Green Healthcare Initiative

NorthShore University Health System

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Purpose, Process, Payoff

- Purpose:
  - Detail options for saving water to comply with Green Healthcare Initiative
- Process:
  - Review cycle chemistry and economics of water savings
  - Review Monitoring and Control requirements for each
  - Evaluate which program is the best fit for each facility
- Payoff:
  - NorthShore can join Green Healthcare Initiative

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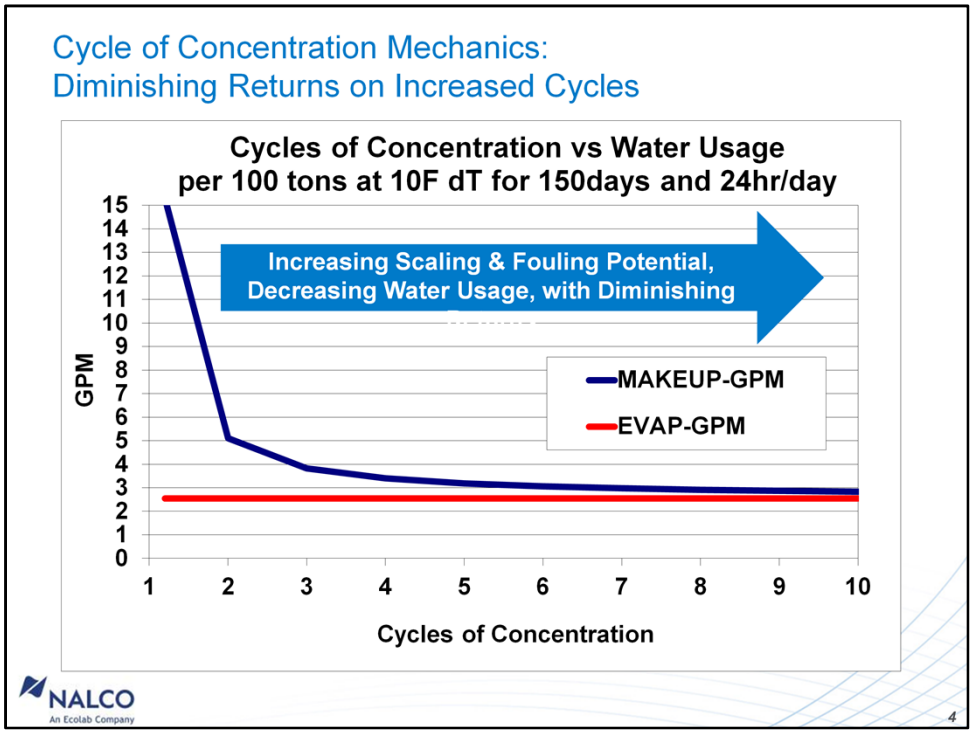
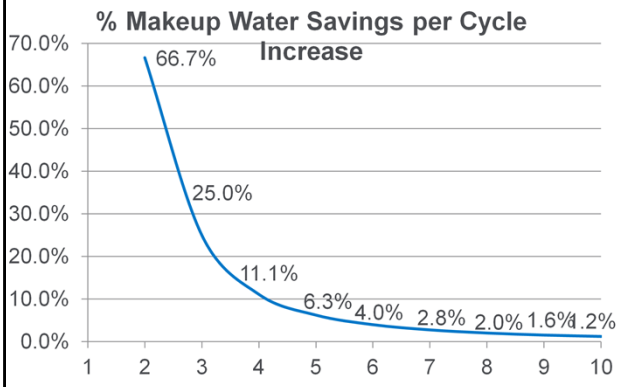
Green Chemistry Award for 3DTRASAR (water savings ~41 billion gallons in 2008) and STABREX



Increasing cycles decreases water usage with diminishing returns. Each increase in cycles increases the scaling/fouling stress of the system. Evaporation rate of an open recirculating cooling water system is fixed because a cooling tower uses evaporation as a mechanism for cooling.

Diminishing Returns on Increased Cycles



CYCLES	MAKEUP-GPM	EVAP-GPM	BLEED-GPM	% savings
1.2	15.3	2.55	12.75	na
2	5.1	2.55	2.55	66.7%
3	3.825	2.55	1.275	25.0%
4	3.4	2.55	0.85	11.1%
5	3.1875	2.55	0.6375	6.3%
6	3.06	2.55	0.51	4.0%
7	2.975	2.55	0.425	2.8%
8	2.9143	2.55	0.3643	2.0%
9	2.8688	2.55	0.3188	1.6%
10	2.8333	2.55	0.2833	1.2%

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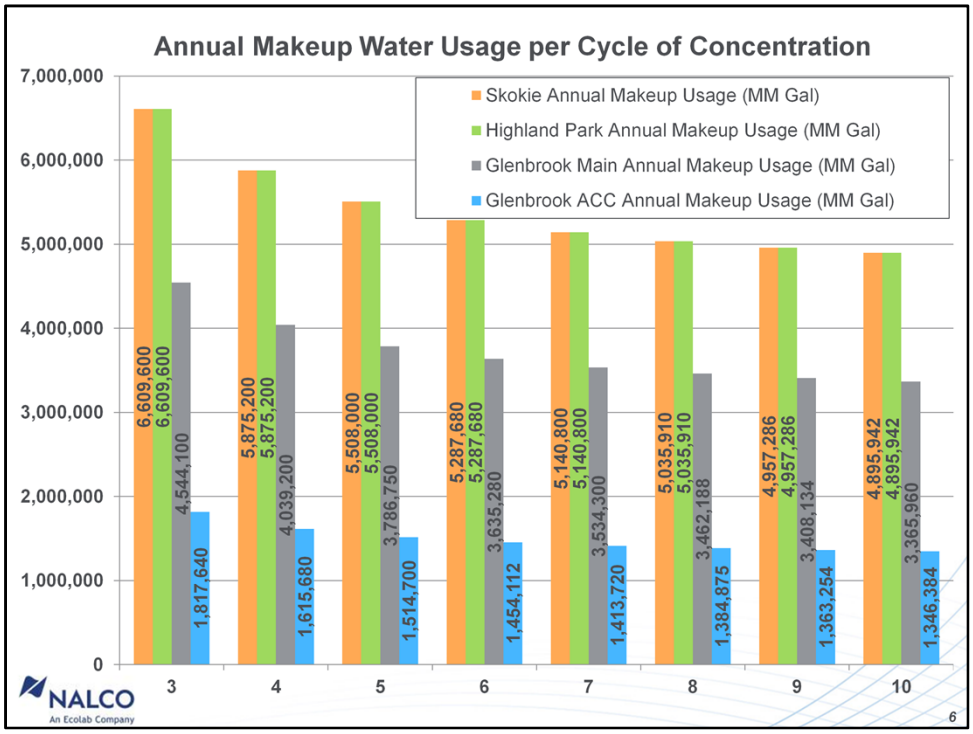
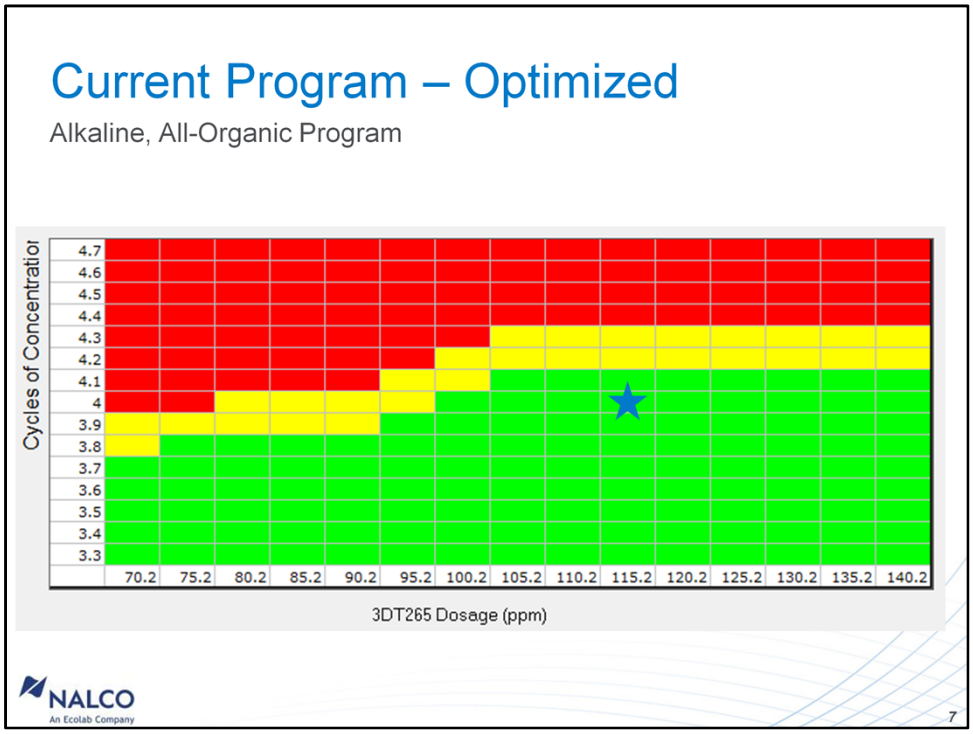
Further demonstration of the law of diminishing returns in cycle chemistry.
Assumptions: 100 tons cooling, 150 days, 24 hr/day, 10F dT



Annual water usage per hospital based on cycles of concentration



Optimizer model of current program at each facility. Incorporates M-O-C survey data for each facility, as well as both the Ryznar and Langelier indeces run through industry-leading software.

Current Water Treatment Program

Monitoring and Control Requirements

- 3DTRASAR: real-time stress management.
  - Nalco360: 24/7 monitoring by a team of engineers
  - Remote alarming and reporting to facility staff and Nalco team
  - Online dashboard with access for facility staff and Nalco team
  - Real-time general corrosion rate data using Nalco Corrosion Monitor
- Wet-Testing/On-Site monitoring Best Practices
  - Daily conductivity, pH, inhibitor, M alkalinity, free chlorine testing
    - Verify controller calibration/program effectiveness using these tests
  - Daily Makeup/Blowdown water meter check
  - Weekly DipSlide testing (more frequently if needed)
  - Quarterly corrosion coupon studies for MS/Cu
  - Nalco to perform hardness balance during on site service.

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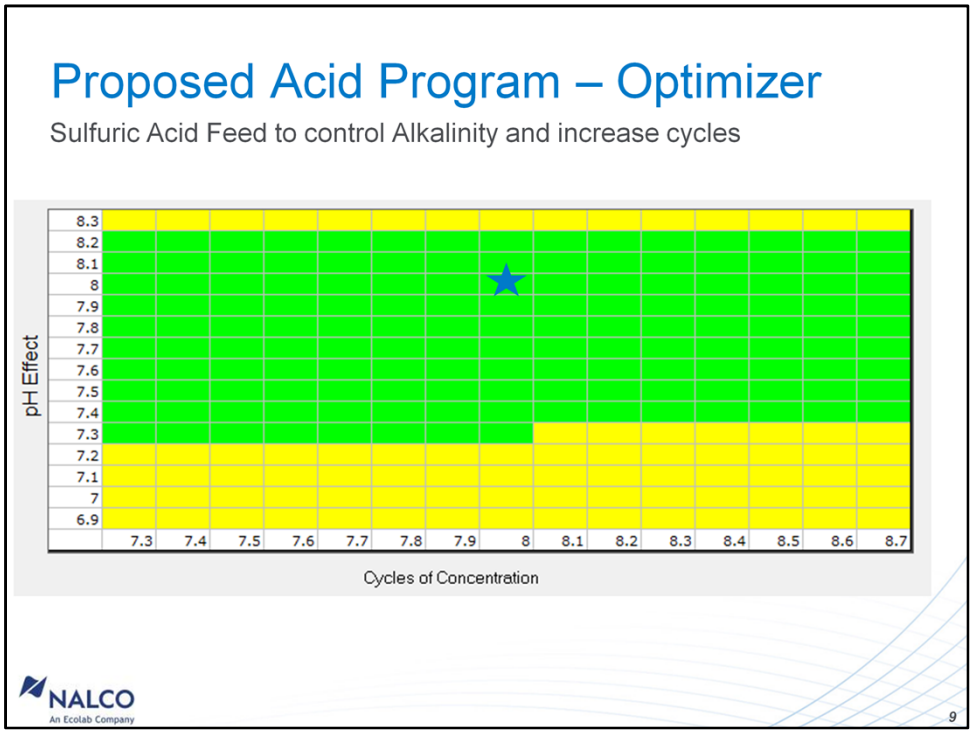
Current Program monitoring and control requirements

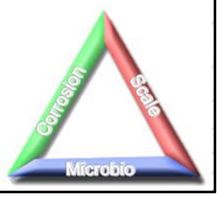


pH should run to 8.0 -8.2. mAlkalinity must not go below 100ppm

Acid Feed Program

Monitoring and Control Requirements

- **3DTRASAR**: real-time inhibitor, pH, and biocide control.
  - Nalco360: 24/7 monitoring by a team of engineers
  - Remote alarming and reporting to facility staff and Nalco team
  - Online dashboard with access for facility staff and Nalco team
  - Real-time general corrosion rate data using Nalco Corrosion Monitor
- **Wet-Testing/On-Site monitoring Best Practices**
  - Daily conductivity, pH, inhibitor, M alkalinity, free chlorine testing
    - Verify controller calibration/program effectiveness using these tests
  - Daily Makeup/Blowdown water meter check
  - Weekly hardness balance
  - Weekly DipSlide testing (more frequently if needed)
  - Quarterly corrosion coupon studies for MS/Cu
- **Start-up Equipment**
  - Sulfuric Acid Pump, Injection Quill, Corrosion Coupon Rack
  - Sulfuric Acid bulk tank + containment
  - Eye wash station, shower



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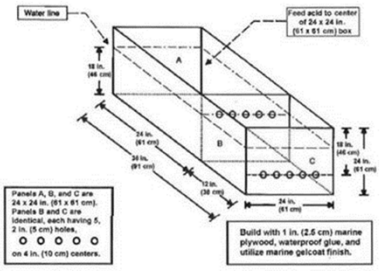
Proposed Acid Program monitoring and control requirements

Acid Feed Program

Safety Considerations

- Consideration should be given to introducing concentrated sulfuric acid in one of two manners
  - Tower Basin (Primary); dilution trough
  - Condenser Piping (Secondary Only if Necessary)
- Additional considerations
  - Acid relay must be interlocked with condenser flow to prevent feeding during low or no flow operation.
  - Acid Bulk Tank must have top closure to prevent contamination from foreign material from outside environment.
  - Acid Bulk Tank Assembly should include a minimum of a 110% containment capability.
  - Minimal transferring of product should be considered at all times.



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BASIN: Concentrated acid should be fed to the basin using a dilution trough near make-up introduction. The dilution water trough should be located near the recirculation pumps but not immediately in the pump suction. Where a dilution trough is not possible, acid should be introduced into the center of the tower approximately one third of the way back from the recirculating pumps. Concentrated acid can be fed near make-up water addition if turbulence in this area is sufficient and constant.

Materials of construction suitable for chemical introduction (chemical pump liquid ends, feed lines, etc.) should be comprised of either Carpenter-20 or 316 Stainless Steel, Kynar or CPVC.

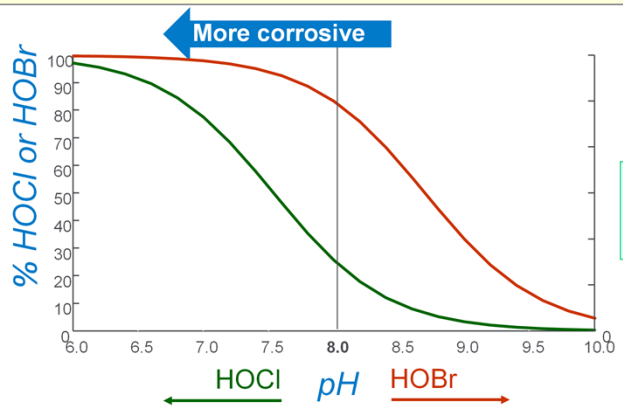
CONDENSER PIPING: Install chemical injection assembly in condenser piping between condenser outlet and by-pass (if installed) as close to the tower as possible at a point at least 10 (ten) pipe diameters upstream from nearest bend, elbow or weld. Doing so will allow for maximum chemical dilution at the tower basin and removal of CO_2 from tower aeration that is generated during acid introduction.

Materials of construction suitable for chemical introduction (Quills, chemical pump liquid ends, feed lines and injection quill valves) should be comprised of either Carpenter-20 or 316 Stainless Steel, Kynar or CPVC.

Injection site should occur in horizontal pipe runs only located at the bottom of the pipe (6:00 position) to allow for proper seating of ball-checks from gravity and prevent premature mixing of the condenser water and acid in a stagnant assembly.

Chlorination *vs.* Bromination

Bromine performs better in alkaline conditions



HOBr and HOCl are active biocide species

At pH 8.0: only 20% HOCl *vs* 80% HOBr

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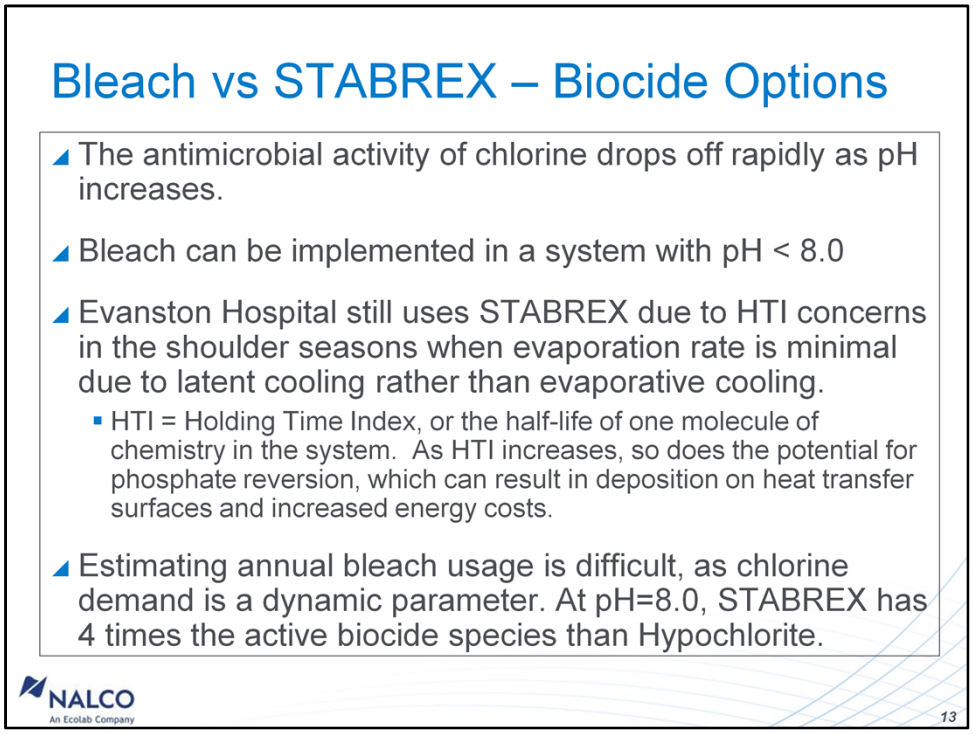

Relative to chlorine, STABREX is 10 times less toxic, yields half of the disinfection by-products, and is more effective for its designed applications

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Meeting Water Reduction Goals using Acid-based pH Control Program

NorthShore University Health Systems High Cycles- Acid Feed- Project Savings

4 Cycles of Concentration NO pH Control

	3DT265	Acid	Make Up	3DT265	Acid	Water
Hospital	gallons	gallons	gallons	$	$	$
Highland Park	129	0	5,827,680	$10,129.11	0	$30,012.55
Glenbrook Main Hospital	89	0	4,006,800	$6,963.77	0	$28,328.08
Skokie	129	0	5,827,680	$10,129.11	0	$29,371.51
Totals			15,662,160	$27,221.99	$0	$87,712.14

8 Cycles of Concentration WITH pH Control

	3DT289	Acid	Make Up	3DT289	Acid	Water
Hospital	gallons	gallons	gallons	$	$	$
Highland Park	69	261	4,996,080	$5,514.12	$1,940.54	$25,729.81
Glenbrook Main Hospital	47	179	3,434,400	$3,790.96	$1,330.87	$24,281.21
Skokie	69	261	4,996,080	$5,514.12	$1,940.54	$25,180.24
Totals			13,426,560	$14,819.20	$5,211.94	$75,191.26

Savings for Acid Program			2,235,600	$12,402.79	-$5,211.94	$12,520.87
Total Water Savings (gallons)		2,235,600				
Total Savings (USD)		$19,711.73				

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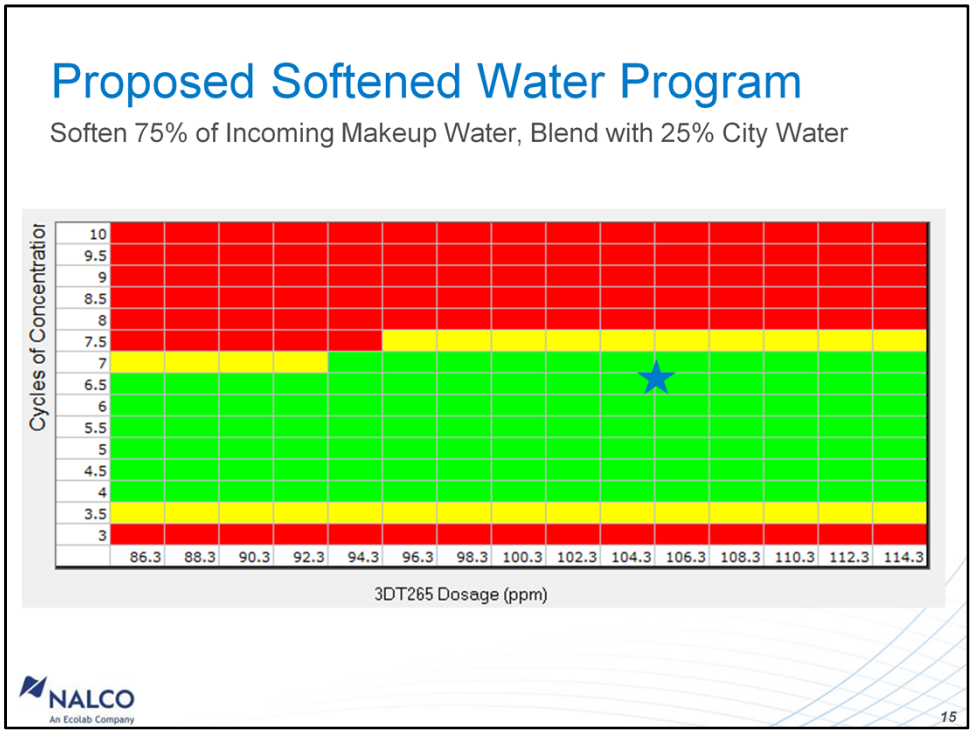

Consider that pH over 9 will cause degalvanizing in galvanized tower. Expected system pH would run high (9.2-9.4) with high cycles soft water program. This would require the feed of a separate corrosion inhibitor to prevent "white rust" phenomenon, 73801WR

Soft Water Program

Monitoring and Control Requirements

- **3DTRASAR**: real-time inhibitor and biocide control.
  - Nalco360: 24/7 monitoring by a team of engineers
  - Remote alarming and reporting to facility staff and Nalco team
  - Online dashboard with access for facility staff and Nalco team
  - Real-time general corrosion rate data using Nalco Corrosion Monitor
- **Wet-Testing/On-Site monitoring Best Practices**
  - Daily conductivity, pH, inhibitor, M alkalinity, free chlorine testing
    - Verify controller calibration/program effectiveness using these tests
  - Daily Makeup/Blowdown water meter check
  - Daily hardness balance
  - Daily brine tank check and salt replacement
  - Weekly DipSlide testing (more frequently if needed)
  - Quarterly corrosion coupon studies for MS/Cu
- **Start-up Requirements**
  - Softeners, brine tanks
  - City Water bypass line with throttling valve (to allow for minimal hardness in system)

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Current Program monitoring and control requirements

Soft Water Program

M-O-C Considerations

- Consider that pH over 9 will cause degalvanizing in a galvanized cooling tower.
  - Loss of zinc coating exposes raw mild steel and results in accelerated corrosion rates.
- Expected system pH would run high (9.2-9.4) with soft water program at high cycles (6-7).
- This would require the feed of a separate corrosion inhibitor to prevent “white rust” phenomenon, **73801WR**
- Consideration should be given to backwash/rinse water, which will be lost to drain during each softener regeneration cycle.
  - This volume of water could be equivalent to losing 1-2 cycles of concentration

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Current Program monitoring and control requirements

Green Healthcare Initiative

Meeting Water Reduction Goals using Soft Water Program

4 Cycles of Concentration NO softening

	3DT265	73801WR	Salt	Make Up	3DT265	73801WR	Softener	Salt	Water
Hospital	gallons	gallons	lbs	gallons	$ USD	$ USD	$ USD	$ USD	$ USD
Highland Park	129		0	5,827,680	$10,129.11	$0.00	0	0	$30,012.55
Glenbrook Main Hospital	89		0	4,006,800	$6,963.77	$0.00	0	0	$28,328.08
Skokie	129		0	5,827,680	$10,129.11	$0.00	0	0	$29,371.51
Totals				15,662,160	$27,221.99	$0.00	$0	$0	$87,712.14

6.7 Cycles of Concentration WITH Soft Water

	3DT265	73801WR	Salt	Make Up	3DT265	73801WR	Softener/Install (Ballpark)	Salt	Water
Hospital	gallons	gallons	lbs	gallons	$ USD	$ USD	$ USD	$ USD	$ USD
Highland Park	75	33	xxx	5,099,760	$5,811.87	$3,124.98	$10,000.00	xxx	$26,263.76
Glenbrook Main Hospital	52	24	xxx	3,505,680	$3,995.66	$2,265.60	$10,000.00	xxx	$24,785.16
Skokie	75	33	xxx	5,099,760	$5,811.87	$3,124.98	$10,000.00	xxx	$25,702.79
Totals				13,705,200	$15,619.40	$8,515.56	$30,000.00		$76,751.71

Savings for Soft Water				1,956,960	$11,602.59	-$8,515.56	-$30,000.00		$10,960.42

Total Water Savings (gallons)		1,956,960
Year 1 Total Savings (USD)		-$15,952.55
Year 2+ Total Savings (USD)		$14,047.45

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Summary

- Three options to reduce water:
  - Run current (alkaline, all-organic) program at higher, but manageable, stress in order to maximize COC
  - Implement pH-Control program using concentrated sulfuric acid feed
  - Implement blended soft water program
- There are benefits to each program, as well as risks
  - We want to help you determine which risks can be tolerated in order to achieve your goals
- Not every facility is the same – which offering is the best "fit" for each?

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