


# A Selective Hardness, Metals, and Sulphate Removal Plant Using an Innovative Approach to Ion Exchange

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# Mine Water Challenges



Mine waters have sulphates, iron, manganese, calcium & magnesium

RO accepted as the most bulletproof water treatment technology (a lot of energy and brine)

Evaporation ponds :

- Expensive to install
- Require large surface areas
- Unsightly
- Vulnerable – fires & sabotage
- Expensive to decommission and remove

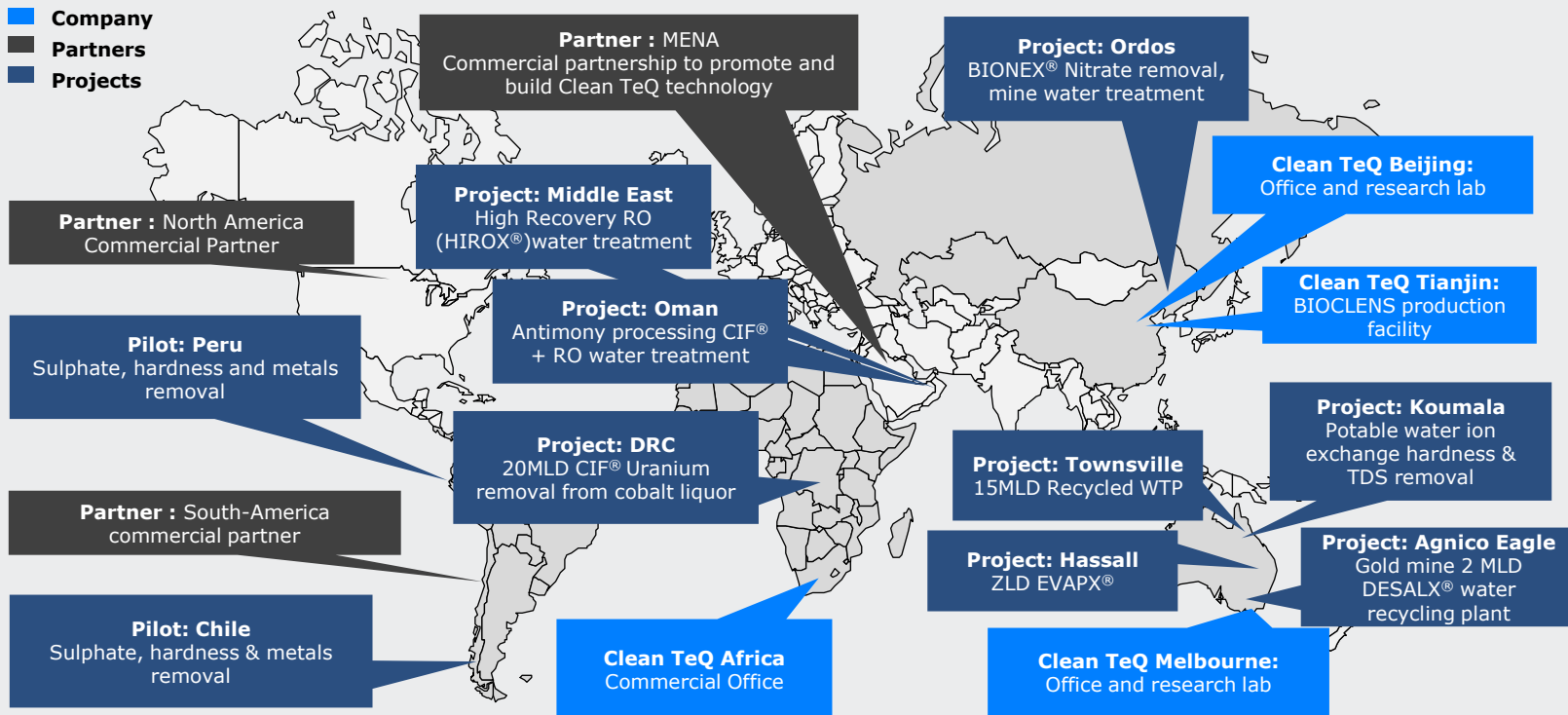
# Clean TeQ Water (ASX:CNQ)



[Introduction To Clean TeQ Water](#)



- **Company**
- **Partners**
- **Projects**



# Portfolio of Solutions



## Continuous Ionic Filtration

Moving resin beds in counterflow to water to improve treatment efficiency, reduce chemical use, produce smaller volume brines and filter solids



## Membrane Free Desalination

Chemical removal of divalent ions resulting in ultra-high recovery treatment of complex wastewater at low cost and without producing saline brines



## Chemical Free Ultra High Recovery RO

CIF® removes hardness to maximize RO recovery and membrane life. RO brine used to regenerate the resins without need for additional chemicals



## Direct Graphene Nanofiltration

Removal of colour, turbidity, micropollutants, bacteria, virus and organics, typically with half the energy use of conventional (polymeric) nanofiltration



## Lens Encapsulated Bacteria

High activity to reach ultra low ammonia/nitrate concentrations with smaller footprints. Can operate under harsh conditions of high salinity and toxicity



## Complete Nitrate Removal

CIF® to remove nitrate to <1 ppm. BIOCLENS® to remove nitrate from the brine for reuse, greatly reducing the OPEX.



## Complete Phosphate Removal and Recovery

CIF® to remove phosphate to <0.1 ppm. Precipitates a solid, reusable phosphorus product enabling brine reuse, greatly reducing OPEX



## Low Energy Evaporation/ Crystallization

Low temperature ambient pressure evaporation to minimize energy use, reduce scaling/fouling and enable effective use of waste heat

# Brief History of Clean TeQ's Resin Technology



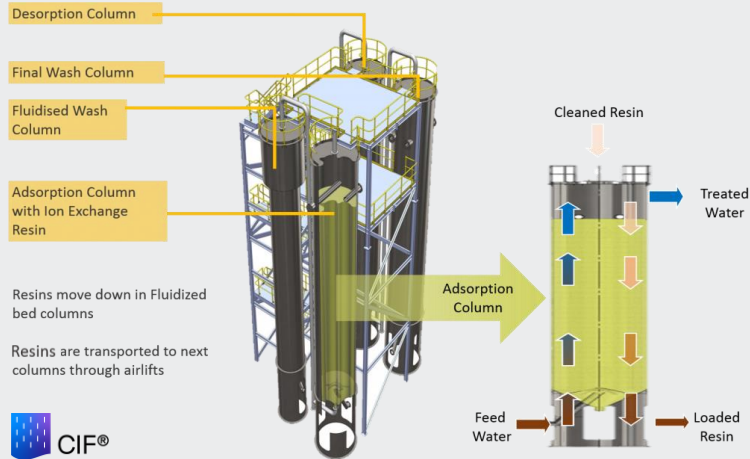
- Clean TeQ's base ion exchange technology was for metal recovery was developed by the All Russian Research Institute of Chemical Technology (ARRICT) over a period of 40 years.
- Since then, Clean TeQ has advanced and adapted the technology for water treatment.
- The former head of ARRICT's adsorption department is Clean TeQ's head scientist



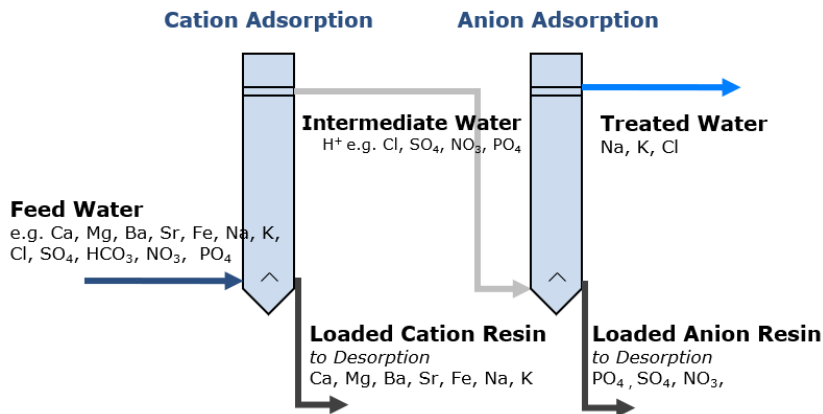
# CIF® (Continuous Ionic Filtration)

## Features

- ✓ High removal efficiencies (liken to 10x lead-lag batch vessels)
- ✓ Tolerates TSS up to 150 mg/L
- ✓ Fouling Resistant - tolerates precipitates forming
- ✓ Lower OPEX chemical consumption in desorption than batch IX
- ✓ Very high water recovery
- ✓ Robust - adaptable to variable flow & composition



# DESALX® (Membrane Free Desalination)



- Removes multivalent cations and anions
- Perfect where sodium is low in the feed

- Low OPEX – lime and sulphuric acid
- Can be paired with HDS systems for ZLD

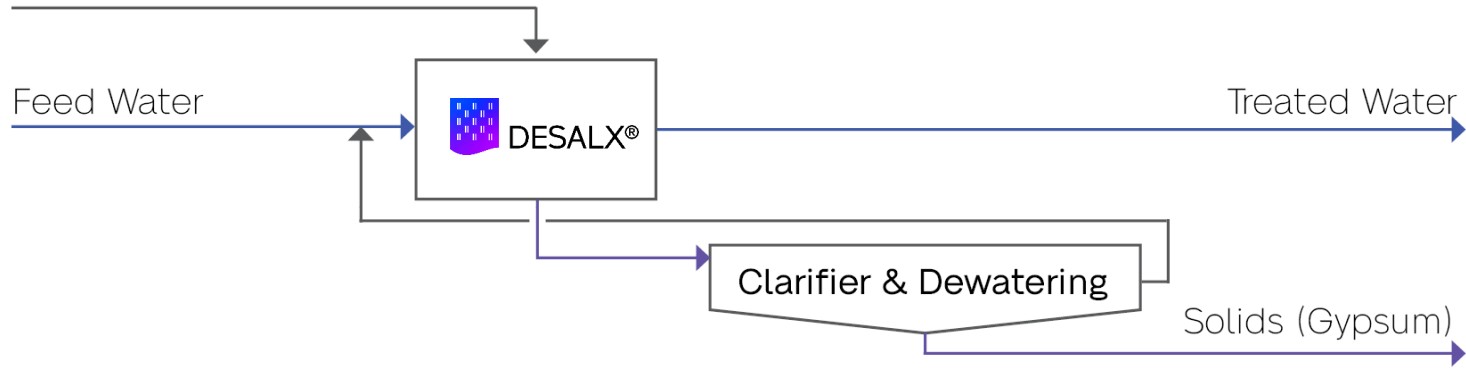
[DESALX Technology Spotlight](#)



# DESALX® - ZLD Flowsheet. HDS Brine Treatment

Hardness and Sulphate Removal – HDS Brine Treatment

Sulphuric acid & lime



# DESALX® - ZLD Flowsheet. HDS Pre-treatment

Hardness and Sulphate Removal – HDS Pre-treatment

Sulphuric Acid

Hydrated Lime

Feed Water

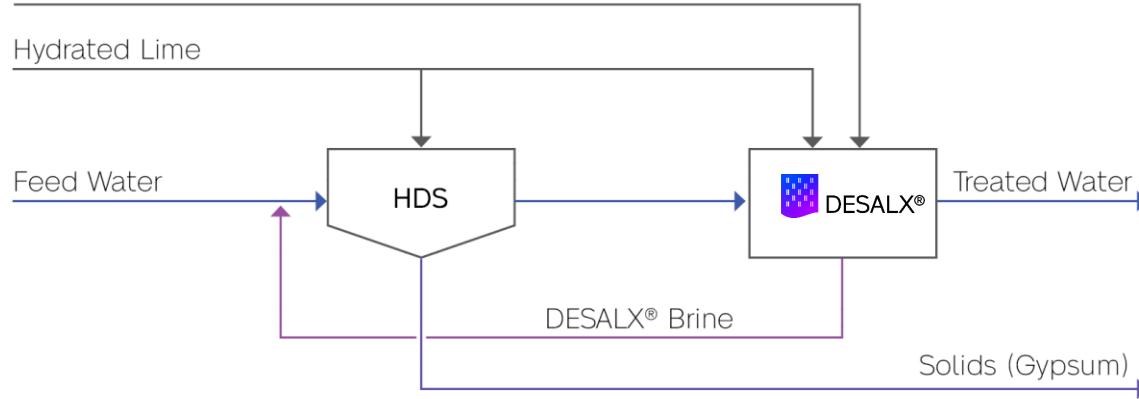
HDS

DESALX®

Treated Water

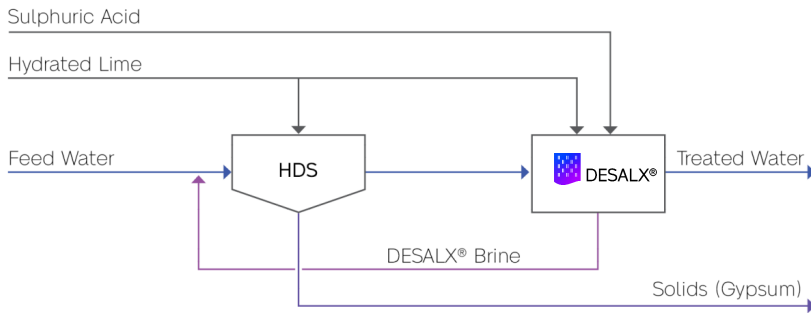
DESALX® Brine

Solids (Gypsum)



# Pilot: Coal Mine in Chile

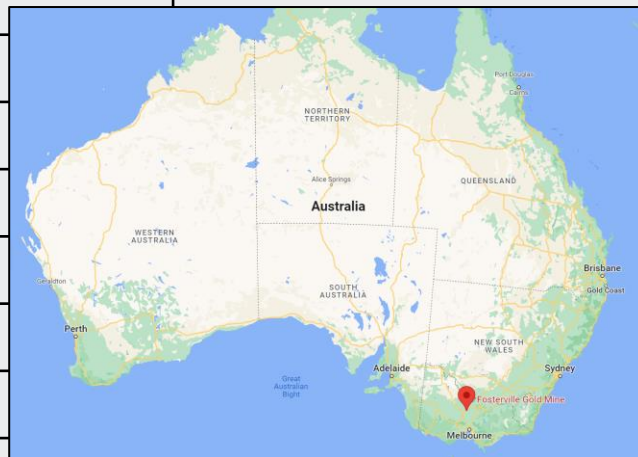
- Produced water from mining pit
- Strict discharge limits
- ZLD solution required
- HDS + DESALX® piloted



Parameter	Units	Feed Water	DESALX® Treated	Gypsum Solids
Flow Rate	m <sup>3</sup> /h	180.0	178.0	2.0
Recovery	%	-	98.9%	-
Water pH	-	8.5	7.0	7.0
TDS	mg/L	1,003	100	31,220
Calcium	mg/L	64.85	0.06	618.26
Magnesium	mg/L	17.38	0.02	753.95
Sodium	mg/L	197.27	25.71	7,462.18
Sulphate	mg/L	410.33	57.78	22,011
Solids	% w/w	0.00	0.00	3.3%

# Case Study – Angnico Eagle Gold Mine

<b>Location</b>	Bendigo, State of Victoria, Australia
<b>Fosterville Gold Mine</b>	<i>Largest Victorian gold producer</i>
<b>Mine Type</b>	Underground, decline access
<b>Production</b>	619,366 ounces (approx. 36.9g/t)
<b>Process</b>	BIOX, CIL, & Gravity Circuit
<b>End Product</b>	Gold doré
<b>Infraestructure</b>	Mill 2,275 tpd capacity
<b>Commenced Operation</b>	2005

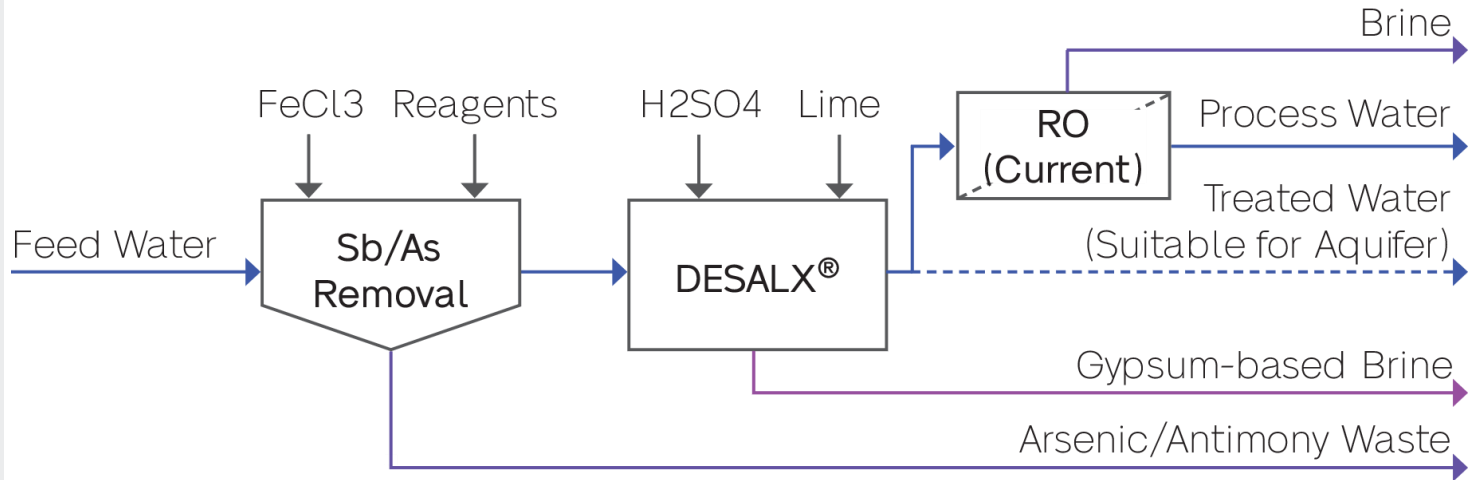


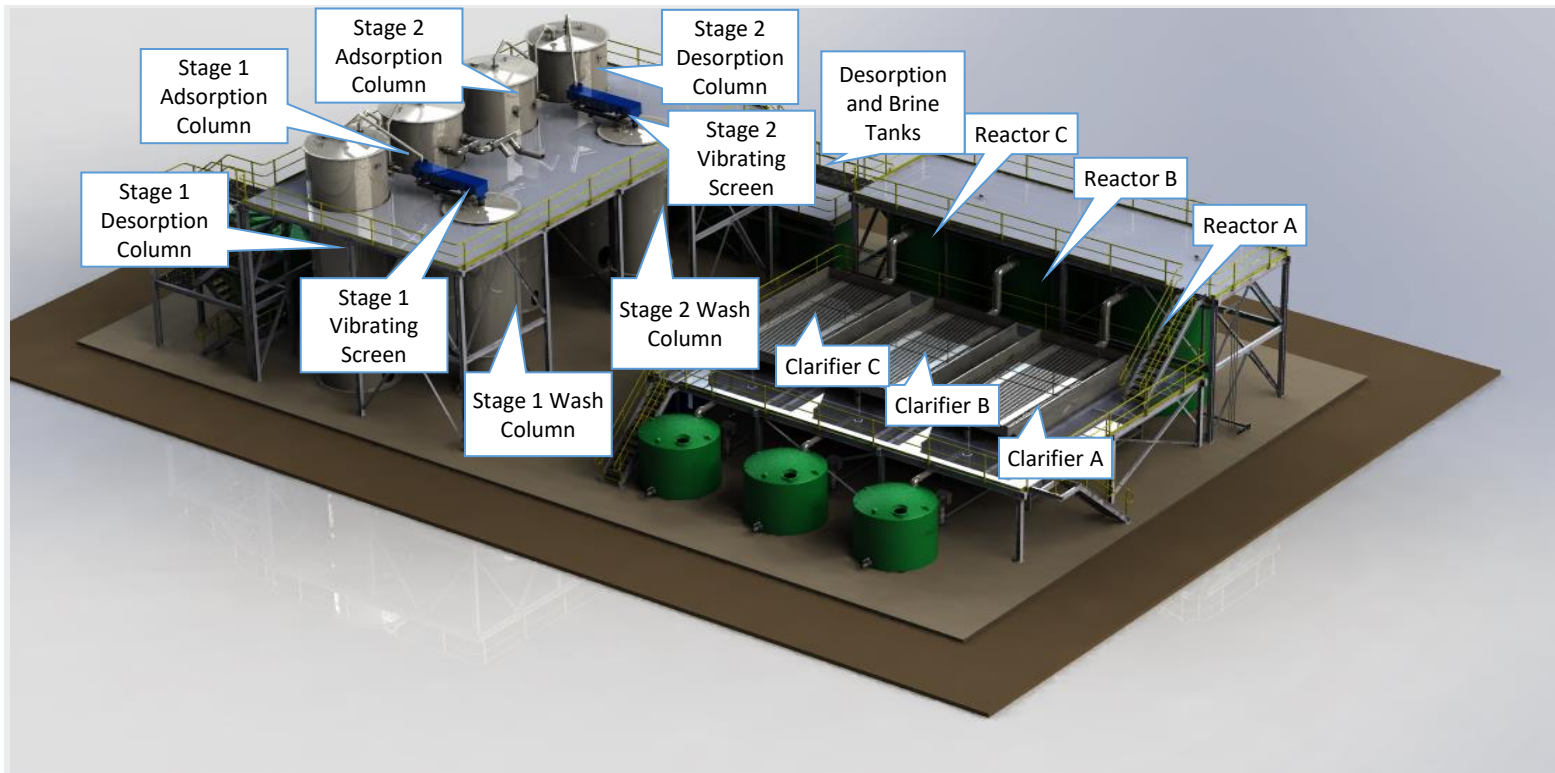
# Case Study – Angnico Eagle Gold Mine

<b>Problem</b>	Excess water containing arsenic, antimony, hardness & sulphate. Stored in old open cuts that were filling up
<b>Client's Thinking</b>	UF + RO
<b>Our Thinking</b>	DESALX®
<b>Benefits</b>	<ul style="list-style-type: none"> <li>✓ Lower OPEX</li> <li>✓ Higher recovery</li> <li>✓ Local company close to site</li> <li>✓ Reduced potable water make-up</li> </ul>
<b>Risks</b>	New moving bed ion exchange technology. First water treatment project.



# Angnico Eagle Flowsheet





# Plant Performance – Angnico Eagle

		Design Basis			Performance
Species	Unit	Before Precipitation	Before DESALX®	After DESALX®	After DESALX®
TDS	ppm	7,400	7,400	5,848	5,410
Calcium	ppm	300	300	85	107
Magnesium	ppm	321	321	96	223
Sulphate	ppm	1515	1515	1000	790
Iron	ppm	1	5	0.1	0.05
Total Arsenic	ppm	0.5	0.03	0.03	0.001
Antimony	ppm	13	0.05	0.05	0.025

- Meets performance criteria:  
SO<sub>4</sub>, Fe, As, Sb
- Chemical usage is below the design criteria
- Water quality for aquifer reinjection
- 85% Recovery from downstream RO not suffering with scaling or high turbidity



# Project Overview - Angnico Eagle

<b>Size</b>	2 MLD Water Treatment
<b>Client</b>	Fosterville Gold Mine Pty Ltd
<b>Date of Award</b>	12 December 2017
<b>Contract Duration</b>	12 December 2017 until 12 weeks after completion of commissioning
<b>Completion</b>	December 2019
<b>Project Value</b>	AUD \$3.5M



# What can we do better next time ?



- Understanding of resin bed hydraulics at large scale
- Resin screening for resin cleaning/dewatering – worked closely with suppliers to optimise design and operation for future projects and implement O&M improvements
- Improvements to As/Sb precipitation sludge management e.g. seeding/recycling to reduce equipment footprint and maintenance
- Buffering capacity between unit operations such as the RO to ensure process does not debottlenecked at higher capacities



# Summary

- Mine waters (Acid Mine Drainage) are high in Metals, Hardness, and Sulphate
- Global regulations demand water reuse and better-quality treated water
- DESALX® (and CIF®) ion exchange technologies are ideal high recovery, non-saline brine alternatives for mine water treatment because of their:
  - ✓ Very high-water recovery
  - ✓ Resistance to scaling and fouling
  - ✓ Selective removal of contaminating species
  - ✓ Synergy with RO or HDS for MLD/ZLD

# DESALX® - True ZLD Without Saline Brines

Typical Sources	
Mine Wastewater	
Oil/Gas Produced Water	
Groundwater	

Example Influent	
TDS	1200 - 6000 ppm
SO <sub>4</sub>	800 - 3000 ppm
Ca	100 - 500 ppm
Mg	100 - 300 ppm
Na*	0 - 1000 ppm
Cl	0 - 350 ppm



Typical Uses	
Process Water	
Irrigation Water	
Drinking Water	

Example Effluent	
TDS	500 - 1500 ppm
SO <sub>4</sub>	250 - 500 ppm
Ca	<10 - 50 ppm
Mg	<10 - 30 ppm
Na	0 - 250 ppm
Cl	0 - 350 ppm

\* Na+Mg+Ca mix can reduce this to 250ppm



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