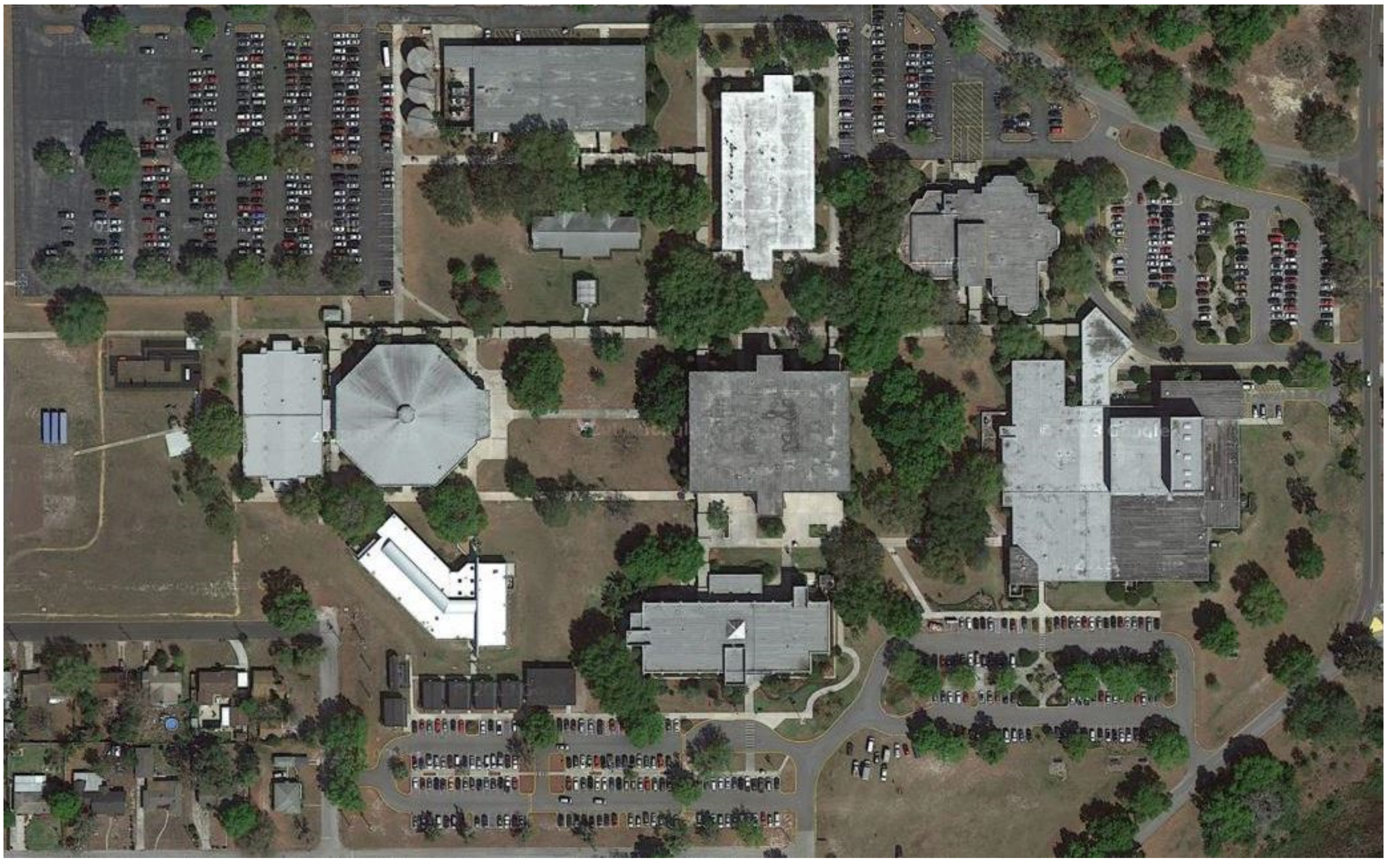
POLK STATE COLLEGE

WINTER HAVEN, FLORIDA



CHILLER PLANT EVALUATION

APRIL 2, 2014

C&A# 5747

CARASTRO & ASSOCIATES, INC.
CONSULTING ENGINEERS
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I. SCOPE OF WORK

1. Carastro & Associates was commissioned to perform a review of the existing chiller plant to determine the best chiller plant replacement strategy that would yield the most value for Polk State College.

II. EXECUTIVE SUMMARY AND RECOMMENDATIONS

1. The intent of this study is to determine the type of chiller plant that would offer most benefits on a Life Cycle basis. For this report, the size (in tonnage) of the new plant is not the primary focus, as long as the chiller plant tonnage is reasonably close to the actual size and consistent throughout all schemes.

2. The size of the proposed chiller plant was estimated through several avenues. First, all of the facilities served by the chiller plant were surveyed to document the HVAC equipment and electrical systems. Second, a model was developed using a DOE approved load simulation software and adjusted to match the existing conditions for the chiller plant. Lastly, the model was revised to account for full student occupancy, building occupancy schedules, future expansion, and ASHRAE compliant ventilation rates. The following steps were followed:

   a) The current chiller plant has a total capacity of 650 tons, while the connected load of all chilled water air handlers appears to be approximately 970 tons. The latter was estimated based on actual Test & Balance data (where available), model numbers of equipment (where available) and tonnage assumptions based on chilled water coil sizes.

   b) A preliminary calculation for code compliant ventilation rates was also performed based on the overall building areas and occupancy rates provided to us. This load was estimated to 270 tons.

   c) It is believed that the existing building HVAC systems do not meet current codes in terms of ventilation rates. The current capacity of the plant (650 tons) and a portion of the outside air load (200 tons) were summed together to obtain the total required tonnage. An additional 350 tons was added to this total for future build outs, which brought the plant tonnage to a total of 1,200 tons. It is estimated that the extra tonnage would be sufficient for 70,000 to 95,000 square feet of new construction. A smaller chiller plant may also be considered for the initial build out and future chillers added as the campus grows.

3. Based on the results of the LCCA – see Data Sheet 3 in Appendix A – a water-cooled plant with centrifugal chillers, cooling towers, variable primary chilled water flow and constant condenser water flow, has the **lowest first cost** and the **lowest life cycle cost over 25 years**. Based on these findings, a water-cooled plant that is efficient, scalable and requires minimal maintenance is recommended.

III. SUMMARY OF EXISTING CONDITIONS - MECHANICAL

1. The existing central energy plant is located in the Multi-Services building (WMS) and serves nine facilities throughout the Polk State College, Winter Haven campus. The facilities include: Administration (WAD), Fine Arts (WFA), Student Center (WST), Science & Math (WSC), Multi-Services (WMS), Rehabilitation (WRH), Criminal Justice (WCJ), Learning Resources (WLR), and Health Center (WHC).

2. The central energy plant consists of a chilled water system and a heating hot water system. The chiller system is a primary/secondary chilled water loop system. The boiler system is a primary heating hot water loop system.

3. The chiller plant consists of three water cooled centrifugal chillers, three cooling towers, three thermal storage tanks, three condenser water pumps, three primary chilled water pumps, two secondary chilled water pumps, and two chilled water storage pumps.

4. Chillers CH-1, CH-2 and CH-3 were installed in 1988. Chiller CH-1 is a York 150 ton chiller. Chillers CH-2 and CH-3 are both York 250 ton chillers. All three chillers still use the environmentally unfriendly R-11 refrigerant. These chillers are 26 years old, which is past the recommended service life of 23 years according to ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers).

5. The three centrifugal chillers currently operate twenty-four hours a day, at full capacity. It has been stated during walk-throughs that the shut-down of any chiller (i.e. failure or for maintenance) results in a fairly quick increase of the campus chilled water supply temperature and insufficient cooling for the school campus. Considering the air-conditioned area of the campus is over 300,000 sq.ft., the existing chiller capacity is very low at 461 sq.ft. per ton when compared to ASHRAE's cooling load check figures for educational facilities (150 to 240 sq.ft. per ton).

6. Cooling towers CT-1, CT-2, and CT-3 are all Marley brand cooling towers. The capacity of cooling tower CT-1 is 150 tons, while towers CT-2 and CT-3 are 250 ton units.

7. The three thermal storage tanks have a capacity of 120,000 gallon storage tanks. These tanks were intended to reduce energy costs by taking advantage of off-peak electricity rates and reduce demand charges. According to personnel onsite, the control systems for these tanks were never properly completed and therefore the thermal storage system has not been utilized to its design intent potential. Their current usage is buffer tanks and, as such, they may provide a little extra chilled water capacity during a chiller failure (i.e. slow down the increase in chilled water temperature by mixing).

8. All existing pumps for the primary chilled water loop are constant flow pumps. The secondary chilled water loop pumps and the heating hot water pumps are equipped with variable frequency drives.

9. The chiller plant is controlled by an Andover Direct Digital Control (DDC) system, although the extent of the controls is limited.

10. The existing chilled water main supply and return piping serving the campus loop is documented as 14" diameter steel piping. Ultrasound testing results provided for our review indicated acceptable piping condition. However, a more in-depth analysis by removing a section or coupons could be performed. In terms of pipe sizing, the 14" main piping is adequate for the 1200-ton plant studied in this report.

IV. SUMMARY OF EXISTING CONDITIONS - ELECTRICAL

1. The existing main electrical service supplying the chiller plant and the multi services building (WMS) consists of a Polk State College owned 1000 KVA 13.2KV to 277/480V pad mounted transformer, two motor control centers and a Square D QED 2000 Amp (Main Circuit Breaker) 480V 3 Phase 4W switchboard MSB. This switchboard supplies:

   a. Three existing chillers.

b. Several 277/480V and 120/208V 3 Phase panel boards that supply power and lighting loads in the building. (These existing loads are not associated with the scope of this study other than by their impact on the existing electrical service).

c. Motor Control Center MCC1 is a Square D 600 Amp 480V 3 Phase Model 5. MCC1 supplies the cooling towers and the following pumps: P-1, P-2, P-4, P-5, P-7, P-9 and HWP-1

d. Motor Control Center MCC2 is a Square D 600 Amp 480V 3 Phase Model 5. MCC2 supplies the following pumps: P-3, P-6, P-8, P-10, and HWP-2.

2. The existing Switchboard MSB is currently in violation of the National Electrical Code (N.E.C.) 240.4(C). The total ampacity of the service entrance conductors is 1530A, the main circuit breaker long time ampere rating is set for 2000A.

   NOTE: This issue can be easily corrected for the existing conditions by adjusting the main circuit breakers long time ampere rating to (1500A). With this adjustment the existing service lateral conductors will be protected in compliance with N.E.C. It was also observed that all the other main circuit breaker's settings are set for the minimum value which may cause nuisance tripping of the main circuit breaker. This issue can be corrected by performing a selective coordination study to set the main circuit breaker properly.

3. Based on a calculation of existing loads the existing pad mounted 1000KVA 13.2KV to 277/480V currently serving the maintenance building is overloaded by 119.9KVA, which constitutes a violation of N.E.C. 450.3(A).

4. During a previous service upgrade, the existing service entrance conductors were pulled through the existing abandoned switchboard main section (converted to a pull box) and extended overhead to the now existing MSB. This constitutes a violation of N.E.C. 230.70(A)(1) which limits the length of the service entrance conductors to a point nearest the point of entrance into the building.

5. The existing feeders currently supplying motor control centers MCC1 and MCC2 have a total ampacity of 510A, however, these are supplied from 600A circuit breakers. While this feeder size complies with minimum N.E.C. 240.4(B) requirements it will not comply with the maximum 2% voltage drop requirements mandated by the Florida Building Code (FBC). The intent of this FBC rule is to increase the efficiency of the installation.

V. CHILLER PLANT SCHEMES

1. The capacity of the new chiller plant was modeled using Carrier HAP software. The model built was developed to account for code and ASHRAE compliant ventilation rates and also allow for some future expansion of the campus. The new chiller plant for this analysis has the following characteristics:
   - 1200 tons of cooling capacity
   - 460V/3Ph power
   - Variable primary chilled water flow

2. Polk State College personnel expressed an interest in ice thermal storage. Therefore, several different schemes were developed, with and without ice storage. After a quick evaluation of their complexity and first cost, four schemes were selected for a Life Cycle Cost Analysis (LCCA). The results of this analysis are included in Appendix A; the data is summarized as follows:

a. Page 1 includes a brief description of the systems analyzed, estimated annual costs for electricity and maintenance, as well as our opinion of probable cost for the equipment in each of the four schemes analyzed.
b. Page 2 has a breakdown of all the equipment and their initial cost estimates, along with a calculated "present worth value" based on their replacement at a particular time within the 25-year cycle, 4% equipment cost increase at the time of replacement and 7% interest rate.
c. Page 3 includes a summary of the Life Cycle Costs associated with the four schemes.
d. Page 4 summarizes the HVAC costs as well as ancillary costs associated with each scheme.
e. Page 5 includes a summary of the estimated annual electricity costs, as well as annual maintenance costs.
f. Page 6 includes a few assumptions made while assembling the LCCA.

SCHEME 1

MECHANICAL

(2) 600 ton Water Cooled Centrifugal Chillers, (2) 600 ton Cooling Towers, (4) Variable flow chilled water pumps. One of the chillers is provided with a Variable Frequency Drive (i.e. for better, more efficient handling of part load conditions), and the second machine is constant speed (i.e. better efficiency at full load).

ELECTRICAL

a. The projected load of the new equipment will impose additional load on the transformer. The existing 1000KVA transformer will have to be replaced with a new 1500KVA transformer.

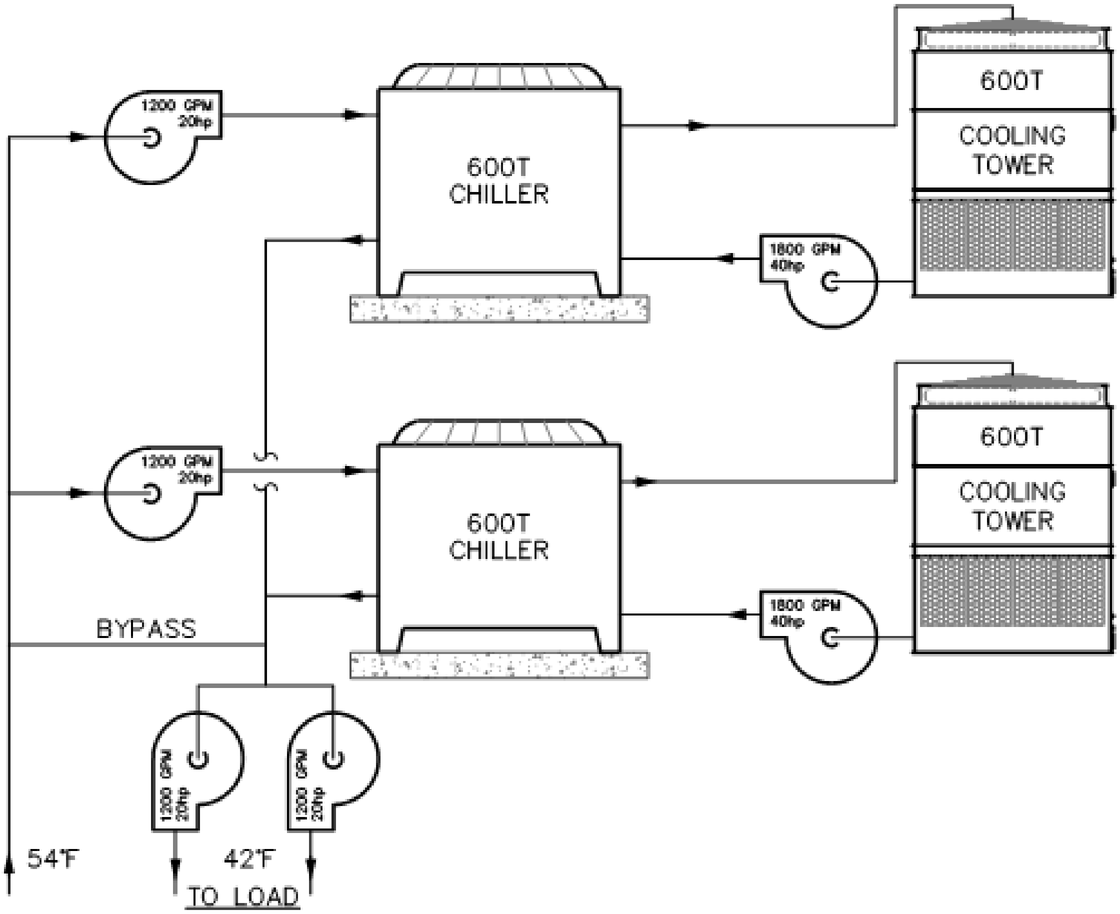
b. The existing switchboard MSB (two sections) may be reused. A new 2000A main circuit breaker shall be provided to replace the existing pull box. Replace the existing service entrance conductors from a new pad mounted transformer to the new main and from the new main to the existing MSB. The ampacity of these new service entrance conductors shall be no less than 2000A in order to use the full capacity of the existing MSB. The ground electrode system and the neutral to equipment ground connection shall be established at the new main circuit breaker location as required by N.E.C. 250.50. Provide new 600A feeders for motor control centers MCC1 and MCC2. These recommendations will be sufficient to comply with N.E.C. as well as Florida Building Code.

ADVANTAGES

- Water-cooled centrifugal chillers are significantly more efficient than air-cooled equipment.
- Proven system, relatively easy to operate and maintain
- Lowest first cost

DISADVANTAGES

- More equipment to maintain when compared to all air-cooled schemes (i.e. no cooling towers)
- Chemical treatment for condenser water



CHILLED WATER FLOW DIAGRAM
SCHEME 1

DR./CK. EH/GS	POLK STATE COLLEGE WINTER HAVEN CAMPUS CHILLER STUDY	CARASTRO & ASSOCIATES, INC. CONSULTING ENGINEERS EB-0001160 2609 W. DE LEON STREET TAMPA, FLORIDA 33609 TELEPHONE: (813) 874-9494 WWW.CARASTRO.COM	SHEET NO. S1
ISSUED 02/2014			

SCHEME 2

MECHANICAL

(1) 600 ton Water Cooled Centrifugal Chiller with Variable Frequency Drive, (1) 600 ton Cooling Tower, (2) 225 ton Air-Cooled Chillers, (18) Ice Storage Tanks, (1) Heat Exchanger, (7) Variable flow chilled water pumps

ELECTRICAL

a. The projected load of the new equipment will impose additional load on the transformer. The existing 1000KVA transformer with a new 1500KVA transformer.

b. The existing switchboard MSB (two sections) may be reused. A new 2000A main circuit breaker shall be provided to replace the existing pull box. Replace the existing service entrance conductors from a new pad mounted transformer to the new main and from the new main to the existing MSB. The ampacity of these new service entrance conductors shall be no less than 2000A in order to use the full capacity of the existing MSB. The ground electrode system and the neutral to equipment ground connection shall be established at the new main circuit breaker location as required by N.E.C. 250.50. Provide new 600A feeders for motor control centers MCC1 and MCC2. These recommendations will be sufficient to comply with N.E.C. as well as Florida Building Code.

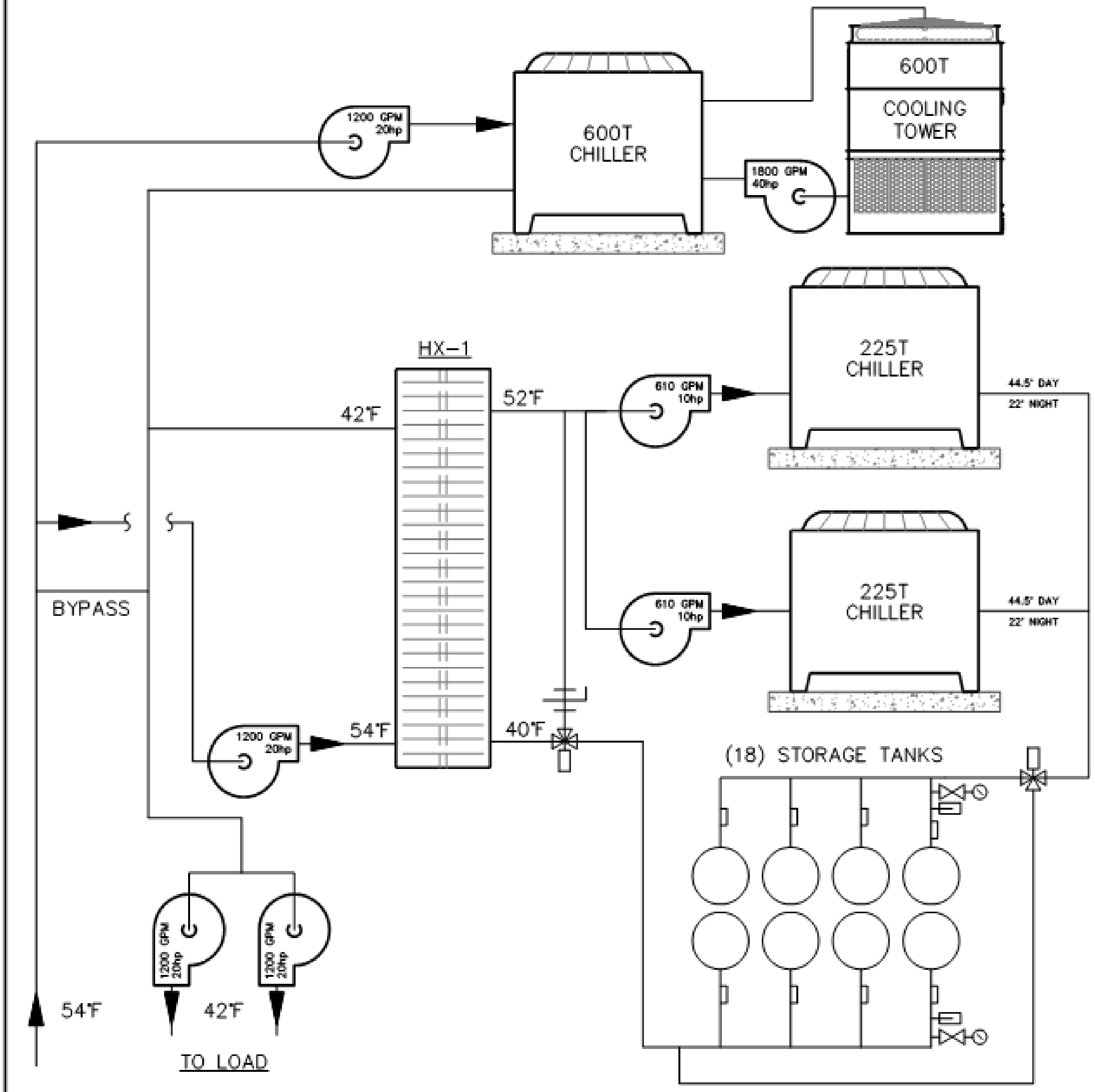
c. The existing motor control centers MCC1 and MCC2 may be reused. There will be a cost associated with the electrical demolition of the existing equipment and wiring to chillers, pumps, etc. as well as new circuit breakers and starters that need to be provided to accommodate the new equipment's power requirements.

ADVANTAGES

- Water cooled centrifugal chillers are significantly more efficient than air-cooled equipment.
- Rebate from power company
- Reduction in demand charges

DISADVANTAGES

- Complex scheme, due to mix of water-cooled and air-cooled chillers
- More equipment to maintain: chillers, pumps, heat exchanger
- Chemical treatment for condenser water
- Higher first cost



CHILLED WATER FLOW DIAGRAM
SCHEME 2

DR./CK. EH/GS ISSUED 02/2014	POLK STATE COLLEGE WINTER HAVEN CAMPUS CHILLER STUDY	CARASTRO & ASSOCIATES, INC. CONSULTING ENGINEERS EB-0001160 2609 W. DE LEON STREET TAMPA, FLORIDA 33609 TELEPHONE: (813) 874-9494 WWW.CARASTRO.COM	SHEET NO. S2

SCHEME 3:

MECHANICAL

(3) – 350 ton High Efficiency Air Cooled Screw Chillers, (30) Ice Storage Tanks, (1) Heat Exchanger, (5) Variable flow chilled water pumps

ELECTRICAL

a. The projected load of the new equipment will impose additional load on the transformer. The existing 1000KVA transformer with a new 2000KVA transformer.

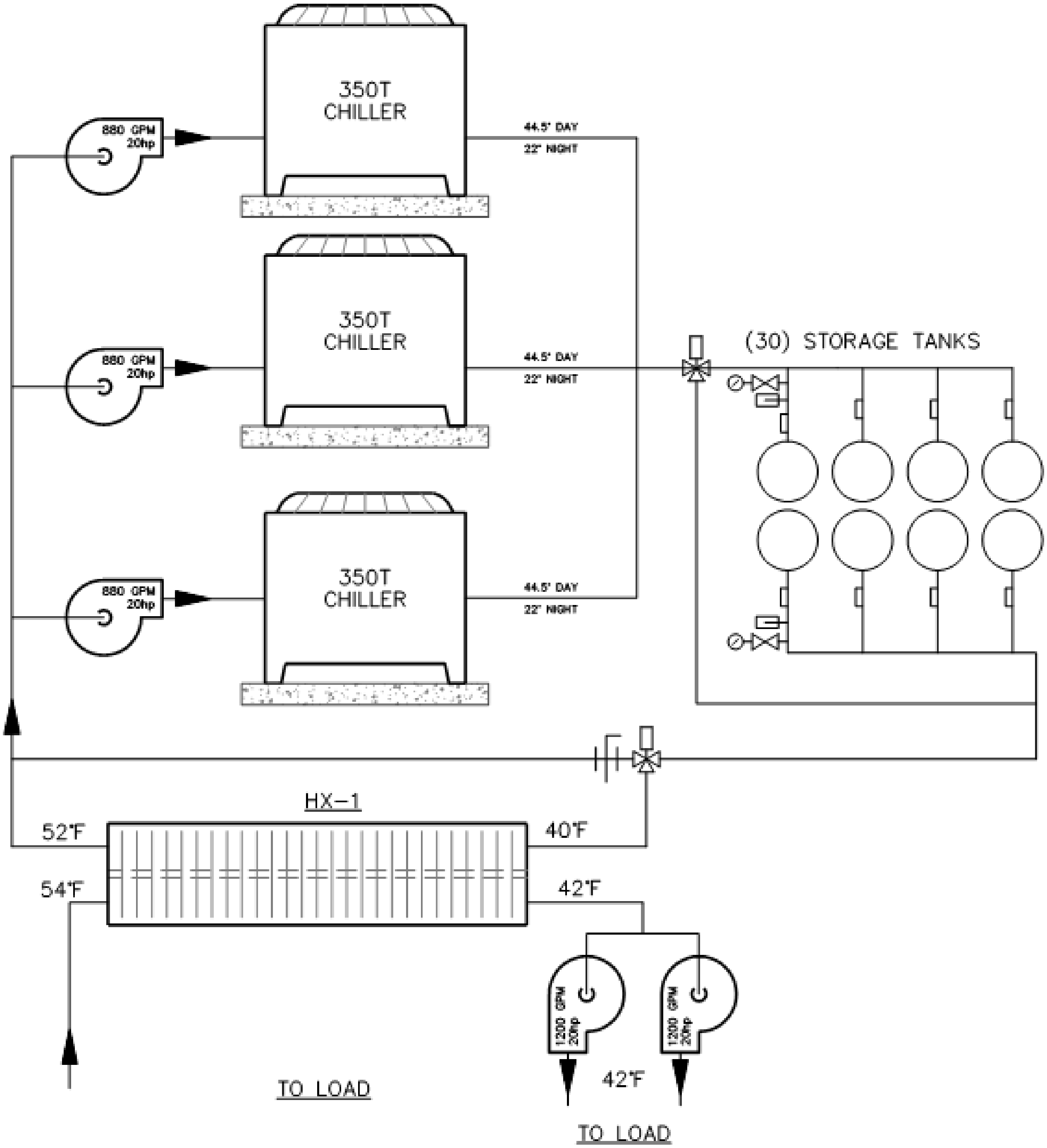
b. Based on the additional loads, the service entrance conductors and the main service switchboard will have to be upgraded. A new 2500A main circuit breaker shall be provided to replace the existing pull box. Replace the existing service entrance conductors from a new pad mounted transformer to the new main and from the new main to a new 2500A double distribution section (to be installed at the existing MSB distribution section location). The ampacity of these new service entrance conductors shall be no less than 2500A. The ground electrode system and the neutral to equipment ground connection shall be established at the new main circuit breaker location as required by N.E.C. 250.50. Provide new 600A feeders for motor control centers MCC1 and MCC2. These recommendations will be sufficient to comply with N.E.C. as well as Florida Building Code.

ADVANTAGES

- Air-cooled equipment is simple to operate and maintain.
- Rebate from power company
- Reduction in demand charges
- No condenser water

DISADVANTAGES

- Operating ice storage requires in-depth knowledge of building's load profile in order to maximize benefits and reduce energy consumption.
- More equipment to maintain: chillers, pumps, heat exchanger
- Higher first cost



CHILLED WATER FLOW DIAGRAM
SCHEME 3

DR./CK.	POLK STATE COLLEGE WINTER HAVEN CAMPUS CHILLER STUDY	CARASTRO & ASSOCIATES, INC. CONSULTING ENGINEERS EB-0001160 2609 W. DE LEON STREET TAMPA, FLORIDA 33609 TELEPHONE: (813) 874-9494 WWW.CARASTRO.COM	SHEET NO.
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SCHEME 4:

MECHANICAL

(1) – 300 ton Premium Efficiency Air Cooled Screw Chiller, (2) – 350 ton High Efficiency Air Cooled Screw Chillers, (24) Ice Storage Tanks, (1) Heat Exchanger, (6) Variable flow chilled water pumps

ELECTRICAL

a. The projected load of the new equipment will impose additional load on the transformer. The existing 1000KVA transformer with a new 2000KVA transformer.

b. Based on the additional loads, the service entrance conductors and the main service switchboard will have to be upgraded. A new 2500A main circuit breaker shall be provided to replace the existing pull box. Replace the existing service entrance conductors from a new pad mounted transformer to the new main and from the new main to a new 2500A double distribution section (to be installed at the existing MSB distribution section location). The ampacity of these new service entrance conductors shall be no less than 2500A. The ground electrode system and the neutral to equipment ground connection shall be established at the new main circuit breaker location as required by N.E.C. 250.50. Provide new 600A feeders for motor control centers MCC1 and MCC2. These recommendations will be sufficient to comply with N.E.C. as well as Florida Building Code.

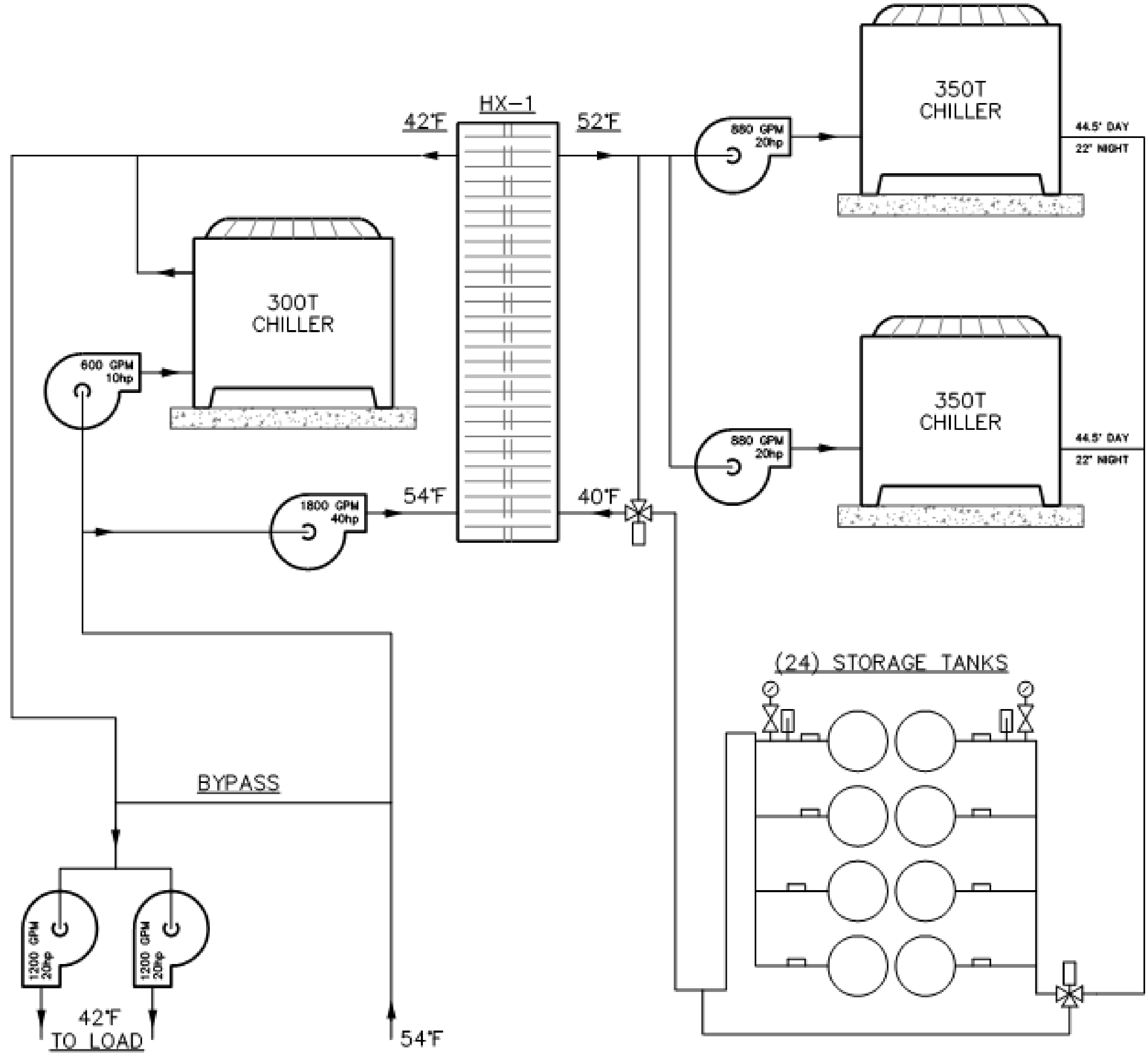
c. The existing motor control centers MCC1 and MCC2 can be reused. There will be a cost associated with the electrical demolition of the existing main switchboard MSB, equipment and wiring to chillers, pumps etc. as well as new circuit breakers and starters that need to be provided to accommodate the new equipment's power requirements.

ADVANTAGES

- Air-cooled equipment is simple to operate and maintain.
- Rebate from power company
- Reduction in demand charges
- No condenser water
- More efficient air-cooled chiller on the building side

DISADVANTAGES

- Operating ice storage requires in-depth knowledge of building's load profile in order to maximize benefits and reduce energy consumption.
- More equipment to maintain: chillers, pumps, heat exchanger
- Higher first cost



CHILLED WATER FLOW DIAGRAM
SCHEME 4

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VI. HEATING HOT WATER – HEAT RECOVERY CHILLER SYSTEM

1. The existing boiler system consists of three boilers and two heating hot water pumps. Boilers B-1, B-2, & B-3 were all installed in 2008. The two heating hot water pumps operate with variable frequency drives. All three boilers are Aerco 1,000,000 BTUH forced draft boilers. These boilers are high efficiency condensing boilers and are fueled by natural gas.

2. Since the boilers are fairly new, replacement is not necessary. However, it would be beneficial to consider adding a Heat Recovery Chiller (HRC). The data below indicates that this upgrade would have a quick payback – i.e. two years, after which it would continue to offer an estimated twenty-four thousand dollars in operational cost savings year after year.

3. The primary task of this machine is to provide heating hot water. The HRC is connected to the chilled water return piping and its byproduct is cold chilled water, thus reducing the work of the main chillers. In the case of a new chiller plant, a reduction in size of the cooling chillers is also an option.

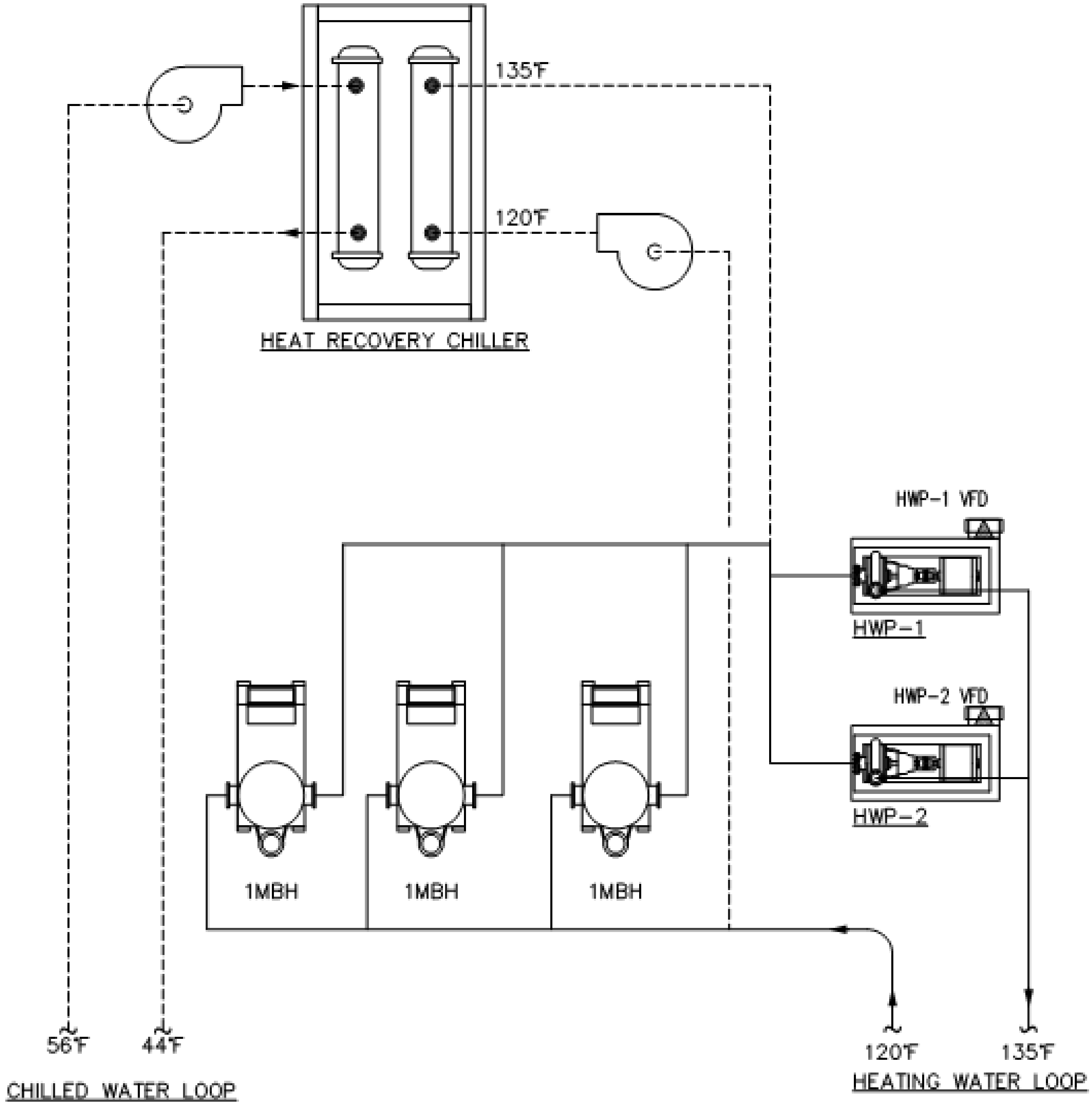
4. For the purpose of this study, we selected a 70-ton Multistack unit, which has a heating output similar to one of the existing boilers. The net heating capacity of the MS070 chiller is 880,300 BTUh, while the cooling capacity is 635,000 BTUh, or 53 tons. Below are our estimated costs and payback analysis for both, the existing plant and the new plant (i.e. chillers efficiencies are different:

EXISTING PLANT				
Chiller Efficiency	**Electricity Cost**			
kw/ton	$/kwh			
0.825	$0.10			
Boiler Efficiency	**Cost per Therm**	**Cost per 100 MBTUh**	**Cost per 880 MBTUh**	
80%	$1.10	$1.38	$12.10	
HEAT RECOVERY CHILLER				
Chiller	**Electricity Cost**	**Heat BTUh**	**Cost to produce 880 MBTUh**	
kw	$/kwh			
72.5	$0.10	880300	$7.25	
Heating BTUh	Cooling BTUh	Equivalent Chiller Plant Tons		
885000	635000	53		
savings from not using the main boiler and running the HRC			$4.85	
cost of tons of cooling produced by main plant in same hour			$4.37	
total savings from using the HRC			$9.22	
Hours per year	**Cost savings per hour**	**Cost savings per year**	**Cost of chiller**	**Simple payback**
2700	$9.22	$24,894	$50,000	2.0

NEW PLANT			
Chiller Efficiency	**Electricity Cost**		
kw/ton	$/kwh		
0.6	$0.10		
Boiler Efficiency	**Cost per Therm**	**Cost per 100 MBTUh**	**Cost per 880 MBTUh**
80%	$1.10	$1.38	$12.10

HEAT RECOVERY CHILLER			
Chiller	**Electricity Cost**	**Heat BTUh**	**Cost to produce 880 MBTUh**
kw	$/kwh		
72.5	$0.10	880300	$7.25
Heating BTUh	Cooling BTUh	Equivalent Chiller Plant Tons	
885000	635000	53	
savings from not using the main boiler and running the HRC			$4.85
cost of tons of cooling produced by main plant in same hour			$3.18
total savings from using the HRC			$8.03

Hours per year	Cost savings per hour	Cost savings per year	Cost of chiller	Simple payback
2700	$8.03	$21,679	$50,000	2.3



HEAT RECOVERY CHILLER
HEATING HOT WATER FLOW DIAGRAM

DR./CK. EH/GS	POLK STATE COLLEGE WINTER HAVEN CAMPUS CHILLER STUDY	CARASTRO & ASSOCIATES, INC. CONSULTING ENGINEERS EB-0001160 2609 W. DE LEON STREET TAMPA, FLORIDA 33609 TELEPHONE: (813) 874-9494 WWW.CARASTRO.COM	SHEET NO. H1
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APPENDIX A

Polk State College, Winter Haven Campus

LIFE CYCLE COST ANALYSIS

CHILLER PLANT UPGRADES - POLK STATE COLLEGE
C&A # 5747

Data Sheet 1

SYSTEM DESCRIPTION

Scheme 1	(2) Water Cooled Chillers, (2) Cooling Towers, variable primary flow
Scheme 2	(1) Water Cooled Chiller, (1) Cooling Tower, (2) Air Cooled Chillers, (18) Ice Tanks, (1) Heat Exchanger
Scheme 3	(3) Air Cooled Chillers, (30) Ice Tanks, (1) Heat Exchanger
Scheme 4	(3) Air Cooled Chillers, (22) Ice Tanks, (1) Heat Exchanger

ASSUMED ENERGY UNIT COSTS

Fuel Type	Units	BTU/Unit	Unit Cost
Electric	KWh	3,413	$0.06148
Demand charge	KWh	3,413	$10.30

ANNUAL OPERATING COSTS

Scheme	Maintenance Supplies	Maintenance Labor	Operating Labor	Electrical Consumption
Scheme 1	$5,000	$10,000	included	$283,454
Scheme 2	$5,500	$10,500	included	$375,081
Scheme 3	$2,000	$6,000	included	$436,804
Scheme 4	$2,000	$6,000	included	$381,259

HVAC SYSTEM INSTALLED COSTS*

(GROSS FROM DATA SHEET 4)

Scheme 1	$2,021,280
Scheme 2	$2,477,920
Scheme 3	$2,460,320
Scheme 4	$2,448,360

Engineer: Carastro & Associates, Inc.

Date: March 4, 2014

The costs listed on this page represent the engineer's opinion of probable cost. A licensed contractor should be consulted for accurate construction costs. *REFER TO PAGE 6 FOR A LIST OF ASSUMPTIONS MADE.*

Polk State College, Winter Haven Campus

LIFE CYCLE COST ANALYSIS

CHILLER PLANT UPGRADES - POLK STATE COLLEGE
C&A # 5747

Data Sheet 2

SINGLE EXPENDITURE DATA

PWF is multiplier from Single Expenditure Chart Present Worth = (Item Cost in Today's Dollars) x CPI x AF x PF x PWF								
Scheme	**Item Name**	**Year**	**Item Cost**	**(1) CPI**	**(2) AF**	**(3) PF**	**(4) PWF**	**Present Worth**
1	Chillers	23	$660,000	2.4647	0.0887	1.8080	0.2109	$55,018
	(2) Cooling Towers	20	$285,000	2.1911	0.0944	4.1002	0.2584	$62,456
	(4) Pumps	20	$30,000	2.1911	0.0944	4.1002	0.2584	$6,574
	DDC	15	$106,400	1.8009	0.1098	7.0236	0.3624	$53,553
2	(1) 600-ton WC Chiller	23	$370,000	2.4647	0.0887	1.8080	0.2109	$30,844
	(1) Cooling Towers	20	$143,000	2.1911	0.0944	4.1002	0.2584	$31,338
	(2) 225-ton AC Chillers	15	$325,000	1.8009	0.1098	7.0236	0.3624	$163,577
	(7) Pumps	20	$43,000	2.1911	0.0944	4.1002	0.2584	$9,423
	(18) Ice Tanks	20	$305,000	2.1911	0.0944	4.1002	0.2584	$66,839
	(1) Heat Exchanger	20	$112,000	2.1911	0.0944	4.1002	0.2584	$24,544
	Glycol System	15	$8,000	1.8009	0.1098	7.0236	0.3624	$4,027
	DDC	15	$145,200	1.8009	0.1098	7.0236	0.3624	$73,081
3	(3) 350-ton AC Chillers	15	$675,000	1.8009	0.1098	7.0236	0.3624	$339,738
	(5) Pumps	20	$32,000	2.1911	0.0944	4.1002	0.2584	$7,013
	(30) Ice Tanks	20	$475,000	2.1911	0.0944	4.1002	0.2584	$104,094
	(1) Heat Exchanger	20	$112,000	2.1911	0.0944	4.1002	0.2584	$24,544
	Glycol System	15	$8,000	1.8009	0.1098	7.0236	0.3624	$4,027
	DDC	15	$126,400	1.8009	0.1098	7.0236	0.3624	$63,619
4	(2) 350-ton + (1) 300-ton AC Chillers	15	$675,000	1.8009	0.1098	7.0236	0.3624	$339,738
	(6) Pumps	20	$40,000	2.1911	0.0944	4.1002	0.2584	$8,766
	(24) Ice Tanks	20	$385,000	2.1911	0.0944	4.1002	0.2584	$84,371
	(1) Heat Exchanger	20	$178,000	2.1911	0.0944	4.1002	0.2584	$39,008
	Glycol System	15	$8,000	1.8009	0.1098	7.0236	0.3624	$4,027
	DDC	15	$134,600	1.8009	0.1098	7.0236	0.3624	$67,746

TOTAL MAJOR REPAIR COST
(Sum of Present Worths on this page)

Scheme 1	$177,602
Scheme 2	$403,673
Scheme 3	$543,034
Scheme 4	$543,655

Engineer: Carastro & Associates, Inc.

Date: March 4, 2014

Notes

(1) consumer price index; 4% cost increase at time of replacement
(2) annual payment for the life of equipment (@ 7%)
(3) lump sum of eqpm. cost for the remainder of service life from year of replacement to year 25 (@ 7%)
(4) adjustment to today's dollars (@ 7%)

The costs listed on this page represent the engineer's opinion of probable cost. A licensed contractor should be consulted for accurate construction costs. *REFER TO PAGE 6 FOR A LIST OF ASSUMPTIONS MADE.*

Polk State College, Winter Haven Campus

LIFE CYCLE COST ANALYSIS

CHILLER PLANT UPGRADES - POLK STATE COLLEGE
C&A # 5747

Data Sheet 3

PRESENT WORTH IN TODAY'S DOLLARS

Initial Cost = HVAC System Installed Cost
Supplies = Annual Maintenance Supplies x 11.65
Labor = Annual Total Labor x 11.65
Major Repair = Total Major Repair Costs for 25 years
Energy Cost = Annual Energy Cost x 12.78

FINANCIAL SUMMARY (Total owning and operating cost over 25-year life of school)

	Scheme 1	Scheme 2	Scheme 3	Scheme 4
Initial Cost	$2,021,280	$2,477,920	$2,460,320	$2,448,360
Supplies	$58,250	$64,075	$23,300	$23,300
Labor	$116,500	$122,325	$69,900	$69,900
Major Repair	$177,602	$403,673	$543,034	$543,655
Energy Cost	$3,622,542	$4,793,536	$5,582,352	$4,872,488
Total O&O Cost	**$5,996,174**	**$7,861,529**	**$8,678,906**	**$7,957,703**
Estimated TECO Rebate	**$0**	**$86,400**	**$144,000**	**$115,200**
Revised First Cost	**$5,996,174**	**$7,775,129**	**$8,534,906**	**$7,842,503**
Percent Increase		*29.67%*	*42.34%*	*30.79%*
Ranking of Schemes	**1**	**2**	**4**	**3**

Campus AC floor area	360,000	Square Feet
Block Load Tonnage	1,200	Tons

Engineer: Carastro & Associates, Inc.

Date: March 4, 2014

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Polk State College, Winter Haven Campus

LIFE CYCLE COST ANALYSIS

CHILLER PLANT UPGRADES - POLK STATE COLLEGE
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Data Sheet 4

Net, Total A/C Floor Area	360,000	**Total A/C Tonnage**	1,200

ESTIMATED HVAC SYSTEM INSTALLED COST

Scheme 1	$1,439,400	**Scheme 2**	$1,849,200	**Scheme 3**	$1,786,400	**Scheme 4**	$1,759,600

ASSOCIATED ESTIMATED CONSTRUCTION COSTS

Electrical Service

Scheme 1	$417,000	**Scheme 2**	$424,000	**Scheme 3**	$507,000	**Scheme 4**	$522,000

BUILDING FLOOR AREA

Scheme 1	$0	**Scheme 2**	$0	**Scheme 3**	$0	**Scheme 4**	$0

STRUCTURAL AND ARCHITECTURAL COSTS

Scheme 1	$35,000	**Scheme 2**	$70,000	**Scheme 3**	$45,000	**Scheme 4**	$45,000

ENHANCED HURRICANE PROTECTION AREA (EHPA)

Scheme 1	$0	**Scheme 2**	$0	**Scheme 3**	$0	**Scheme 4**	$0

CHEMICAL TREATMENT COST

Scheme 1	$29,000	**Scheme 2**	$33,000	**Scheme 3**	$20,000	**Scheme 4**	$20,000

TEST AND BALANCE SERVICES

Scheme 1	$880	**Scheme 2**	$1,720	**Scheme 3**	$1,920	**Scheme 4**	$1,760

DEMOLITION, DISPOSAL, GENERAL CONDITIONS

Scheme 1	$100,000	**Scheme 2**	$100,000	**Scheme 3**	$100,000	**Scheme 4**	$100,000

TOTAL, ESTIMATED GROSS OR INITIAL COST TO INSTALL HVAC SYSTEM (with associated costs from above)

Scheme 1	$2,021,280	**Scheme 2**	$2,477,920	**Scheme 3**	$2,460,320	**Scheme 4**	$2,448,360

Engineer: Carastro & Associates, Inc.

Date: March 4, 2014

The costs listed on this page represent the engineer's opinion of probable cost. A licensed contractor should be consulted for accurate construction costs. ***REFER TO PAGE 0 FOR A LIST OF ASSUMPTIONS MADE.***

LIFE CYCLE COST ANALYSIS

CHILLER PLANT UPGRADES - POLK STATE COLLEGE
C&A # 5747

Data Sheet 5

Electricity cost estimates					
Scheme	Description	Chillers+ Towers	Pumps	Demand Charge Reduction	Chiller Plant Total
1	(2) Water Cooled Chillers, (2) Cooling Towers, variable primary flow	$220,194	$63,260	$0	$283,454
2	(1) Water Cooled Chiller, (1) Cooling Tower, (2) Air Cooled Chillers, (18) Ice Tanks, (1) Heat Exchanger	$337,193	$69,028	$31,140	$375,081
3	(3) Air Cooled Chillers, (30) Ice Tanks, (1) Heat Exchanger	$430,564	$58,424	$52,184	$436,804
4	(3) Air Cooled Chillers, (22) Ice Tanks, (1) Heat Exchanger	$371,496	$53,700	$43,937	$381,259
Supplies and Labor estimates					
1	Supplies				$5,000
	Labor				$10,000
2	Supplies				$5,500
	Labor				$10,500
3	Supplies				$2,000
	Labor				$6,000
4	Supplies				$2,000
	Labor				$6,000

The costs listed on this page represent the engineer's opinion of probable cost. A licensed contractor should be consulted for accurate construction costs. ***REFER TO PAGE 6 FOR A LIST OF ASSUMPTIONS MADE.***

LIFE CYCLE COST ANALYSIS

CHILLER PLANT UPGRADES - POLK STATE COLLEGE
C&A # 5747

Data Sheet 6

The following assumptions were made while assembling this brief analysis:

1) Annual electricity costs used in this calculation are only those for chillers, cooling towers and pumps.
2) Equipment sizing shown on this form is based on preliminary evaluations and shall be reviewed and revised during a chiller plant design project.

Engineer: Carastro & Associates, Inc.

Date: March 4, 2014

The costs listed on this page represent the engineer's opinion of probable cost. A licensed contractor should be consulted for accurate construction costs. ***REFER TO PAGE 6 FOR A LIST OF ASSUMPTIONS MADE.***

APPENDIX B

As an alternative to chemically treating the condenser water, we recommend reviewing the system designed by Water Conservation Technology International. It consists of one or multiple water softeners and controls monitored on a regular basis that offer significant water savings. Below, you will find an example of potential savings on a 1,200 ton chiller plant. In this example, the net water savings exceed $29,000 per year and the system's payback is only twelve months.

If Polk State College wants to further research this item, we would gladly put together a presentation by the local manufacturer's representative.

Water Conservation Technology International

EQUIPMENT SELECTION & PERFORMANCE GUIDE

U.S. Patents 6929749; 6949193; 6998092; 7122148; 7517493; 7708939; 7955553.

Use restricted to licensed WCTI distributors and agents.

Water and cost calculations are based on average^ load and water quality.

1200 Tons	*City*	*State*	Distributor =>	*Natural Green Chemistry*		
Tower Information	**Current**	**WCTI**	**Equipment Design Selections**			
Tower / Evap Cooler Name =>	Tower 1	Tower 1	Click & Select Tons or RDT =>		Tons	
Tons Design Capacity =>	1200	1200	Data in all (Blue =>) cells is required for correct design			
Tons Design Evaporation GPM	30.0	30.0	ESPG V0114 USA	HES Models	HEF Models	
Tons Peak Load =>	1000	1000	Select HES & HEF =>	HESDA-RPA 32 ^03	Not Required ^01	
Tons Peak Evaporation GPM	25.0	25.0		HESDA-RPA 32 ^03	# Units =>	1
Tons Average^ Load =>	500	500	Same HEF Size =>	Not Required ^01	# Units =>	0
Tons Average^ Evaporation GPM	12.5	12.5	Select HES & HEF Models, then enter # Units (Tons or RTD)			
	3.0				# Units =>	1
	5,000				# Units =>	0
	75					
	70					
Current COC =>	2.5	50	<= ZBD / COC; depends on tower drift eliminators, water losses			
Blowdown / Water Loss GPM	8.3	0.3	<= Zero Tower BD, water losses only from drift or small leaks.			
Make-Up GPM	20.8	12.8				
Make-Up GPD	30,000	18,367				
Tower Makeup Water Chemistry	# Note Actions Below for Correct HES / HEF Design and Operation					
MU Peak TH (as CaCO3) =>	250	0.5	<= High MU Peak TH, use reduced HES Service Run below			
MU Avg^ TH (as CaCO3) =>	200	0.2				
Peak TDS =>	450					
Avg TDS =>	350					
Peak Turbidity NTU* =>	0.7	<= *If city water, Turbidity is normally low, so input "0" for Avg and Peak				
Avg Turbidity NTU* =>	0.2					
MU Water SIO2, Mg/L =>	10.0					
MU Water Total ALK, Mg/L =>	100.0					
MU Water Chlorine, Mg/L =>	0.5					
Regenerations per Day	Average^ TH	1.5				
Gallons per HES Service Run	Average^ TH	11,904	<= Modify HES (GrnPG) to match this Gallons per Service Run			
Water Use Reduction / Water Cost Savings Calculations						
Blowdown Water Use Reduction	GPM	8.1	** Enter current MU cost below, if no lower cost option			
Make-up cost /1000 Gals =>	Current MU	$ 3.00	$ 3.00	<= Enter lower cost source water **		
Blowdown cost /1000 Gals =>	Sewer / WWT	$ 4.00	** Examples: Recycled WW; RO reject; Storm; Well water			
Load Hours (vs Avg^ Tons) =>	Hours/Day	24.0	<= Do not reduce hours if Avg^Tons load input to B14			
Load Days (vs Avg^ Tons) =>	Days/Year	365	<= Do not reduce days if Avg^Tons load input to B14			
Make-up Water Reduction	Gallons/Day	11,633				
Blowdown Water Reduction	Gallons/Day	11,633				
Current Annual Water Use	Gallons	10,950,000				
WCTI Annual Water Use	Gallons	6,704,082				
Annual Blowdown Saved	**Gallons**	**4,245,918**				
Make-up Water Savings	$/Year	$ 12,738				
Blowdown Water Savings	$/Year	$ 16,984				
Lower Cost Water Savings	$/Year	$ -	<= Lower cost source water used by tower evaporation			
Total Water Savings	$/Year	$ 29,721				
Regeneration Water Cost	$/Year	$ 478				
Net Water Savings	$/Year	$ 29,244				
Regenerate Water Usage / Salt Use and Cost Calculations						
Regenerate Waste Water Volume^		Salt Use^	Use clean salt			
Gallons Per Regeneration	121	salt #/cuft resin	Prefer pellet salt			

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Gallons Per Day	187	4.0	
Gallons Per Year	68215	4.0	<= WCTI Design
Salt Use / Day	Lb / Day	52	<= Daily use rates will be higher during peak loads / hardness
Salt Cost / Lb	$ / Lb	$ 0.13	<= You can lower salt cost with use of Bulk Salt / Brine Maker
Annual Salt Cost *Lbs / Yr =>*	19148	$ 2,489	Example, Bulk Brine Maker = $80,000. Bulk salt cost $0.04 / Lb.
NET ANNUAL BD WATER SAVINGS (less salt cost)		$ 26,755	TDS Lbs /Yr from current BD => 31,963
WCTI Pre-treatment Equipment Cost and Water Savings ROI Analysis			
HES Systems; # units / cost =>	1x HESDA-RPA 32	$ 14,300	
HEF Systems; # units / cost =>	0x Not Required ^	$ -	
Installation Cost Estimate	enter 0 or num =>	$ 10,000	
Shipping Cost Estimate	enter 0 or num =>	$ 1,000	Example
Equipment Cost Additions	enter 0 or num =>	$ 750	Wireless hardware and service
Total Equipment Cost		$ 26,050	
Equipment ROI (water savings)	Months (ROI)	12	
WCTI Distributor Program Fee	Annual Cost	$ 14,000	Example
Prior Chemical / Program	Annual Cost	$ 7,500	Example
Prior Maint (scale, corr, clean)	Annual Cost	$ 5,000	Example
Prior Prog + BD + Maint (- WCTI)	Annual Cost	$ 25,255	Example
WCTI Net Program Savings ROI	Months (ROI)	12	Example

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