Arsenic Removal During Iron Removal

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Arsenic Rule Webcast
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Iron-Based Arsenic Removal Processes

- Adsorptive properties of iron mineral toward arsenic are well known
- That knowledge is the basis for many arsenic treatment processes
  - *IRON REMOVAL*
  - Coagulation with iron coagulant
  - Iron-based adsorption media

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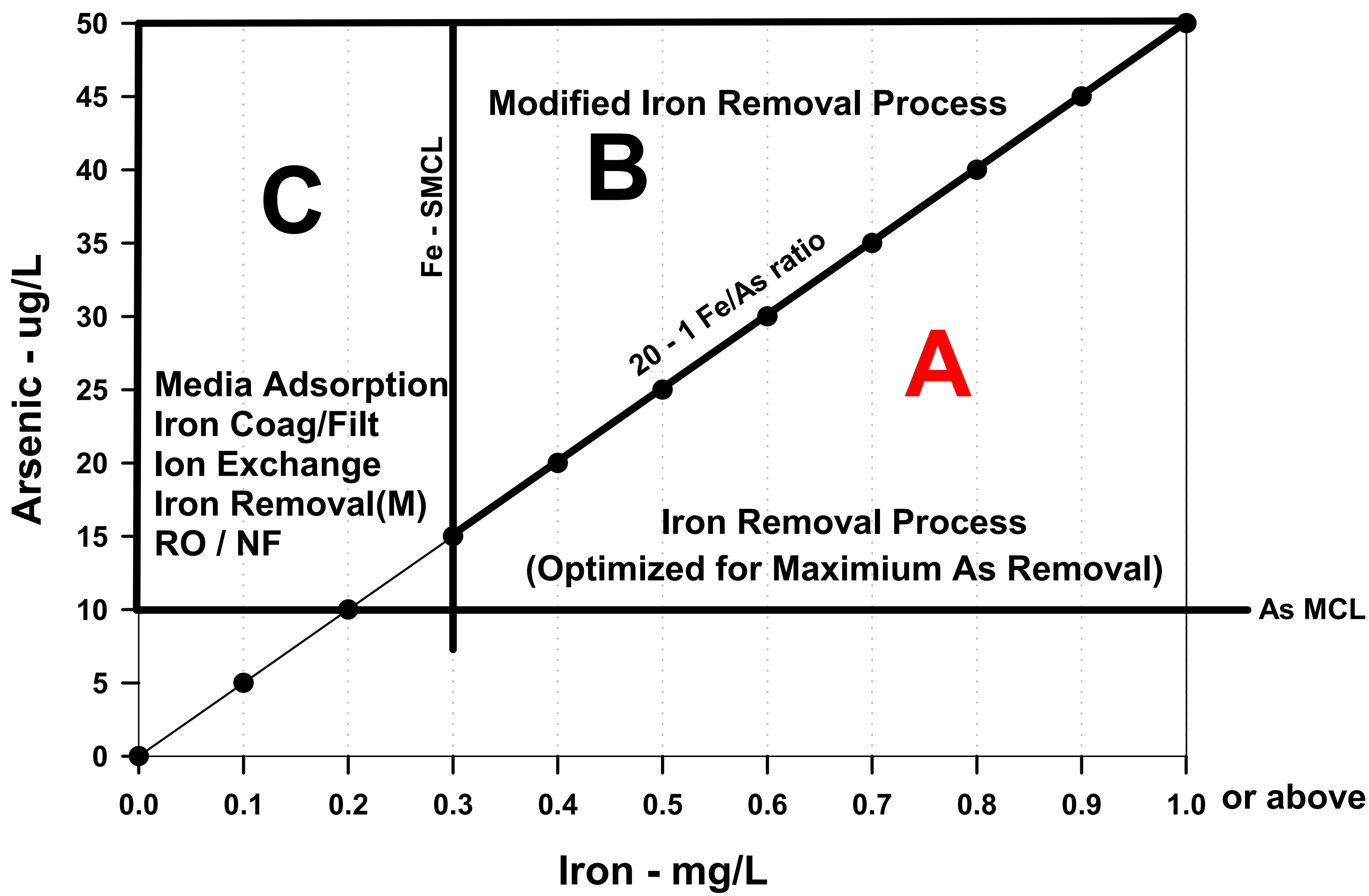
Arsenic Treatment - Process Selection Guide



Removal of 1 mg/L of iron

achieves

removal of 50 ug/L arsenic
(Optimized conditions and As[V])

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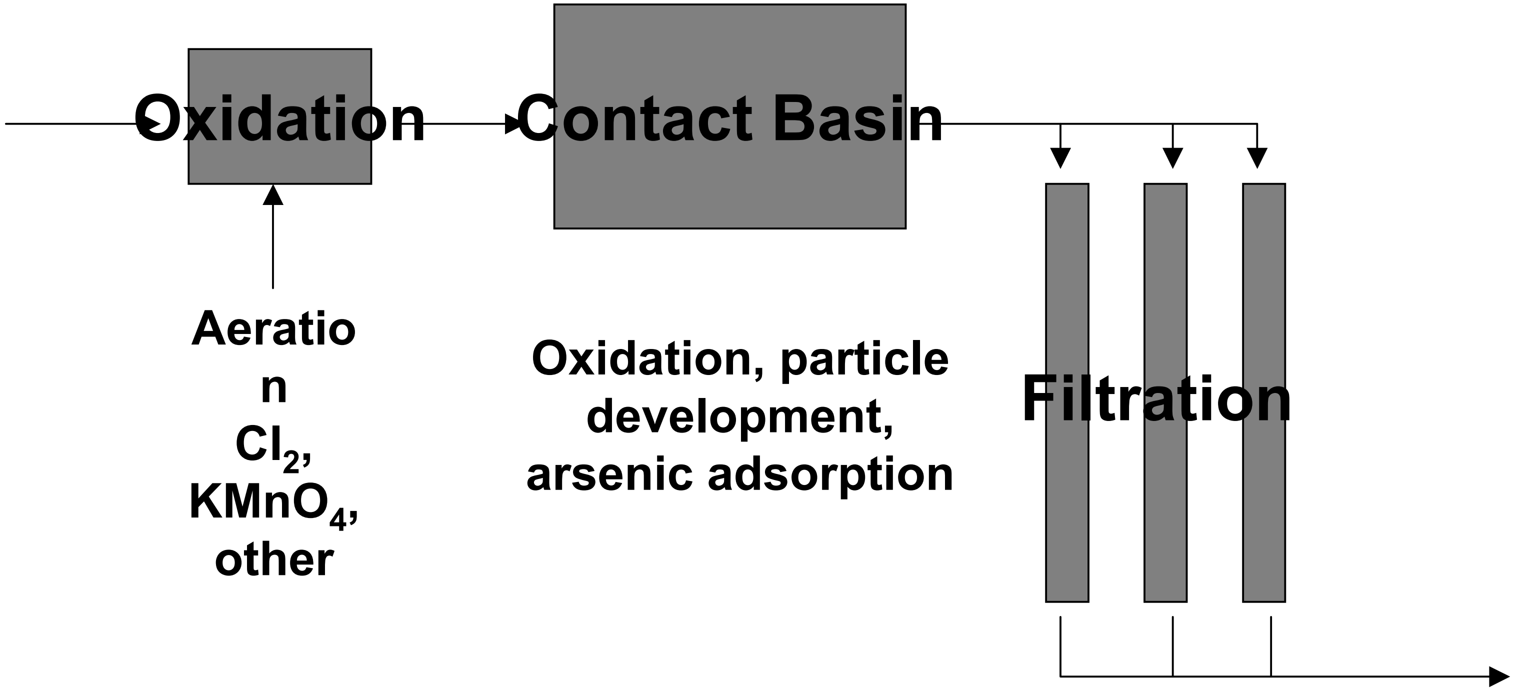
Iron and Arsenic (and Mn) Removal



Iron and Arsenic (and Mn) Removal

Fe(II), As(III) → Fe(II)/Fe(III), As(III) and/or As(V)

→ Oxidation →

Aeration
Cl_2,
$KMnO_4$,
other

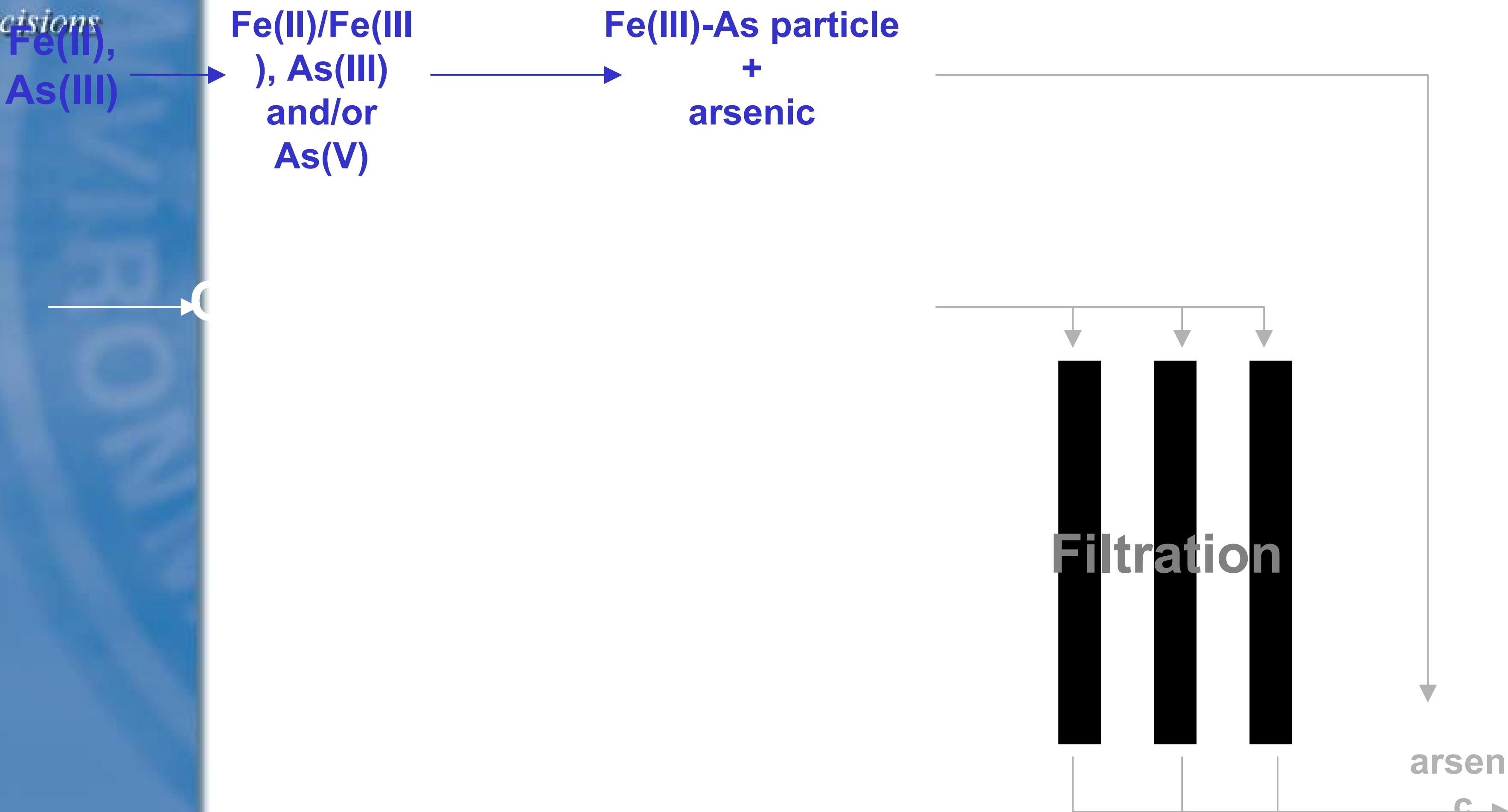
Iron and Arsenic (and Mn) Removal

Fe(II), As(III) → Fe(II)/Fe(III), As(III) and/or As(V) → Fe(III)-As particle + arsenic

→ Contact Basin

Oxidation, particle development, arsenic adsorption/coprec.

Iron and Arsenic (and Mn) Removal



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Case Studies

Factors the impact arsenic removal during iron removal.

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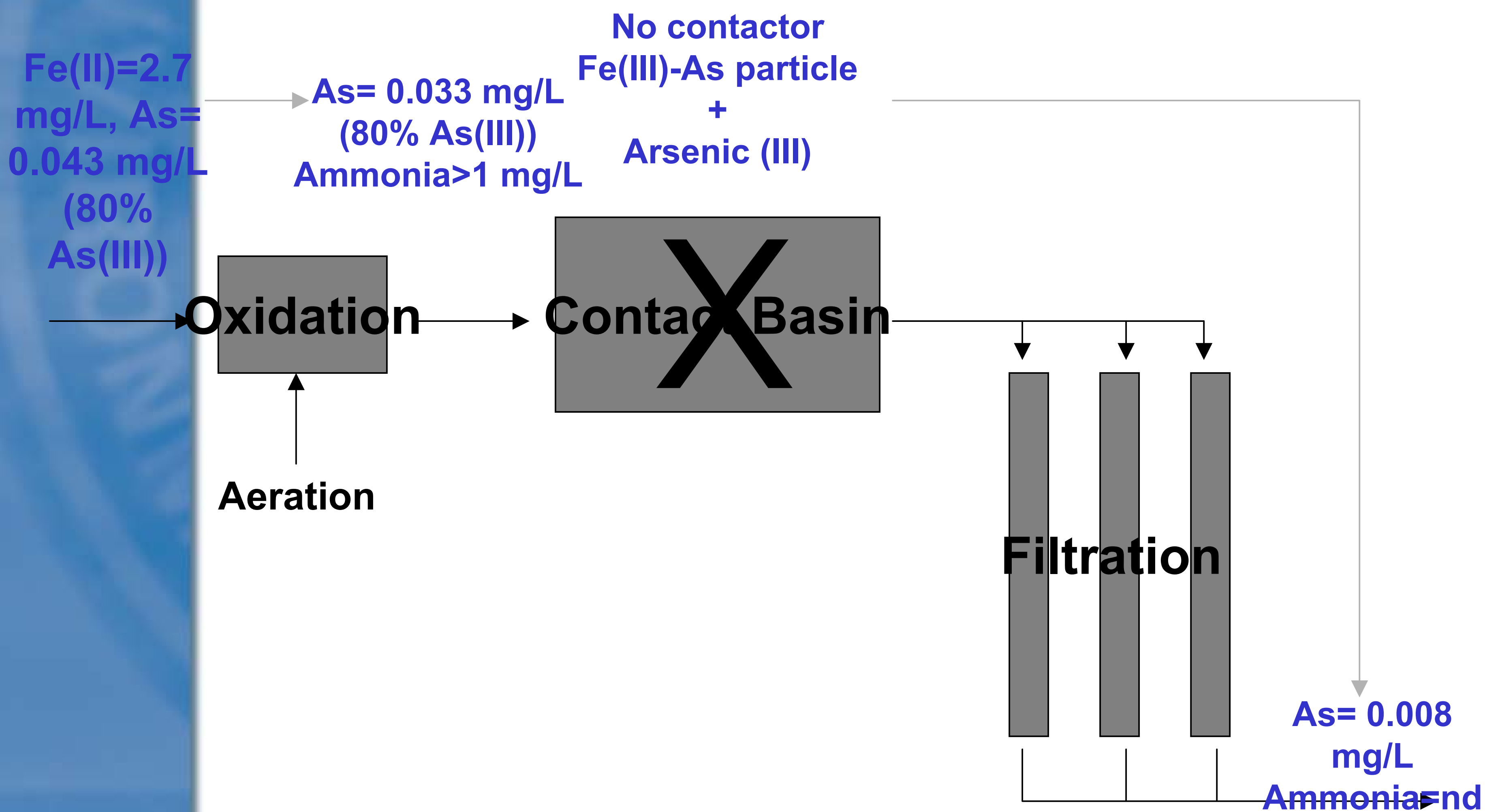
Form of Arsenic

As(III) vs As(V)

- **As(III) is removed during iron removal and other iron-based processes- just not as well as As(V)**
- **Aeration will oxidize Fe(II) to Fe(III) but not As(III) to As(V)**

Case Study 1-Ohio

As Oxidation State-Removal of As (III)



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As (III) Oxidation

Effective!

- Free Chlorine
- Potassium Permanganate
- Ozone
- Solid Oxidizing Media (${MnO_2}$ solids)

Ineffective

- Chloramine
- Chlorine Dioxide
- UV Radiation
- Oxygen

Oxidant Type

- Depends on As, Fe and Mn
- Aeration
  - May need contact basin
  - Will not address Mn and As oxidation
  - Iron particles have less surface area
  - May have longer filter run lengths
- Strong oxidants (chlorine, permanganate, etc)
  - Address Mn and As oxidation
  - Shorter filter run time possible
  - More particle surface area
  - Difficult to feed
  - Probably no contactor needed

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Oxidation- Case Study 2- Ohio

Source Water Quality

Parameter	Concentration
Arsenic - ug/L	69 - 132
As III	85 %
As V	15 %
Calcium - mg/L	115
Magnesium - mg/L	58 - 60
Iron - mg/L	0.5 - 1.4
Manganese -mg/L	0.2 - 0.9
Sulfate - mg/L	1.2 - 10.0
Silica - mg/L	NA
pH - units	7.9

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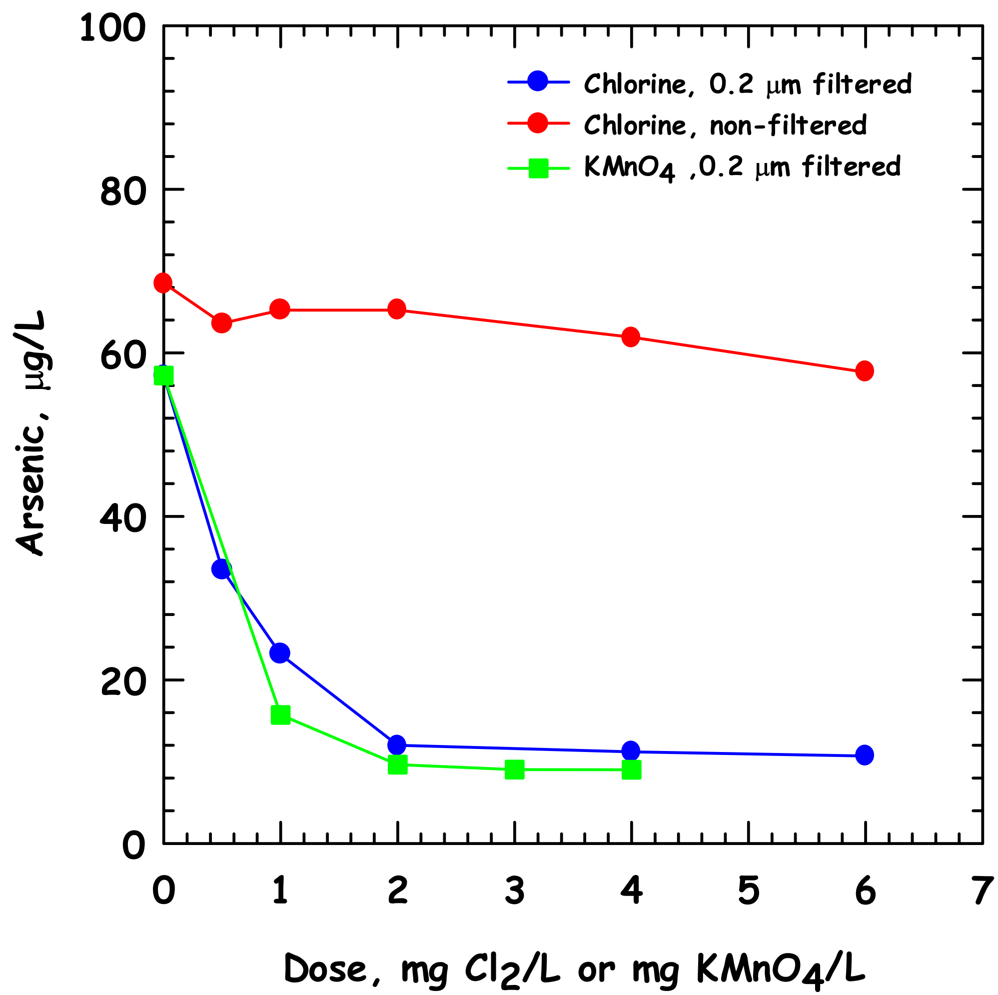
Effect of Oxidant Type and Concentration

Case Study 2- Ohio- pH 8.2, 1.7 mg O_2/L



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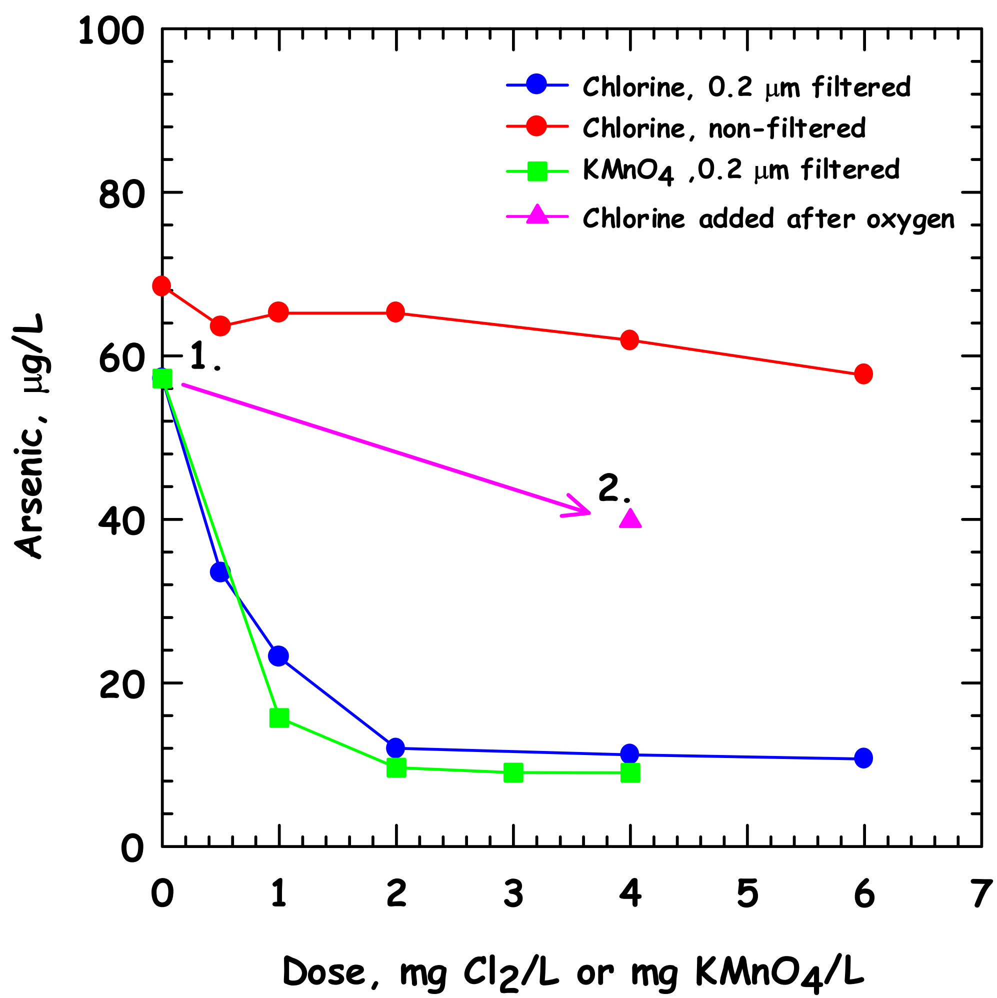
Effect of Oxidant Type and Concentration

Case Study 2- Ohio- pH 8.2, 1.7 mg O_2/L



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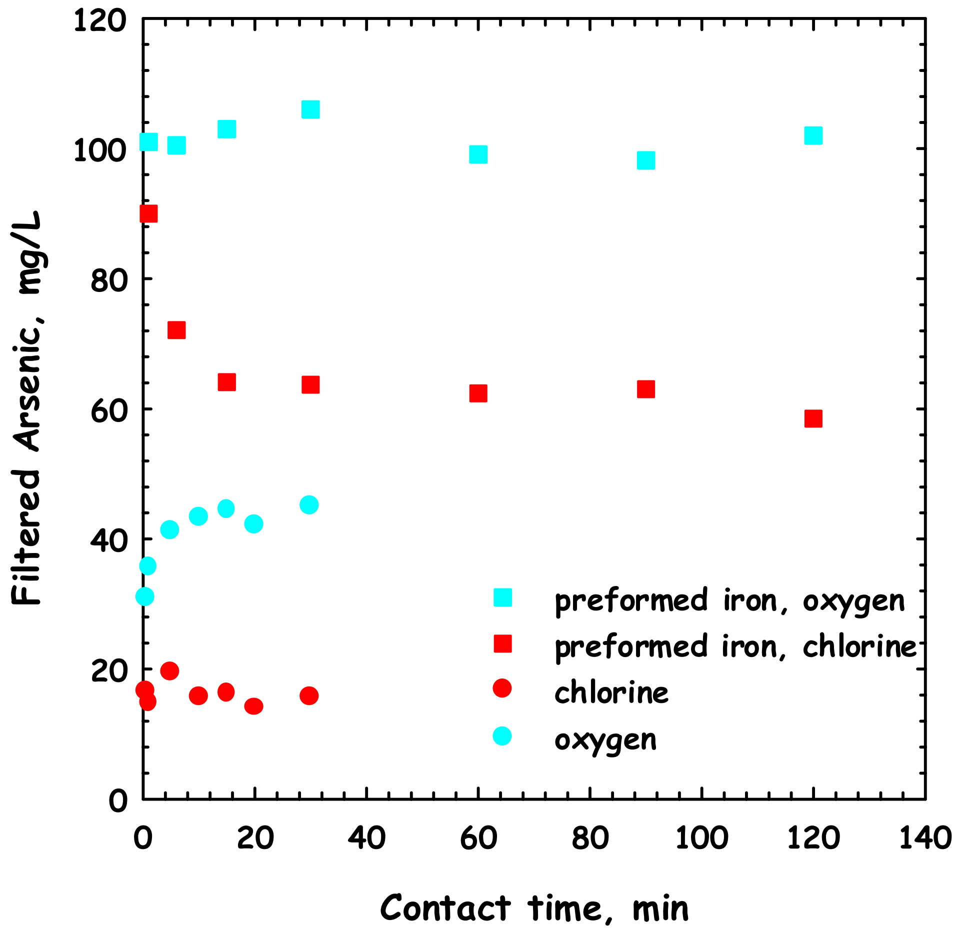
Oxidation

pH=8, DIC=10 mg C/L, As(V)=100 ug/L, Fe=1 mg/L

Point of Application and Contact Time



Oxidation- Point of Application

Case Study 3- Michigan

Parameter	Concentration
Arsenic – ug/L	19 - 24
As III	95 %
As V	5 %
Calcium – mg/L	74 - 84
Magnesium – mg/L	30 - 33
Iron – mg/L	0.5 - 0.6
Manganese –mg/L	0.02
Sulfate – mg/L	50 - 60
Silica – mg/L	12 - 13
pH - units	7.1 - 7.3

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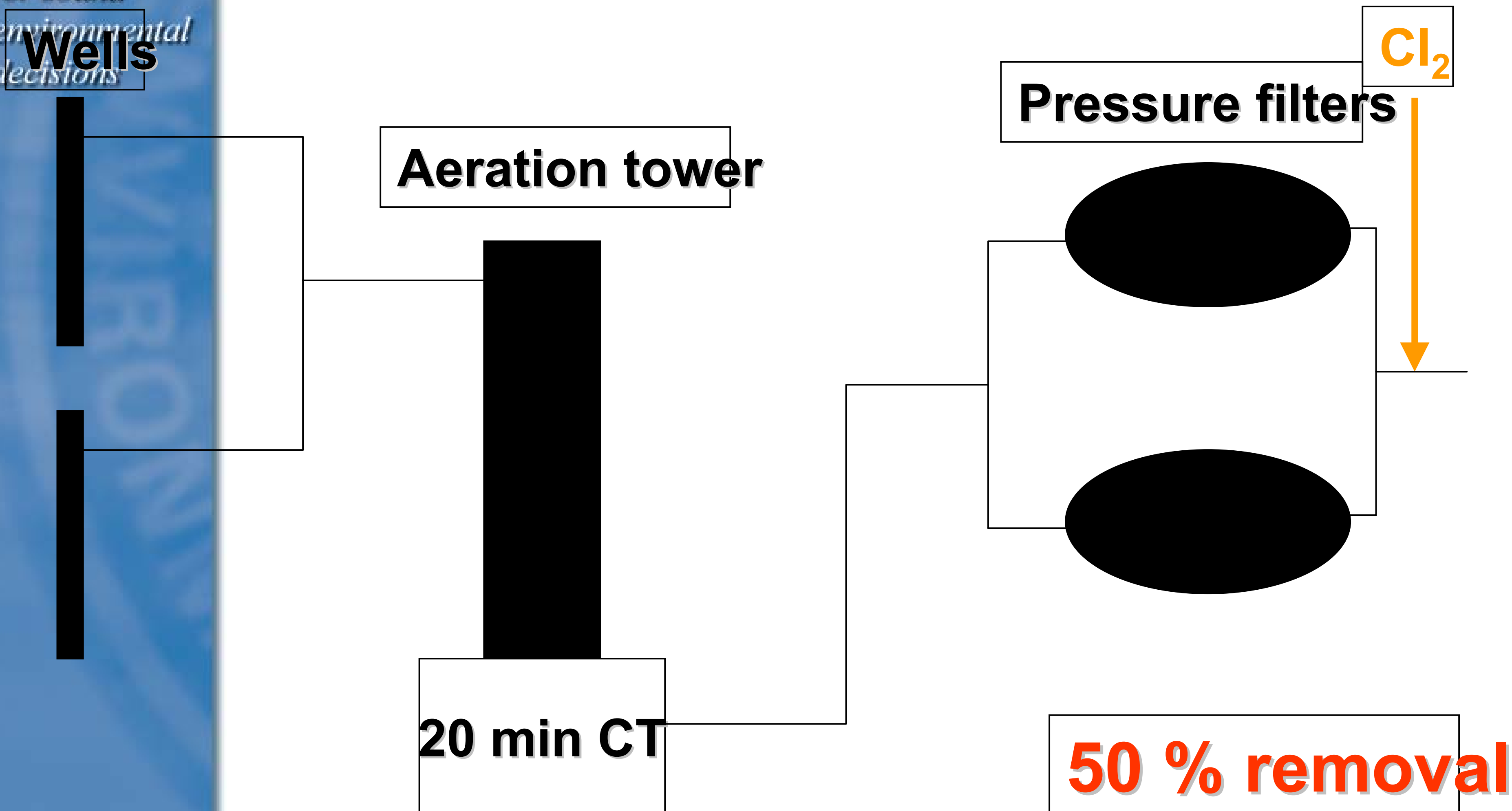
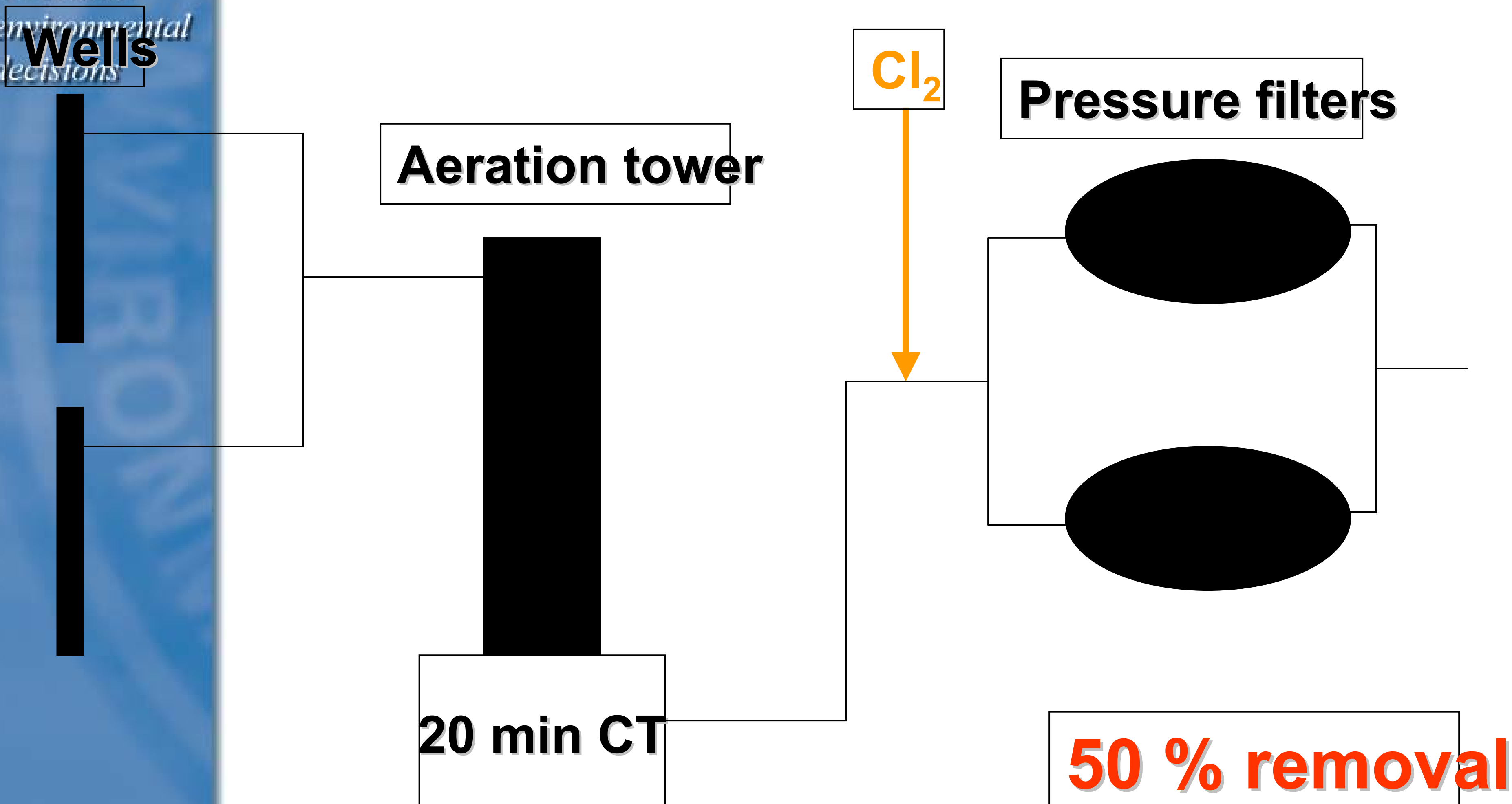
Oxidation- Point of Application

Case Study 3- Michigan



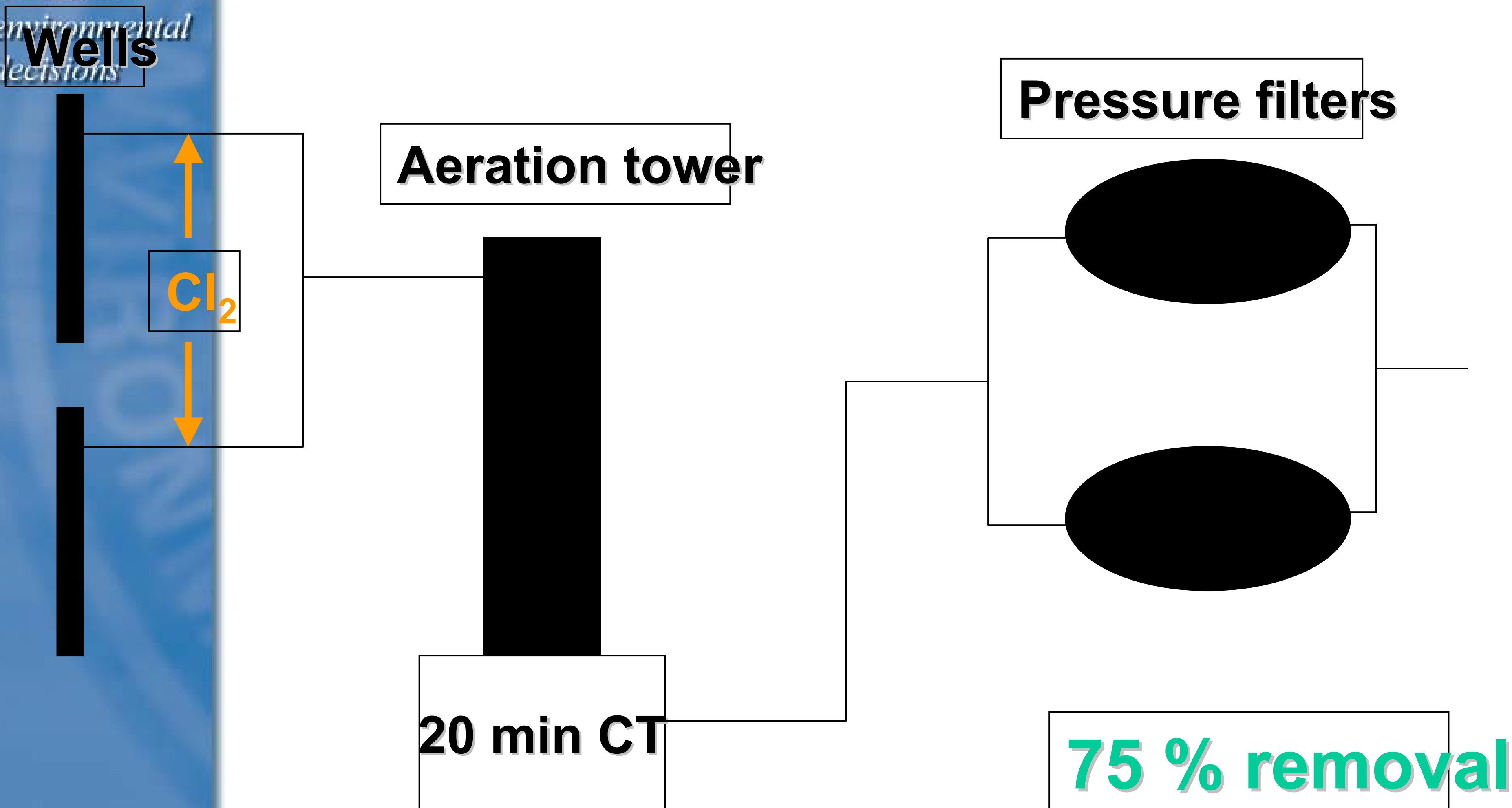
Oxidation- Point of Application

Case Study 3- Michigan



Oxidation- Point of Application

Case Study 3- Michigan



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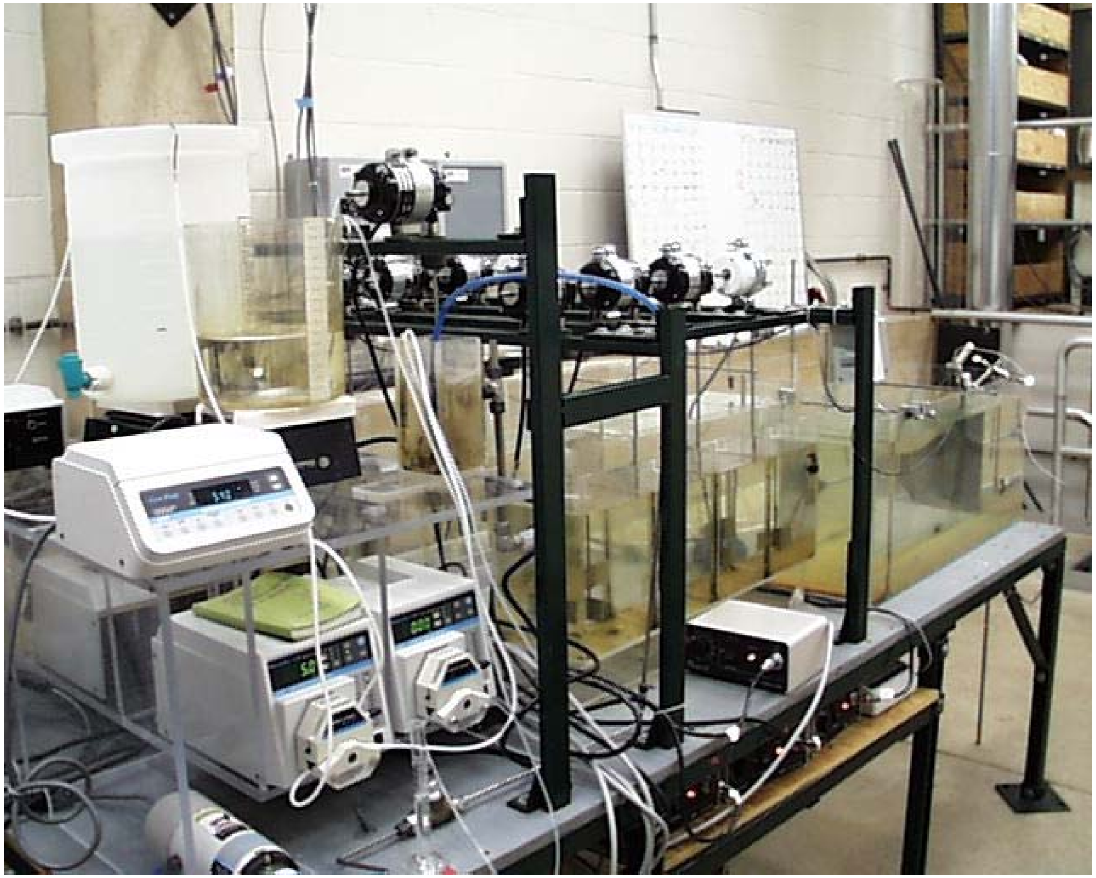
Pilot Plant Rapid Mix, Flocculation, Sedimentation



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Pilot Plant Filters

Arsenic Pilot Plant Screening Runs Arsenic Removal

(pH 7.2 with 20 mg/L DIC and 1.5 mg/L Fe)

Date	Floc	Cl_2 (mg/L)	As (mg/L)	As(mg/L)*$_{final}$
8/12	Yes	1	100 (V)	7
8/13	Yes	-	100 (V)	13
8/14	No	-	100 (V)	30**
8/18	No	1	100 (V)	7
8/19	Yes	-	100 (V) added after floc	85
8/20	Yes	1	100 (V) added after floc	48
8/22	Yes	-	100 (III)	44
8/25	Yes	1	100 (III)	8

* Average filter effluent value over complete test run

** Soluble iron passed filter

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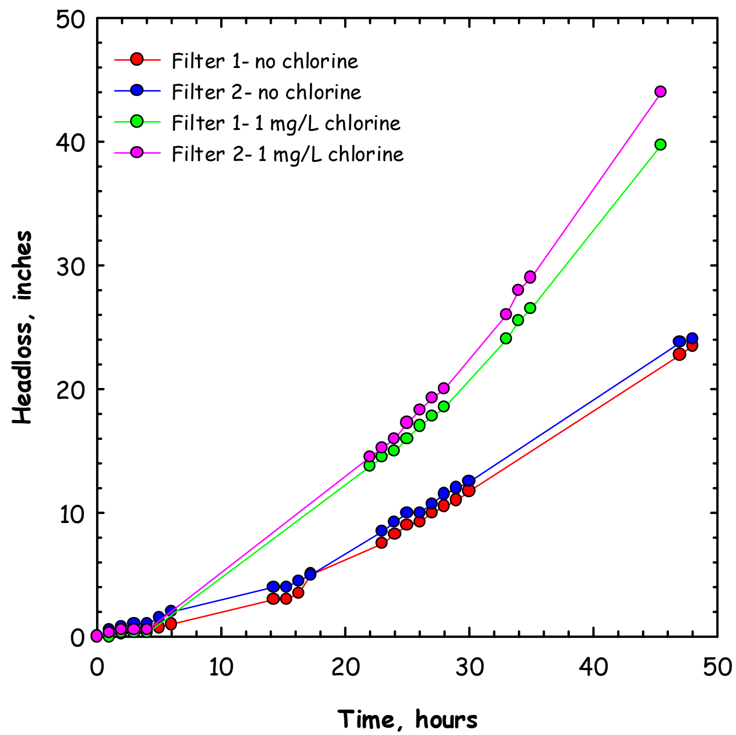
Arsenic Pilot Plant Runs

Headloss Build-Up

(pH 7.2 with 20 mg/L DIC and 1.5 mg/L Fe)

NO Calcium



Process Modifications

Increasing As Removal

Utility with iron removal in place or will be in place but can not meet MCL:

- Increase iron concentration
- Adjust pH
- Replace media w/ As adsorption media
- Change point of oxidant addition

Conclusions

- Iron removal = arsenic removal
- Arsenic speciation is important
- Oxidant type is important
- Point of oxidant application is important
  - Arsenic removal impacted
  - Plant operation impacted

Thank-you.