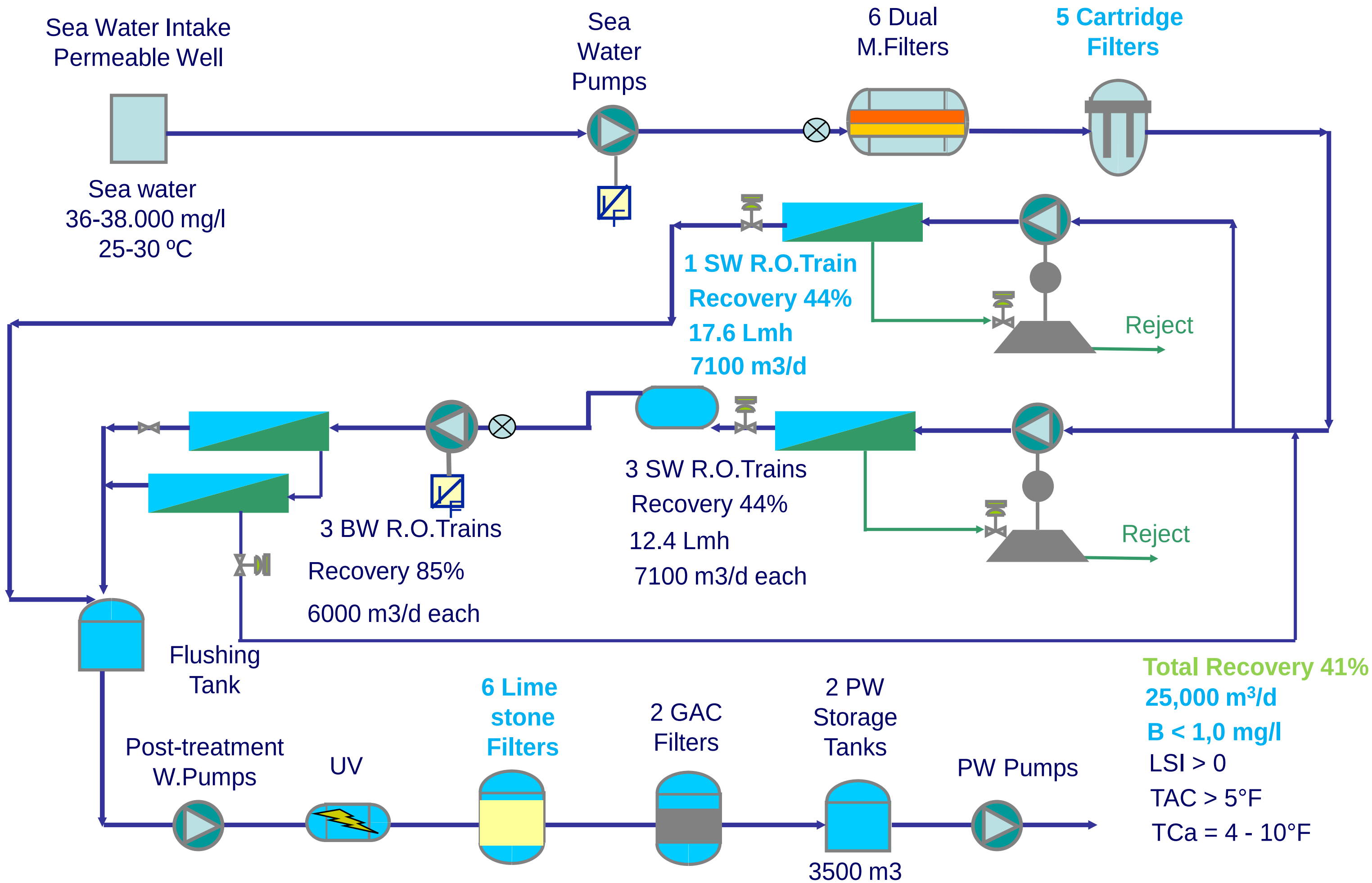
The Santa Barbara Desalination Plant facts:

- Located at the east end of the island of Curacao, providing water for approximately half of the island, and designed to serve the growing tourism industry on this part of the island
- Designed and built by Degremont
- Commissioned at the end of 2005
- Operated by its owner, Aqualectra formerly known as Integrated Utility Holding

# Original Plant Design



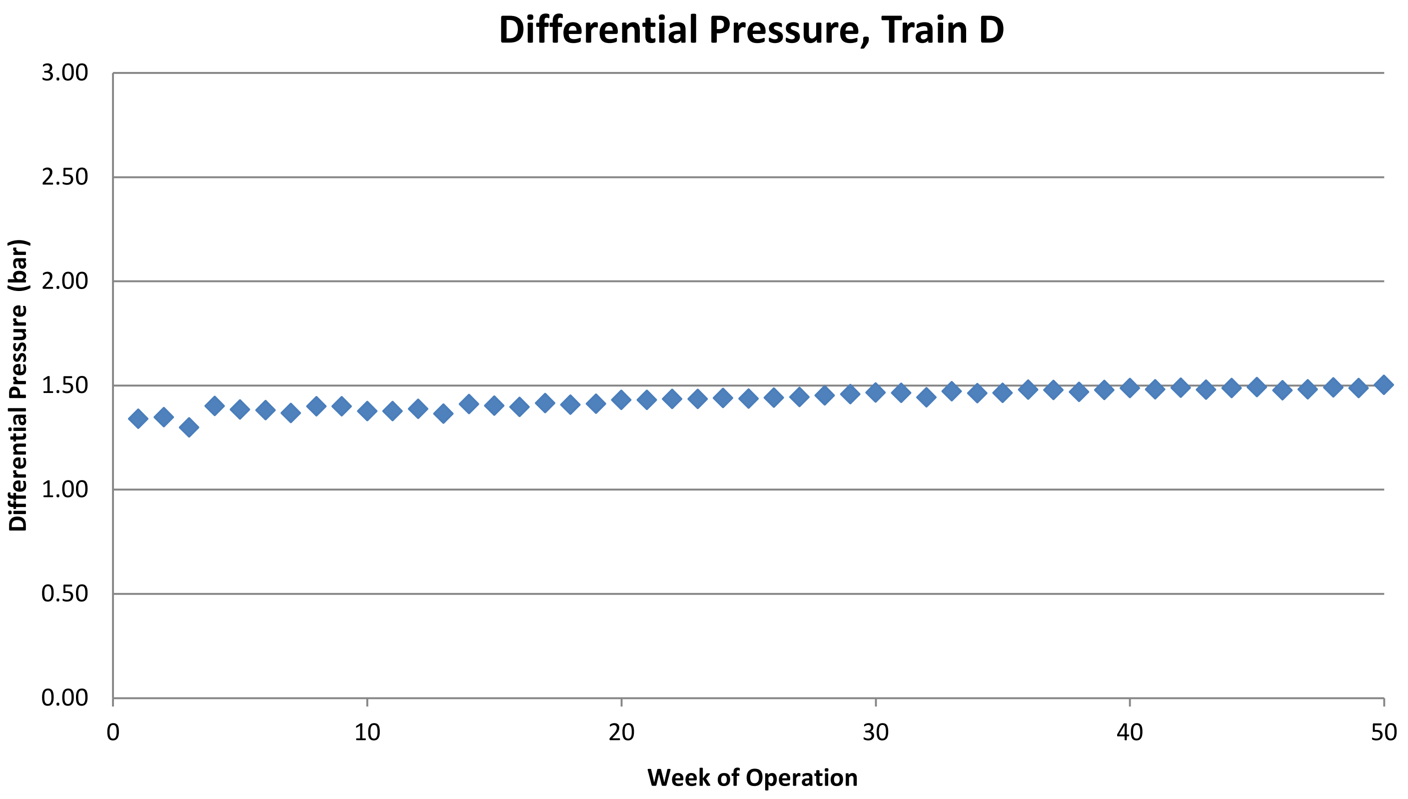
# Final Plant Design with Expansion



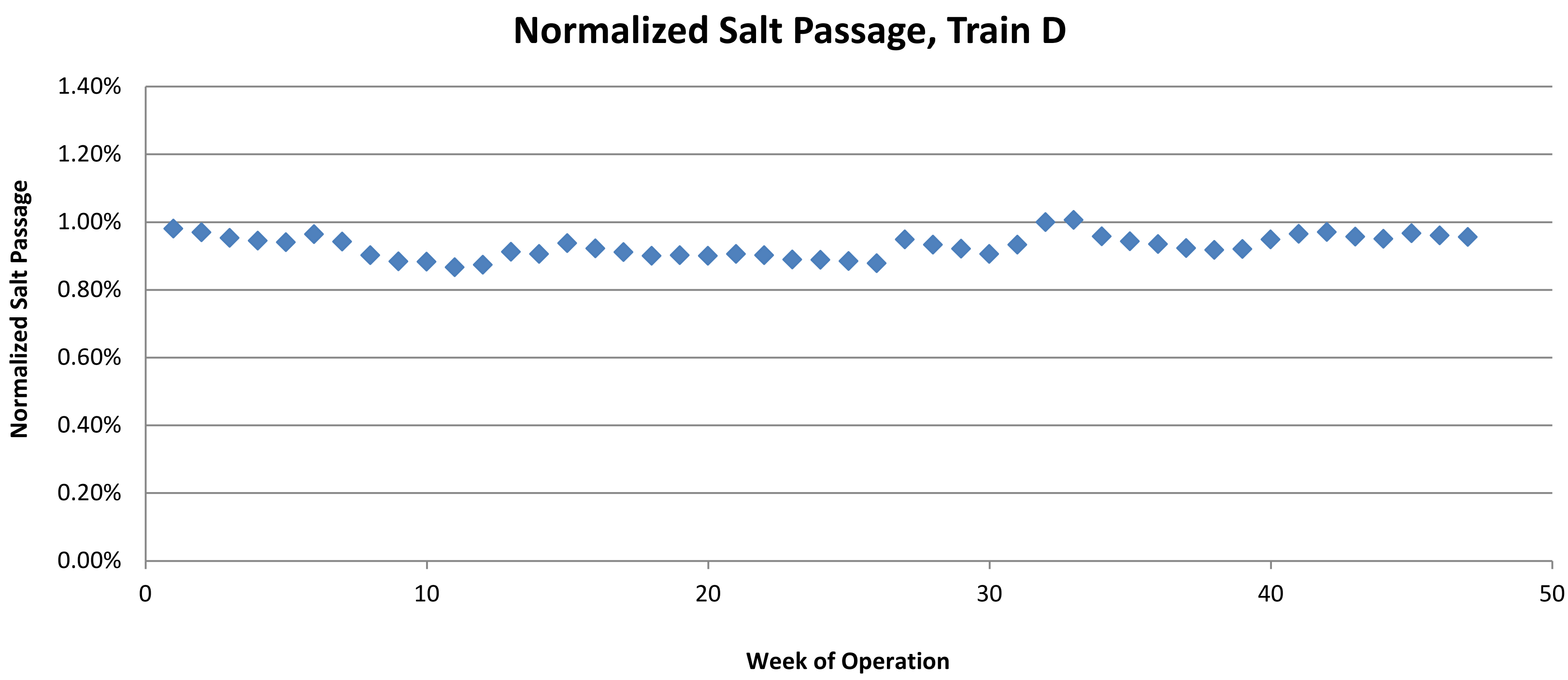
# First Pass Train Performance

| | Unit | Train A, B, C | Train D |
|---|---|---|---|
| Operating Conditions | | | |
| RO Feed TDS | ppm | ~35,400 | ~35,400 |
| Temperature | °C | 27.0 | 27.0 |
| Production Capacity | $m^3/h$ | 300 | 300 |
| Recovery | | 44.00% | 44.00% |
| Average Flux | gfd | 7.4 | 10.5 |
| SWRO Design | | | |
| # PV | | 92 | 65 |
| # Element per PV | | 7 | 7 |
| Element Configuration | | Element A | Hybrid Design<br>(2) Qfx SW 400 SR<br>(5) Qfx SW 400 R |
| Performance | | | |
| TDS | ppm | <350 | <295 |
| Transmembrane Pressure | Bar | ~52 | ~52 |

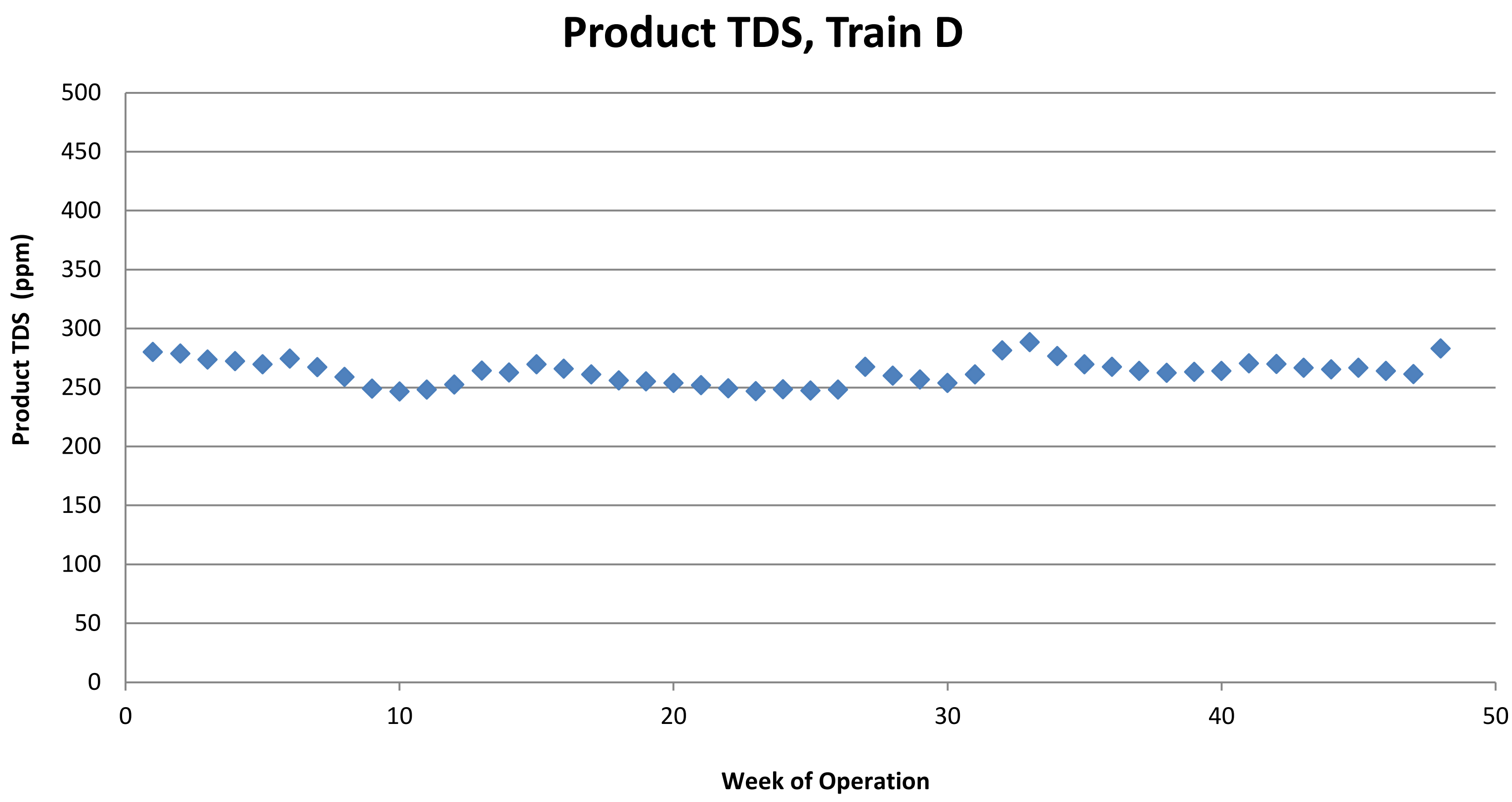
# Train D: Differential Pressure



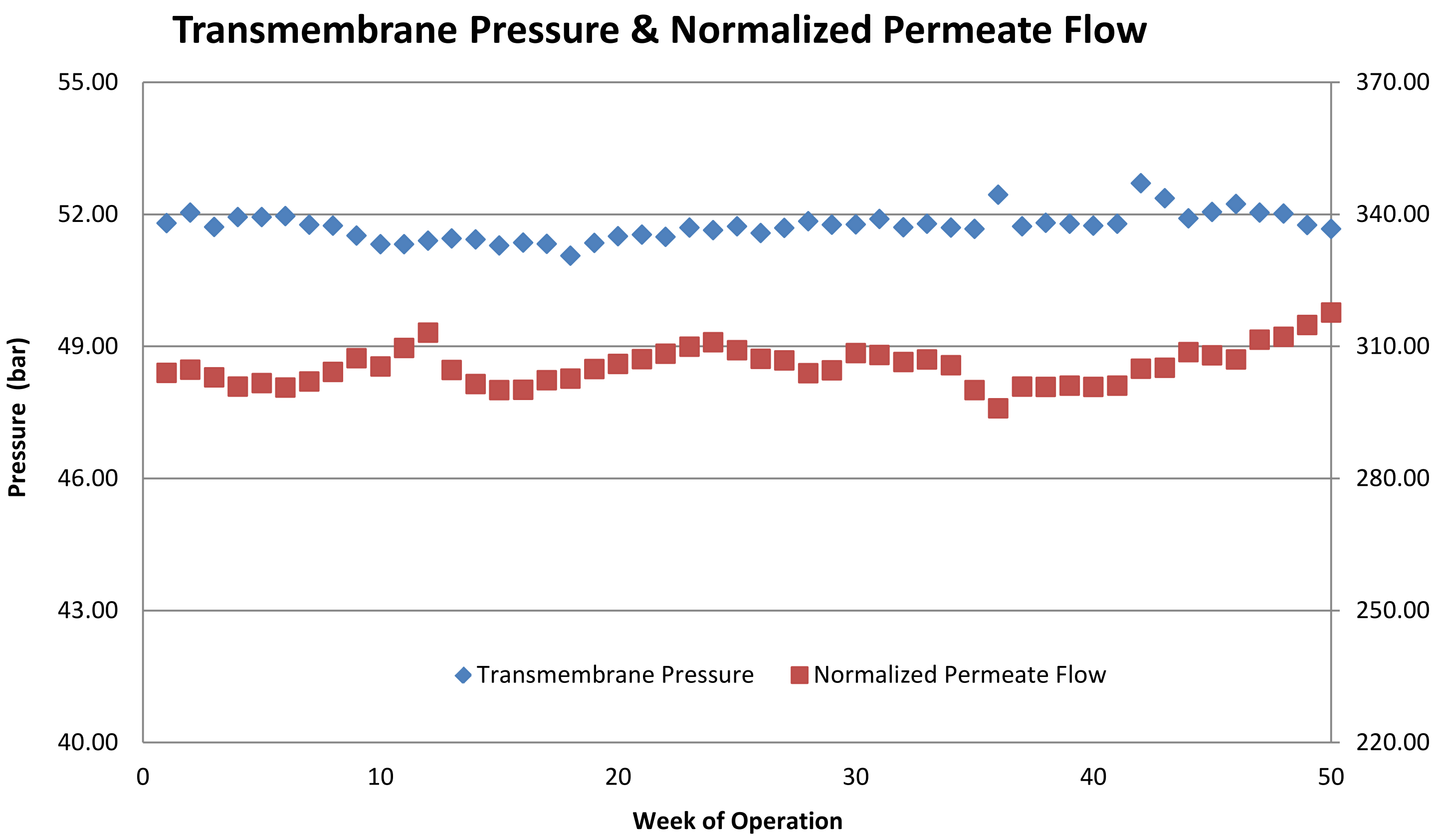
# Train D: Normalized Salt Passage



# Train D: Product Quality



# Train D: Transmembrane Pressure and Permeate Flow



# Summary

The expansion train with the nanocomposite elements in a hybrid configuration offers:

- 29% less SWRO elements per train than the existing first-pass trains
- Same operating feed pressure as the existing first-pass trains while the system flux is significantly higher.
- Better product quality than the first-pass product from the existing trains.
- Stability of the salt passage and permeability of the elements despite the system running at a higher average flux

This installation at Santa Barbara Curacao showcases the benefits of using low and higher flux nanocomposite membrane in a hybrid configuration to significantly increase the system flux, and lower capital without compromising the product quality and the performance stability over time.

# Thank You