Recovering Both Water and Salts From a Saline Inland Groundwater

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CDM

SANDOVAL COUNTY
STATE OF NEW MEXICO

Outline

- Background of Project
- Water Quality Challenges
- Proposed Treatment Process
- Pilot Testing Results
- Conclusions

Sandoval County

- Located in Central NM, 20 miles north of Albuquerque
- 102,000 residents occupy 3,700 square miles
- Avg rainfall < 9 inches/yr
- Future growth constrained by lack of water supplies
- Brackish aquifers only alternative for new supplies

Brackish Wells

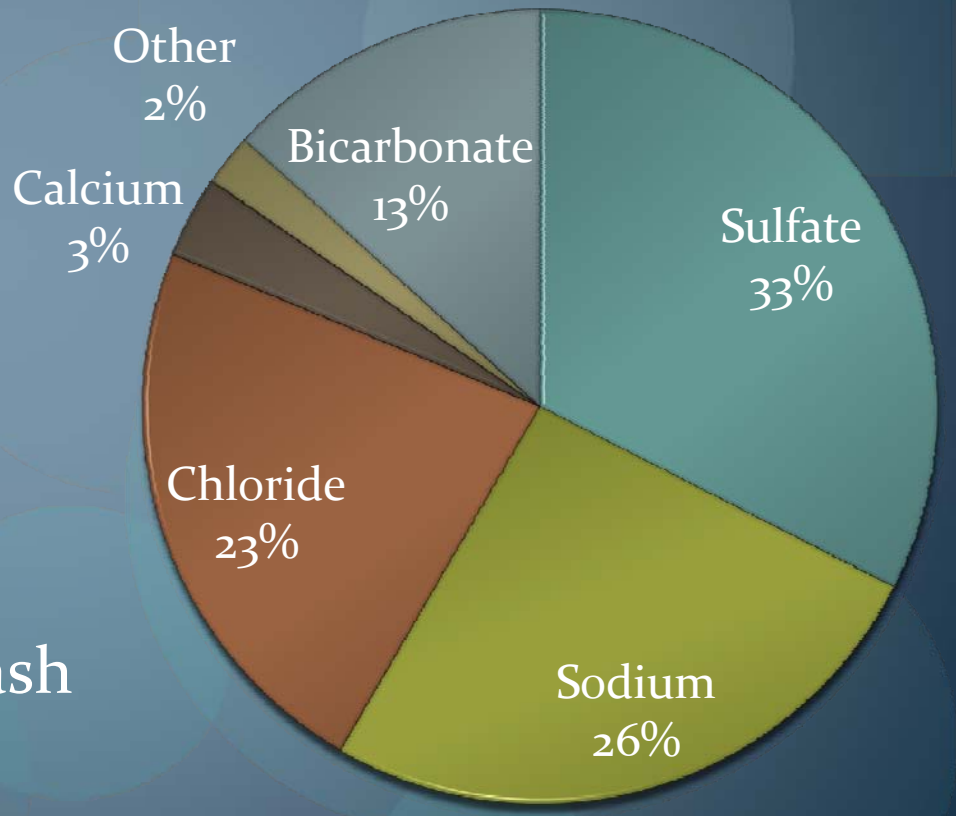
- Two exploratory wells drilled in 2007
- Brackish aquifer found 3500 ft below surface
- Planning 5 mgd WTP, allowing future growth
- Wells have 160 psi artesian pressure at 150 F
- High salinity water (12,000 mg/L)

Primary Water Quality Challenges

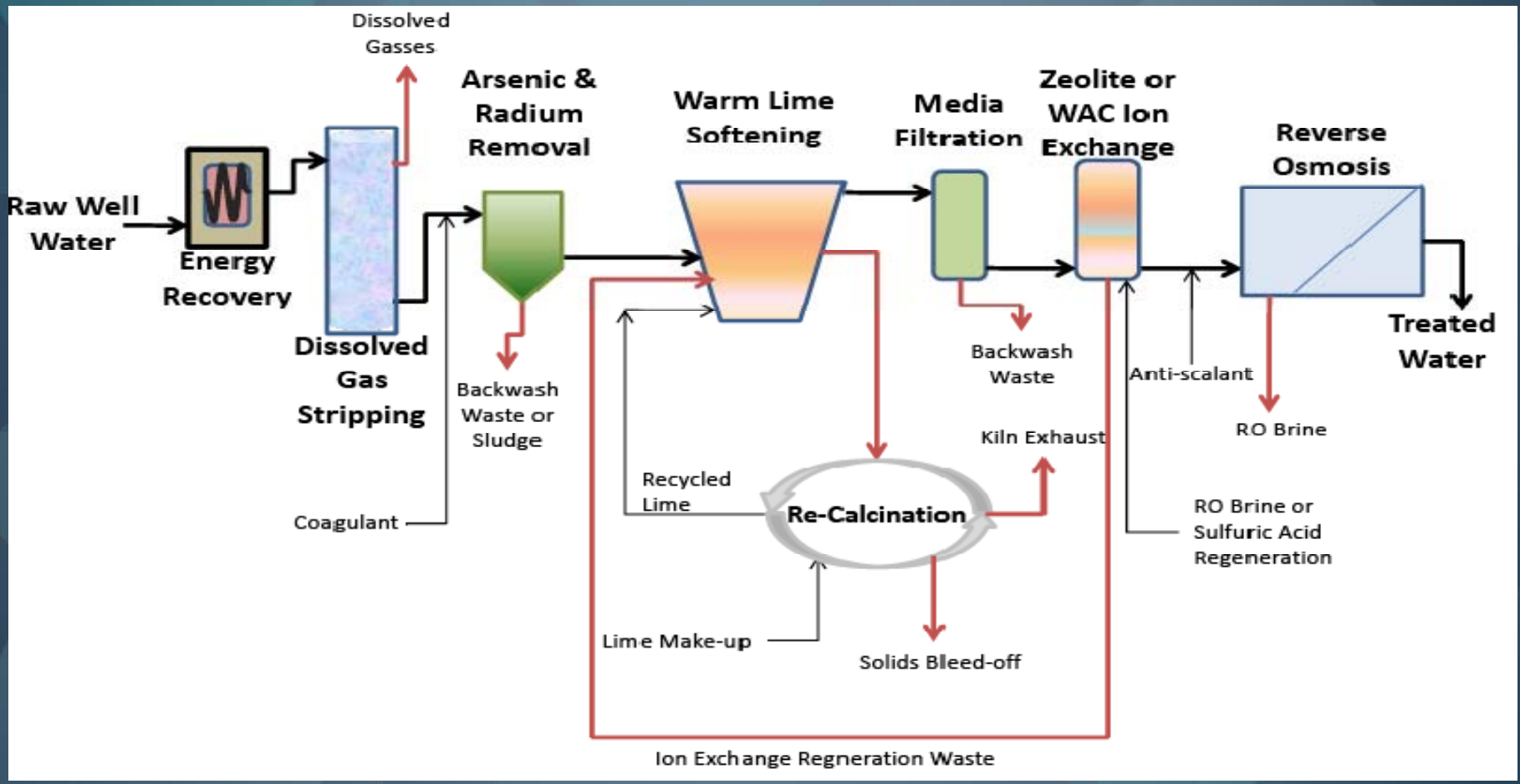
Parameter	Concentration	Concern
Calcium	450 mg/L	Will scale RO membranes. Will need to be reduced in pretreatment.
Alkalinity	1,800 mg/L	
Sulfate	4,400 mg/L	
Iron	3.3 mg/L	Will foul RO membranes. > 0.3 mg/L secondary MCL
TDS	12,000 mg/L	High osmotic pressure will limit RO recovery. 5 mgd plant will produce 250 tons of salt per day
Arsenic	0.71 mg/L	Exceeds 0.01 mg/L MCL, challenge for waste disposal
Gross Alpha	209 pCi/L	Exceeds 15 pCi/L MCL, challenge for waste disposal
Radium 226+228	85 pCi/L	Exceeds 5 pCi/L MCL, challenge for waste disposal
Boron	9.7 mg/L	Levels above 1 mg/L can be damaging to many plants

Primary Constituents

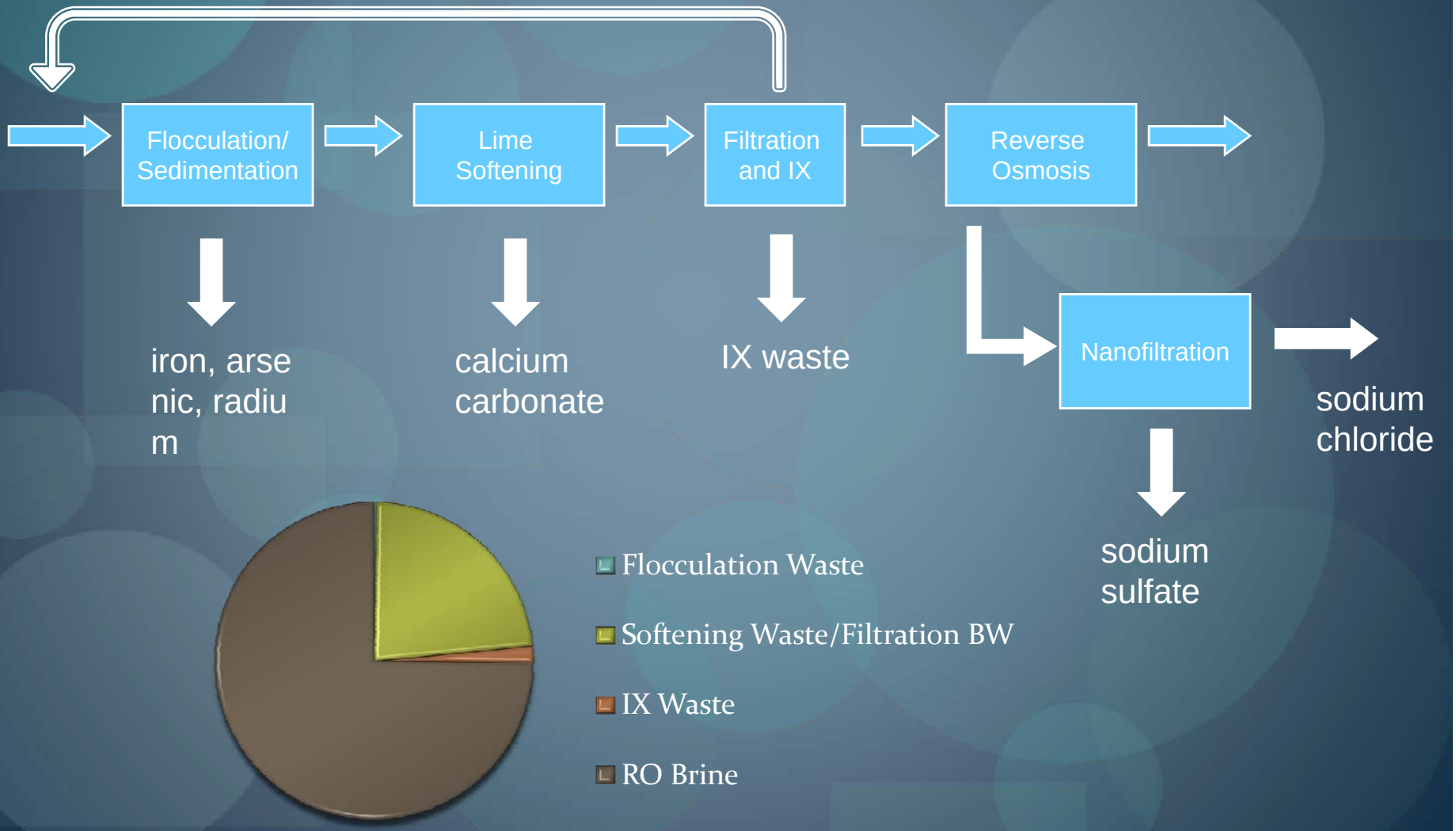
- 95% of solids found in four constituents
- Potential value
  - NaCl ($70-170/ton)
  - Na_2SO_4 ($100-130/ton)
  - CaO ($50-80/ton)
  - Gypsum, baking soda, calcium chloride, soda ash considered



Proposed Process Train



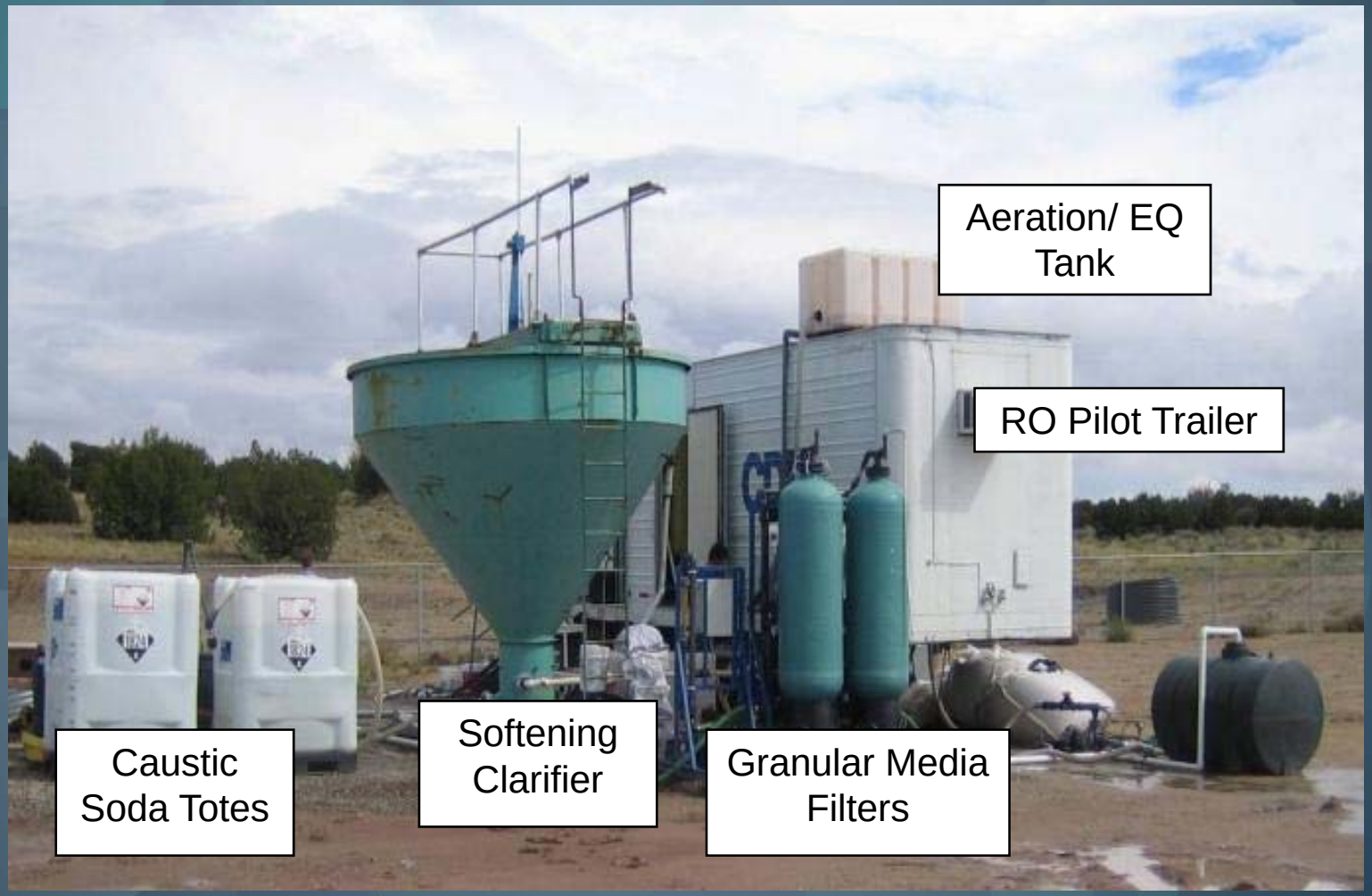
Process Waste Streams



Bench Scale and Pilot Testing

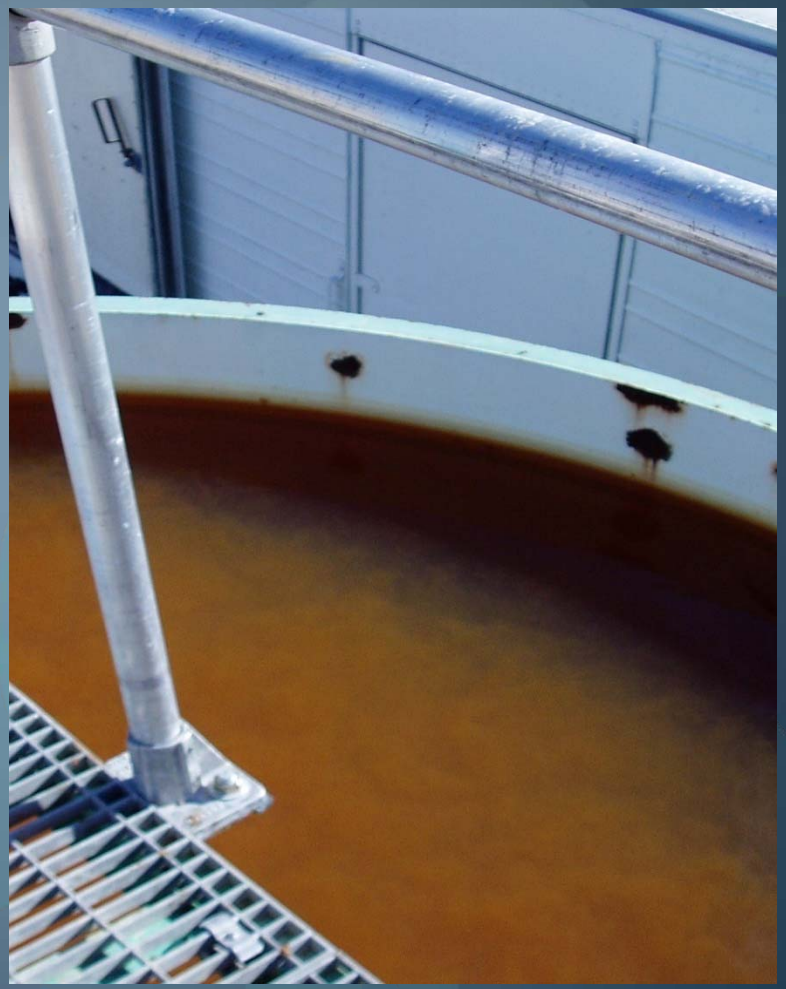
- 2 months piloting using proposed treatment train
- Confirm that water quality goals can be met
- Evaluate quality and quantity of waste streams
- Identify operating conditions and develop preliminary costs for future facility

Pilot Facility



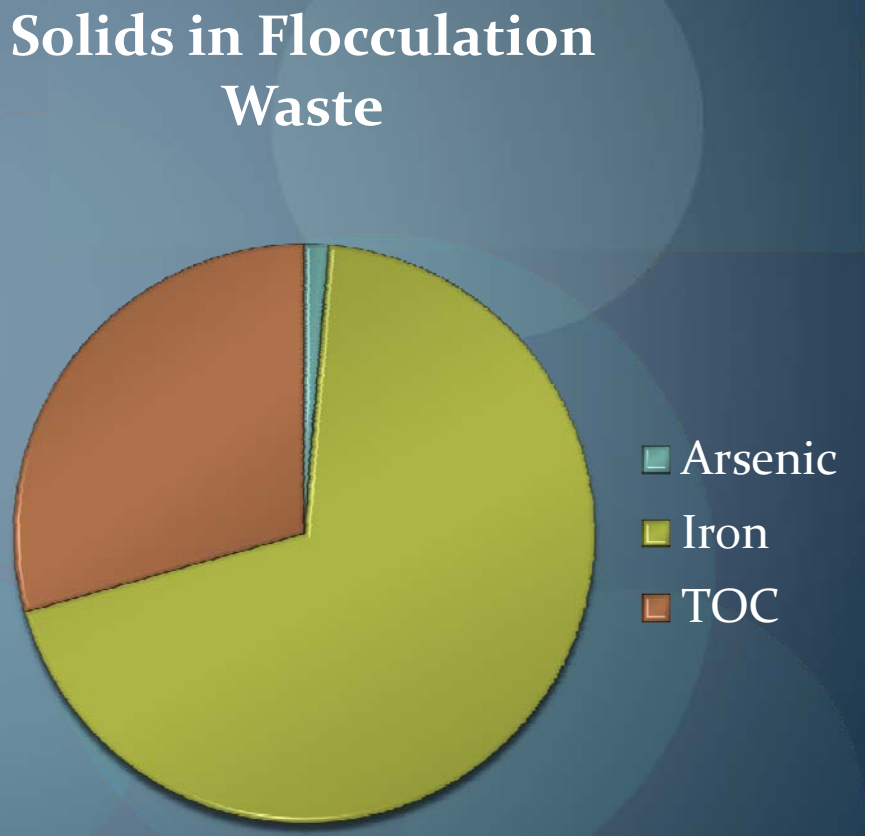
Flocculation/Sedimentation

- 50 mg/L ferric chloride
- 10 mg/L M358 polymer
- 12-ft diameter Claricone™ conical clarifier (same clarifier used for softening)
- Operated for 5 days without pH adjustment to evaluate impact on iron, arsenic, and radium



Flocculation/Sedimentation

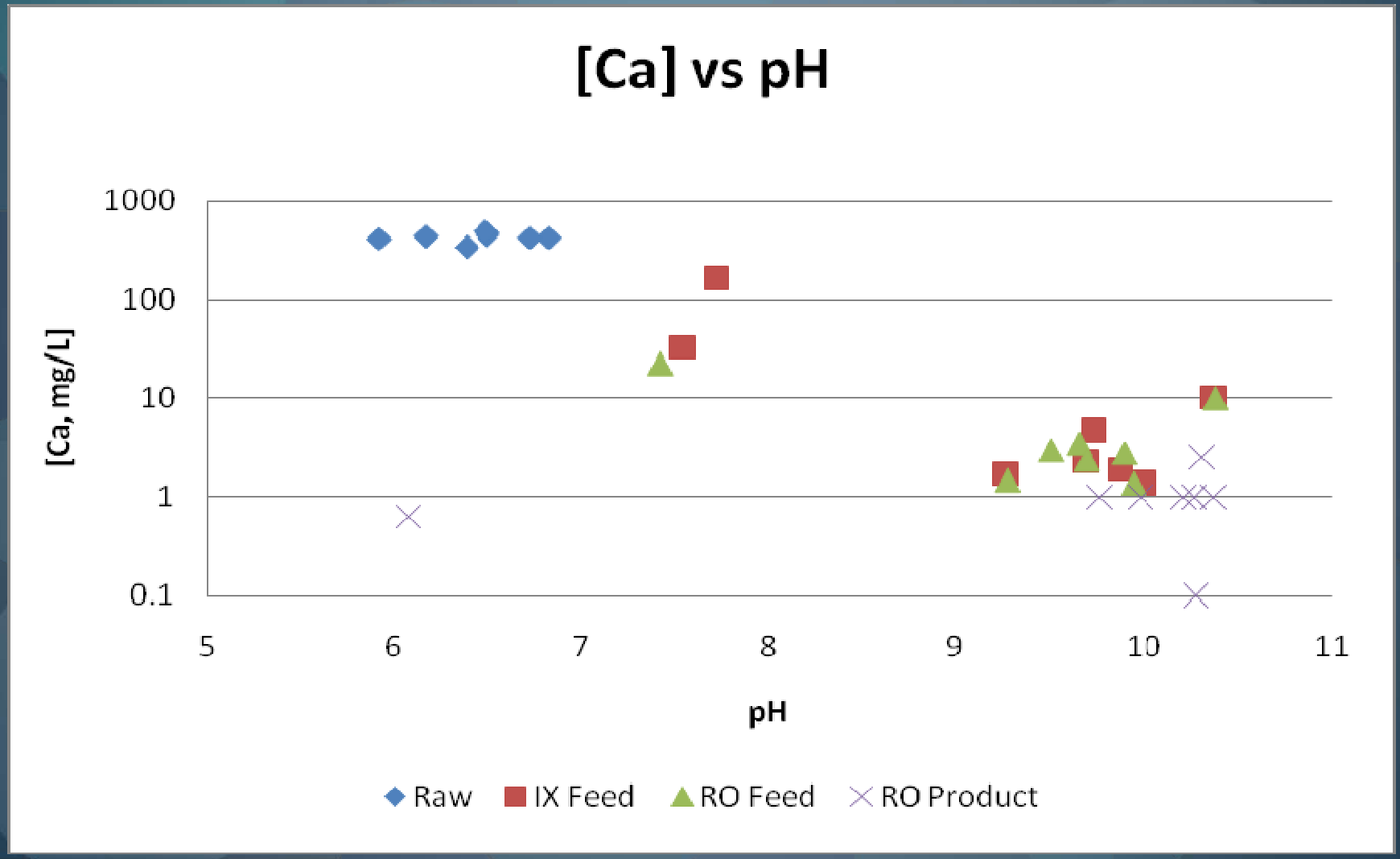
- Removal Efficiency
  - 85% of arsenic
  - 70% of iron
  - 30% of TOC
  - 20% of radium
- Waste stream
  - Primarily iron and TOC
  - Constitutes 0.3% of solids from source water



Chemical Softening

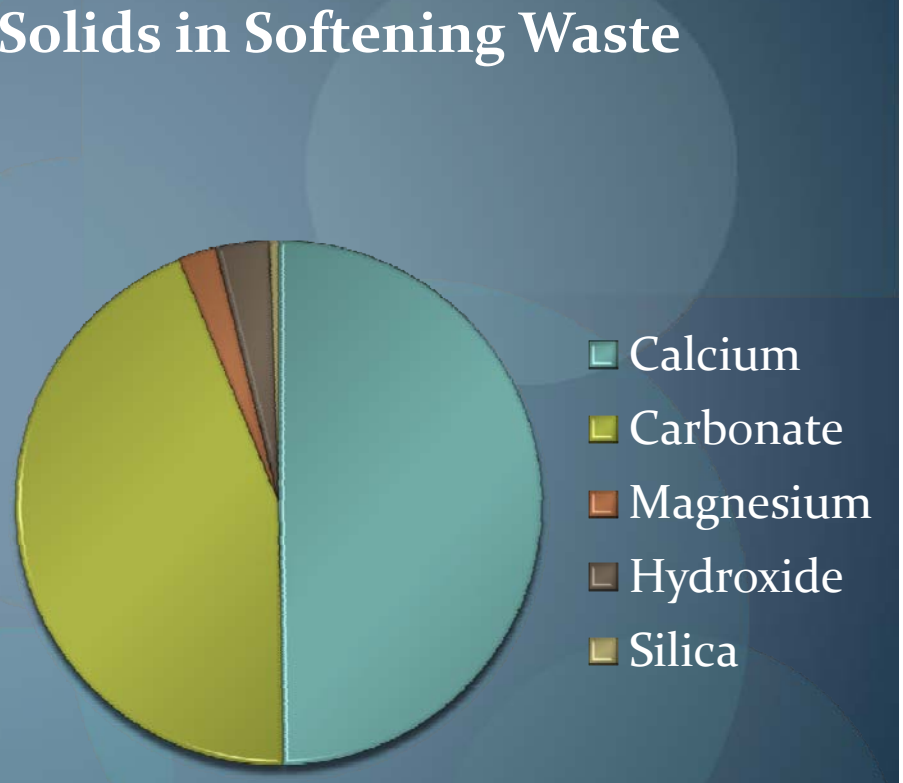
- Remove calcium and magnesium to prevent scaling of RO
- Used sodium hydroxide in pilot to adjust to pH 9.5
- 2,000 mg/L NaOH required
- Full-scale would employ lime
  - reduce carbonate
  - allow recalcination and recycle

Chemical Softening



Chemical Softening Waste

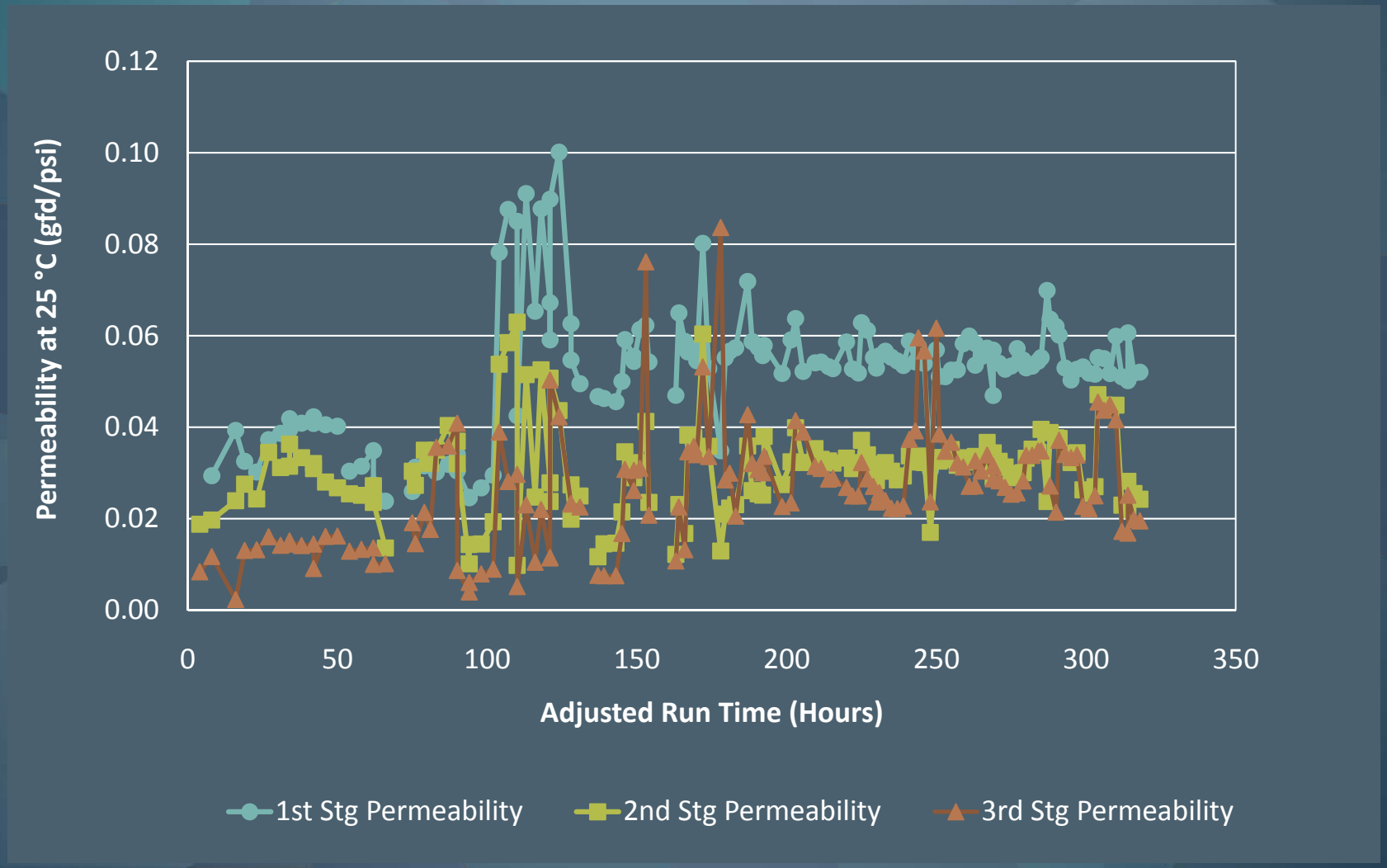
- 93% calcium carbonate
- 6.5% magnesium hydroxide
- Constitutes 23% of total waste stream solids
- Trace levels of radium could create challenge to recycle or sell



Reverse Osmosis

- IX polishing and cartridge filters ahead of RO
- Three stage process using SWRO elements (Dow SW30 HRLE) and third stage boost
- 80% recovery limited by osmotic pressure
- Average flux 10.4 gfd

Reverse Osmosis Performance

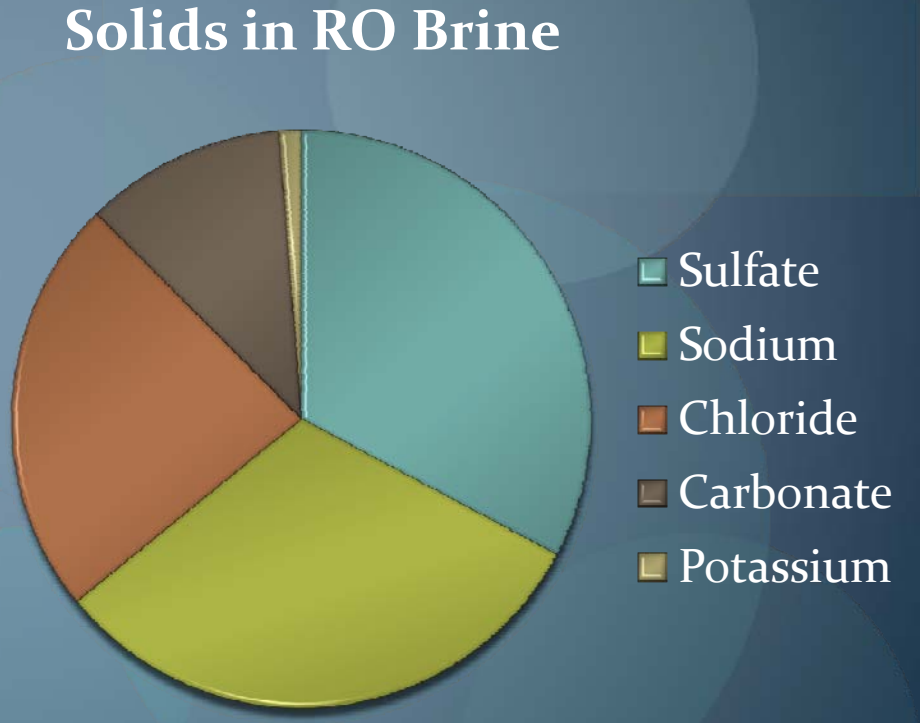


RO Product Water Quality

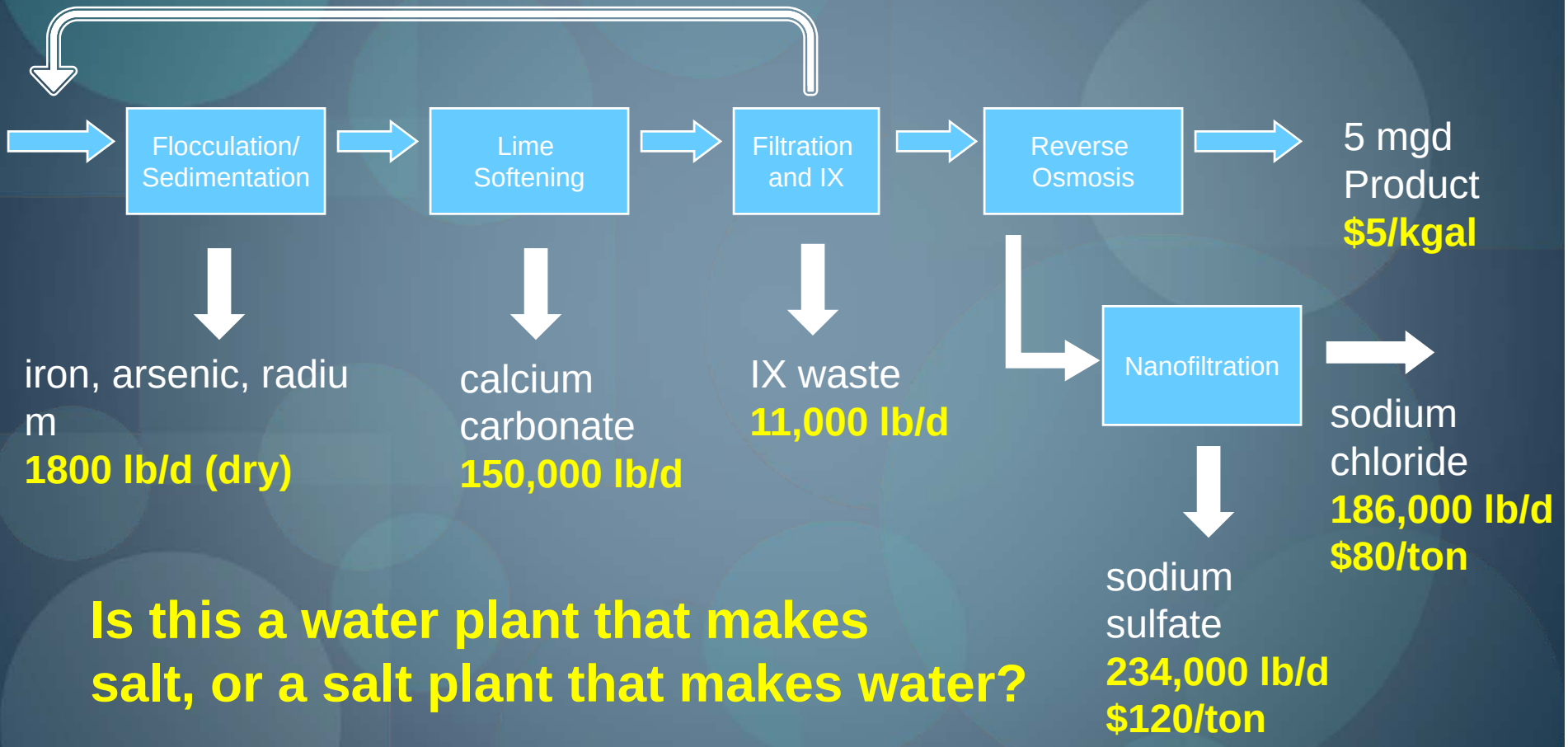
Parameter	Source Water	RO Permeate	Drinking Water Standard
Total Alkalinity (mg/L)	1,800	40	N/A
Calcium (mg/L)	450	< 1	N/A
Magnesium (mg/L)	97	< 1	N/A
Sodium (mg/L)	3,600	40	N/A
Chloride (mg/L)	3,100	40	250
Sulfate (mg/L)	4,400	10	250
Boron (mg/L)	9.7	0.6	N/A
TDS (mg/L)	12,000	120	500
Arsenic (mg/L)	0.71	< 0.002	0.01
Gross Alpha (pCi/L)	209	< 0.3	15
Radium 226+228 (pCi/L)	85	< 0.5	5

Reverse Osmosis Waste Stream

- 83% sodium chloride or sodium sulfate
- 15% sodium carbonate (soda ash) will decrease when using lime
- NaCl and Na_2SO_4 can be separated using NF membranes to allow recovery of salts



Process Flow Diagram



Is this a water plant that makes salt, or a salt plant that makes water?

Conclusions

- Pilot testing demonstrated high quality water can be produced from highly saline groundwater
- Majority of waste stream solids can be recovered with potential to sell high value salts (NaCl, Na_2SO_4)
- Lime recalcination could reduce chemical purchase and disposal costs
- Operating costs substantial, making it essential to recover solids for feasibility of project

Acknowledgements

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