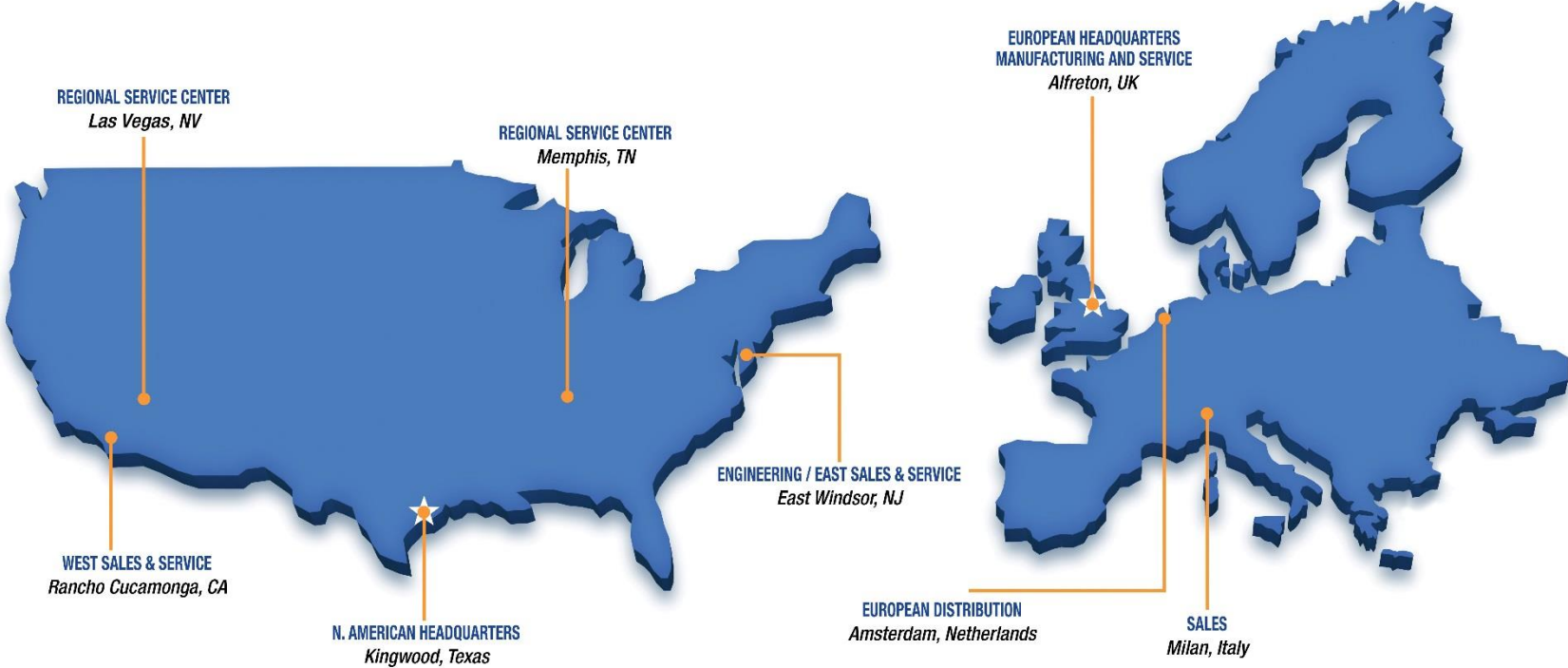




Envirogen's AMRS Technology for Treatment of Selenium and Other Metals

The Global Envirogen Group



Envirogen: Representative Solutions

Service offerings underpinned by proprietary know-how and technology



MBR – Beverage Plant



Containerized CDI System



*Biotrickling
Filter
Tower*



Containerized IX Unit



*FBR – Perchlorate,
Chlorate, Nitrate,
Chromate, Selenate,
Selenite Remediation*



Dual P-600 Modular Biofilter



Cross-flow Filtration



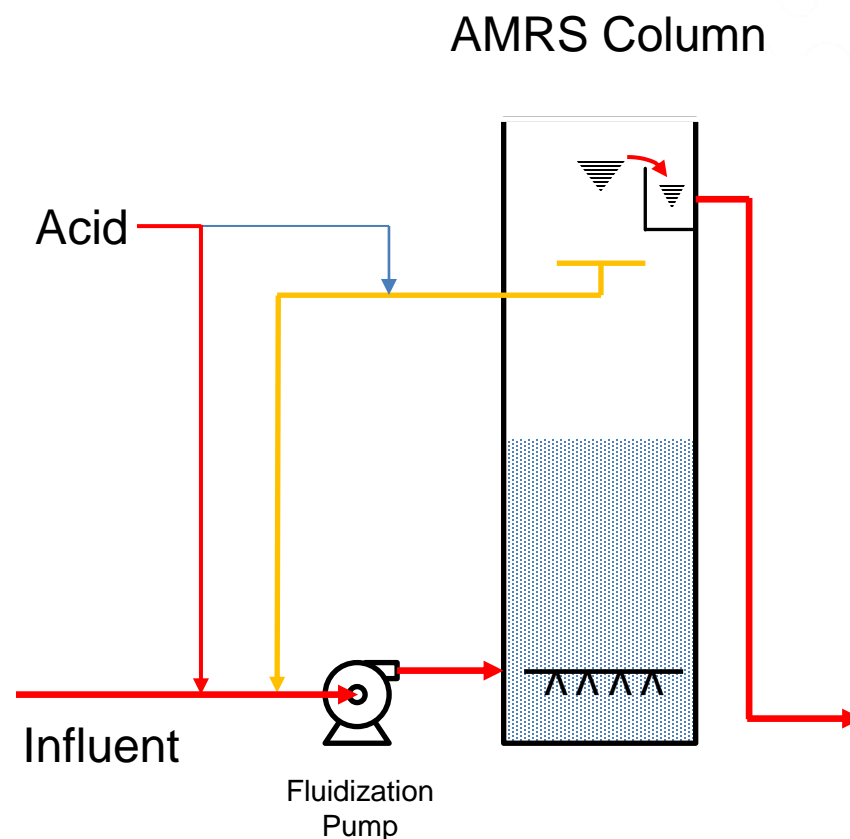
Consumables

Adsorptive & Reactive ZVI Media Process

- Removes selenate, arsenate, chromate and other oxyanion contaminants via chemical reduction
- Adsorption and chemical reduction mechanisms release Fe^{+2}
- Chemical reduction continues via adsorbed and released Fe^{+2}
- **Water composition determines release of Fe^{+2}**
- Insoluble metals and Fe^{+3} remain on the media
- Insoluble metals are not released
- Iron oxides are removed via automated cycles

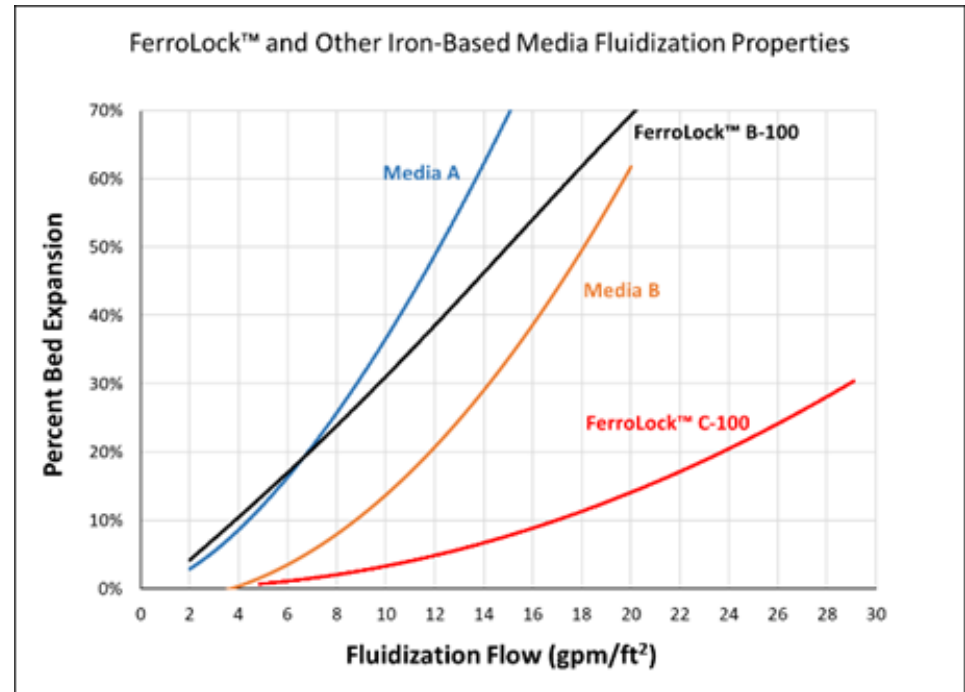


Zero Valent Iron (ZVI) Media

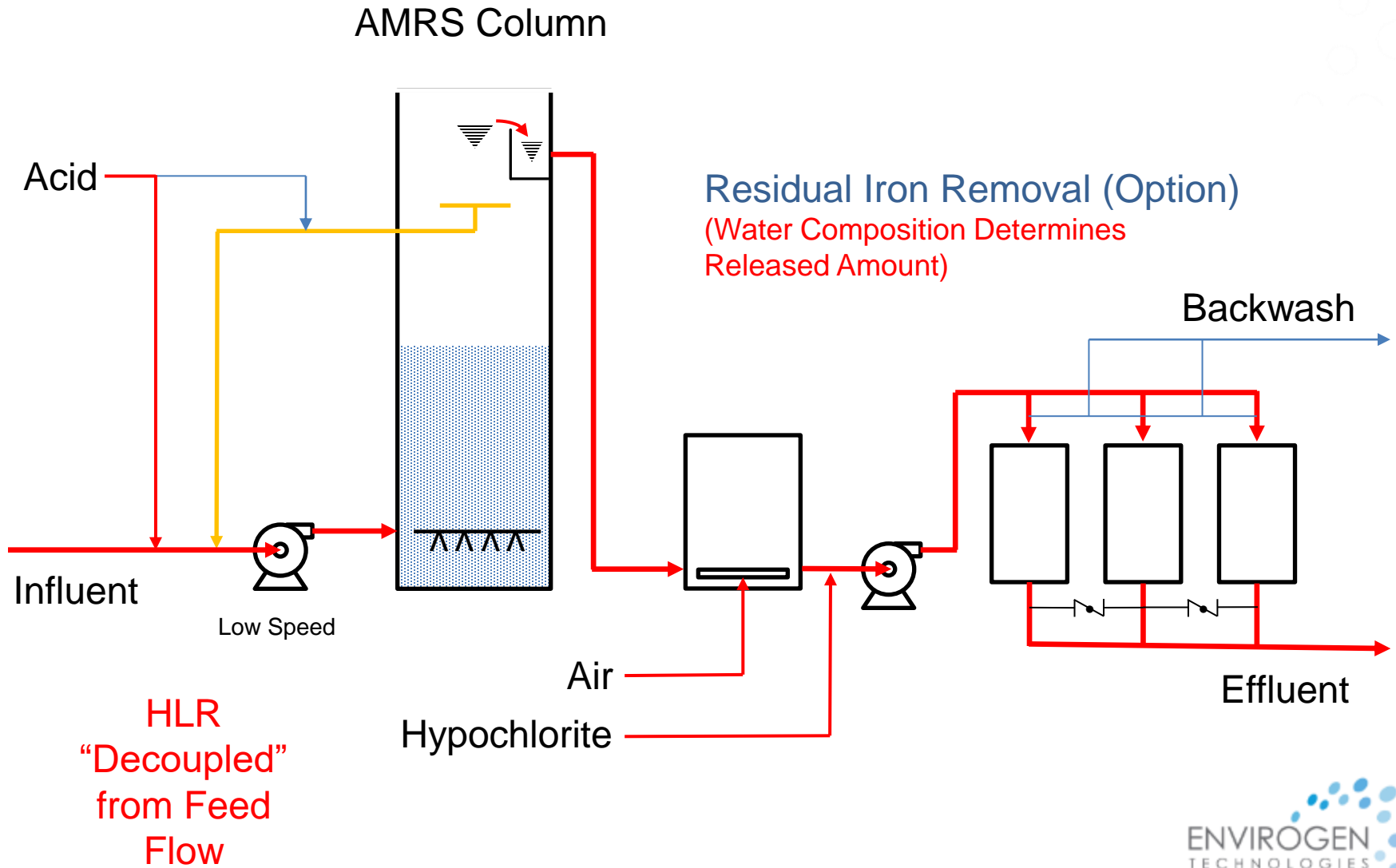


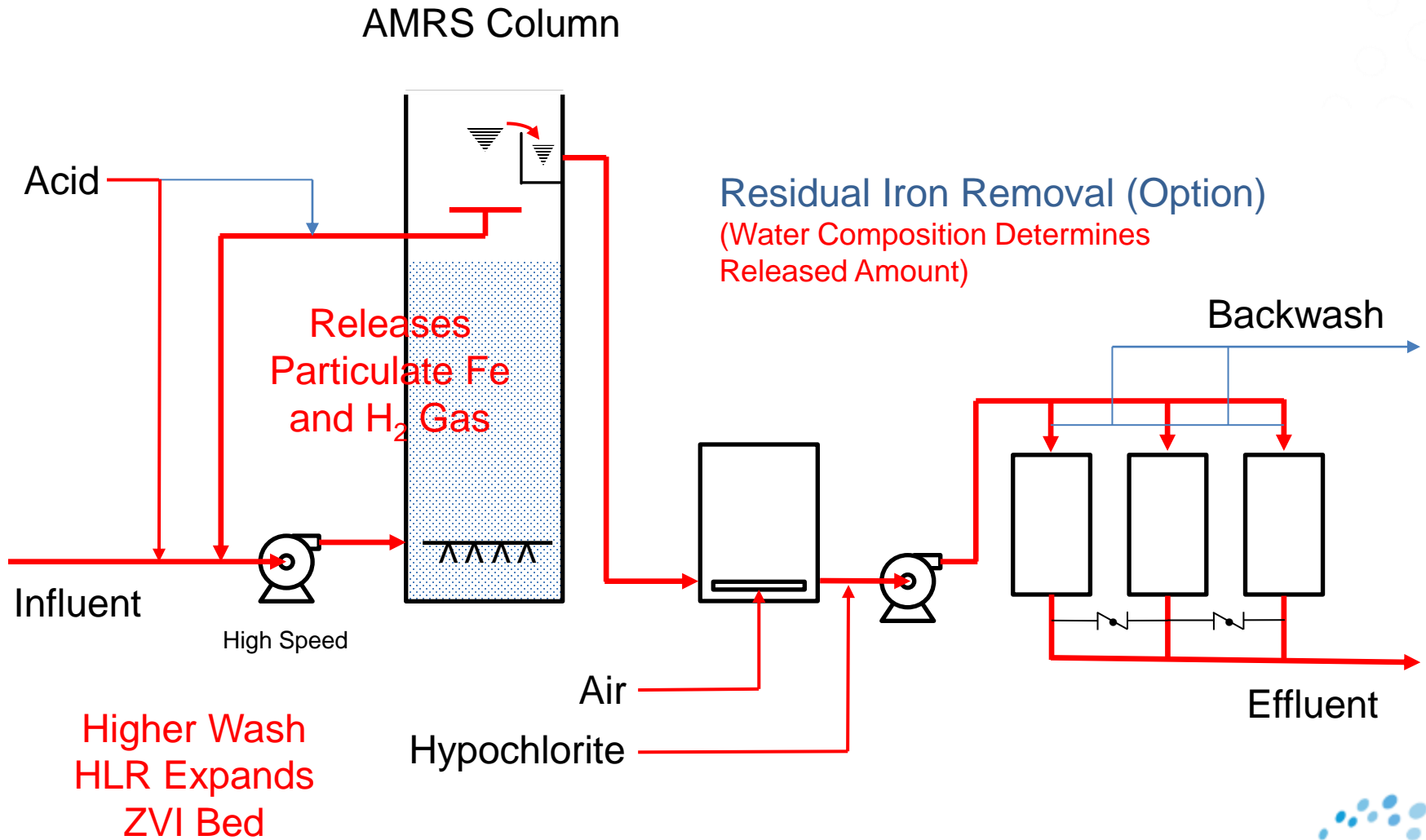
No “One Size Fits All” Approach

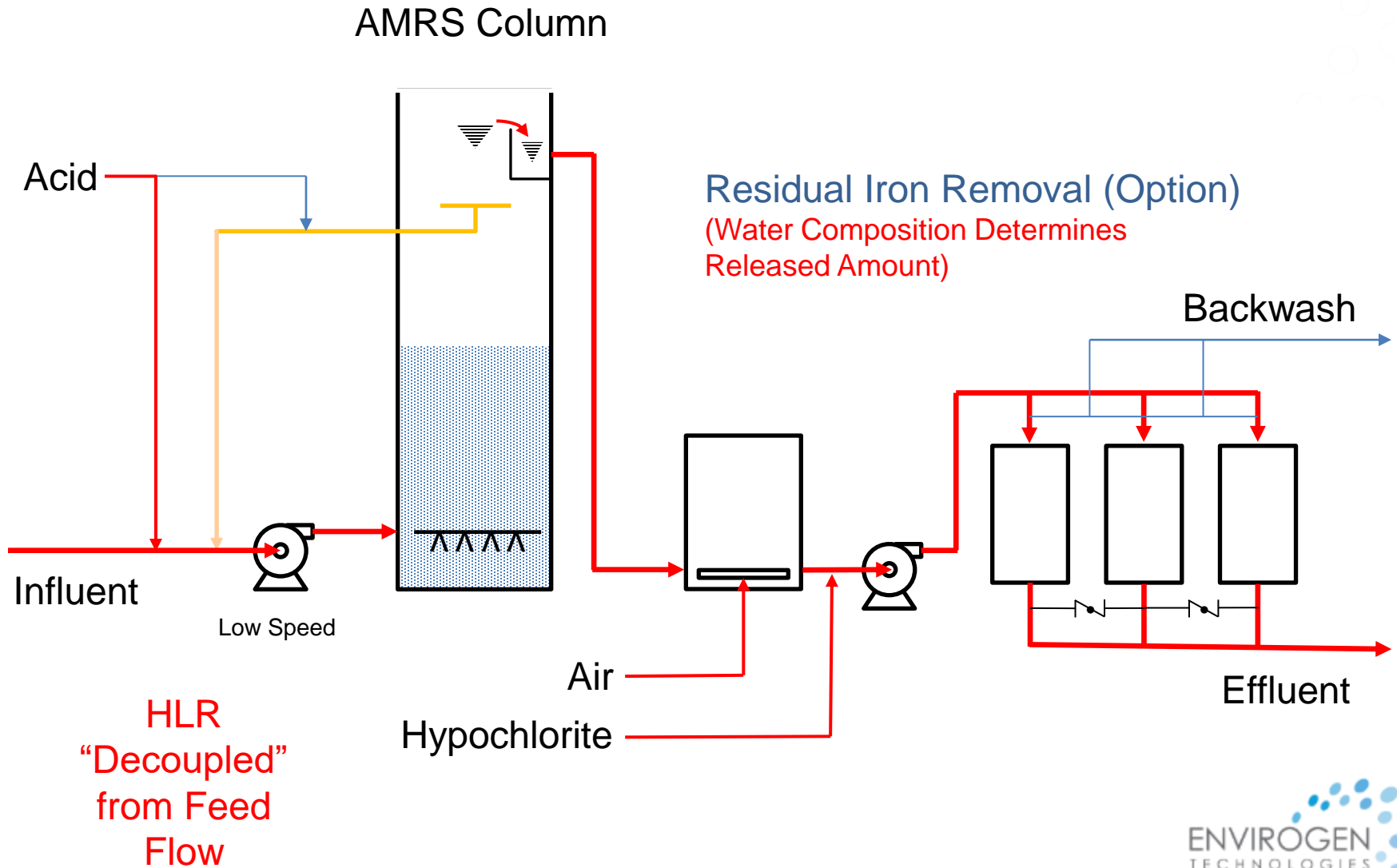
- Waters containing high concentrations of certain salts can quickly dissolve the iron from some ZVIs
- Sulfate affects some ZVI formulations more than others
- Envirogen has tested multiple ZVIs and has developed their own optimized FerroLock™ ZVI formulations; on-going development program
- The AMRS is engineered to operate optimally regardless of media size, porosity and density
- **You are never locked into a single ZVI media**
- The AMRS can utilize Envirogen’s specially formulated FerroLock™ ZVI or other iron-based media



- **Continuous Forward Feed**
 - Design Empty Bed Contact Time (EBCT)
 - Design Hydraulic Lift Rate (HLR)
- **Dissolved Iron Removal (If Needed)**
 - Continuous Removal of Leached Ferrous Iron
 - Oxidation
 - Clarification (For Higher Leached Iron Concentrations)
 - Filtration (Conventional or GreensandPlus™)
- **Media Wash Cycle**
 - Periodic to Remove Oxidized Iron Particles and Release Hydrogen
 - Frequency is Site-specific
 - Short Duration
 - Higher HLR to Expand ZVI Bed
- **Media Reconditioning Cycle**
 - Periodic to Remove Oxidized Surface Iron
 - Much Less Frequent than Wash Cycle
 - Longer Duration than Wash Cycle
 - Higher HLR to Expand ZVI Bed
 - Recirculation with Acid (HCl) Addition

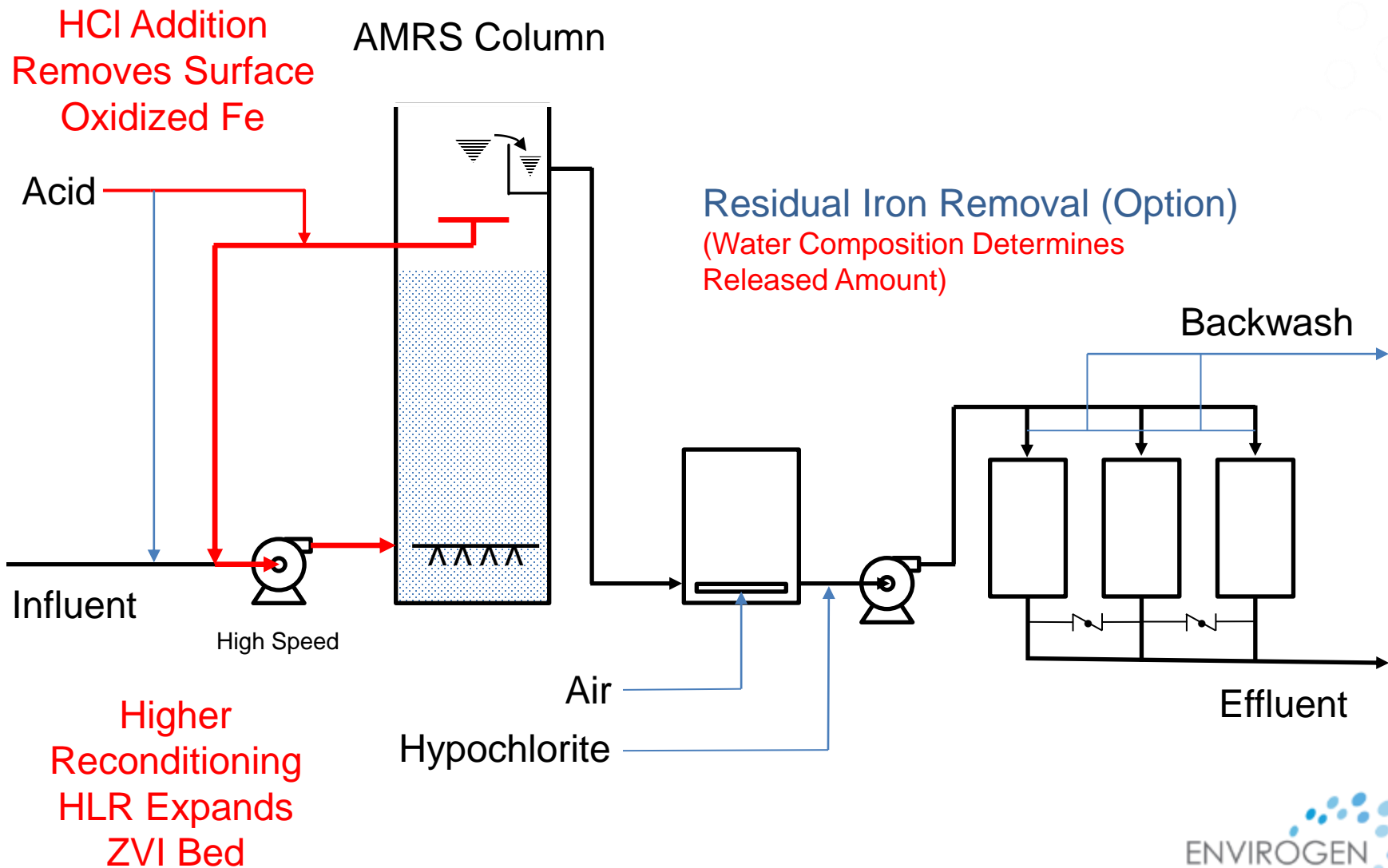


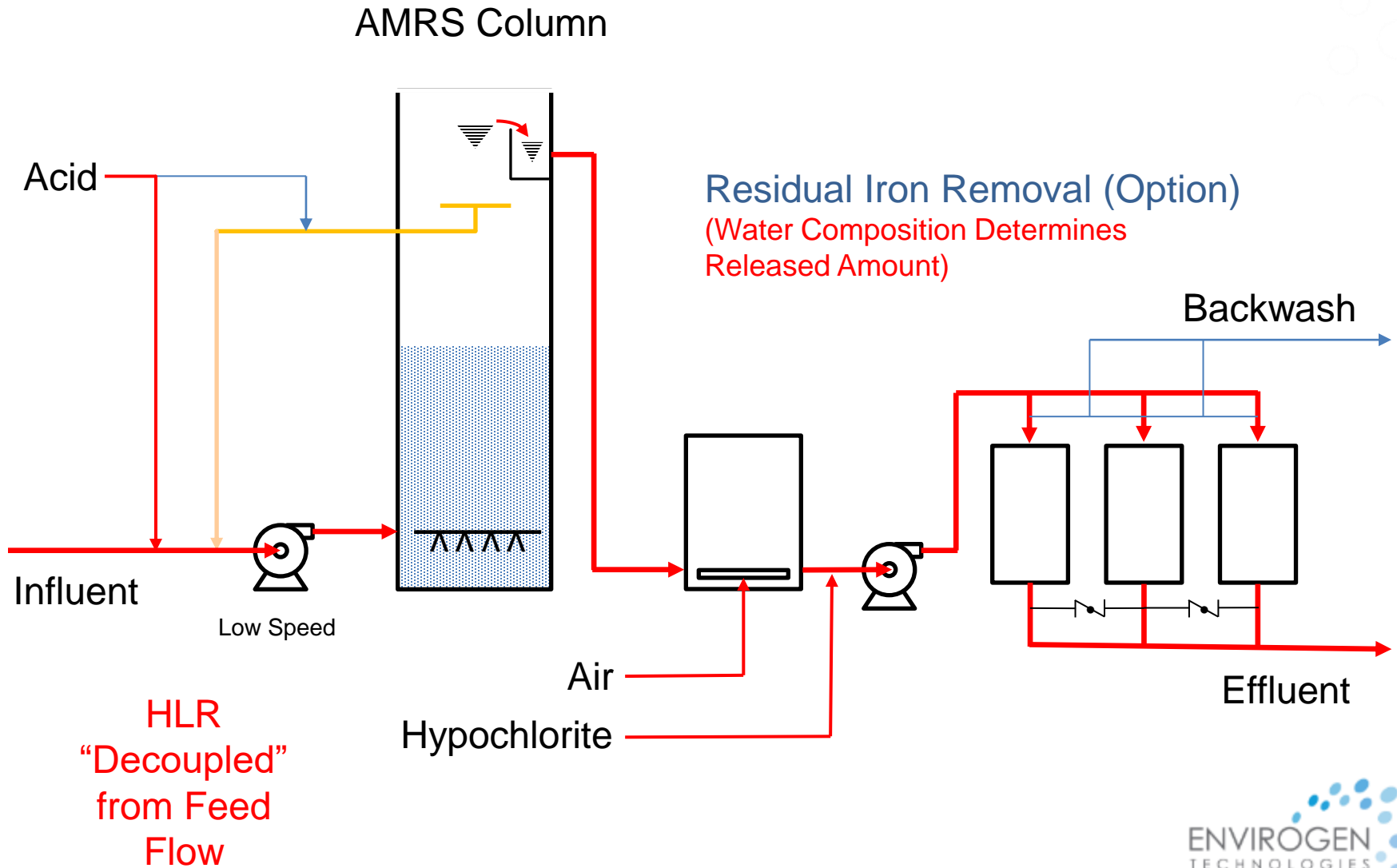




AMRS Media Reconditioning Cycle

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- 30 GPM (Max. 35 GPM)
- ~30 Min EBCT
- Two AMRS Columns in Series
 - 3' Dia. x 21' Height
 - 3' Dia. x 17.5' Height
- Magnetic ZVI Addition System
- Very High and Variable Selenate Along With Competing Oxyanion Metals
- Customer Transitioning to FerroLock™ B-100
 - Inconsistent performance of initial ZVI media; high Fe solubilization
 - Screened/tested FerroLock™ ZVIs in Envirogen's Memphis laboratory on plant wastewater
 - FerroLock™ B-100 showed similar performance at half the cost of the initial ZVI (projected) with much less Fe solubilization
 - Customer has replaced the media in the 1st AMRS column with FerroLock™ B-100
 - Performance is now more stable



- **Step 1 – Feasibility Bottle Assays**
 - Kinetic and Adsorption Tests Using Three ZVI Formulations
 - Five Gallons of Water
 - Measure Selenate Prior to Shipment; Add Selenate if Needed Before Testing
 - Measure Se Concentration vs. Time in Batch
- **Step 2 – On-site Pilot for 4-6 Weeks**
 - Two “Best” ZVIs Operated Side-by-Side
 - Determine Performance vs. EBCT (System Size)
 - Determine Media Regeneration Frequency
 - Measure Soluble Fe in Effluent
 - Post-treatment Requirements
- **Step 3 – Full-scale Proposal**

Envirogen Mobile Pilot Trailer

