UNLV UNIVERSITY OF NEVADA, LAS VEGAS

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

The Influence of Humic Substances and Sulfate on the removal of Perchlorate from a Groundwater by Ion-Exchange Resins

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Sybron Chemicals and Purolite Provided Resin Samples

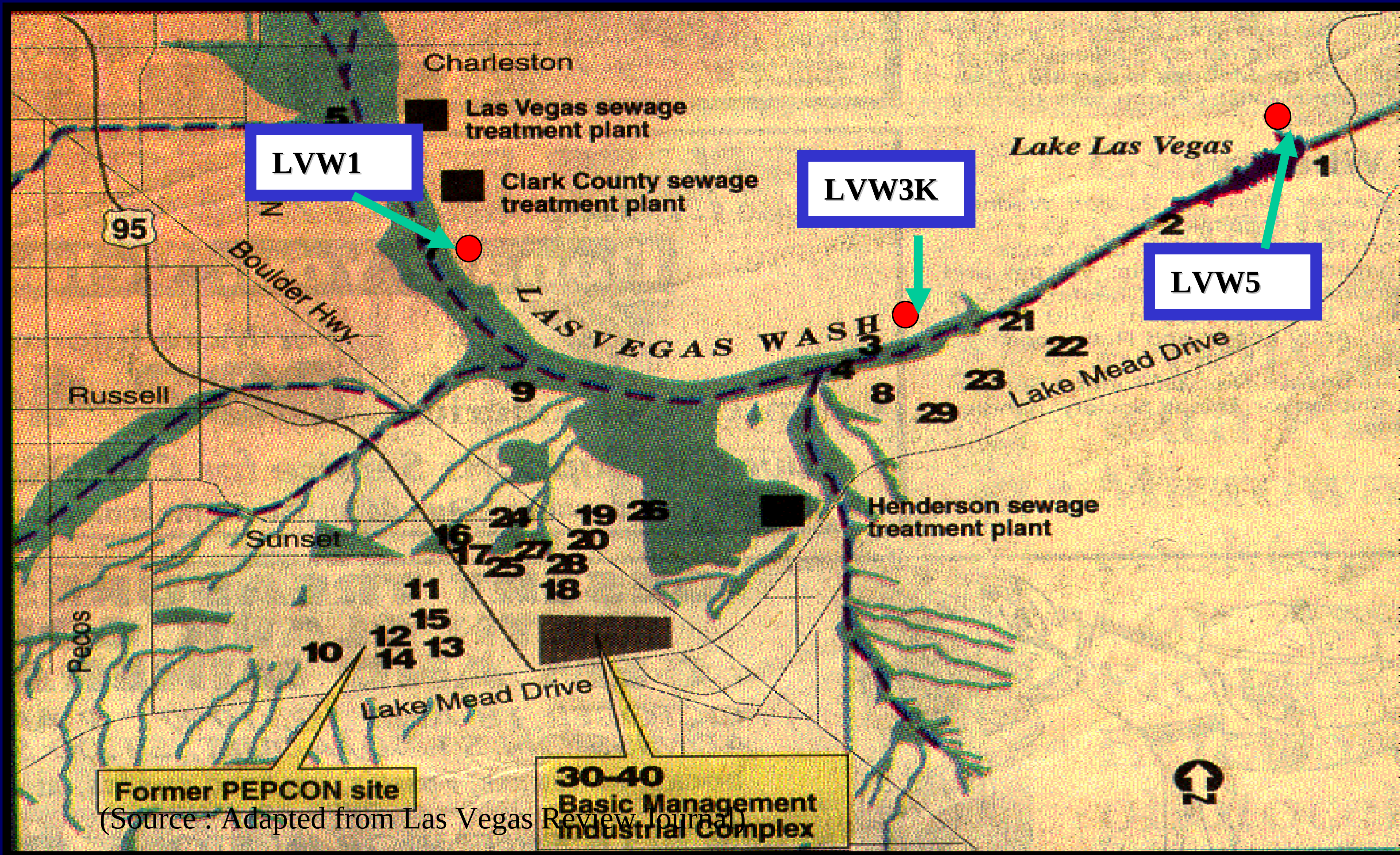
Treatment Technologies under Investigation for Perchlorate Removal

- Ion exchange
- Biological reduction
- Ozone/granular activated carbon
- Reverse osmosis and nanofiltration

Ion Exchange Technology

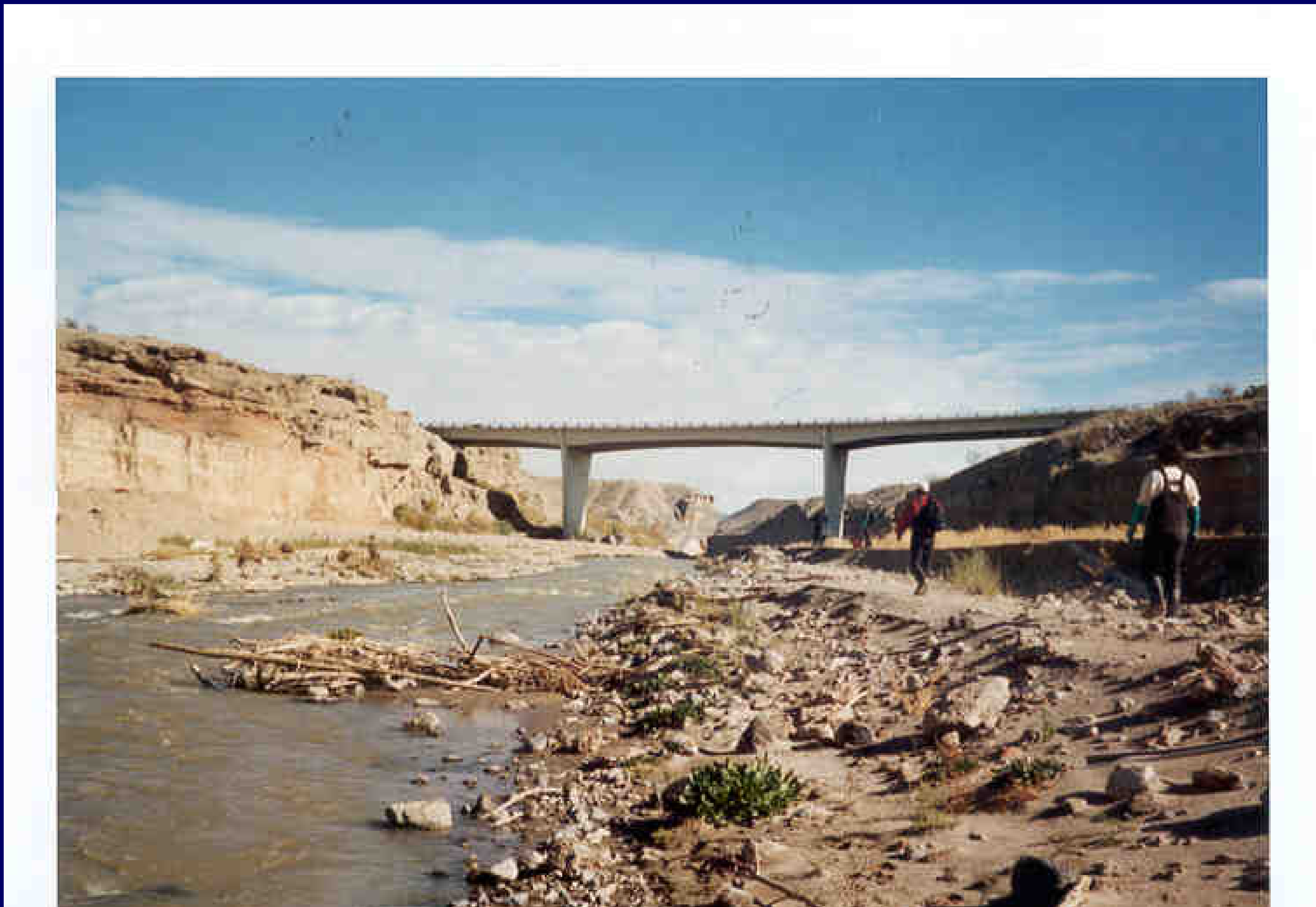
- Instantaneous correlation between ClO_4^- and ion exchange treatment due to its previous use for nitrate and arsenate removal
- Familiar technology to the water industry

Background of Perchlorate Contamination in Las Vegas

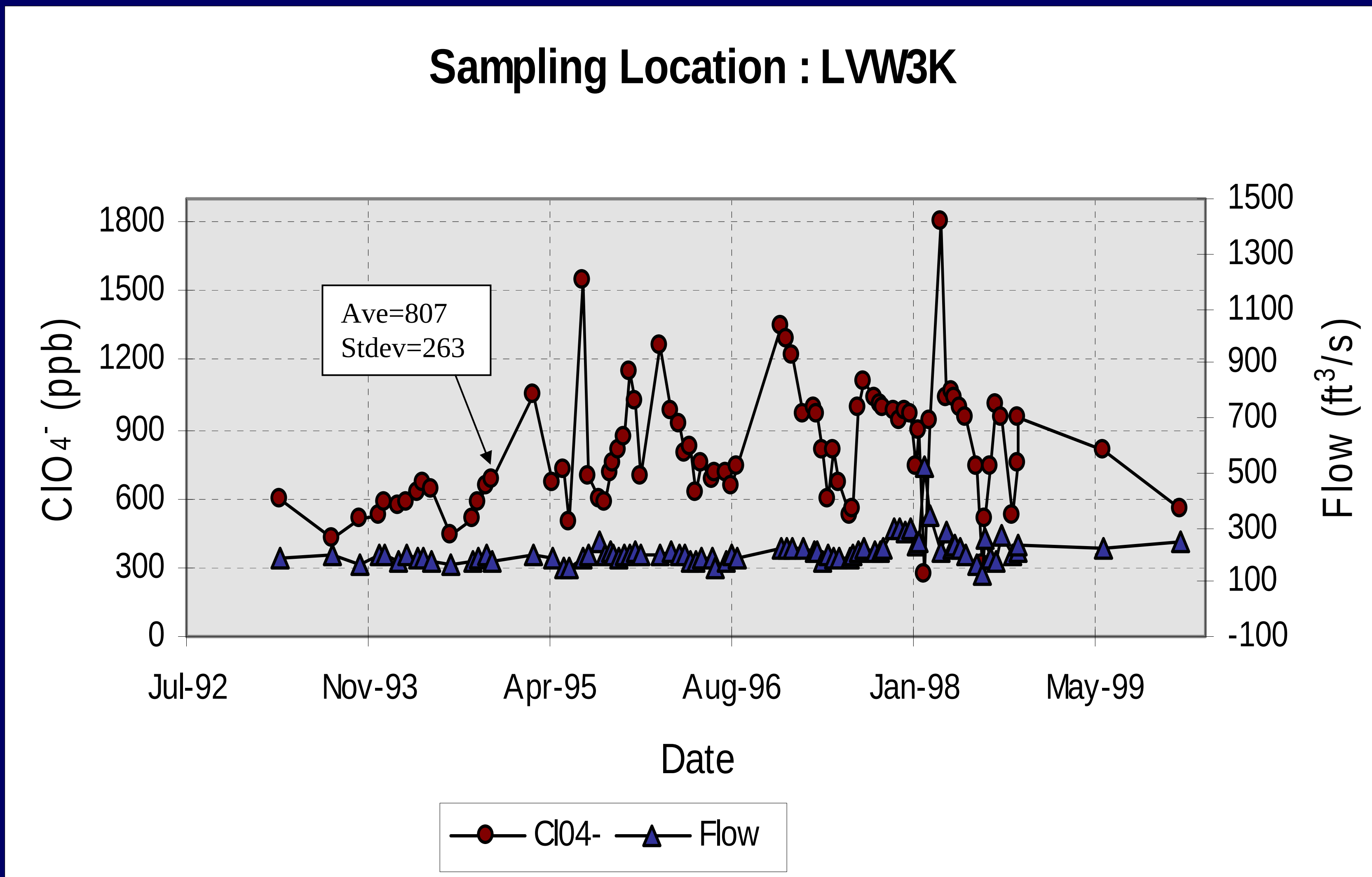


(Source : Adapted from Las Vegas Review Journal)

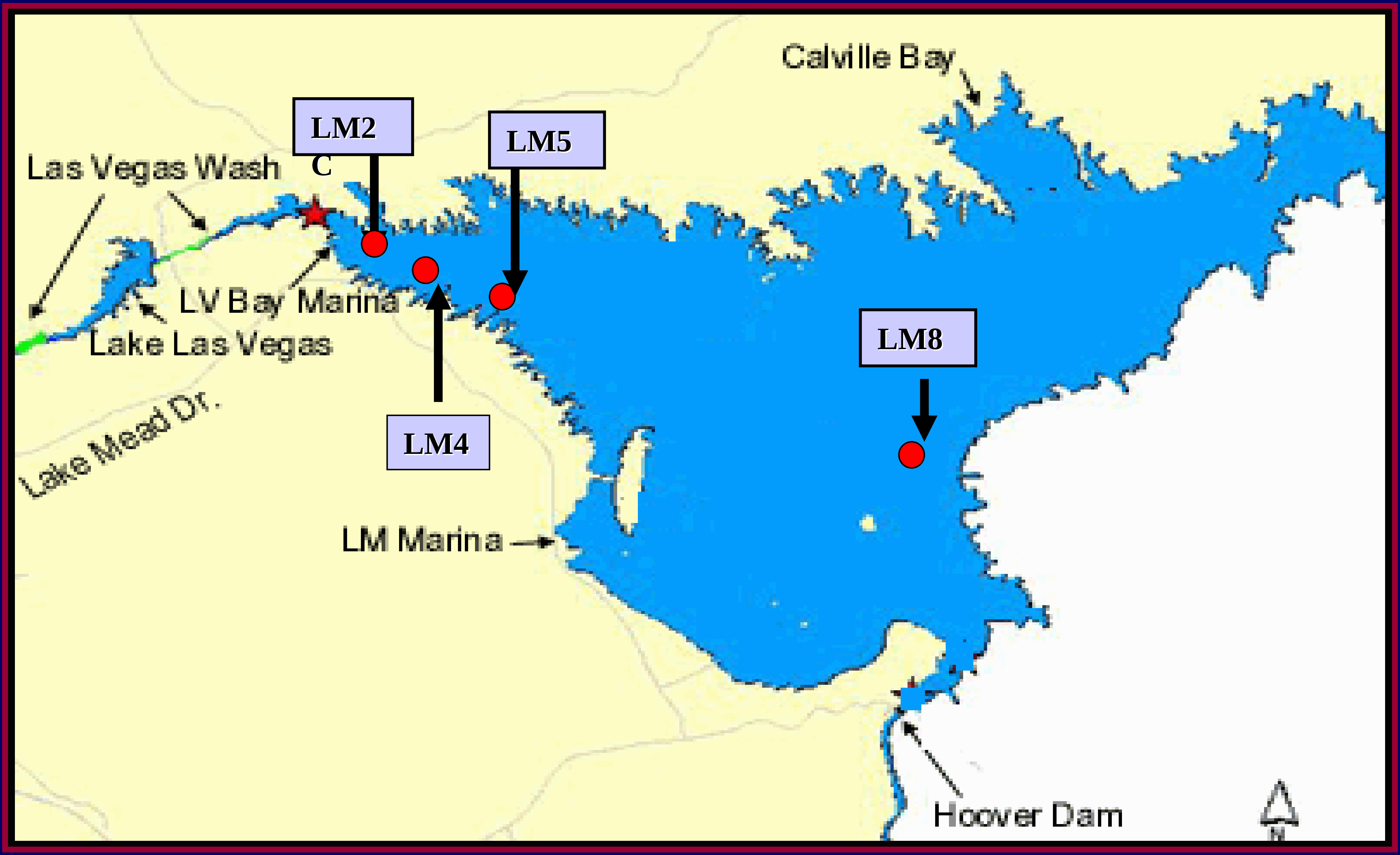
Las Vegas Wash at LVW5



RESULTS
Perchlorate in Las Vegas Wash

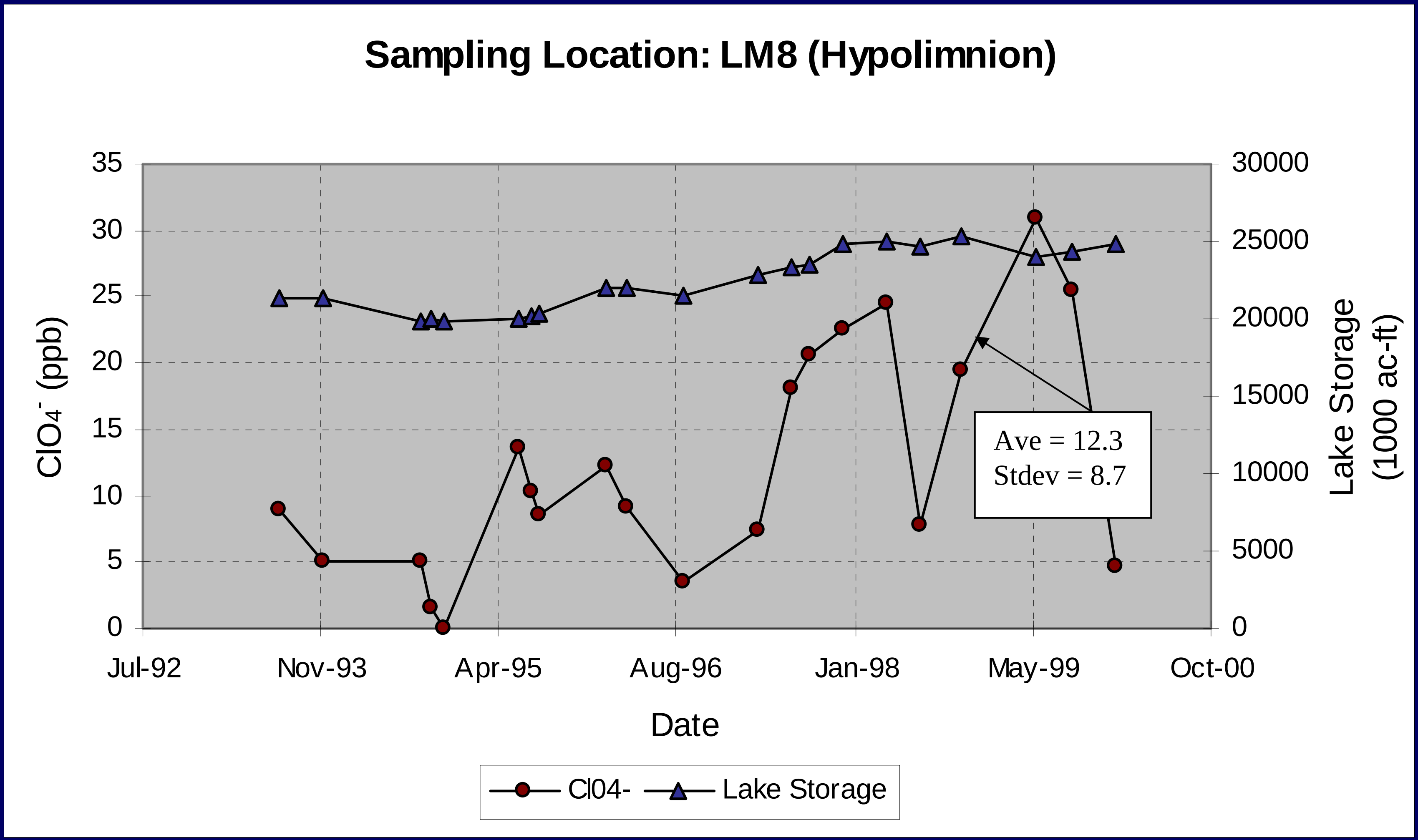


Sampling Points within Lake Mead



RESULTS

Perchlorate in Lake Mead



Objectives

To examine the potential of ion exchange to remove perchlorate from a “real” water from a contaminated site in the Las Vegas Valley using different types of resins.

Experimental

- Several strong and weak-base anionic exchange resins were tested. Fixed-bed column tests were performed using 1.5-2.5 cm ID glass columns with one-foot resin beds

- Columns were fed with the contaminated groundwater from the Las Vegas Valley. Regeneration was performed with sodium chloride.

- Anions were analyzed by ion-chromatography. Organic carbon was analyzed by TOC analyzer

RESULTS

“Real” Water Testing

Average Concentration of Major Anions in the “Real” Water

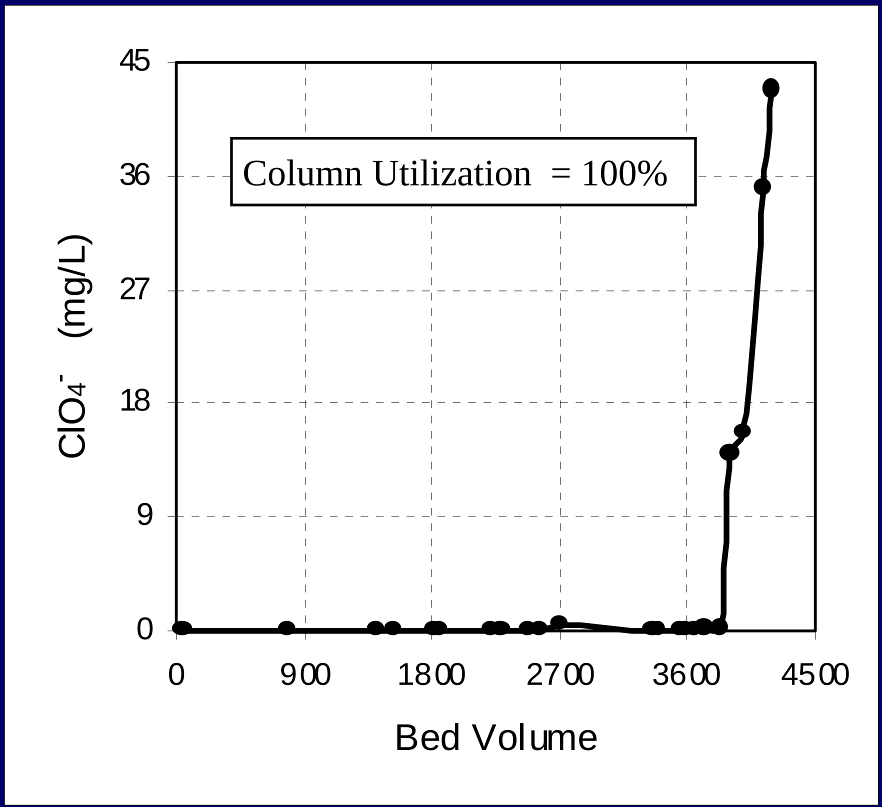
ClO_4^-	Cl^-	NO_3^-	SO_4^{-2}	TOC
80.3	2009	48.8	1968	45.3

Concentrations in mg/L

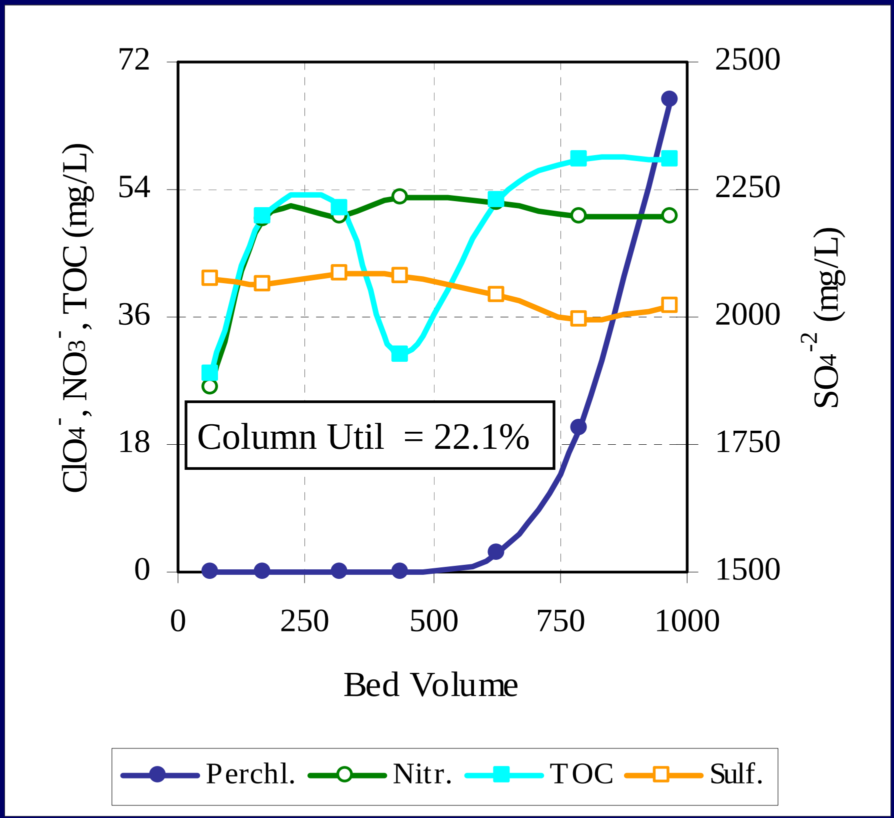
LOADING - ASB 1

Styrenic Strong Base - Trimethyl Quaternary Amine

Synthetic Solution



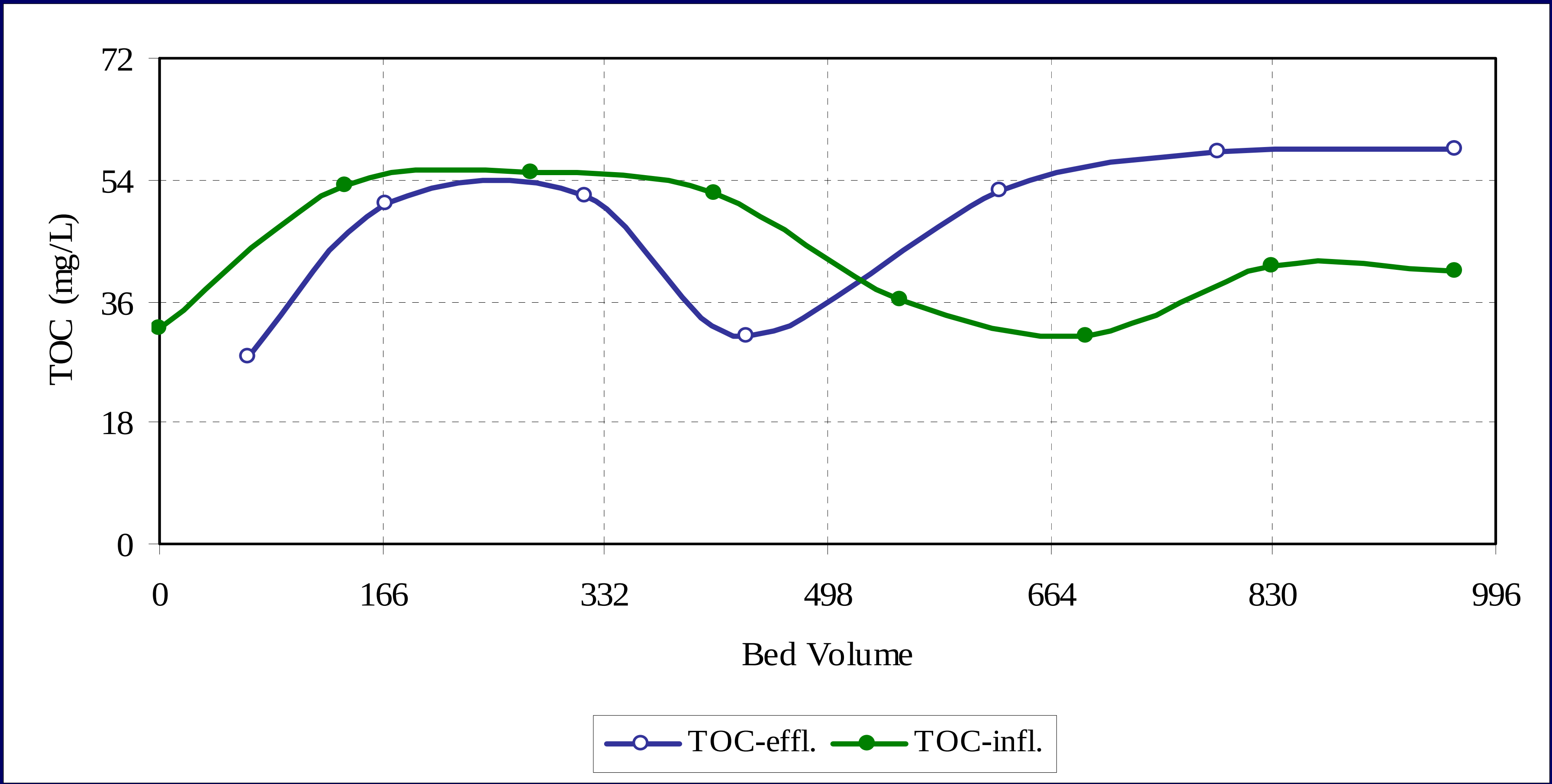
"Real" Water



LOADING - ASB 1

Styrenic Strong Base - Trimethyl Quaternary Amine

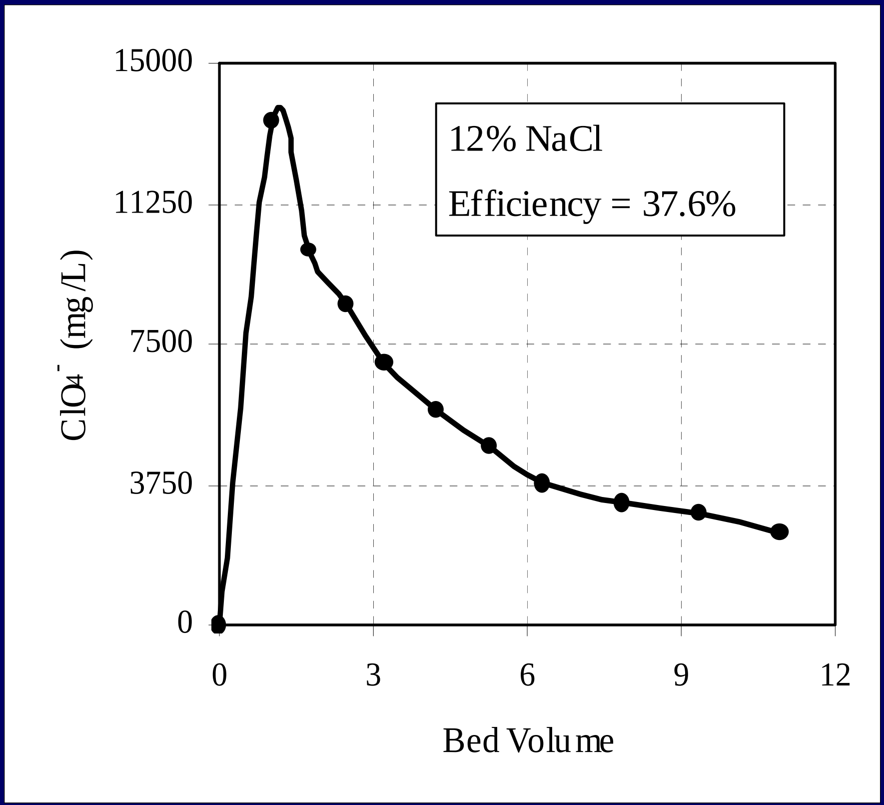
Influent and Effluent TOC Concentrations



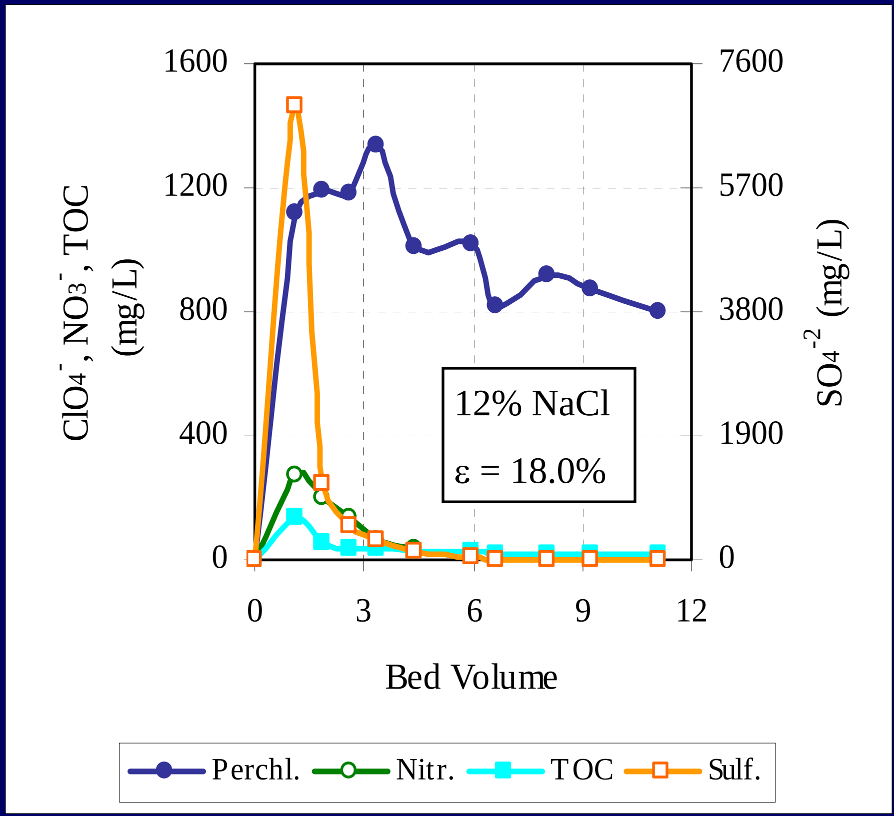
REGENERATION - ASB 1

Styrenic Strong Base - Trimethyl Quaternary Amine

Synthetic Solution



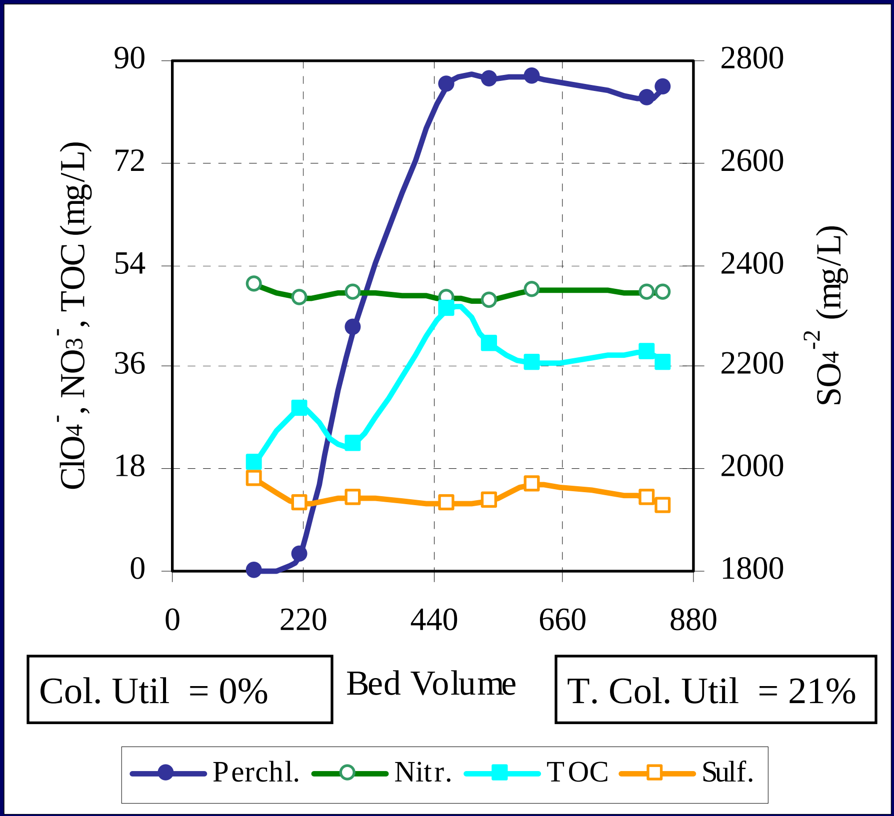
"Real" Water



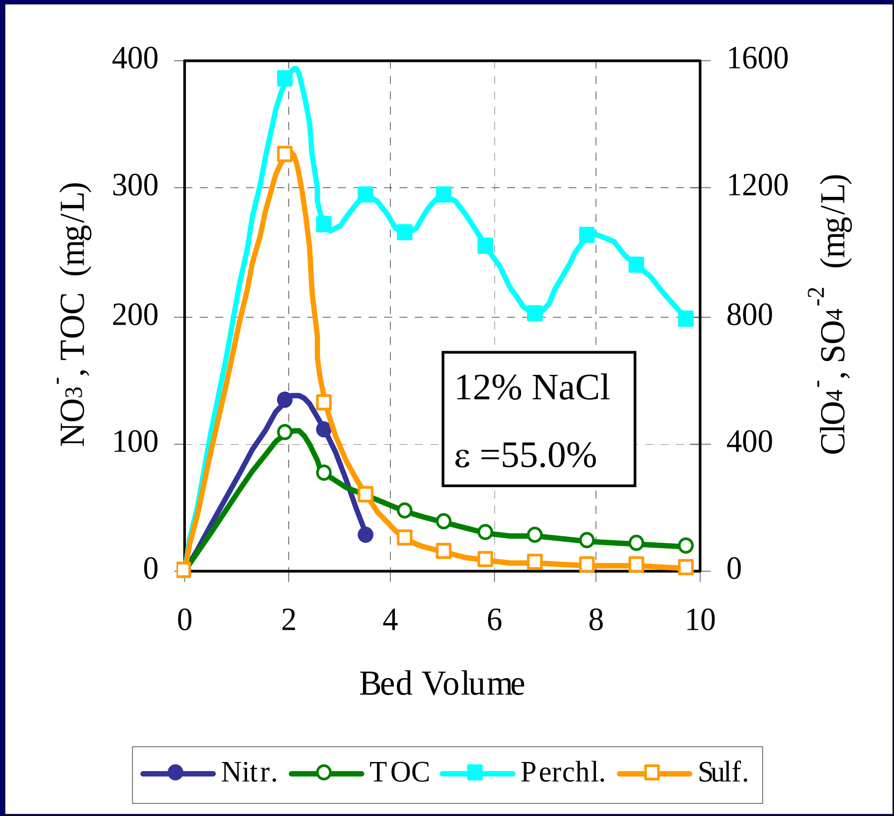
ASB1 PC - “Real Water”

Styrenic Strong Base - Trimethyl Quaternary Amine

Loading



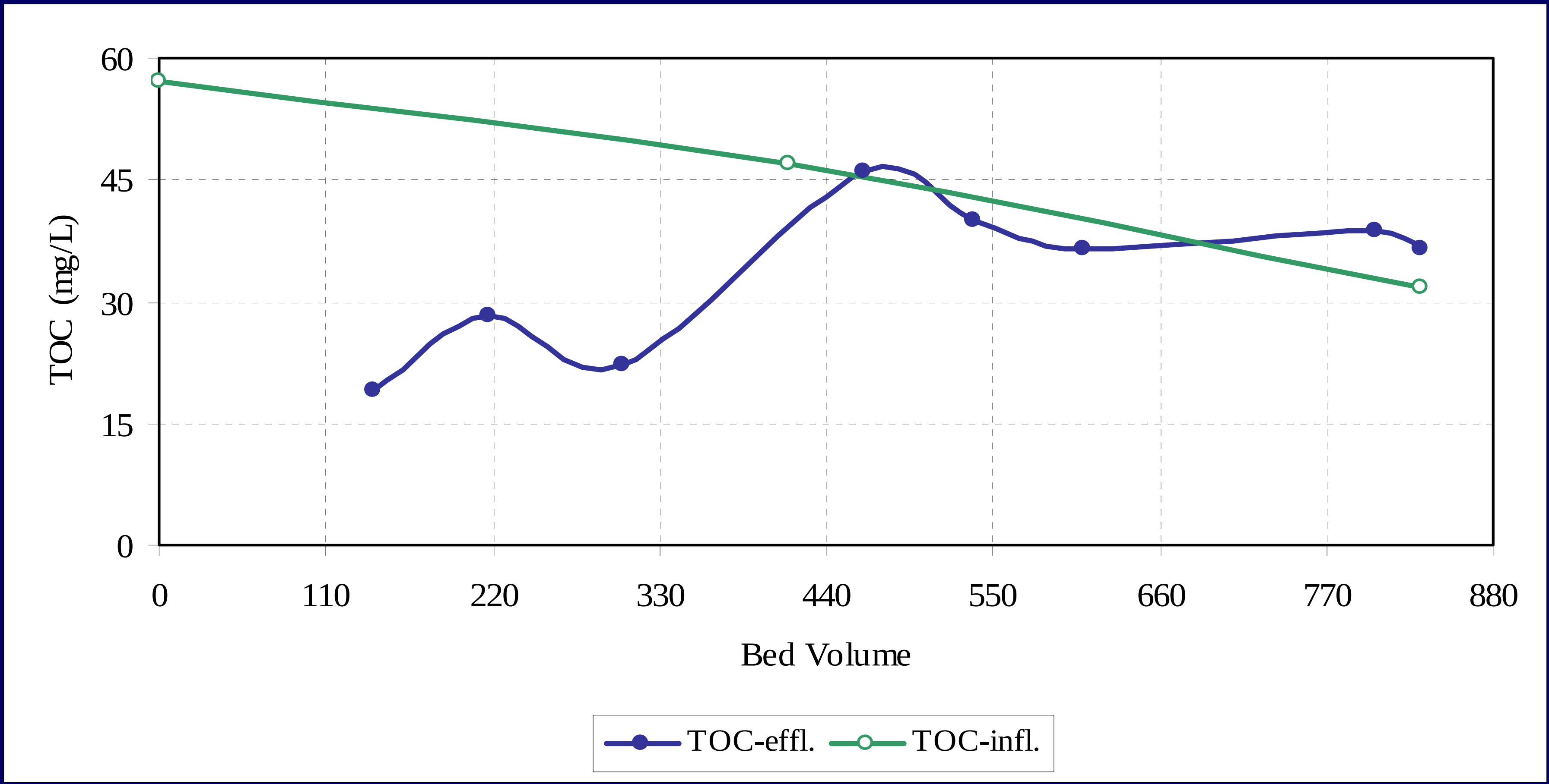
Regeneration



LOADING - ASB1 PC - "Real Water

Styrenic Strong Base - Trimethyl Quaternary Amine

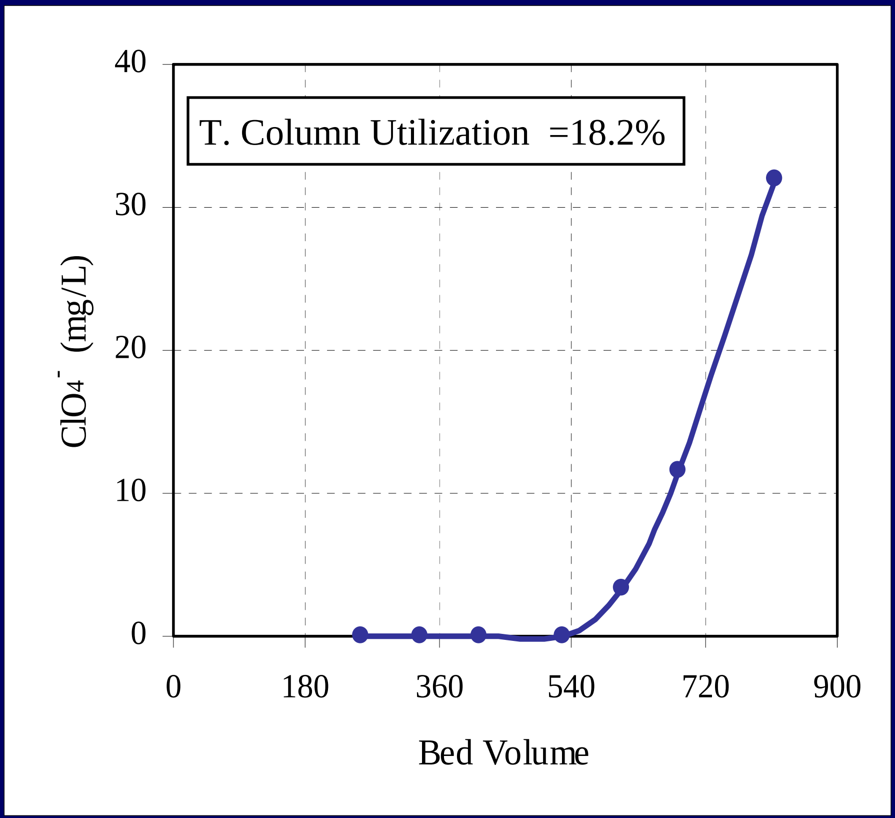
Influent and Effluent TOC Concentrations



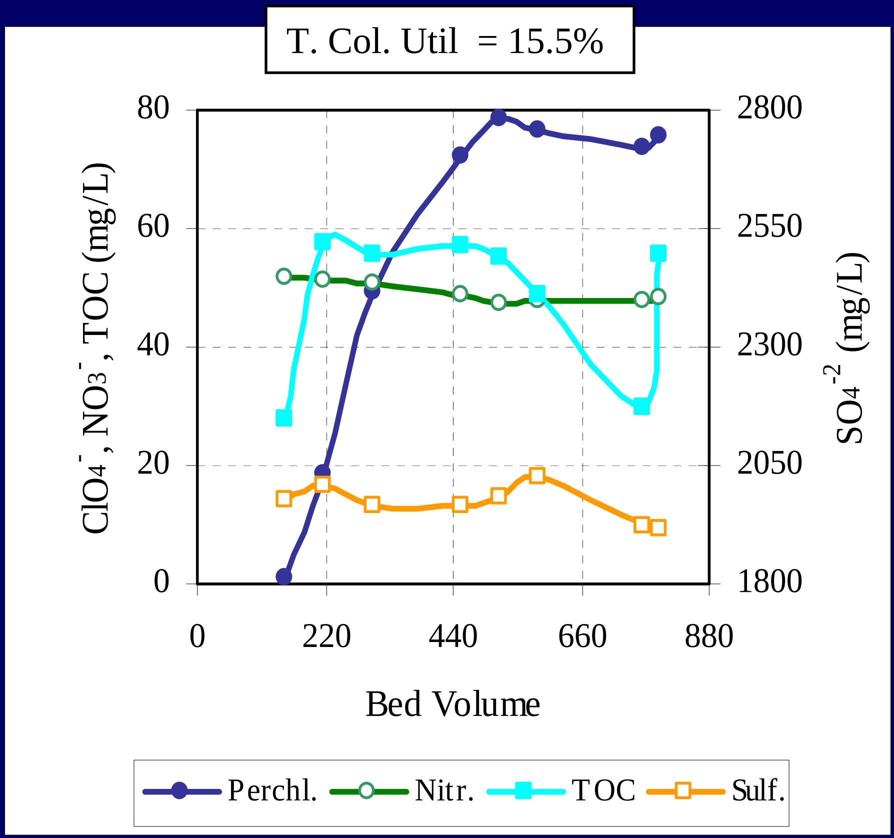
LOADING - AFP 329

Styrenic Weak Base - Tertiary Amine

Synthetic Solution



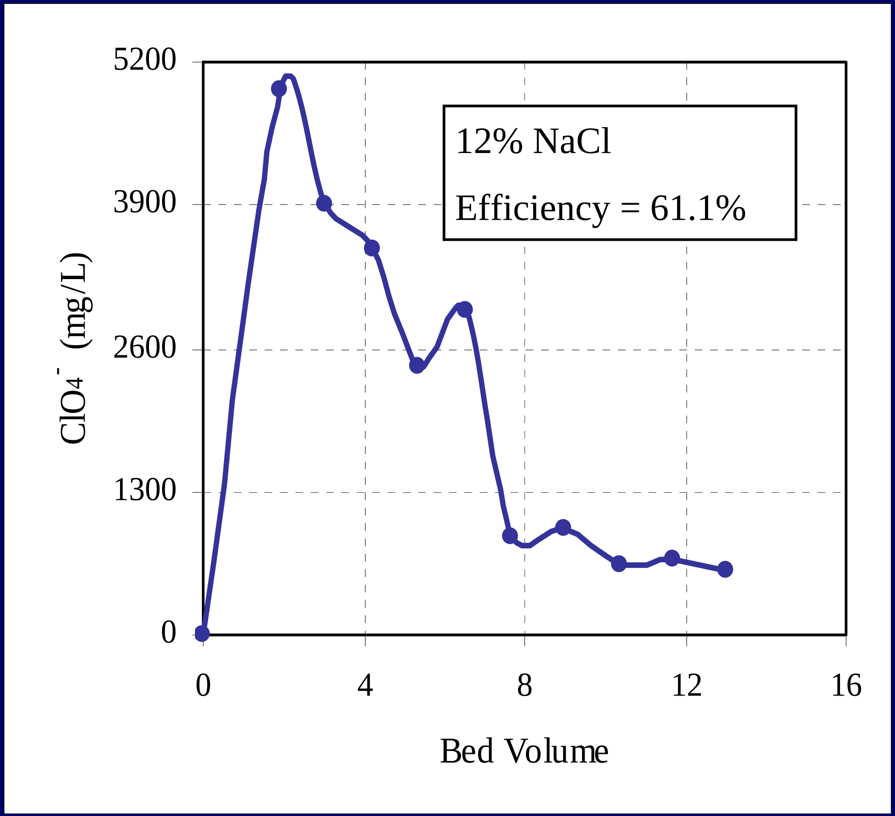
"Real" Water



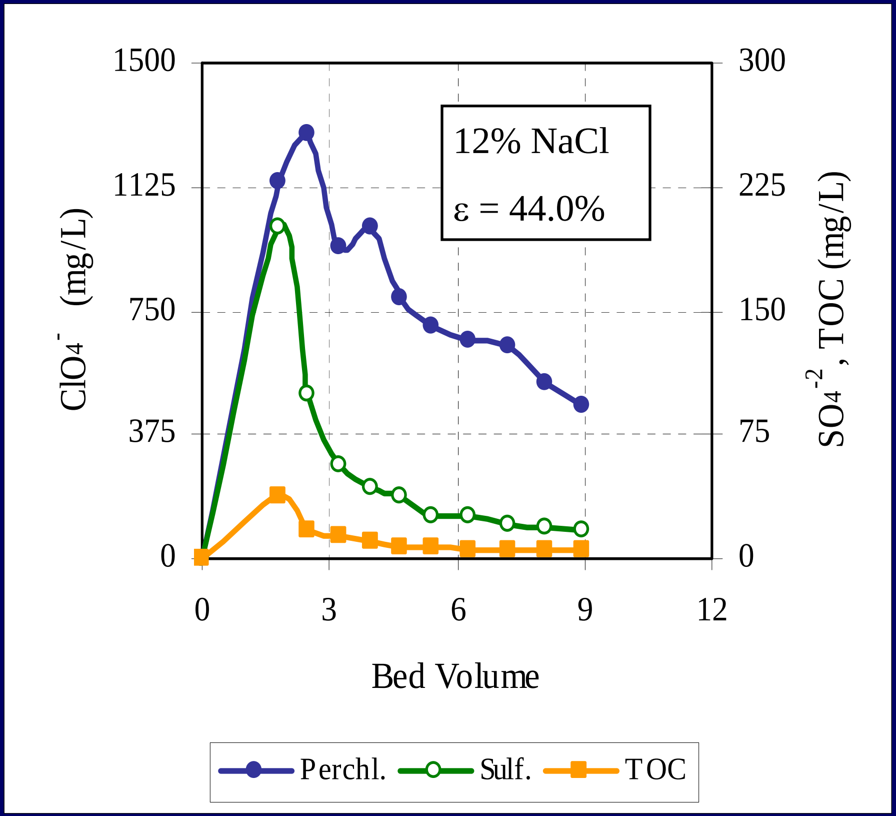
REGENERATION - AFP 329

Styrenic Weak Base - Tertiary Amine

Synthetic Solution



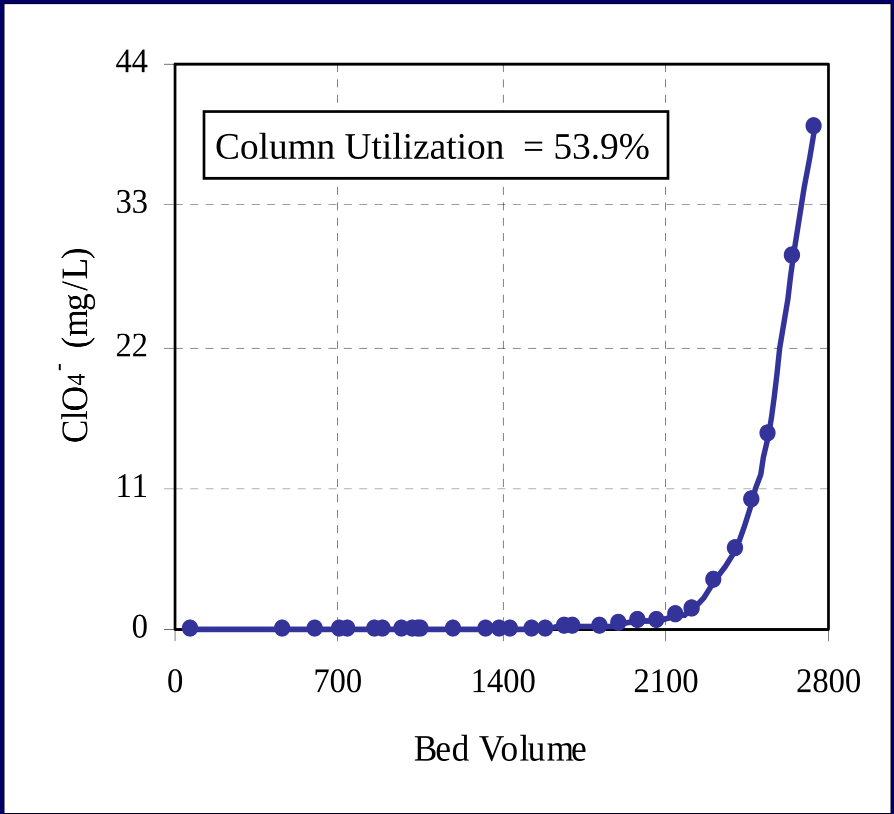
"Real" Water



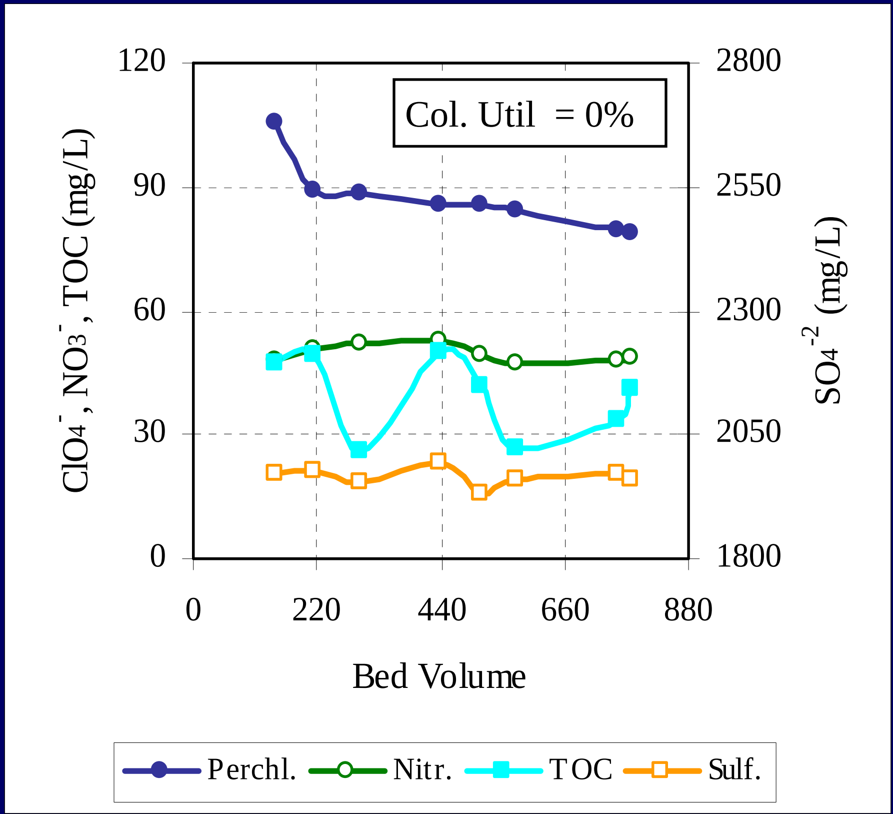
LOADING - Macro T

Acrylic Strong Base - Trimethyl Quaternary Amine

Synthetic Solution



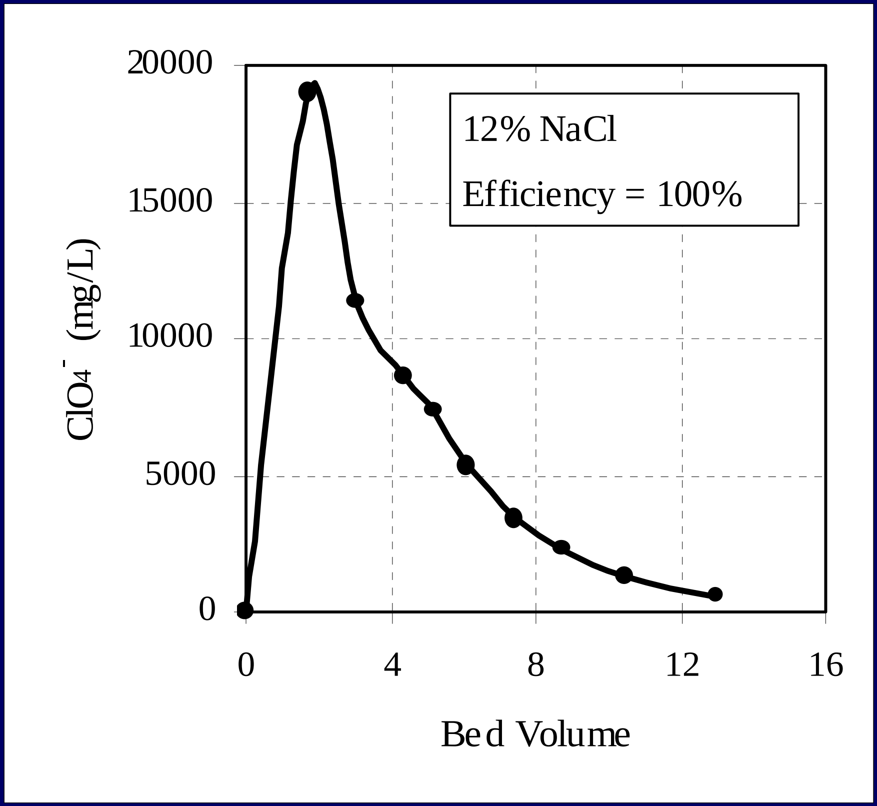
"Real" Water



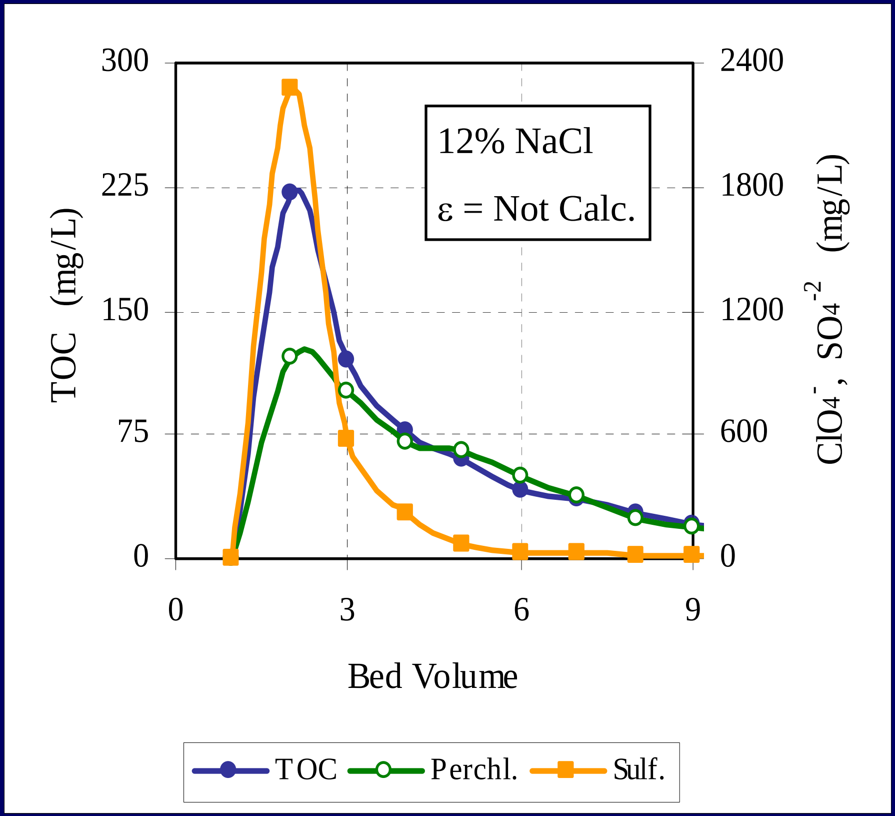
REGENERATION - Macro T

Acrylic Strong Base - Trimethyl Quaternary Amine

Synthetic Solution



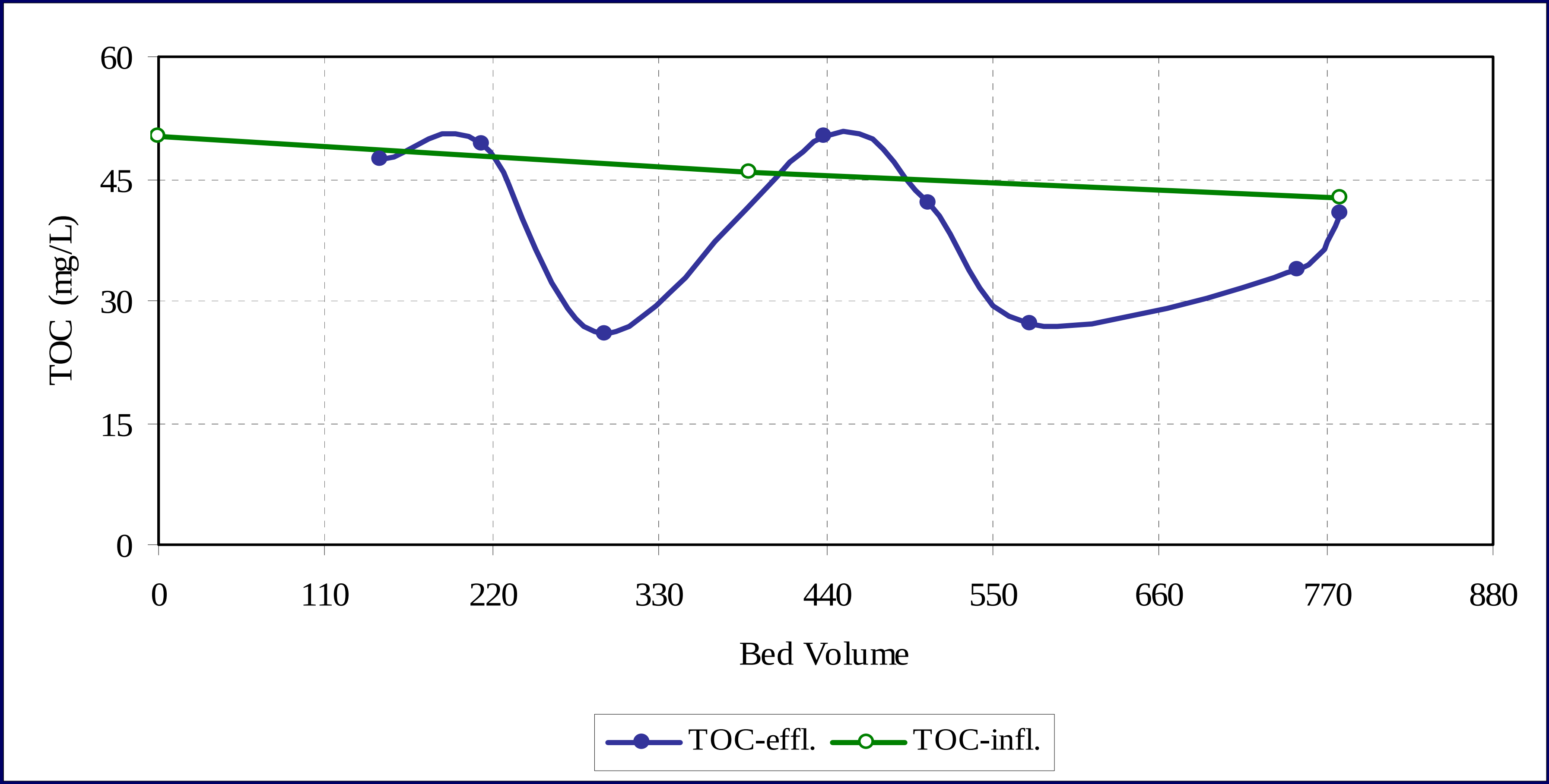
"Real" Water



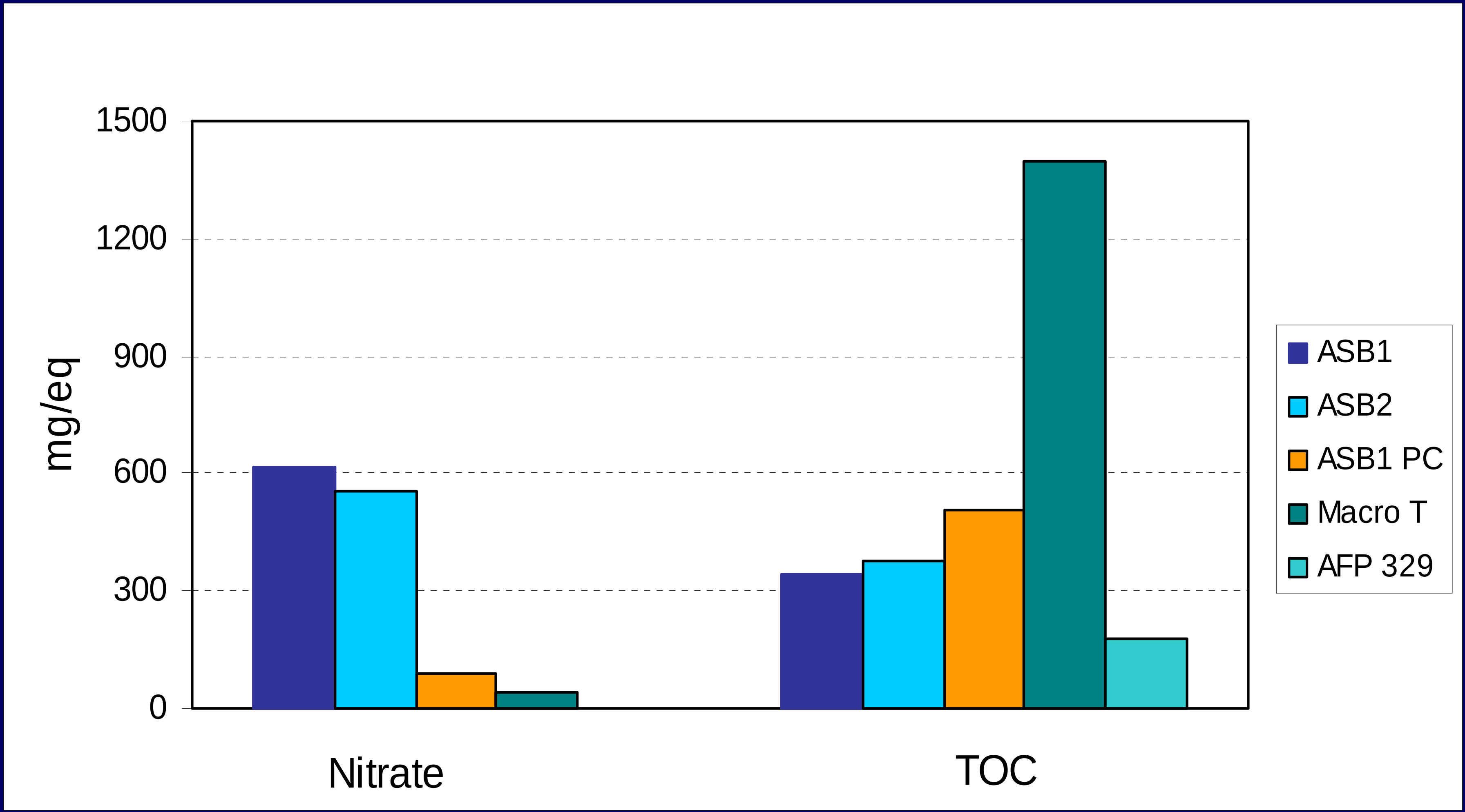
LOADING - Macro T

Acrylic Strong Base - Trimethyl Quaternary Amine

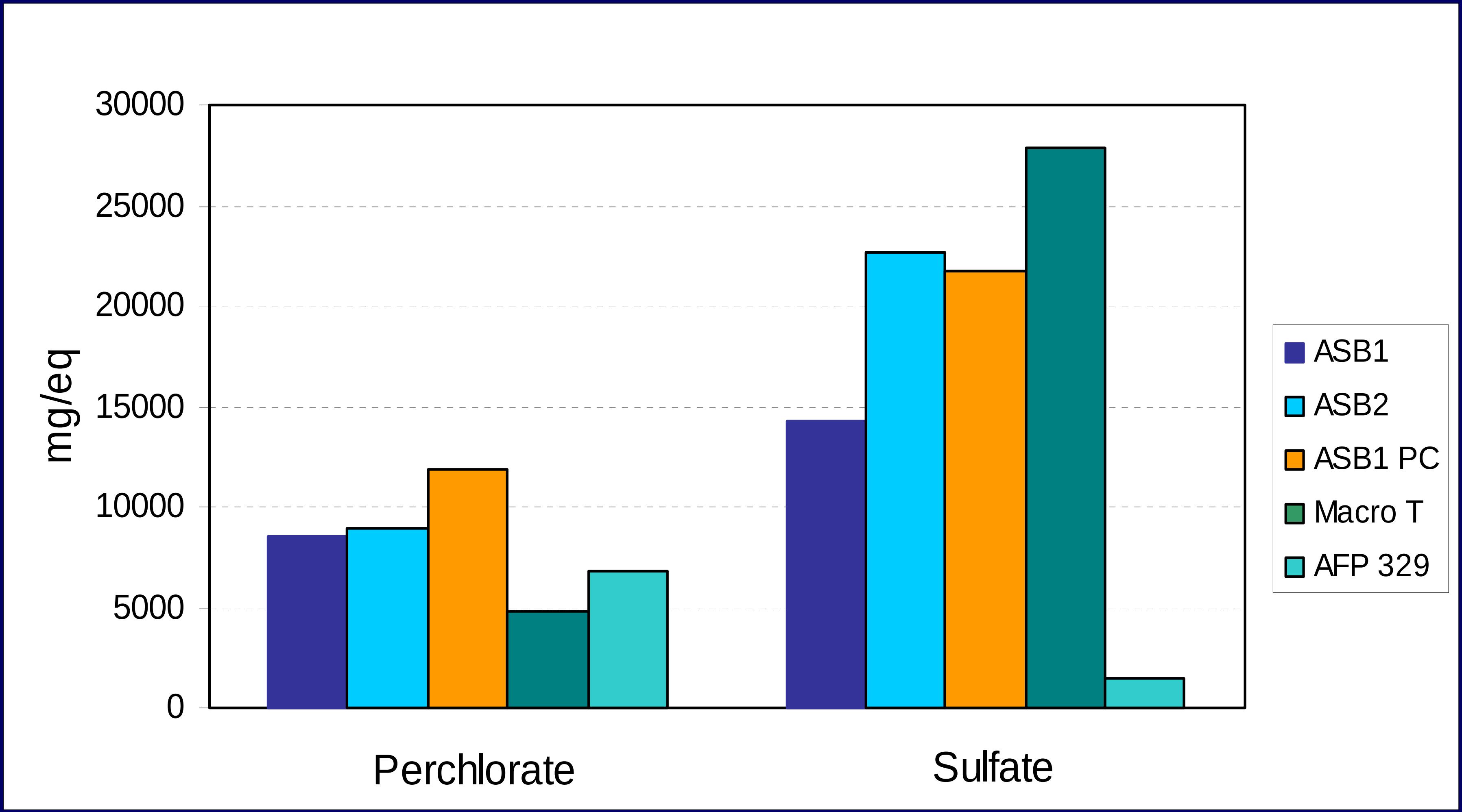
Influent and Effluent TOC Concentrations



Amount of Anions Released per Equivalent of Resin by Regeneration



Amount of Anions Released per Equivalent of Resin by Regeneration



Conclusions - “Real Water”

1. For two styrenic strong-base (ASB1 and ASB2), the total column utilization were only 48% and 36%, respectively, indicating that about 50% of the resin capacity was occupied by anions other than perchlorate.

2. High concentrations of SO_4^{-2} in the water rapidly saturated the resin. ClO_4^- was continuously removed from the water by pushing sulfate out of the resin.

Conclusions - "Real Water"

3. For a macroporous strong-base styrenic resin (ASB1 PC), about 21% of the column capacity were utilized by perchlorate. This resin exchanged considerable amount of humic acids and ClO_4^- and they could be stripped out easier from ASB1 PC than from ASB1 and ASB2

4. The capacity of the styrenic weak-base (AFP 329) for ClO_4^- was moderately affected by the presence of humic substances as compared to other resins. Humic acids were not exchanged with this resin

Conclusions - "Real Water"

5. The efficiency of the strong-base acrylic resin (Macro T) was significantly affected by the presence of humic substances contained in the "real" water. ClO_4^- did not exchange with this resin. This resin showed the highest TOC concentration in the regenerant brine

6. The presence of humic acids in waters may significantly affect the removal of perchlorate by ion exchange resins..

Research Needed

To examine the effects of humic acids and other anions (e.g. sulfates, nitrate) on perchlorate removal by ion exchange resins, by using binary solutions of humic acids and different anions at different concentrations.

Questions

and

Comments