

Treatment Options

Part 1

Tom Sorg
Darren Lytle

Water Supply and Water Resources Division
Office of Research and Development
U.S. Environmental Protection Agency
Cincinnati, OH

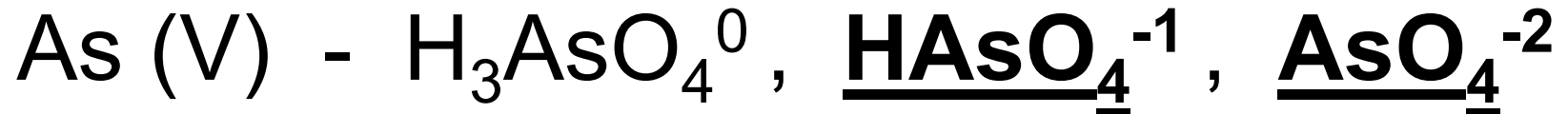
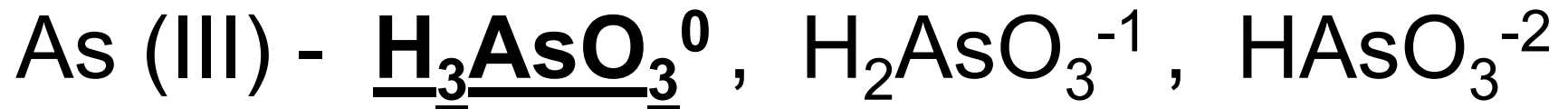
Topics – Part 1

- **Arsenic Chemistry**
- BAT Technology
- Adsorptive Media



Arsenic Chemistry

Arsenic Species



Arsenic Chemistry

What is the significance of arsenic speciation?

As V more effectively removed than As III by most treatment technologies



Arsenic Occurrence

Surface waters - predominantly As (V)

Ground waters – usually found as As (III), however, it can As (V) or a combination of As (III) and As (V).



Arsenic Chemistry

For maximum As removal

oxidize As (III) to As (V)

before applying treatment



As III Oxidation

Effective!

- Free Chlorine
- Potassium Permanganate
- Ozone
- Solid Oxidizing Media (MnO₂ solids)

Ineffective

- Chloramine
- Chlorine Dioxide
- UV Radiation



Oxidation of As III by aeration not effective



Topics – Part 1

- Arsenic Chemistry
- **BAT Technology**
- Adsorptive Media



Arsenic Rule

Best Available Technology (BAT)

| <u>Technology</u> | <u>Maximum Percent Removal (As V)</u> |
|-----------------------------------|---------------------------------------|
| Ion Exchange | 95 |
| Activated Alumina | 90 |
| Reverse Osmosis | >95 |
| Modified Coag/Filtration | 95 |
| Modified Lime Softening | 80 |
| Electrodialysis Reversal | 85 |
| Oxidation/Filtration (20:1 Fe/As) | 80 |



Arsenic Rule

Other Ground Water Processes

Technology

Reason for not being listed as BAT

Coagulation Assisted
Microfiltration

No full scale history

Granular Ferric
Hydroxide (GFH)

Lack of published data



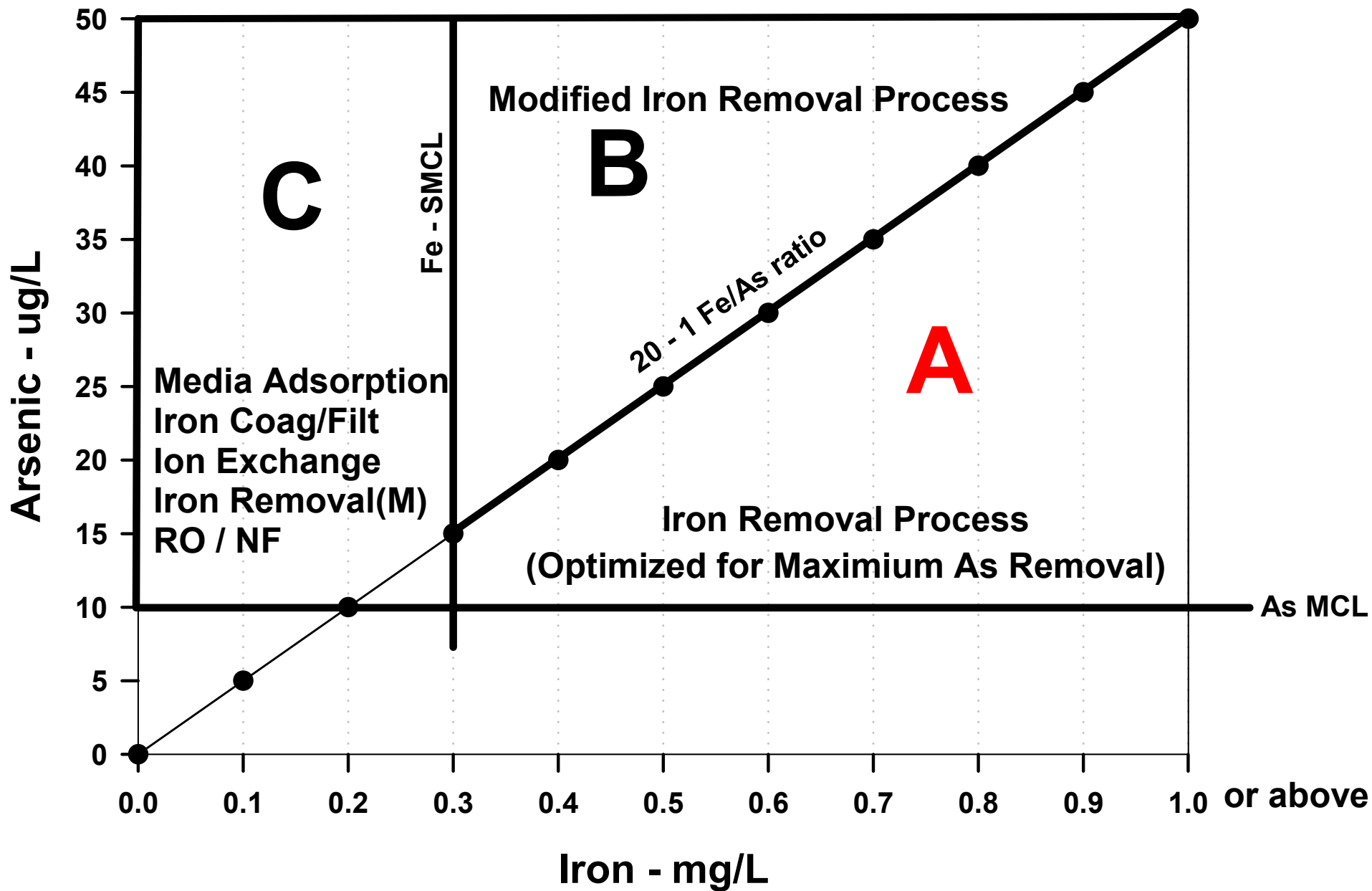
Arsenic Rule

Small Systems Compliance Technologies

- Centralized Treatment – IE, AA, MC/F, MLS, Fe Removal
- POU - RO, Activated Alumina
- POE – Activated Alumina



Arsenic Treatment - Process Selection Guide



Topics – Part 1

- Arsenic Chemistry
- BAT Technology
- **Adsorptive Media**



Arsenic Demonstration Program – Round 1

Technologies selected for demonstration (12 sites)

Adsorptive media – 9

Iron media – 7 (E 33, Sorb 33, GFH)

Iron based media – 1 (G2)

Modified activated alumina –1 (AAFS 50)

Ion exchange – 1 (As & NO₃)

Iron removal – 1

Treatment modification (iron removal process) - 1



Adsorptive Media Processes

Advantages

- Simple process
- High removal capacity
- Non hazardous waste products
- Low cost



Adsorptive Media Treatment

Disadvantages

- Removal capacity impacted by water chemistry, such as pH
- pH adjustment may be required
- Media replacement



Adsorptive Media Treatment

Key design factors

- Media
- Bed configuration

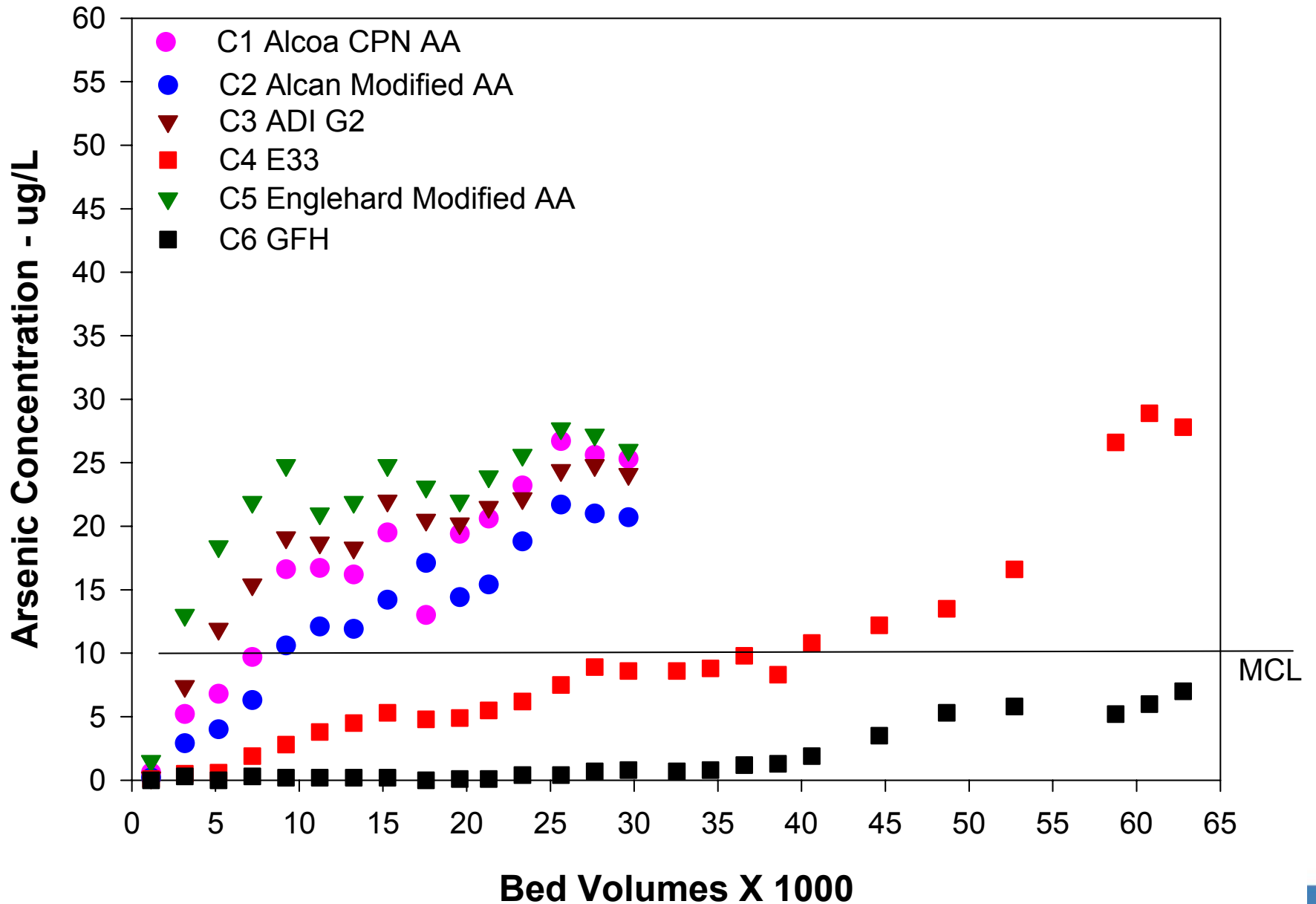


Adsorptive Media Listed in NSF/ANSI STD 61

| <u>Company</u> | <u>Base Material</u> | <u>Name</u> | <u>Material</u> |
|-----------------------|----------------------|-------------|------------------------|
| Alcan (4) | Aluminium | AAFS - 50 | Mod AA |
| Alcoa (2) | Aluminium | CPN | AA |
| Apyron | Aluminium | Aqua-Bind | Mod AA |
| Engelhard | Aluminium | ARM 100 | AA |
| Engelhard | Iron | ARM 200 | Iron Oxide |
| ADI Internat. | Iron | G2 | Iron based |
| SMI | Iron | SMI III | Iron/sulfur |
| US Filter | Iron | GFH | Iron Hydroxide |
| Bayer AG | Iron | E 33 | Iron Oxide |
| WRT | Zeolite | Z – 33 | Mod Zeolite |
| Magnesium Elektron | Zirconium | Isolux | Zirconium Hydroxide |



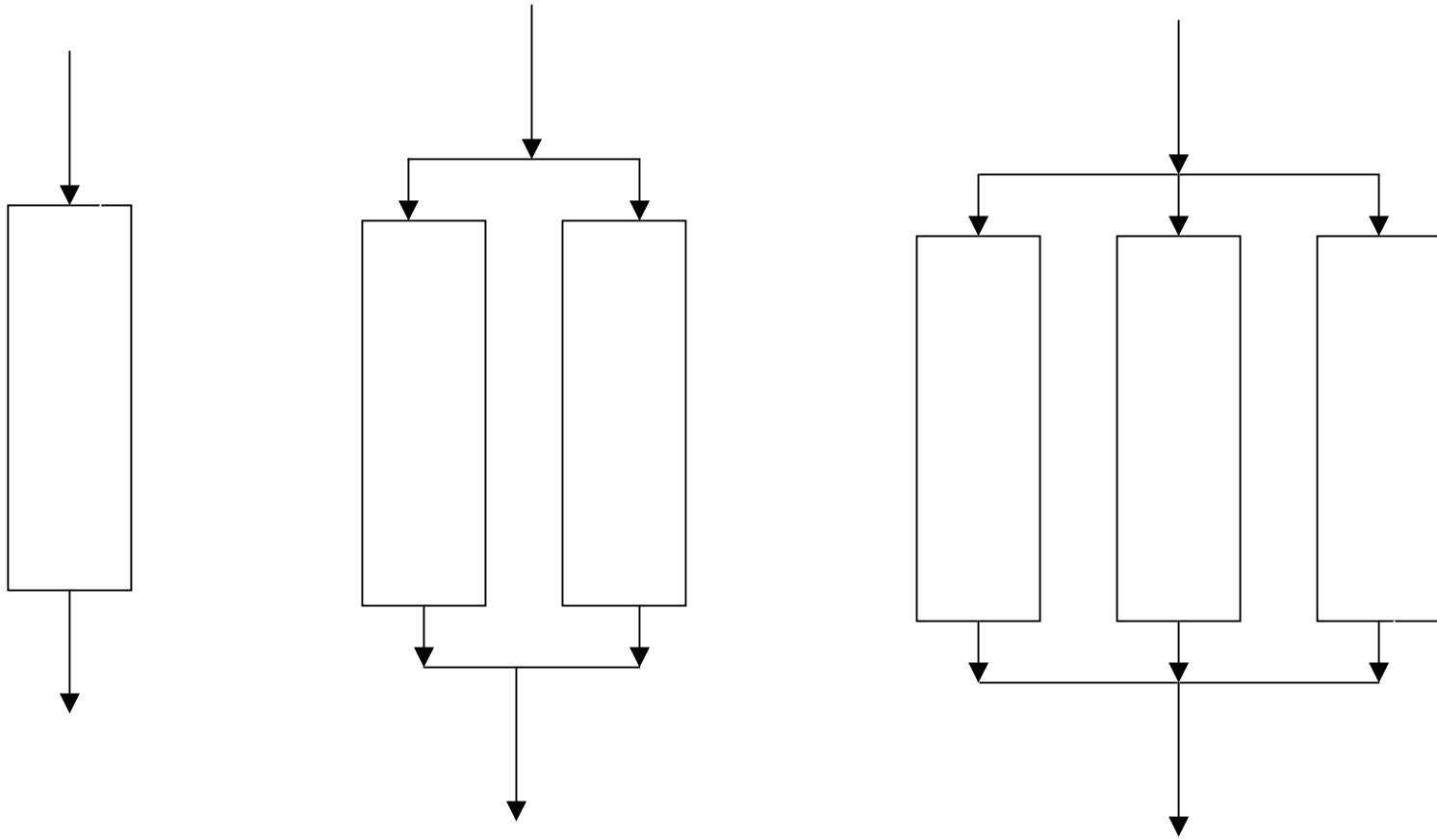
Figure 1. Results of Arsenic Removal by Adsorptive Media Pilot Plant Studies.





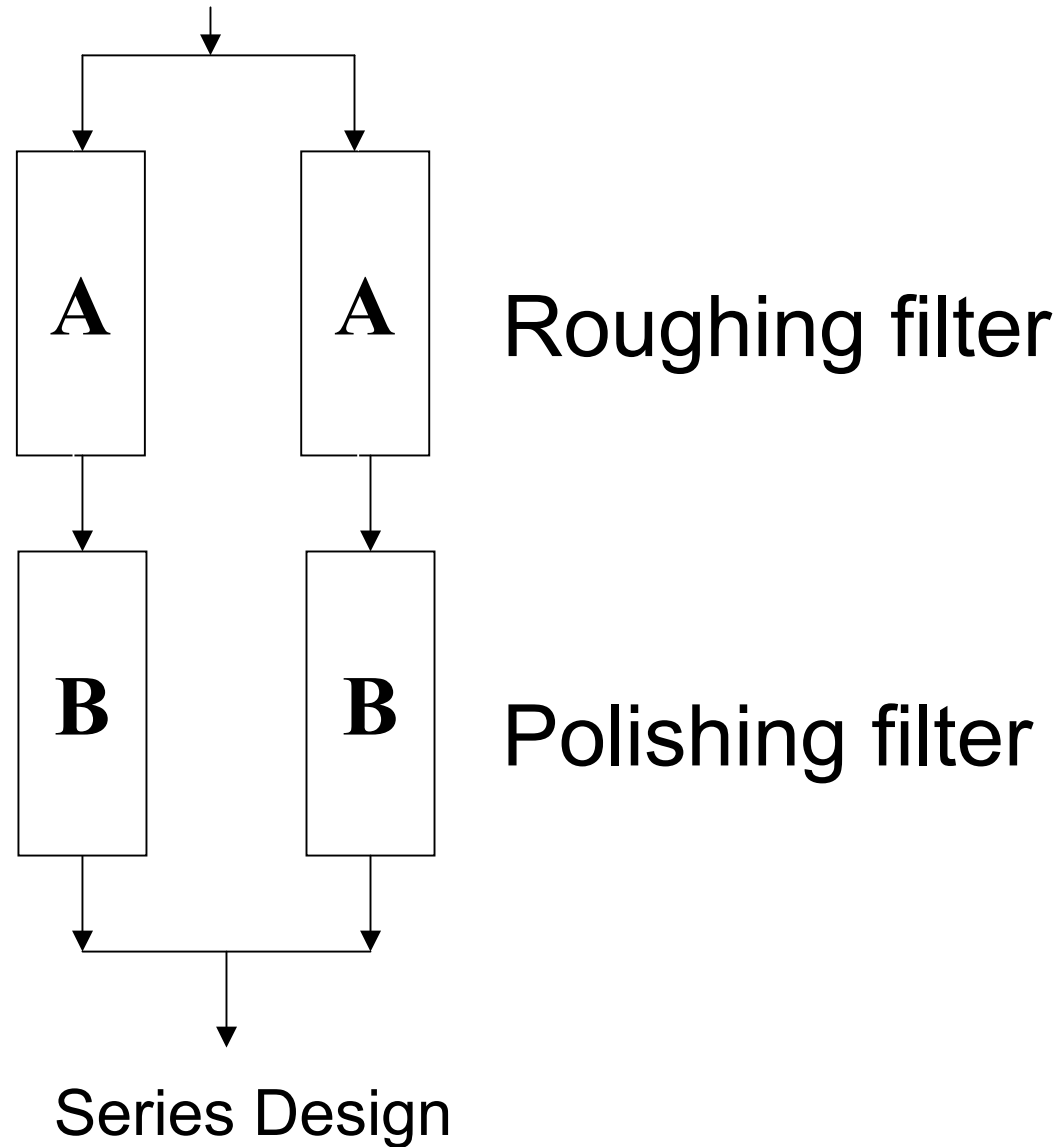
Building a scientific foundation for sound environmental decisions

Adsorptive Media System Designs



Simple 1, 2, or 3 beds in parallel

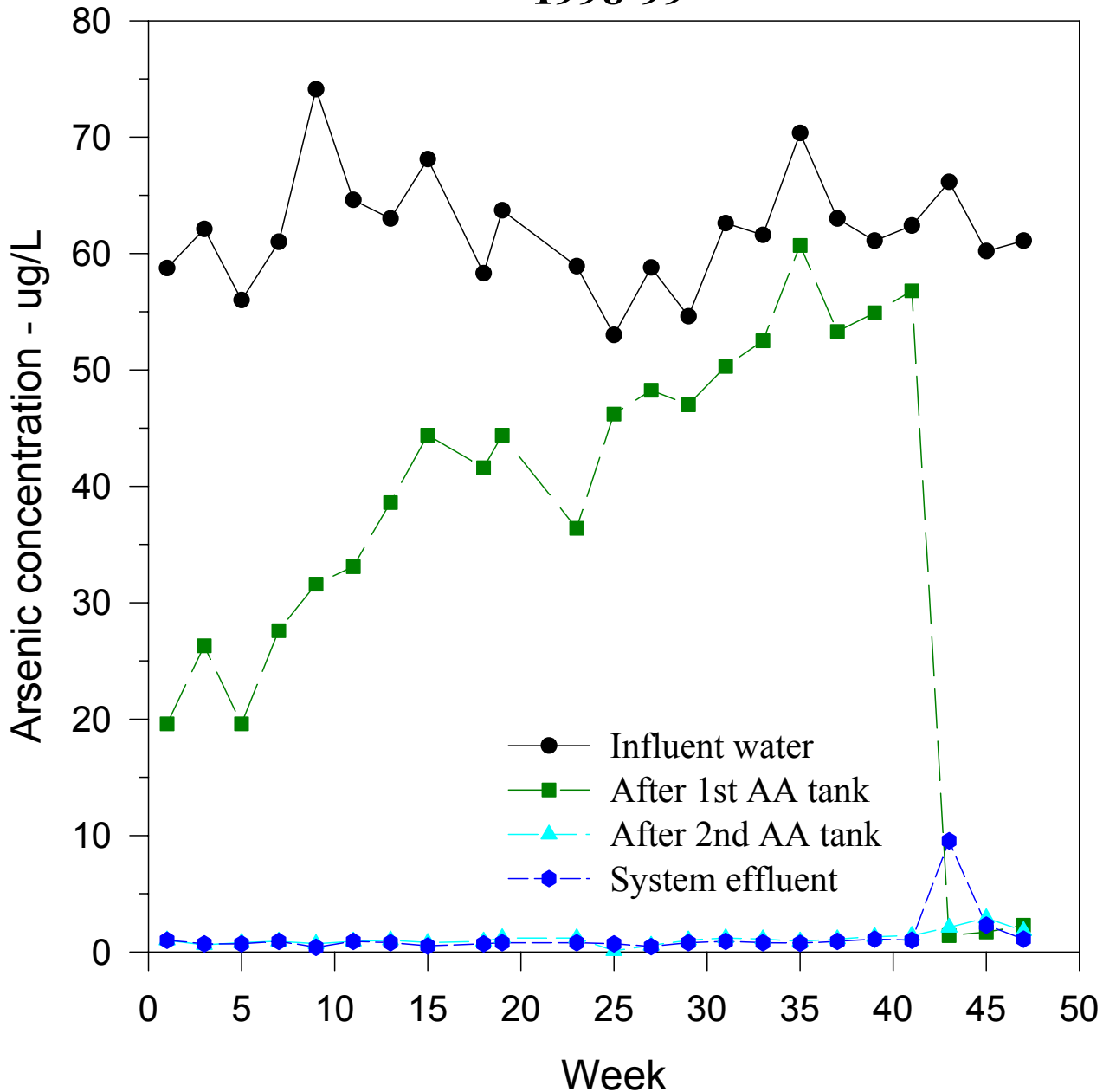
Adsorptive Media System Design



Activated Alumina System - New Hampshire



Arsenic Removal, Activated Alumina System(CS), NH. 1998-99



Influent water: pH 8.2, alk 58 mg/L (CaCO₃), Fe <0.03 mg/L



Adsorptive Media Treatment

| Flow gpm | Media | Design | Total Capital Investment (TCI) | Equipment Cost | Eq Cost % of TCI |
|-------------|--------|----------|-----------------------------------|-------------------|---------------------|
| 70 | G2 | Series | \$154,700 | \$102,600 | 66 |
| 37 | AAFS50 | Series | \$228,309 | \$122,646 | 54 |
| 45 | E33 | Series | \$90,757 | \$66,235 | 73 |
| 100 | E33 | Parallel | \$106,568 | \$82,081 | 77 |
| 145 | E33 | Parallel | \$139,251 | \$112,211 | 80 |
| 300 | E33 | Parallel | \$211,000 | \$129,500 | 62 |
| 320 | E33 | Parallel | \$153,000 | \$112,600 | 73 |
| 350 | GFH | Parallel | \$232,309 | \$157,646 | 68 |
| 640 | E33 | Parallel | \$305,000 | \$218,000 | 71 |

