

Kennedy/Jenks Consultants

Engineers & Scientists

Arsenic & Antimony Removal with Elevated Competing Ions

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Overview



- ▼ Background
- ▼ Previous EPA Demonstration Study
- ▼ Pilot Study
- ▼ Current Status



South Truckee Meadows General Improvement District



- ▼ STMGID serves a portion of S Truckee Meadows
- ▼ 8,300 customers
- ▼ Water supply
 - | 10 wells
 - | Intertie with Truckee Meadows Water Authority
- ▼ System operated by Washoe County Dept of Water Resources



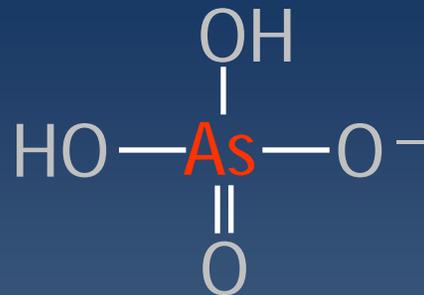
STMGID Well 9



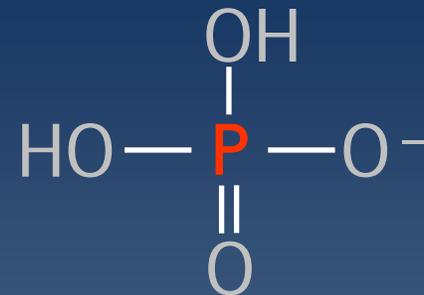
- ▼ 350 gpm peaking well
- ▼ Operates 3 to 4 hr/day for 4 months
- ▼ Water quality
 - | Arsenic 45 - 88 $\mu\text{g/l}$
 - | Antimony 16 $\mu\text{g/l}$
 - | pH 7.4 - 7.5
 - | Silica 52 – 69 mg/l as SiO_2
 - | Vanadium 3 $\mu\text{g/l}$
 - | Iron 0.005 – 0.020 mg/l
- ▼ Blended with Wells 1, 2, 3 & 11



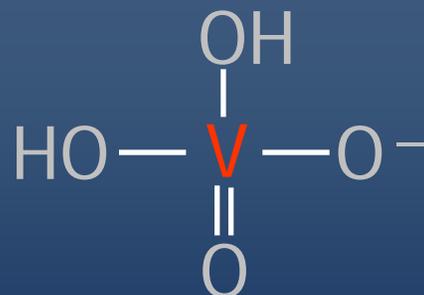
Competing Ions



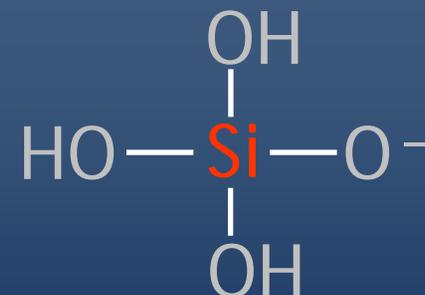
Arsenate



Phosphate



Vanadate



Silicate



EPA Arsenic Demonstration Program



- ▼ Full scale demonstration arsenic removal
- ▼ Battelle contracted with EPA for the study
- ▼ Round 1
 - | 12 sites
 - | 9 with adsorptive media
 - 6 (E33)
 - 1 (G2)
 - 1 (AAFS50)
 - 1 (GFH) – STMGID Well 9



Well 9 Demonstration Facility



1st Run Raw Water Quality



	Average	Range
▼ Arsenic	67 µg/l	35 to 88 µg/l
▼ Antimony	15 µg/l	10 to 21 µg/l
▼ Silica (as SO ₂)	73 mg/l	52 to 95 mg/l
▼ Total P (as PO ₄)	0.35 mg/l	0.27 to 0.46 mg/l
▼ pH	7.1	6.5 to 7.9



Adsorptive Media Performance



- ▼ Prechlorinated: 1.0 mg/l Cl₂ target residual
- ▼ 3 – 5'6" diameter vessels operated in parallel
- ▼ Vendor projected media life - 38,000 BV
- ▼ 1st Run
 - | 275 gpm average
 - | As breakthrough at 10 µg/l - 7,200 BV
 - | Sb breakthrough at 6 µg/l - 3,000 BV
 - | 1st week treated water
 - pH dropped from 7.1 to < 4.5
 - Chlorine residual dropped from 0.8 to 0.2 mg/l



Rapid Small Scale Column Test



▼ GFH	11,000 BV
▼ ArsenX ^{np}	9,000 BV
▼ ARM 200	8,000 BV
▼ Adsorbsia GTO	4,000 BV



Second Run



- ▼ 1 vessel GFH media
- ▼ 2 vessels Kemiron media
- ▼ Bed Volumes to 10 $\mu\text{g/l}$
 - | GFH 2,500 BV
 - | Kemiron 2,500 BV



Media Disposal & Replacement



- ▼ Media volume: 240 CF
- ▼ Media cost: \$57,000
- ▼ Labor & disposal: \$13,000
- ▼ Media passed the TCLP test
 - | Arsenic below the reporting limits
- ▼ Landfill disposal
- ▼ Estimated operating cost: \$5.46/ 1,000 gal

Source: Cumming (2007) Buzzzone (2008)



Post Demonstration Study



- ▼ EPA terminated demonstration project August 2007
- ▼ Turned the demonstration facility over to STMGID
- ▼ GFH too expensive
- ▼ County evaluated
 - | Abandon well and purchase wholesale water
 - | Continue to operate well & GFH treatment
 - | Construct new well
 - | Convert process to iron coagulation/filtration
 - Bench scale study – coagulation with 30 mg/l FeCl_3 followed by filtration met the As & Sb MCLs



Pilot Testing



- ▼ Silica sand & anthracite
- ▼ Sand
 - | 6 inch depth
 - | ES 0.8 mm
- ▼ Anthracite
 - | 36 inch depth
 - | ES 1.55 mm
 - | UC 1.55
- ▼ 3.9% FeCl₃ solution



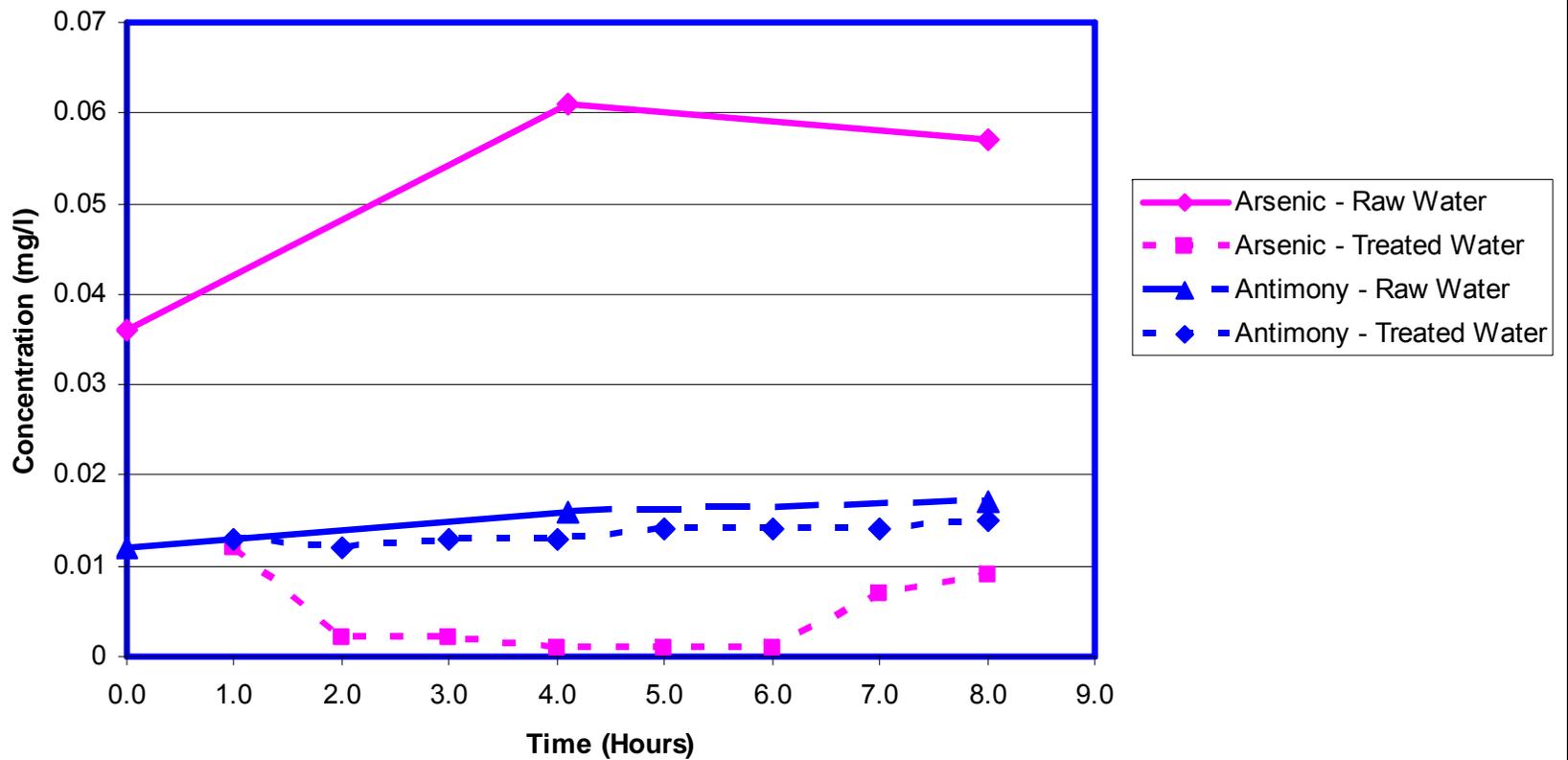
Pilot Results



- ▼ Filter run: 8 hr
- ▼ Filtration rate: 3.4 gpm/SF
- ▼ 96% As removal
- ▼ 16% Sb removal
- ▼ Fe:As – 81:1 (not optimized)



Pilot Results



Current Status



- ▼ Washoe County designing conversion from iron adsorption media to coagulation/filtration
- ▼ Estimated conversion cost - \$100,000±
- ▼ Need on line by this summer
- ▼ Blend with other wells to meet Sb MCL
- ▼ Backwash disposal to sewer
- ▼ Temporary facility – 3 to 5 years
- ▼ Abandon Well 9 when new WTP comes on line



Walnut Grove



Walnut Grove Water Quality



- ▼ Arsenic 12 – 16 $\mu\text{g/l}$
- ▼ Silica 44 – 45 mg/l as SiO_2
- ▼ Phosphate 0.60 – 0.95 mg/l as PO_4
- ▼ pH 8.2 mg/l raw
- ▼ Adjusted pH 7.0 target



Operation and Performance



- ▼ Bayoxide E 33 media
- ▼ pH fluctuations
- ▼ Short run times
- ▼ 45,000 BV projected
- ▼ 28,000 BV actual



Questions?



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Sacramento County Pilot Study



Bed Volumes (BV) Treated

Adsorbent	4 µg/l As Target		8 µg/l As Target	
	pH 7.8	pH 7.0	pH 7.8	pH 7.0
AAFS50	2,040	4,940	2,860	7,210
GFH	4,000	>11,250	8,000	>11,250
GFO	10,850	20,180	17,200	32,870



Competitive Ion Effects



▼ Vanadium

- | GFH: ~ twice as competitive as arsenic
- | GFO: ~60-70% competitive as arsenic
- | AAFS50: ~ twice as competitive as arsenic

▼ Phosphate

- | Early data non-detect (RL of 100 mg/l as P)
- | Roughly 20-30 mg/l of phosphorus removal by GFO and AAFS50 as arsenic removal approaches zero

▼ Silica

- | High initial removal tapers off around 2,000 BV
- | No observed relationship to pH

