ACTIVATED CARBON FOR DBP CONTROL

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PURPOSE

Activate Carbon for DBP control

- GAC vs. PAC
- TOC and UV surrogates for DBP control
- Target is 1 mg/L NPDOC

METHODS

- Select Four Carbons
- Isotherm Study
  - ✓ Determine Capacity
  - ✓ Estimate mass transfer zone
- Kinetics Study
  - ✓ Determination of MTC
- Column Study
  - ✓ Determine Runtime for varying EBCT
  - ✓ Conduct a RSSCT for the selected carbon
- Cost Comparison
  - ✓ Compare cost based on PAC versus GAC

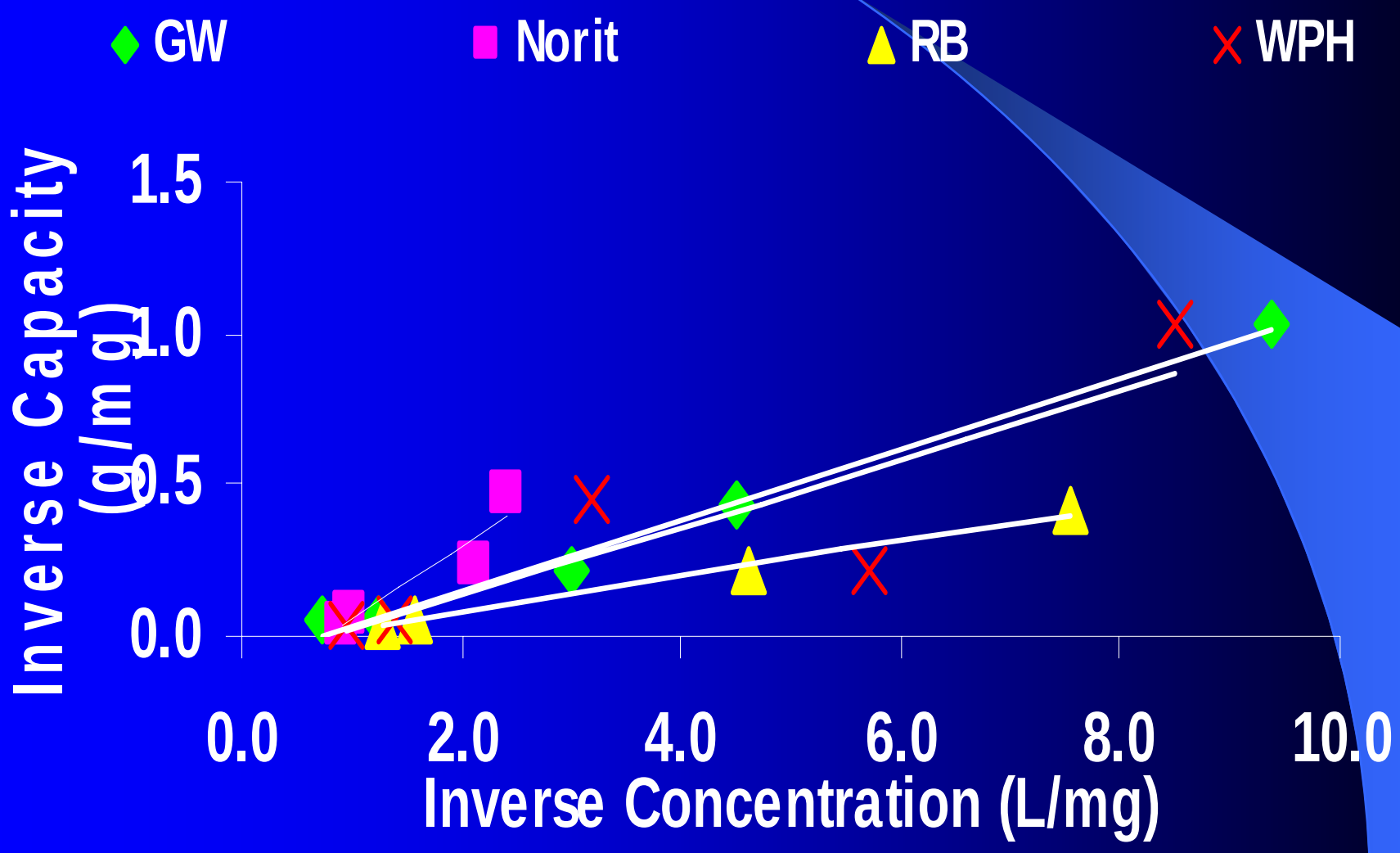
CARBON SPECIFICATIONS

Specification	Units	GW	Norit	RB	WPH
Iodine No.	mg/g	850 min.	660	600 min	800 min.
Mean Particle Diameter	mm	0.9-1.1	1.3	0.9-1.1	0.9-1.1
Ash	Weight %	11.0 max.	0.30 max.	23 max.	-
Moisture	Packed %	2.0 max.	8.0 max.	2.0 max.	8.0 max.

ISOTHERM STUDY

- Langmuir Isotherm
  - ✓ Theoretically Based on reversibility
  - ✓ a monolayer accumulation of contaminants on carbon sites
  - ✓ $X/M = abC_e/(1+aC_e)$

ISOTHERM STUDY



ISOTHERM STUDY

Carbon	Equation	Correlation, %
GW	*1/Ce = 0.1160(M/X) – 0.0795*	99.3
Norit	*1/Ce = 0.2455(M/X) – 0.1897*	89.3
RB	*1/Ce = 0.0598(M/X) – 0.0457*	*99.6*
WPH	*1/Ce = 0.1121(M/X) – 0.0871*	73.9

ISOTHERM STUDY

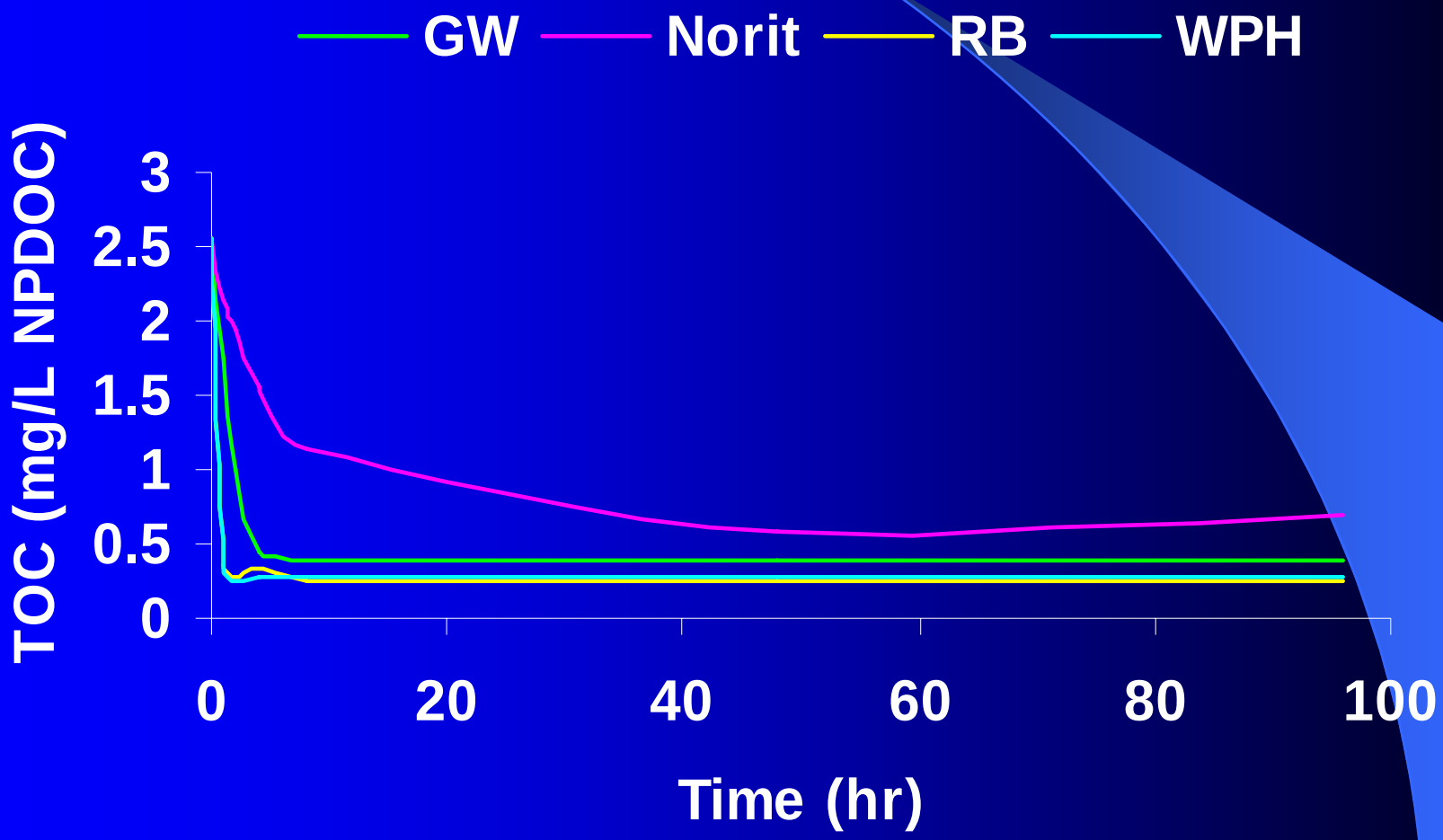
Carbon	Capacity, mg/g
GW	*5.12*
Norit	*2.30*
RB*	***9.48***
WPH	*5.02*

- C_o = 2.5 mg/L
- C_e = 1.0 mg/L
  - MTZ = 4.4 x (10^{-5}) m
  - SLR = 5.0 gfsm
  - % Utilization > 99%

KINETIC STUDY

- 1st order reaction
- Concentration versus Time graphs determines equilibrium conditions
- Kinetic data determines the MTC using the integrated form of the equation below
  - ✓ $F_m(dc/dt) = k_a(C-C_e)$

KINETICS STUDY



KINETICS STUDY

Carbon	MTC (hr^{-1})
GW	-0.014
Norit	-0.019
RB	-8.1
WPH	-9.3

COLUMN STUDY

- RSSCT- GAC mini-column that uses dimensional analysis to simulate a full-scale GAC column
- Water quality monitoring conducted
- Conducted study using RB (Filtersorb 400) carbon

RSSCT COLUMN DESIGN

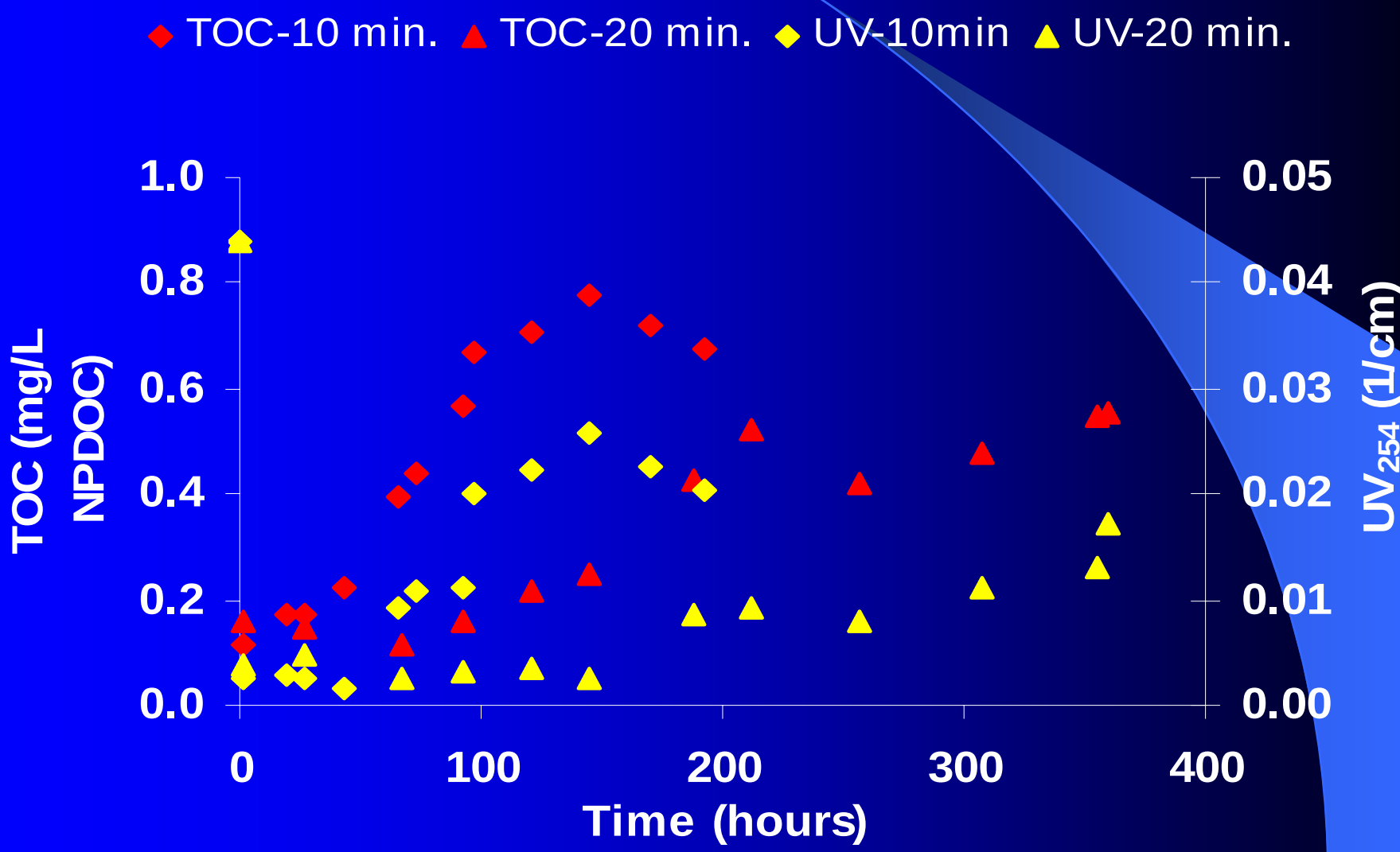
Parameter	Units	10 min. $EBCT_{LC}$	20 min. $EBCT_{LC}$
$EBCT_{SC}$	min.	1.0	2.0
SLR	m/hr	7.2	7.2
Q_{SC}	ml/min	9.4	9.4
m_{SC} (g)	grams	5.1	10.2
Runtime	days	8.9	17.7

COLUMN DESIGN

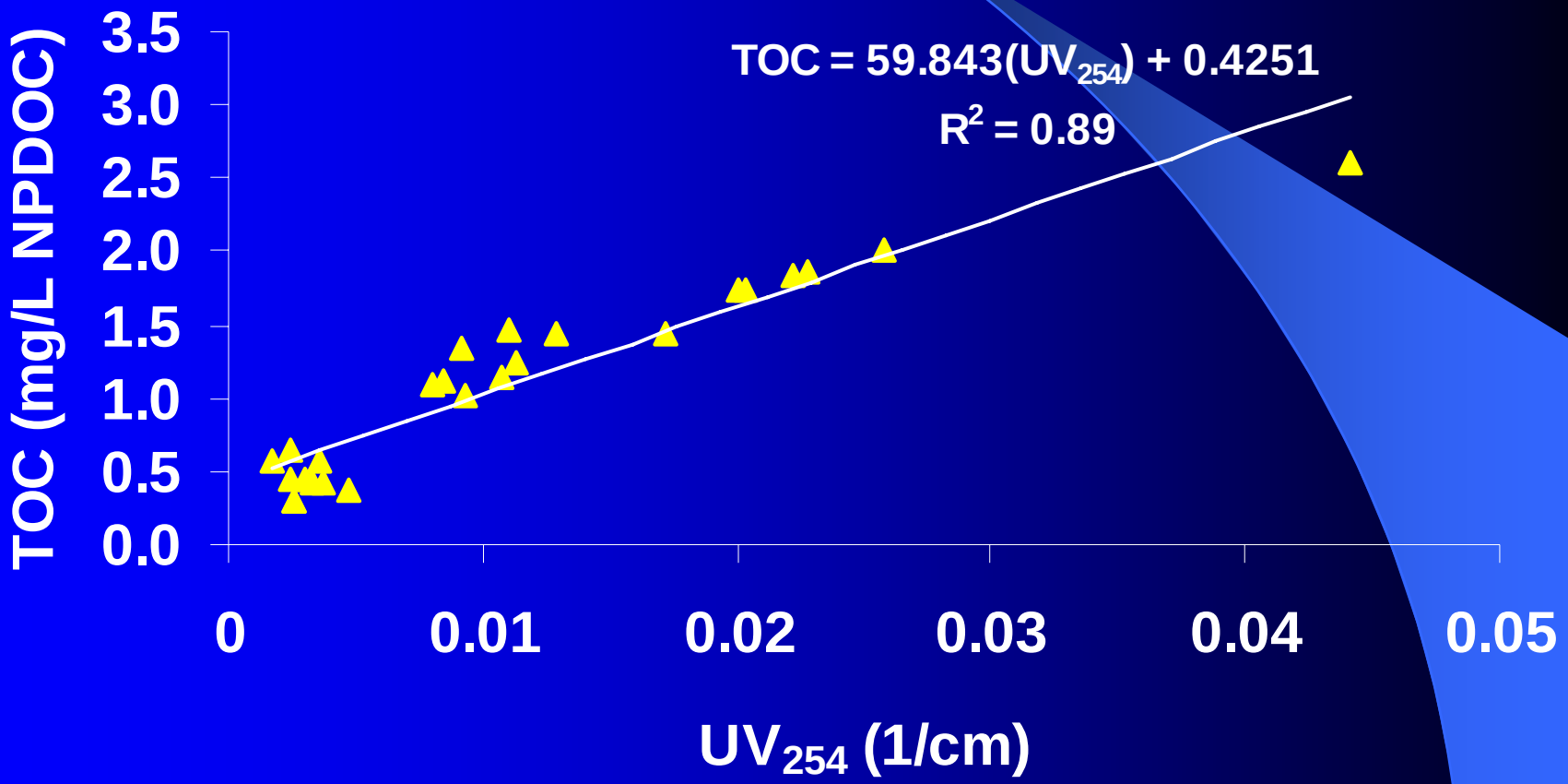
Parameter	Units	10 min. $EBCT_{LC}$	20 min. $EBCT_{LC}$
$EBCT_{LC}$	min.	10.0	20.0
SLR	cm/min.	10.1	10.1
Runtime	months	3.0	6.0

CARBON RSSCT

COLUMN STUDY



SURROGATES


TOC = 59.843(UV254) + 0.4251
R2 = 0.89
TOC (mg/L NPDOC)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
0.01
0.02
0.03
0.04
0.05
UV254 (1/cm)

COST COMPARISON

4 MGD, $0.70/lb

	Co-Current Cost (10^6/yr)		Counter Current Cost (10^6/yr)	
C_e, mg/L	C_o = 5 mg/L	C_o = 2.5 mg/L	C_o = 5 mg/L	C_o = 2.5 mg/L
0.5	6.34	2.82	2.21	1.19
1.0	3.59	1.35	1.96	*0.89*

COST COMPARISON

- RB GAC at $0.70/lb for 4 MGD Plant
- C_o = 2.5 mg/L
- C_e = 1 mg/L (Target)

Item	Cost (10^6/yr)
Co-Current	1.35
Counter Current	0.89
Savings	*0.46*

CONCLUSIONS

- Significant difference in GAC capacity
- Column design significantly less cost than coagulation basin addition of activated carbon
- Monolayer adsorption adequately describes TOC removal by GAC

CONCLUSIONS

- UV-254 is an adequate surrogate for TOC removal
- Laboratory studies justified for selection of carbon and co or counter current application.