Evaluation of Non-Traditional Sources of Cooling Water

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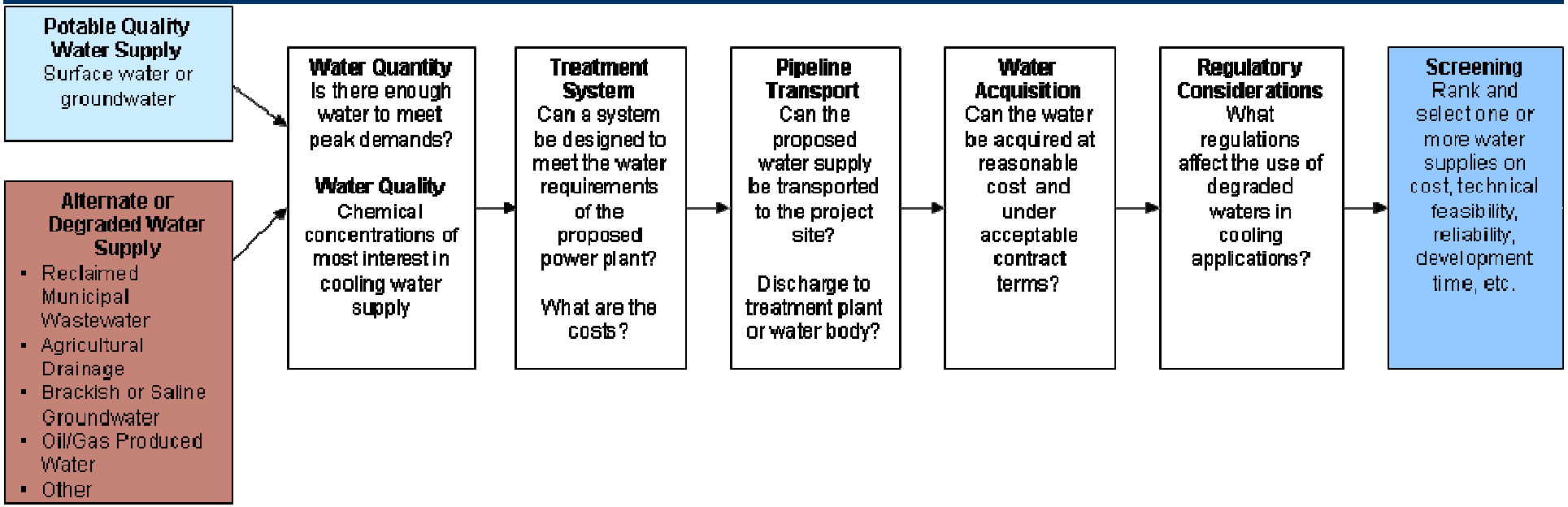
Non-Traditional Sources Considered

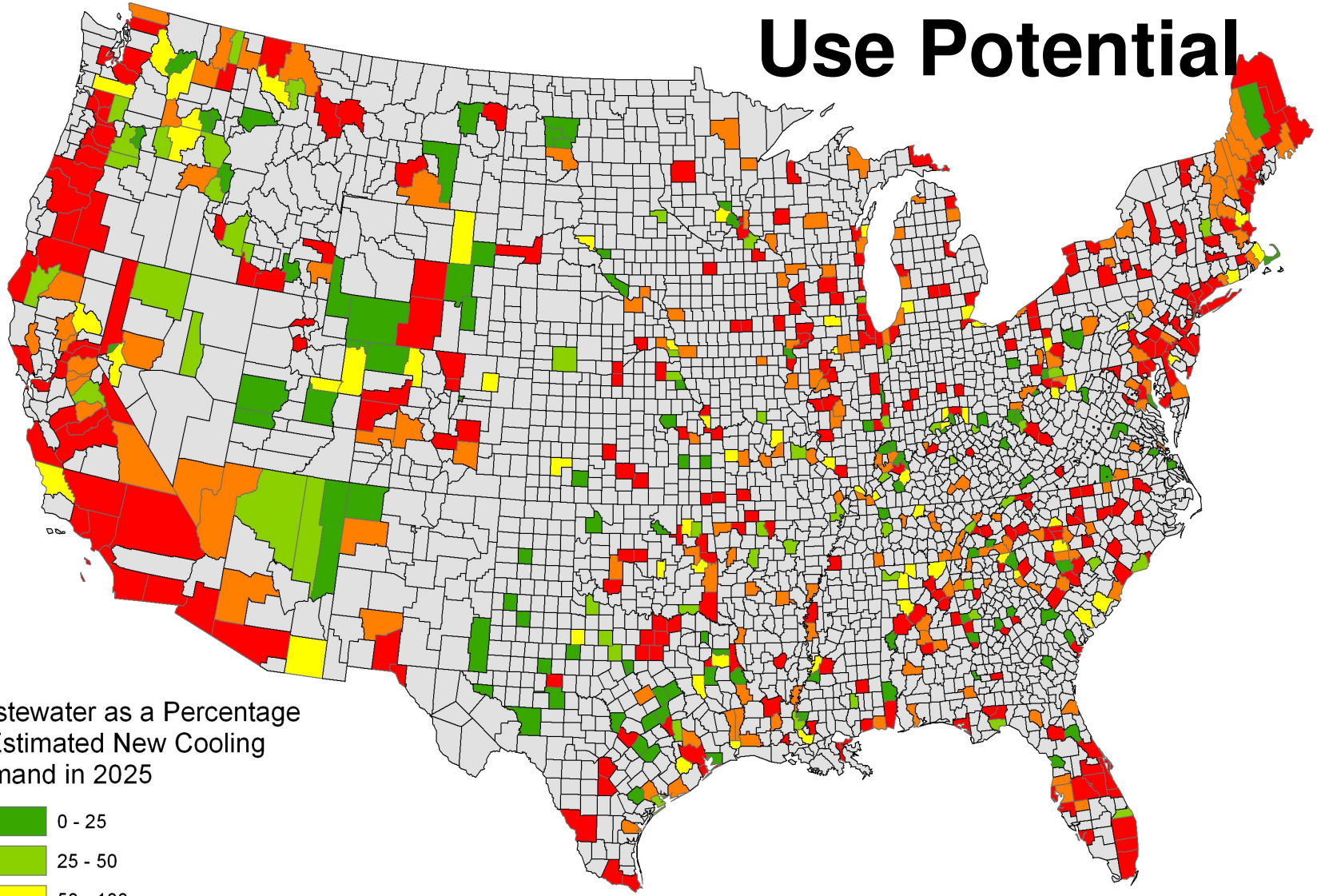
- Reclaimed wastewater
- Agricultural drainage
- Brackish or saline groundwater
- Produced water from oil and gas operations
- Other industrial waste streams; water from mining operations

-Focus of an EPRI Technical Report, *Use of Alternate Water Sources for Power Plant Cooling*, 1014935, March 2008

Evaluation Steps

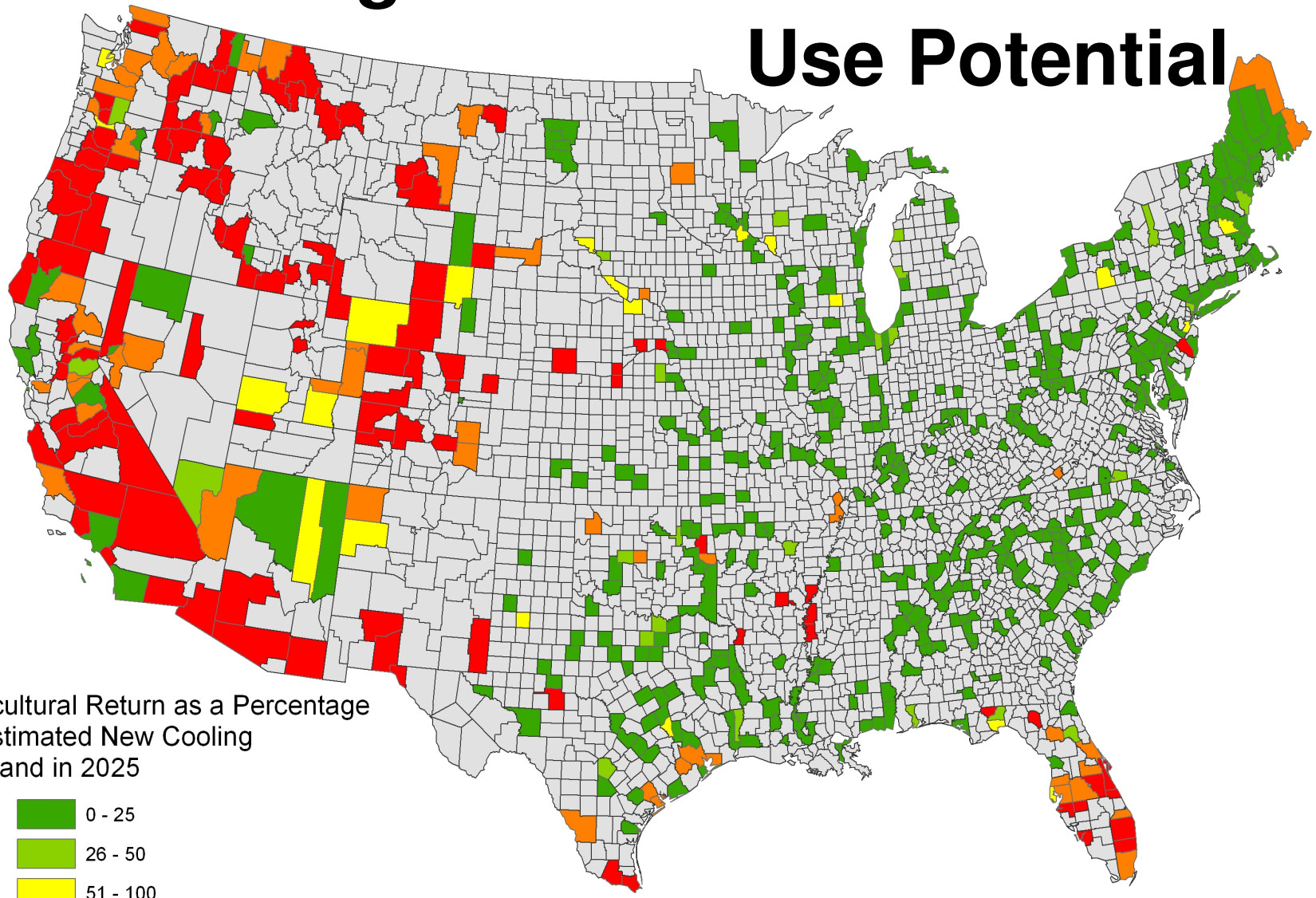


Reclaimed Municipal Wastewater Use Potential



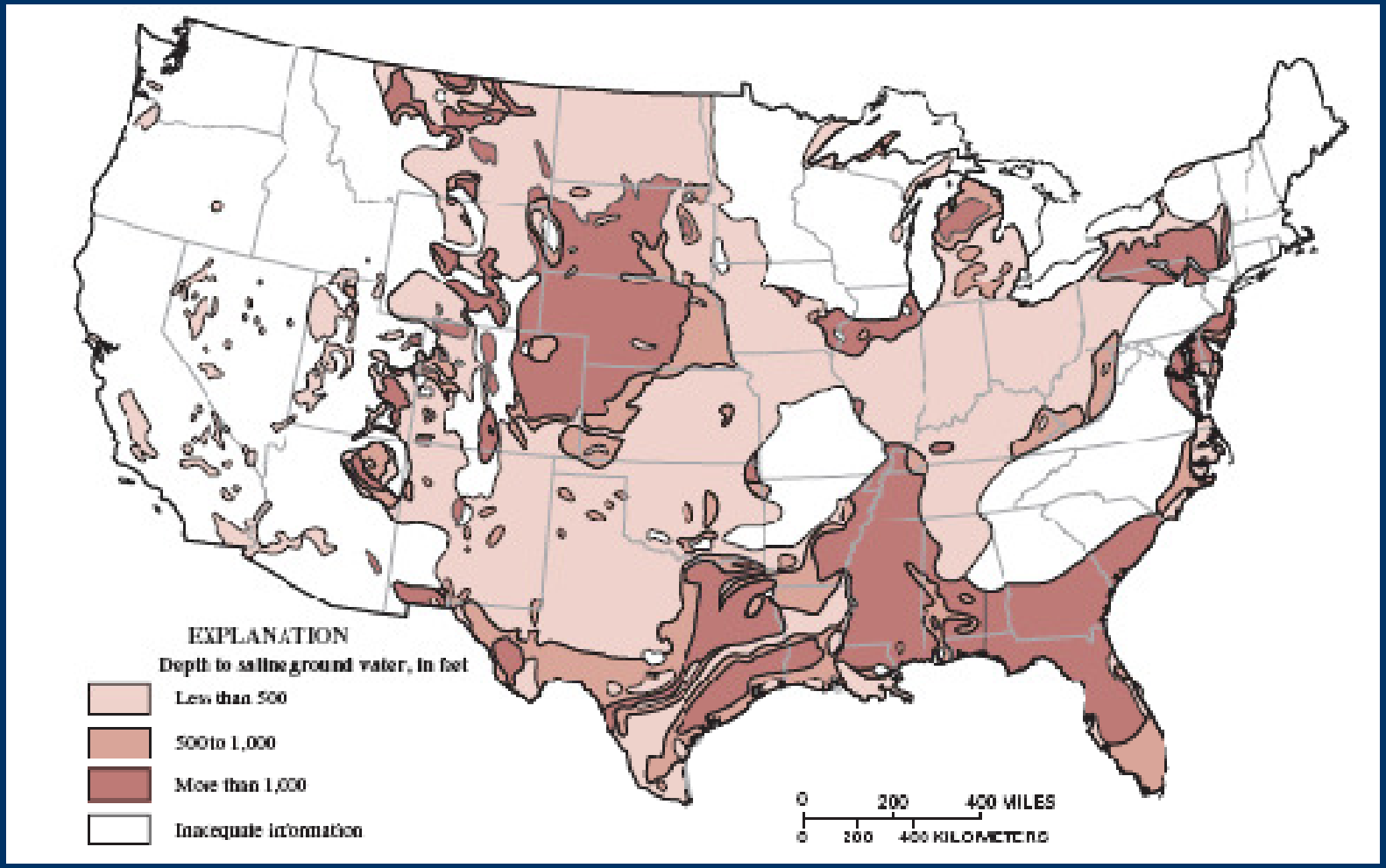
Assumes cooling water need = 600 gal/MW-hr

Agricultural Return Water Use Potential



Assumes cooling water need = 600 gal/MW-hr

Depth to Saline Groundwater (USGS, 1965)

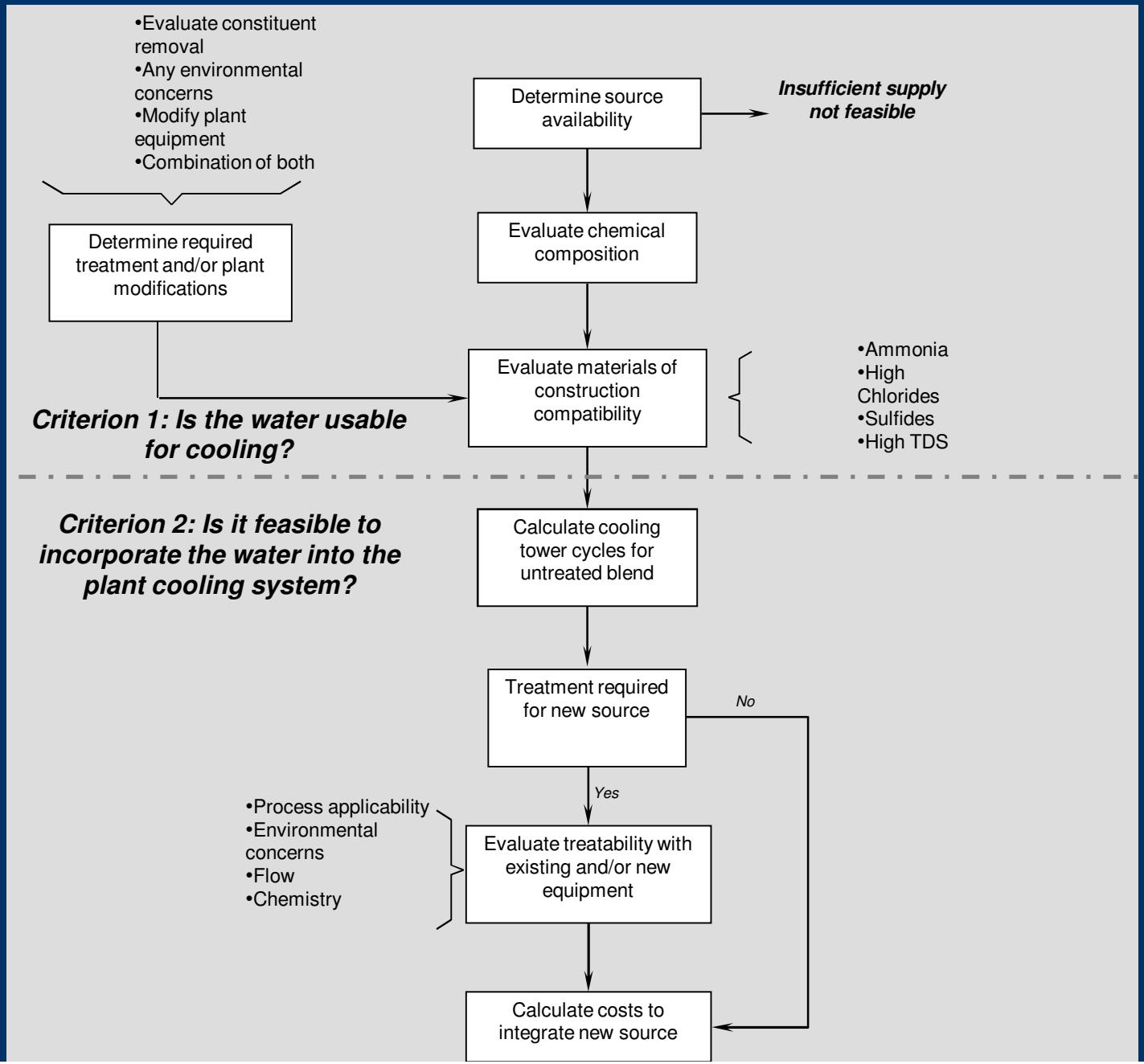


Water Quality Concerns

Related to material compatibility, scale formation, and potential discharge limitations

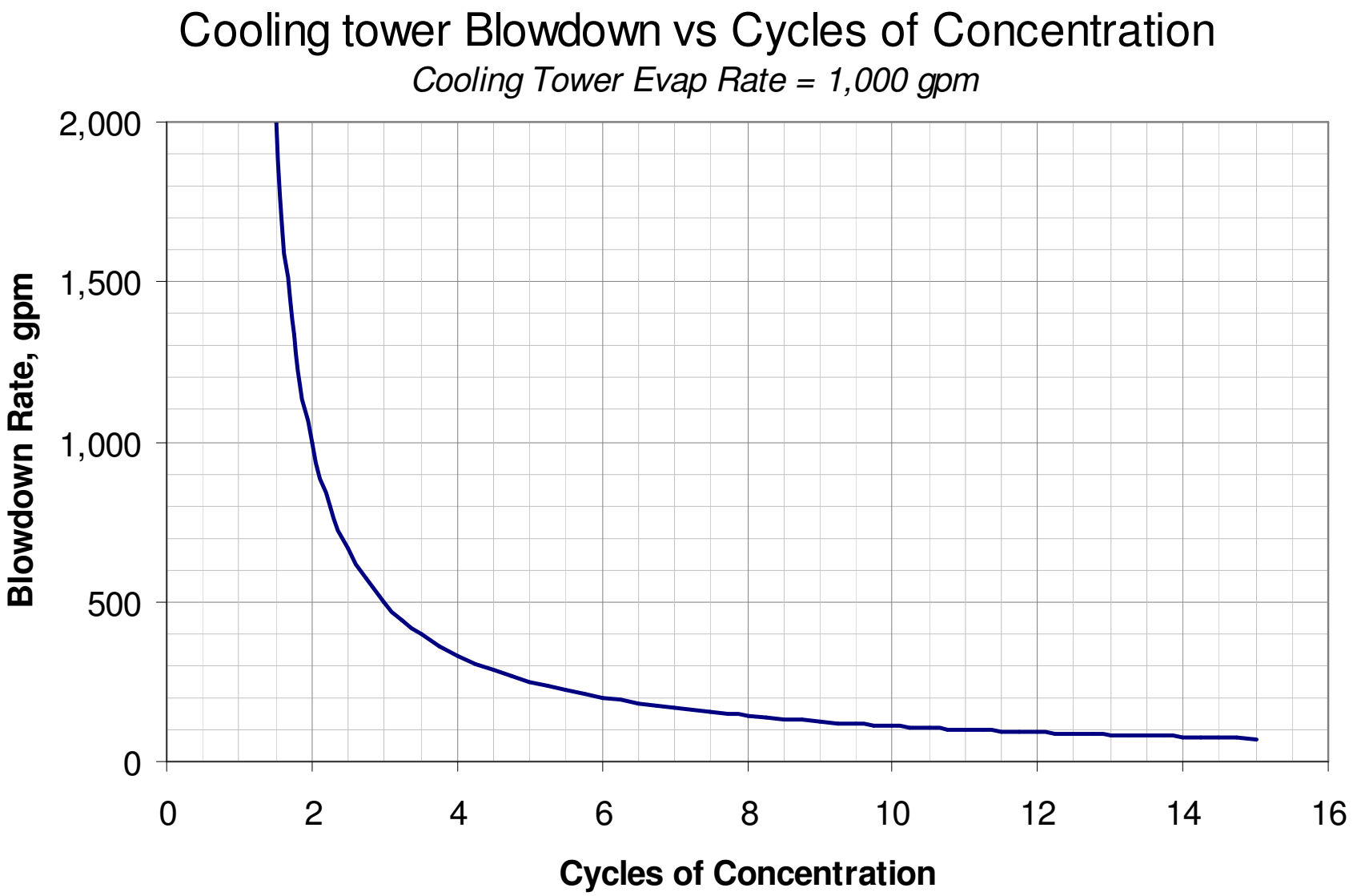
- Reclaimed wastewater: potential presence of pathogens, even though the water is disinfected, ammonia, nutrients
- Agricultural drainage: TDS, pesticides, nutrients
- Saline groundwater, produced water: TDS, trace elements

Decision Logic for Evaluating Non-Traditional Water Sources



Material Compatibility Issues

Component Material	Chemical Constituent Acceptable Range
Stainless Steel	Chloride < 1,000 – 1,200 mg/l
Copper Alloys	Ammonia < 2 mg/l Sulfide < 3 – 5 mg/l
Carbon Steel Pipe, Rebar	TDS < 2,000 – 3,000 mg/l
Concrete	Sulfate < 2,000 – 3,000 mg/l

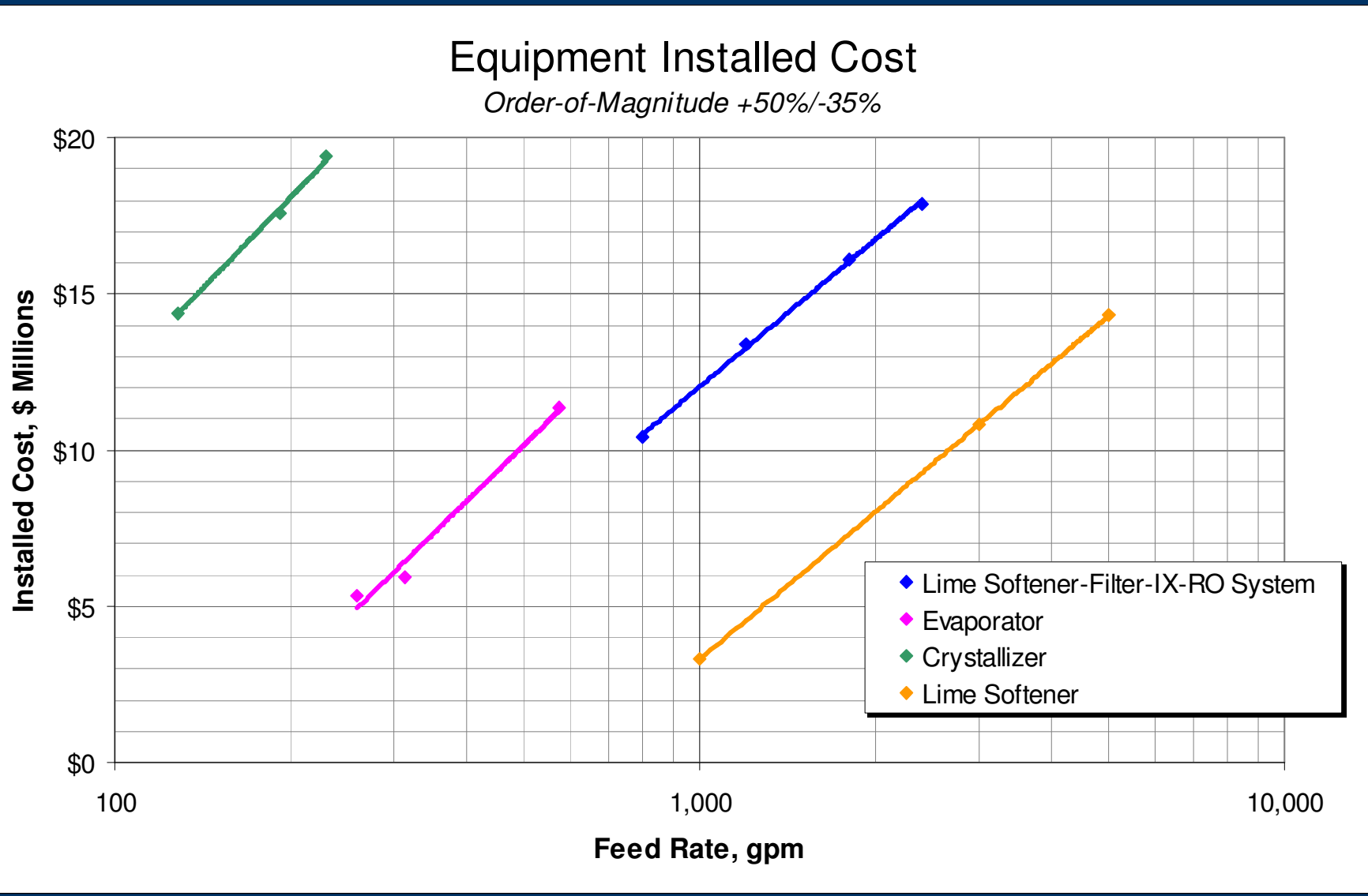

Cooling tower Blowdown vs Cycles of Concentration
Cooling Tower Evap Rate = 1,000 gpm
Blowdown Rate, gpm
2,000
1,500
1,000
500
0
0
2
4
6
8
10
12
14
16
Cycles of Concentration

Case Study with EPRI Reference Criteria

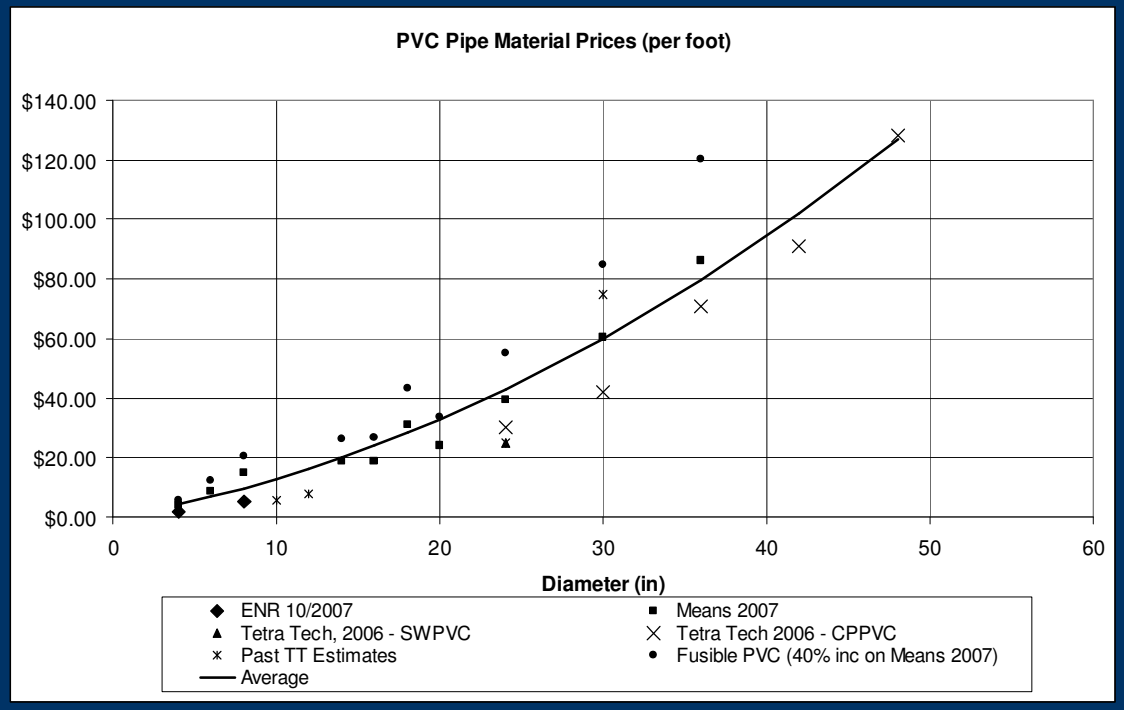
Parameter	Units	EPRI Guidelines	Degraded Source Water	Prelim Cycles of Conc
Ca	mg/l_{CaCO3}	(no guideline)	100	
Ca x SO_4	mg/l x mg/l	500,000		16.3
Mg x SiO_2	mg/l_{CaCO3} x mg/l_{SiO2}	35,000		5.8
M Alkalinity	mg/l_{CaCO3}	(no guideline)	127	
SiO_2	mg/l	150	23	6.5
Ortho-PO_4	mg/l	(no guideline)	3.8	
Fe (Total)	mg/l	<0.5	0.14	3.6
Mn (Total)	mg/l	<0.5	0.03	16.7
Cu	mg/l	<0.1	NA	
Al	mg/l	<1	0.35	2.9
TDS	mg/l	<70,000	472	148
TSS	mg/l	<100 – <300	<<1	
BOD	mg/l	(no guideline)	9.3	
COD	mg/l	(no guideline)	NA	
Cl, mg/l (Stainless Steel)		<1,000 – 1,200	90	11 – 13
NH_3, mg/l (Copper Alloys) [3]		<2	2.1	1.0
S, mg/l (Copper Alloys) [3]		<3 – 5	ND	NR
TDS, mg/l (Carbon Steel, Rebar)		<2,000 – 3,000	472	4 – 6
SO_4, mg/l (Carbon Steel, Rebar)		<2,000 – 3,000	47	42 – 63

Treatment Processes Required When Reference Criteria Exceeded

- Ion exchange: for removal of specific ions, TDS
- Reverse osmosis: for removal of all dissolved constituents
- Lime softener: for reducing calcium and magnesium


Equipment Installed Cost
Order-of-Magnitude +50%/-35%
Installed Cost, $ Millions
$20
$15
$10
$5
$0
100
1,000
10,000
Feed Rate, gpm
Lime Softener-Filter-IX-RO System
Evaporator
Crystallizer
Lime Softener

Pipeline Transportation Costs



- Large body of experience from the water and wastewater industry
- EPA guides available for making planning level estimates of material, pumping, and installation costs as a function of flow volume and distance

Regulatory Requirements and Related Issues

- Key regulatory concern related to reclaimed water use is the migration of pathogens in aerosols emitted by cooling towers; requires treatment, monitoring, biocide residual, setback distances from cooling towers, etc.
- Fewer specific regulations for other water sources at present
- Need long-term contracting arrangement for water supply
- For most municipalities that supply reclaimed water, there is a cost, typically $1-2 per 1,000 gallons

Summary

- In principle, a significant fraction of new thermoelectric cooling water needs could be met through non-traditional sources
- Reclaimed municipal wastewater is the most commonly degraded water source (localized, relatively stable resource); where transportation costs are significant, other options may be considered
- Sources such as oil and gas produced water, or mine pool water have been studied, but there are only a few documented examples of their use