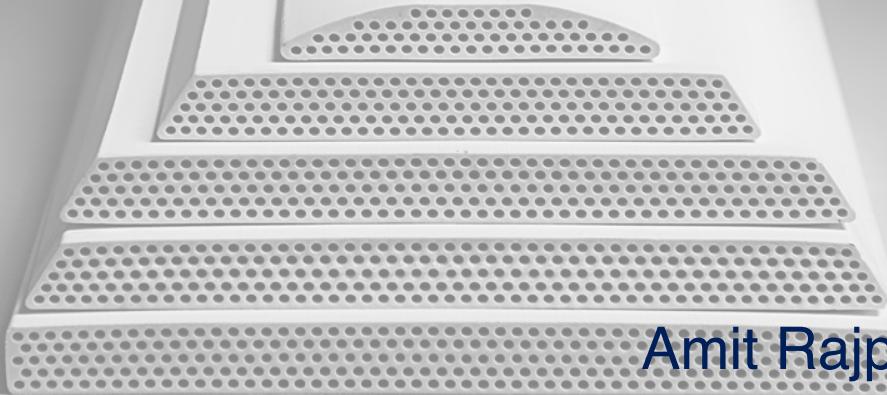


Nanostone Water Overview

Ceramic UF Membrane



Amit Rajput

amit.rajput@nanostone.com

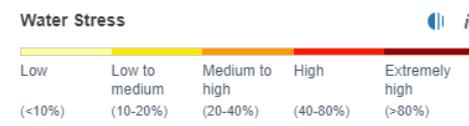
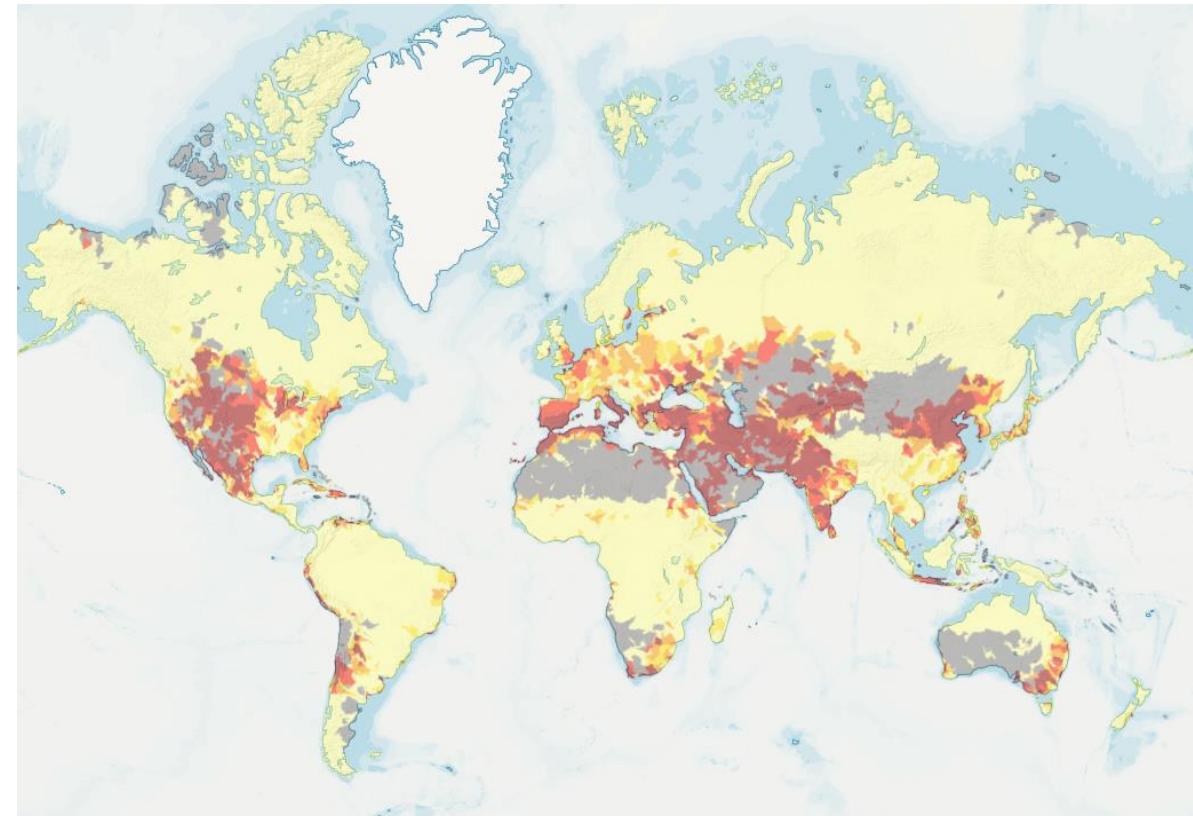
Complex Water Treatment Made Simple

The world is turning to wastewater, seawater and challenging surface and ground water to meet growing water demands, bringing increased complexity to water treatment.

We make water treatment reliable, simple and cost effective with our robust ceramic filtration solutions.

Nanostone Water's advanced ceramic-based filtration solutions physically remove suspended solids and pathogens from even the most challenging waters with reliable, robust and cost-effective processes while significantly reducing land and environmental footprints.

Global Map of Water Stress by 2040



Arid & low water use
No data

<https://www.wri.org/applications/aqueduct/water-risk-atlas/>

Company Background

Total Global Capacity ~ 300
MLD 2016-2020

True North Venture Partners acquires established innovative ceramic technology, launches Nanostone Water

Beta product launched and initial demonstration projects deployed

First commercial installations; microelectronics, boiler feed

Largest industrial and drinking water installations in operation

Expand into Desalination

R&D advances to prototype and alpha product field testing; pilot production line upgraded

Commercial product development and qualification and commercial production line design and retrofit

First commercial drinking water installations

Global expansion of both business and resources

2012 2013 2014 2015 2016 2017 2018 2019 2020 2021



- HQ Waltham, MA
- Manufacturing Halberstadt, GER
- Sales & Engineering Offices



Halberstadt, Germany: Automated production line with largest ceramic membrane capacity in the world.

Manufacturing Process

Raw Material Preparation



Extrusion



Sintering



Membrane Coating



Sintering



Packaging



Module QC



Module Assembly



Membrane Segment QC



Ceramic Configurations

TUBULAR

Legacy Ceramic Technology

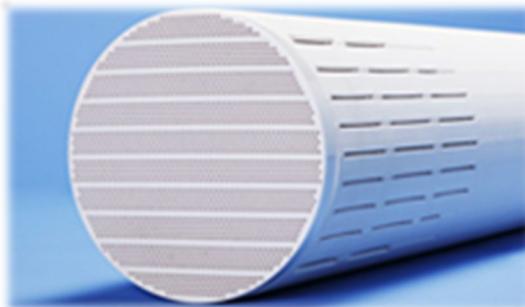
Low surface area/piece
High manufacturing cost
High operating cost



MONOLITH

Initial Ceramic for Mainstream

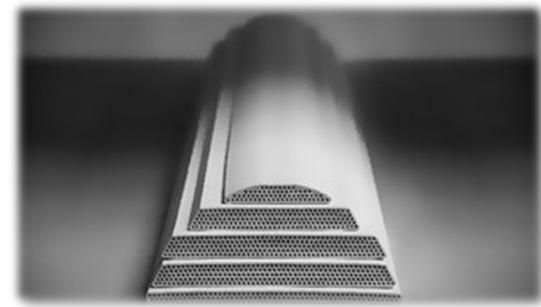
High Surface area
Reduced manufacturing cost
Low operating cost
Deformation lowers yield
Post firing machining cost



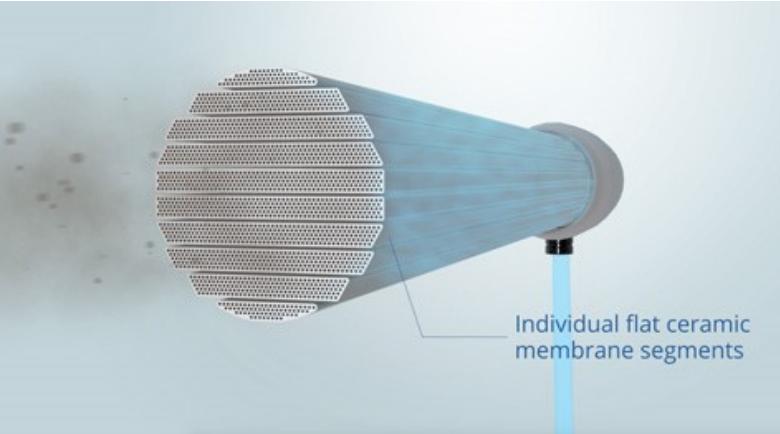
SEGMENTED

Nanostone Water Patented Design

High surface area
Segments – no machining
Segments – high yield
Lowest cost to manufacture



Nanostone Module (Universal Design)



24.3 m² area
 α - Al₂O₃ ceramic membrane

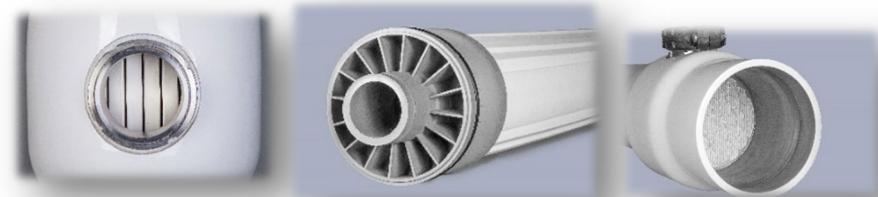
**Inside-Out Filtration
Dead-end operation**

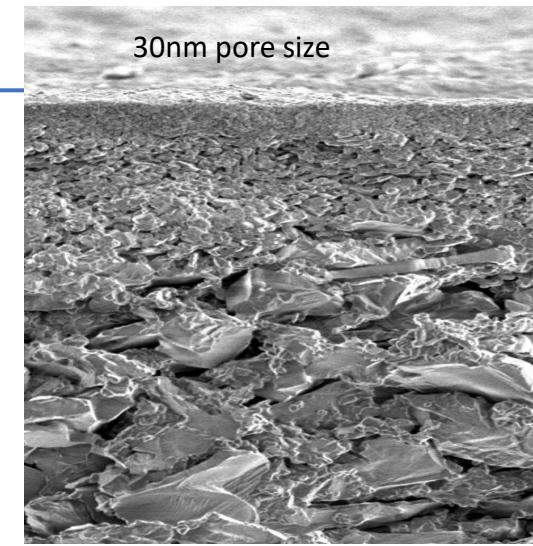
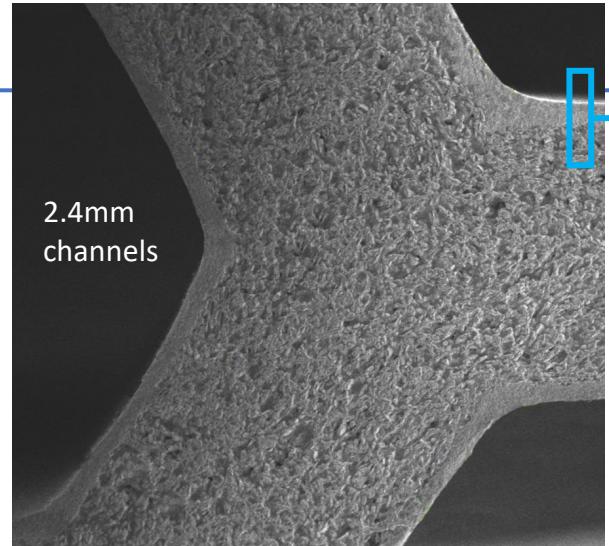
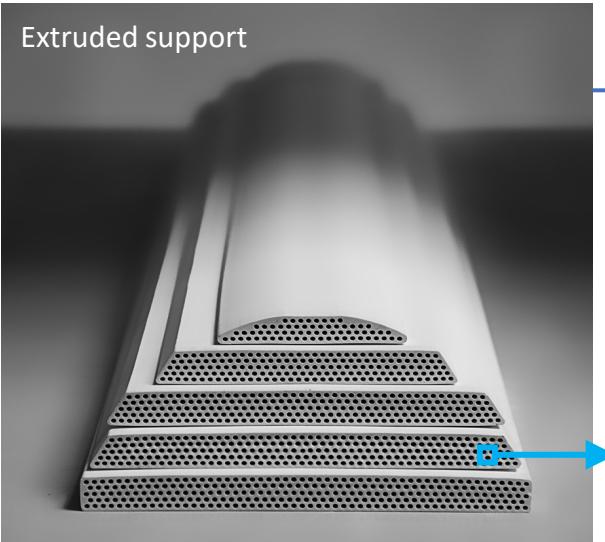


Vessel height 1.9 m, Dia 9.8 in, Shipping weight 95 kg

7 Bar rated FRP
vessel

Super Duplex 2507
Permeate Port





- Nanostone Water is leading the industry with our **innovative ceramic design**
- We've optimized our product and production process to **optimize yield** and **lower capital costs** and **operating costs**
- The ceramic surface coating also enables tight pore size distribution **improved performance and reliability**

Nanostone Ceramic Membranes – Key Features and Benefits

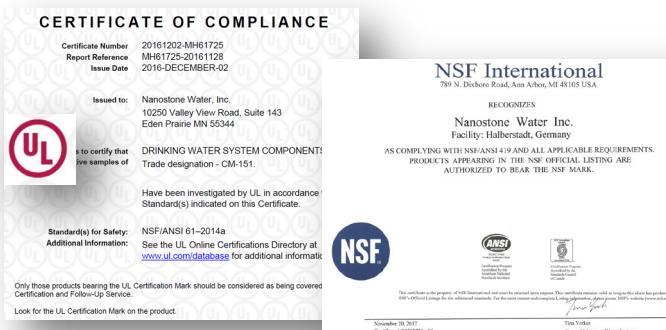


- Operates at **very high flux** (3–6 times higher than PUF)
- Higher **recovery** than polymeric MF/UF
- Runs stably at **high solids loading**, especially inorganics
- Dosing of **coagulant** is well-tolerated and even **improves performance**
- Stable operation **without pre-treatment** (ceramic UF eliminates the need for clarifiers, multi-media filters or DAF)
- **CapEx-competitive** on a system-to-system basis with compact footprint
- **pH resistance** from 1–13 in cleaning, 2–12 in operation
- **Operational temperature** 33 –113 °F (0.5 –45 °C)
- Depending on application, membranes may be **guaranteed for up to 20 years**
- **Robust and reliable** (no fibers to break or repair)
- **Lower operational complexity and cost** (no air scour required, fewer chemicals and electricity when removing treatment steps, higher water recovery)

Commercial References

Drinking Water Certifications

- NSF / ANSI 61 / 372 Certification
- NSF / ANSI 419 Certification
- Virus testing using MS2 Challenge – NSF
- State Approvals in US
- UK Regulation 31 Approval – expected Q2 '21
- China drinking water approval in process



Representative Installations

Industry	Application	Capacity (m³/d)	Start Date
Drinking Water	Retrofit of failed PUF	10,200	May, 2018
Drinking Water	Retrofit of failed PUF	18,900	Apr, 2018
Drinking Water	Retrofit of failed PUF	54,500	Mar, 2019
Semiconductor	Cutting & grinding WW	5,000	Aug, 2018
Semiconductor	Mixed reuse	1,200	Sep, 2016
Power	Cooling tower blow down	10,000	Mar, 2019
Power	Boiler feed	8,400	Oct, 2017
Coal Mining	Mine water reuse	36,000	May, 2019

> 50 Total Commercial Installations
> 300 MLD of water treated

Municipal Drinking Water Treatment

The Problems We Solve:

As clean, simple groundwater sources are depleted reliance upon more challenged water sources—such as wastewater, seawater and challenged surface and ground water—is becoming the norm. More challenging feedwaters require more complex and costly multi-step treatment processes. Higher levels of contaminants and greater variability in feedwater quality increase water quality risks and the frequency of fouling and operational disruptions.

In coping with these treatment challenges, water utilities must meet increasing regulatory water quality standards and address growing environmental sustainability pressures.

Nanostone Water's Value Proposition:

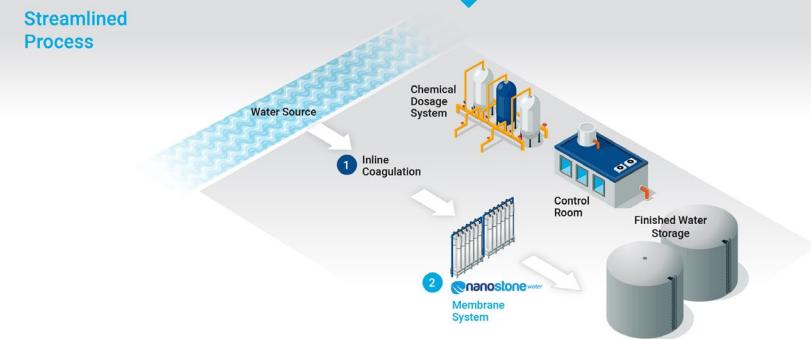
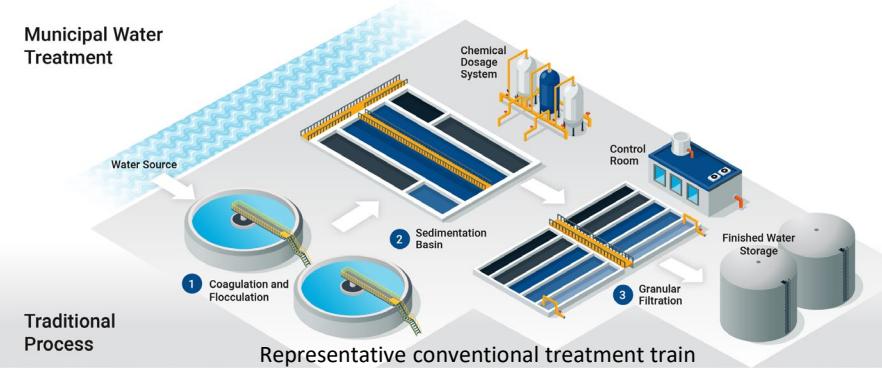
For municipal water utilities faced with these types of challenges, Nanostone Water provides a ceramic-based filtration system that physically removes suspended solids, viruses and other pathogens while:

- Performing robustly for up to 20 years without fiber breakage or down time
- Eliminating chemical dosing and other pretreatment steps required with traditional treatment
- Operating at a continuously high sustained flow rate; and
- Replacing multiple treatment processes traditionally required

Our customers can be confident of consistently achieving their water quality, operational and financial goals year over year, regardless of variable influxes of suspended solids and pathogens.

Markets We Serve:

We are integrating our solutions into plant upgrade and capacity expansion projects for municipal utilities in Europe, Asia and North America. We are also retrofitting our solutions into treatment plants suffering from under-performing polymeric membrane solutions.



Simplified Nanostone treatment train

Case Study: Drinking Water Polymeric Membrane Retrofit

Canyon Regional Water Authority - New Braunfels, Texas

Capacity: 55 MLD

Installation Date: June, 2019

CHALLENGE

Difficulty meeting capacity due to high downtime for membrane cleaning and repairs

Frequent membrane fiber breakage threatened water quality

Low water recovery rate of 83%; high amount of wasted water and environmental impact

High labor, chemical and power costs

NANOSTONE SOLUTION

Able to achieve full rated capacity of plant without additional footprint

Easily passes daily integrity tests without operator intervention; water quality improved

Recovery rate improved to 97%

Significant reductions including 50% less power consumption

"When it was finally time to replace the polymeric UF membranes, we first conducted side-by-side pilot tests of two PVDF membranes and Nanostone's CM-151. Nanostone has been the answer to our problems. The ceramic membranes are robust, low maintenance, use less process water to operate."

Adam Telfer | CRWA Operations Manager



Expanded treatment capacity by 40% in same footprint

End-User Name	Canyon Regional Water Authority
Application:	Clarified Surface Water
Incumbent	KOCH Targa
Overall Plant Flow:	55 MLD
Feed Quality:	5 NTU
Design Flux:	Operating at 365 LMH
Recovery:	97.8%



Side by Side Comparison

Matching skids

Operational Flow

Incumbent

44 Modules

6.4 MLD

Nanostone

44 Modules

9.1 MLD

Desalination Pretreatment

The Problems We Solve:

Reverse osmosis (RO), the state-of-the-art technology for seawater desalination, performs well over extended periods so long as the feedwater is largely free of suspended solids and low in dissolved organics. However, existing pre-treatment technologies supplying RO systems struggle when exposed to high levels of dissolved organics, harmful algae blooms, and other sudden and variable influxes of suspended solids. When this material passes the pre-treatment system RO fouling increases drastically, reducing plant capacity, increasing cleaning cycles and chemical consumption and causing premature RO membrane failure.

For developers, owners and operators, these problems result in:

- Reduced plant utilization, which severely impacts plant economics;
- Elevated risks of operational disruptions; and
- Higher treatment costs

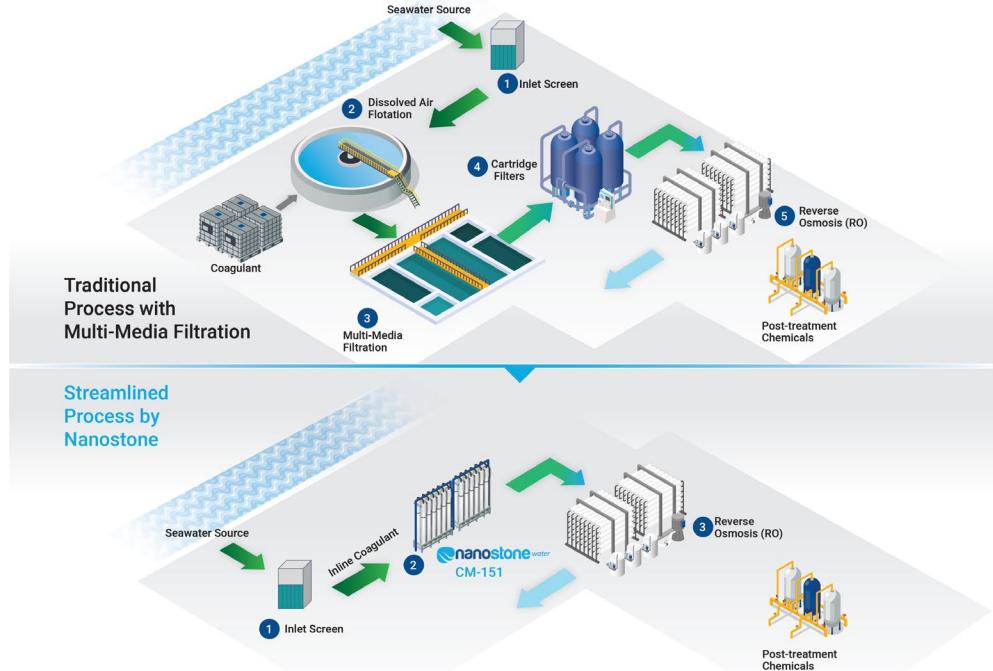
Nanostone Water's Value Proposition:

Nanostone Water's ceramic desalination pretreatment system removes harmful algal blooms, suspended solids and high levels of dissolved organics from seawater with high reliability, enabling RO desalination systems to operate to rated capacity and planned costs over an extended life. Our single-step solution also eliminates multiple pretreatment processes, reducing capital expense and footprint.

We significantly reduce treatment costs and operational and financial risks for our customers.

Markets We Serve:

We are working with leading developers, owners and operators of large seawater desalination plants in the Middle East and Asia to integrate our solutions into greenfield desalination plants and also to retrofit our solutions into under-performing plants currently in operation.



Case Study: Challenged SWRO Plant

Public Utility Board's Tuas Testbedding Facility - Singapore

Installation Date: October, 2020

CHALLENGE	NANOSTONE SOLUTION
Unreliable SWRO pretreatment necessitating multiple pretreatment steps (DAF)	Dependable, uninterrupted pretreated water with a single step
Variable seawater quality causing plant shutdowns	Operates through algal blooms with no downtime, no intervention
Inadequate pretreatment requiring frequent SWRO cleans	Dependable, consistently high quality feed to SWRO
Expensive combination of processes	Lowest cost of ownership available



Case Study: Challenged SWRO Plant

Location Barka, Oman

Plant Type SWRO

Capacity 57,000 m³/d

Water Source Gulf of Oman, high salinity and subject to red tide.

Process Train Open seawater intake, MF (Pall).



- Operating 35 – 50% lower flux than design due to HAB (twice the frequency of cleaning)
- Plant shut down for multiple extended periods due to algal activity
- KAUST cooperation for pre & post online Biofoul monitors, LC-OCD
- Piloting underway, demonstrating techno economic value

THANK YOU

Nanostone Water

www.nanostonewater.com

