MDNR CONSUMPTIVE WATER USE STUDY - APPENDIX

FOR THE

MINNESOTA DEPARTMENT OF NATURAL RESOURCES

FEBRUARY, 1990

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Prepared By:

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OSM Commission #4485

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APPENDIX

Calculations

ASSUMPTIONS

Electrical Costs.
A value of $.045/KWH will be assumed.

Pumping Costs.
In cases where the brake horsepower or head pressure of the pump is not known, it is assumed that the motor is loaded to 85% of rated horsepower. Where motor efficiency is not known, a 90% value for efficiency is assumed.

$$HP \times .746 \frac{KW}{HP} \times .85 \text{ LOADING} \times \frac{1}{.90 \text{ EFFICIENCY}} \times \frac{\$.045}{KWH} = \frac{\$}{HR}$$

Chiller Capacity.

Chilled Water Pumps $$Tons = \frac{GPM \times TD}{24}$$

Condenser Water Pumps $$Tons = \frac{GPM \times TD}{30}$$ (Where Condenser Heat Rejection is 1.25 x Capacity = 1.25 x 24 = 30)

Annual Operating Costs.

Pumps

$$HP \times .746 \times .85 \times \frac{1}{.90} \times \frac{\$.045}{KWH} \times \frac{\text{OPERATING HRS}}{YEAR} = \frac{\$}{YEAR}$$

Chillers/Heat Pumps

$$KW \times \frac{HR}{YR} \times \frac{\$.045}{KWH} = \frac{\$}{YR}$$ (Where KW Input Data is Available at Operating Conditions)

- OR -

$$TONS \times \frac{KW}{TON} \times \frac{HR}{YR} \times \frac{\$.045}{KWH} = \frac{\$}{YR}$$ (Where KW/Ton is Estimated for Particular Device and Condenser EWT/LWT)

APPENDIX

LIFE CYCLE COST CALCULATIONS

ASSUME: 20 YRS, 8% DISCOUNT (COST OF $), NO SALVAGE VALUE

A) ESCALATION CALC - ELECTRICAL COSTS ESCALATE @ 5%/YR

DEF= DISCOUNT-ESCALATION FACTOR, DEF
WHERE; DEF BASED ON N=20, E=5, D=8
(DEF 20,5,8) = 15.07582
source; DEF Tables in
"life Cycle Costing"
Robt J. Brown & Rudolph R. Ynuck
Fairmont Press, 1980

B) ESCALATION CALC - WATER TREATMENT & MISC COSTS @ 4%/YR

DEF = DISCOUNT-ESCALATION FACTOR
(DEF 20,4,8) = 13.77

C) RESULTANT PRESENT WORTH

PW = ANNUAL OPER COST x DEF

WHERE ; PW= PRESENT WORTH IN 1989 DOLLARS FOR 20 YR OPER, 8% COST OF MONEY, DEF AT (4 OR 5)% ESCALATION.

NOTE: SUNK COSTS (EXISTING INSTALLATIONS) NOT INCL: PW IS FOR OPER FROM 1989 FORWARD. FIRST COSTS OF CONVERSION ARE COST x 1.0 IN 1989 DOLLARS.

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LIFE CYCLE COSTING - BROWN & YANUCK
FAIRMOUNT PRESS, 1980

N = 20 20 YRS
D = 8 % (COST OF $) = DISCOUNT
E = 4 % OR 5 % = ESCALATION
; DEF = DISCOUNT - ESCALATION FACTOR

PW = A x DEF PW = PRESENT WORTH, A = ANNUAL

$$DEF = \frac{(1+e)}{1+i} + \frac{(1+e)^2}{(1+i)^2} \cdots \frac{(1+e)^n}{(1+i)^n}$$ EQUA 10-1

TABLE
N = 20
D = 8
E = 5 → DEF = 15.07582

CALCULATE EQUA 10-1
N = 20
D = 8
E = 4

DEF = 13.77

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APPENDIX

WATER TREATMENT
INSTALLATION AND OPERATING COSTS

A) FIRST COST
1) ACID PROGRAM
BASED ON DEARBORN CO. QUOTE 10/9/89
1800 GPM SYSTEM ; COST = $4033

INCREASE PUMPS + TANKS FOR LARGER SYSTEMS :

2750 GPM

$4033 + \left[\text{PUMP } \$558 \times \left(\frac{2750}{1800}\right) + \text{TANK } \$123 \left(\frac{2750}{1800}\right) \right] - 558 - 123 = \$4392$

3860 GPM

$4033 + \left[(558 + 123)\left(\frac{3860}{1800}\right) \right] - 558 - 123 = \$4812$

4050 GPM

$4033 + \left[(558 + 123)\left(\frac{4050}{1800}\right) \right] - 558 - 123 = \$4884$

FIRST COST OF WATER TREATMENT IS SMALL RELATIVE TO TOWER COST (~53-60$/TON) AND TOWER INSTALLATION — THE WATER TREATMENT FIRST COST WILL BE ROLLED INTO TOTAL 30% CONTINGENCY USED IN FIRST COST

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OPERATING COSTS – CHEMICAL TREATMENT

ASSUME: CITY OF ST. PAUL, TOTAL HARDNESS = 28.2
ALKALINITY = 56

ASSUME: TOWER WATER TEMP ΔT = 95-85 = 10°; WB = 78°
THEREFORE RANGE = 10°, APPROACH = 7°

CALCULATE MAKE-UP (MU) GALLONS BASED ON DESIRED CHLORINE CONCENTRATIO[N] OF 750 PPM & CHLORINE CONCENTRATION OF MAKEUP WATER IS 250 PPM.

NUMBER CYCLES = 750/250 = 3

1) EVAPORATION RATES

2750 GPM 10° ΔT → 27.5 GPM

3864 GPM 10° ΔT → 38.6 GPM

4050 GPM → 40.5 GPM

2) BLOW-DOWN RATES @ 3 CYCLES

2750 GPM = 9 GPM

3864 GPM = 19.4 GPM

4050 GPM = 20.5 GPM

TOTAL MAKE-UP = EVAP + BLOWDOWN = TOTAL

GAVIIDAE	2750 :	27.5 + 9	=	36.5 GP[M]
GENERAL MILLS	3864 :	38.6 + 19.4	=	58.0
HONEYWELL	4050 :	40.5 + 20.5	=	61.0
METHODIST	3441 :	38.6 + 19.4	=	58

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WATER TREATMENT COSTS (CONT'D)

SYSTEM GPM 2750	MAKEUP GPM	GAL/DAY		* GAL/YR @ .90 FACTOR $\times 10^{?}$
2750	36.5	$\frac{GAL}{MIN} \times \frac{60\,MIN}{HR} \times \frac{24\,H}{DY} =$	52 560	1.726
3864	58.0		83 520	2.744
4050	61.0		87840	2.886

* LOAD FACTOR OF 90% ASSUMED.

ACID PROGRAM – (DEARBORN CO.)

POLYELph 975 @ \$.04/100 GAL MU
(SCALE & CORROSION INHIBITOR)

ACID @ .0266/100 GAL MU

DEARCIDE 712 @ \$225.00 ANNUAL ONE-TIME PURCHASE
(BIOCIDE/ALGAECIDE)

DEARCIDE 735 @ \$153 ANNUAL ONE-TIME PURCHASE
(BIOCIDE/ALGAECIDE)
TTL = 378

TOTAL COSTS

	SYSTEM GPM	GAL MAKEUP	TOWER HRS ×	ACID + SCALE INHIB COST PER 100 GAL	+ ALGAECIDE BIO/ALGAE	= ANNUAL TREATMENT COST TOTAL
[illegible]	2750	36.5 GAL/M × 60 MIN/HR	× 1450	(.04 + .0266)/100	+ 378	= \$ 2493
[illegible]	3864	58 GPM	1700 HOURS		378	= 4318
HONEYWELL	4050	61 GPM	2700		378	= 6959
Methodist	3441	58 GPM	2100 HOURS		378	= 5245

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COOLING TOWERS — WATER MAKEUP

A) A MAXIMUM RATE OF MAKE-UP WATER AS A PERCENT OF TOTAL WATER CIRCULATED IS 5%. THIS WAS A FIGURE OFFERED BY MEMBERS OF ONCE-THROUGH ADVISORY GROUP AT JAN 4, 1990 MEETING AT MDNR AND GENERALLY AGREED AS ACCURATE.

THIS WAS USED IN "METHODS AND MEASURES" SECTION. IT IS A HIGH FIGURE, REPRESENTING A MAXIMUM RATE OF MAKE-UP REQUIREMENTS.

EXAMPLE$_1$: GENERAL MILLS AT 1284 TONS = $\frac{GPM \times 10^{\circ} RANGE}{30}$ ⇒ GPM = 3852 G

MAKE-UP = 3852 x .05 = 192.6 GPM

EXAMPLE$_2$: USED IN "METHODS & MEASURES" A TYPICAL 100 TONS

100 TONS = $\frac{GPM \times 10}{30}$ ⇒ GPM = 300

MAKEUP = 300 x .05 = 15 GPM

B) ACTUAL RATES OF MAKE-UP

ARE TYPICALLY LESS THAN 5% — MAY BE 1.5% TO 2% DEPENDING ON CONDITIONS.

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WATER MAKE-UP
B) (CONTINUED) ACTUAL RATES OF MAKE-UP

1) SOURCE: "COOLING TOWER FUNDAMENTALS"
MARLEY COOLING TOWER CO,
MISSION, KANSAS
ED, JOHN C. HENSLEY, 1982

PERCENT EVAPORATION = RANGE x .08 %
PERCENT DRIFT = .02 %
PERCENT BLOWDOWN = (GRAPH @10° RANGE & 3 # CONCENTR) = .4 %

FOR 10° RANGE, 85/95, 3 #'s OF CONCENTRATIONS:
E = 10 x .08 = .80 %
D = = .02 %
B = = .40 %
1.22 %

EX, : GENERAL MILLS @ 3852 GPM & 10° RANGE & #3 CON
3852 x .0122 = 47.0 GPM MU

2) SOURCE: BETZ CO. OF TREVOSE, PENN.

"COOLING WATER CALCULATIONS" CALCULATOR; © 1979
EX, : GEN'L MILLS @ 3852, 3 CONCENTR, 10° RANGE
EVAP = 38.5
BLOWDN = 19.4
TTL 57.9 GPM

57.9 / 3852 = .01503 = 1.5 % MAKE-UP

THIS WAS THE METHOD USED TO CALCULATE MAKE-UP REQUIREMENTS IN THE ANNUAL COSTS OF CONVERSION FOR THE 4 FACILITIES.

ECONOMIC & KW IMPACT

```
.
. SUM MBH
   125 records summed
      MBH
  567653.9
```

47304 TONS

```
. SUM R_MGY
   125 records summed
      R_MGY
    11158.0
```

REPORTED 1987 MGY

```
. SUM MBH FOR USE='CW COIL'
    37 records summed
      MBH
  109718.5
```

9143 TONS

```
. SUM MGY FOR USE = 'CW COIL'
Variable not found.
         ?
SUM MGY FOR USE = 'CW COIL'
. SUM R_MGY FOR USE='CW COIL'
    37 records summed
      R_MGY
     3399.0
.
. SUM MBH FOR USE='CHILLER'
    10 records summed
      MBH
  126005.0
```

10500 TONS

```
. SUM R_MGY FOR USE='CHILLER'
    10 records summed
      R_MGY
     2001.1
. SUM MBH FOR USE='HEAT P'
    11 records summed
      MBH
   47440.6
```

3953 TONS

```
. SUM R_MGY FOR USE='HEAT P'
    11 records summed
      R_MGY
     1490.6
. SUM MBH FOR USE='COND'
    43 records summed
      MBH
  261339.8
```

21778 TONS

```
. SUM R_MGY FOR USE='COND'
    43 records summed
      R_MGY
     4017.4
. QUIT
*** END RUN   dBASE III PLUS
```

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TOTAL ELECTRICAL REQMTS

KW IMPACT BASED ON A SUM OF KW OF EACH CATEGORY X KW/TON OF EACH CATEGORY —

KW/TON BASED ON CALCULATONS AS USED IN "SEVEN TYPICAL SYSTEMS"

CW COIL (ITEM D) — KW

9143 X (.50 - .105) KW/TON = 3611.5

CHILLER (ITEM E)

10,500 TON X .425 KW/TON X .20 INCREASE = 89[illegible]

HEAT PUMPS (ITEM B)

3953 X 1.086 KW/TON X .20 INCREASE = 858.6

CONDENSER (ITEM C) X .20 INCREASE = 1970.5

21778 X .4524 KW/TON

7,333 KW

TOTAL TONS = 47304

22 Dec '89

Kris Leaf:

Environmental impacts for "assessment of once-through well water systems" should use the following data for calculations:

assume load will be met with metro plants

heat rate is 11,200 Btu/kWh
emission rates to use are ← million
sulfur dioxide : 1.2 lbs. SO_2/MBtu
oxides of nitrogen: 0.9 lbs NO_x/MBtu
particulates: 0.05 lbs part./MBtu
carbon dioxide: ~~call Patti Boyce @ 7630 for this #~~
→ 3,740 ~~4,070~~ lbs./~~ton~~ of coal (subbituminous, 51% carbon content) ← coal type

(Energy in coal = 8500 Btu/lb)

I have done some of the mark up on the draft of the report. Please do not include emissions of carbon monoxide, volatile organic compounds, lead, or PM-10. Their emission rates are estimates only.

Please send me a revised copy of the report for review. I apologize for the delay in getting you this information; other urgent issues came up as well. Call me @ 5628 w/ questions.

Regards,

Janet Anderson

Post-It™ brand fax transmittal memo 7671	# of pages ▸ 2
To George Poltentoger	From Kris Leaf
Co.	Co. NSP
Dept.	Phone # 330-6087
Fax # 331-3806	Fax #

12/27/89

[redacted]

The thermal effects of generating additional kilowatt-hours at peak periods by metro area plants:

To air:	1,548	Btu/kWH
To river water:	5,000	Btu/kWH
Total thermal effects:	6,548	Btu/kWH

Kris

Metro plants (i.e. Riverside + Black Dog) discharge to river water, not towers.

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ENVIRONMENTAL IMPACT

A) KW ADDED - ESTIMATES

OSM : 7.33 MW

SAM STEWART (BOMA) : 15 MW

NSP : (PRELIMINARY) : 5 MW

B) EQUIVAVELNT FULL LOAD HOURS -
NSP : 876 HRS

ASSUME 5 MW

$5 \times 10^6 W \times \frac{KW}{10^3 W} \times 876\ HR = 4.38 \times 10^6\ KWH$

C) HEAT RATE OF COAL, PER NSP = 11200 BTU/KWH

$4.38 \times 10^6\ KWH \times \frac{11200\ BTU}{KWH} \times \frac{MM\ (Million)}{10^6} = 49056\ MM$ (Mil

D) EMMISION RATES PER NSP, ANNUAL

SO_2 : $\frac{1.2\ lbs\ SO_2}{MBTU} \times 49056\ MBTU = 58867$ lb

NO_x : $\frac{.9\ lb}{MBTU} \times 49056 = 44150$ lb

PARTICULATES : .05 lbs × 49056 = 2453 lb

CO_2 $\frac{1070\ lbs\ CO_2}{2000\ lb\ coal} \times \frac{lb\ coal}{8500\ Btu} \times 49056 \times 10^6\ BTU =$

Total thermal EFFECTS:

$6558\ \frac{BTU}{KWH} \times 4.38 \times 10^6\ KWH = 2.868 \times 10^{10}\ BTU$

(14)

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ENVIRONMENTAL IMPACT CONT'D

COST FOR PLANT
PER KRIS LEAF @ NSP
1990 CONSTR COSTS
@ ESTIM 5 MW

GAS
$\frac{\$536}{KW} \times 5000\ KW = \$2.68$ MILLION — BUT GAS IS EXPENSIVE

COAL
$\frac{\$1395}{KW} \times 5000 = \$6.975 \times 10^6$ — BUT COAL IS CHEAP TO BURN

TABLE 24:
DETERMINATION OF ELECTRIC AND WATER USAGE EFFICIENCIES FOR SEVEN COMMON HVAC SYSTEMS

SYSTEM DESCRIPTION

A CHILLED WATER
50 DEG WELL WATER ENTERING EVAPORATOR AND LEAVING AT 45 DEG, THEN FLOWING THROUGH SYSTEM LOAD AND DISCHARGING TO STORM AT 55 DEG.
(NOT USED IN FOUR FACILITIES; FOR EXAMPLE ONLY.)

B HEAT PUMP
50 DEG WELL WATER ACTS AS HEAT SINK FOR HEAT PUMP WHICH DISCHARGES TO STORM AT 85 DEG.

C CONDENSER
50 DEG WELL WATER ENTERING CONDENSER AND DISCHARGING TO STORM AT 80 DEG.

D COOLING COILS
50 DEG WELL WATER ENTERING COOLING COILS AND DISCHARGING TO STORM AT 60 DEG.

E EVAPORATOR TO CHILLED WATER COILS TO CONDENSER
50 DEG WELL WATER ENTERING EVAPORATOR AND LEAVING AT 45 DEG, THEN FLOWING THROUGH COOLING COILS AND LEAVING AT 55 DEG., THEN FLOWING TO CONDENSER AND DISCHARGING TO STORM AT 67.5 DEG.

F COOLING TOWER
50 DEG WELL WATER ENTERING COOLING TOWER AS MAKEUP WATER.

G COOLING COILS TO CONDENSER
50 DEG WELL WATER ENTERING COOLING COILS AND LEAVING AT 60 DEG., THEN FLOWING TO CONDENSER AND DISCHARGING TO STORM AT 85 DEG.

* *

-----> COST FACTOR: $0.045 / KW <-----

SYSTEM	TONS	D.T.	GPM	KW	ELEC COST	GPM/TON	KW/TON
A	100	10.0	240	51.5	$2.32	2.40000	0.51500
B	100	35.0	86	108.6	$4.89	0.85714	1.08640
C	100	30.0	100	45.2	$2.04	1.00000	0.45240
D	100	10.0	240	10.5	$0.47	2.40000	0.10500
E	100	17.5	240	42.5	$1.91	2.40000	0.42500
F	100	10.0	15	82.0	$3.69	0.15000	0.82000
G	150	35.0	120	54.9	$2.47	0.80000	0.36593

NOTE: THESE COSTS DO NOT INCLUDE WATER TREATMENT AND MAKE-UP WATER COSTS, SYSTEM EFFICIENCY LOSSES, ETC., BUT ARE ONLY EXAMPLES OF AFFECT OF WELL-WATER USAGE.

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YIC

TABLE 24
SEVEN COMMON SYSTEMS — CALCULATIONS

A) CHILLED WATER CRITERIA

ASSUME: CHILLER TONS = 50 @ 50/45 WELL WATER EWT/LWT

SYSTEM TONS (TO BLDG): 100 TON COIL LOAD.

COILS @ 45/55

1) GPM OF COIL:

$$\text{TONS} = \frac{\text{GPM } \Delta T}{24}$$

GPM = 240

SO:

WELL PUMP @ 240 GPM

2) KW

1) CHILLER @ 85/95 : .6 KW/TON × 50 TONS = 30 KW
2) WELL PUMP BIG 1510-3E 10 HP = 8.53 KW
3) COND PUMP BIG 1510-3BB 5 HP = 4.2 KW
4) TOWER FANS EVAPCO "AT 4-94" TOTAL 6HP = 4.2 KW

46.9

ASSUME: 51.4

3) 100 TONS COOLING

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B) HEAT PUMP DESIGN CRITERIA -

1) GPM 50 EWT / 85° LWT Heat exch, WELL WATER SIDE

100 TONS COOLING 125 TONS HEAT REJECTION

HEAT EXCH

$125 = \frac{GPM \; 35}{24} = $ 86 GPM WELL WATER → .86 GPM/TON

2) KW

i) WELL WATER ; 86 GPM @ 100' HEAD (WELL HD + SYSTEM (H

1750 RPM

B&G 1510

5 HP 59% EFFIC

$\frac{5 HP \times .746 \times .80 \text{ LOAD}}{.59 \text{ EFFIC}} = 7.9$ KW = .079 KW/TON

ii) WATER SOURCE PUMP

100 TONS COOLING, 125 TONS HEAT REJECTION

$125 = \frac{GPM (\Delta T)}{24}$ ASSUME 15° ΔT water side per T.A. PERR

200 GPM @ 50' HD 1750 RPM

4 BHP = 5 HP 80% LOAD

B&G 1510 - 2BC, 63% eff.

$\frac{5 HP \times .746 \times .80}{.63} = 4.74$ KW = .047 KW/TON

iii) HEAT PUMPS — per T.A. PERRY CO @ 70°/85° SOURCE W

12.5 EER = 12.5 BTUH/WATT

$1 / \left(12.5 \frac{BTUH}{WATT} \cdot \frac{1 \text{ TON}}{12000 \text{ BTUH}} \cdot \frac{1}{100 \text{ TONS}} \cdot \frac{1000 W}{1 KW}\right) = 96$ KW

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C) CONDENSOR

ASSUME: 100 COOLING TONS 1.25 HEAT REJECTION FACTOR, 50/80 WELL WATER TEMP

.4 KW/TON CHILLER

1) GPM: $100 = \frac{GPM \cdot 30}{30}$ (24 × 1.25) → GPM = 100 1.0 GPM/TON

2) KW
1) CHILLER .4 KW/TON × 100 = 40 KW
2) WELL PUMP = COND P = SINGLE PUMP B&G 1510-2E = 5.24 KW

3) 100 TONS

D) COOLING COILS
ASSUME: 100 TONS, COILS @ 50/60 EWT/LWT

1) GPM $100 = \frac{GPM \cdot 10}{24}$ GPM = 240

2) KW
WELL PUMP @ 240 GPM = = 8.53 KW
ASSUME: 10.5 KW

3) TONS 100

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E) EVAP TO CHW COILS TO COND

ASSUME: 1) 50 TONS AT CHILLER, 50/45 EWT/LW

2) 45° SUPPLY TO CH. W. COILS PICK UP 100 TO
BUILDING LOAD @ 45/55 EWT/LWT

3) 55° WATER TO CONDENSER

GPM

COIL REQM'T DICTATES GPM

$100 = \frac{GPM \cdot 10}{24}$ **GPM = 240** $\frac{2.4\ GPM}{TON}$

EVAP $50 = \frac{240\ \Delta T}{24}$ $\Delta T = 5°$ OK, AS ABOVE

COND $50 = \frac{240\ \Delta T}{30}$ $\Delta T = 6.25$ → 55/67.5 EWT/

KW

CHILLER USE .34 KW/TON = 34

WELL PUMP, SINGLE PUMP FOR COND = 240 GPM PUMP 8.53 KW

TONS 100

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F) COOLING TOWER

EVAPCO 'AT'
85/95 = 10° RANGE
78° WB - 85 = 7° APPROACH) CAP CORRECTION = 1.0

1) GPM

100 TONS = GPM (85-95) / 30 ⇒ Recirculated GPM = 300 × .05 MAKE UP = 15 GPM well water

2) KW

i) FAN HP

MODEL AT 4-94
2 FANS @ 3 HP = 6 HP TOTAL, BELT DRIVEN

KW = 6 HP × .746 × .80 LOAD / .85 EFFIC = 4.21 KW (≅ .042 KW/TON FANS)

ii) TOWER WATER (CONDENSER) PUMP
300 GPM PUMP @ 50' HEAD, 1750 RPM

SERIES 1510 B&G 3" BB; 5 HP, 71% IMPELLER EFFIC.

KW = 5 HP × .746 KW/HP × .80 LOAD / .71 EFFIC = 4.203 KW ≅ .042 KW/TON

iii) chiller at .70 KW/TON × 100 TONS = 70 KW

TOTAL = 78.4 KW
ASSUME: 82.0 KW

3) TONS 100

GPM is WELL WATER @ 15 GPM MU

.82 KW/TON

APP

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6) COOLING COILS TO CONDENSER

ASSUME: 50° WELL WATER

100 TONS CHILLER CAP
COND: 60° EWT / 85 LWT = 25° ΔT
1.25 HEAT REJECT FACTOR
$100 = \frac{GPM \cdot 25}{30}$ → GPM = 120 REQU[illegible]
1.2 G[illegible]

COILS: 50° EWT / 60° LWT

120 GPM $TONS = \frac{120 \cdot 10}{24} = 50$ TONS

1) GPM 120 WELL W

2) KW
WELL PUMP 120 GPM @ 1750 RPM, 100' HD
B&G 1510-2E 5 HP, 61% effic
$\frac{5 \times .746 \times .8}{.61} = 4.89$ KW

CHILLER .5 KW/TON × 100 TONS = ___ KW

3) TONS
COILS = 50
CHILLER = 100
150 TONS

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Client MDNR By GER
Project WATER USE STUDY Sheet 1 of 2
Comm. No. 4485 Date 2/7/90

TABLE 33

MUNICIPAL WATER INSTEAD OF WELL W IN EXISTING DESIGNS,
- ANNUAL O&M -

FACIL	M/y	COST 1000 GAL	ADD'L COST	ORIGINAL ANNUAL	NEW ANNUAL	NEW $/TONHR
GENL MILLS	238	$ 1.14	271,320	86011	357331	.1412
GAVIIDAE	525.6	↓		42692		.9313
HONEYWELL	246.3			242,810		.0742
METHODIST	222.0	↓		204,304		.123

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TABLE 34

WELL WATER VS AIR COOLED TOWER
ANNUAL COST COMPARISON – OPER COST –

ASSUME WELL WATER IS AVAILABLE AS A SOURCE FOR MAKE-UP; COST IS $.05/1000 G

EXAMPLE CALCULATION
GENERAL MILLS

58 GAL/M × 60 M/H × 2100 H = 7,308 × 10^6

× $1.14/1000 CITY W

= 8331 $

– 7,308 × 10^6 GAL × .05/1000 = 365 $

ORIGINAL OPER COST IS 100,862
NEW OPER = 100862 – 8331 + 365 = 92 896

$92 896 / 2,355,610 TON HR = .039436

FACIL	ORIGINAL ANNUAL	CITY W	WELL W	NEW ANNUAL	NEW $/T
GENERAL MILLS	$100862	– 8331	+ 365	92896	.039
GANNDAE	48030	– 4868	292	43,460	.063
HONEYWELL	387277	– 20865	915	367,272	.042
METHODIST	160072	– 8331	365	152,106	.04

A P P E N D I X

GENERAL MILLS

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GENERAL MILLS
ANNUAL OPERATING COSTS – SUMMARY

A) EXISTING OPERATION

PUMPING	14907
COMPRESSORIZED EQPT	55304
WATER TREATMENT	15800
TOTAL	$86,011

B) CONVERSION

PUMPING	10,192
TOWER	3,859
COMPRESSORIZED EQPT	69,689
WATER TREATMENT	4,318
WATER MAKEUP & SEWER	12,304
	100,862

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Client: MDNR
Project: WATER USE STUDY
Comm. No.: 4485
By: GEM
Sheet 2 of 2
Date: 12/12/89

GENERAL MILLS

I TON-HOUR CALCULATIONS

A) EXISTING DESIGN

CHILLER #	TONS	LOAD*	ANNUAL HRS OPERATION*	TON HOURS
1	360	.70	2100	529,200
2	360	.70	2100	529,200
3	STANDBY			
4	150	.60	250	22,500
5	410	.85	3000	1,045,500
6	160	.40	50	3,200
COILS	400	1	1000 **	400,000

* PER GENERAL MILLS ** ASSUMED

TOTAL ANNUAL TON HRS = 2,529,600

B) CONVERSION

CHILLER #	TONS	LOAD	HRS OPER	TON HOURS
1	319	.70	2100	468,930
2	319	.70	2100	468,930
3	350*	1	1000**	350,000
4	127	.60	250	19,050
5	410	.85	3000	1,045,500
6	160	.40	50	3,200
COILS	0			0

*CHILLER ON-LINE TO REPLACE WELL WATER COILS

TOTAL TON HR 2,355,610

II ANNUAL COST / TON HOUR

A) EXISTING

$\frac{\$86011}{2,529,600} = .0340$ $/TON H

B) CONVERSION

$\frac{\$100,862}{2,355,610} = .0428$ $/TON H

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GENERAL MILLS - WELL WATER OPERATING COSTS

A) PUMPING COSTS - ANNUAL

- CALC: HP x .746 KW/HP x .85 BHP FACTOR FROM NAMEPLATE x 1/.90 PUMP EFFIC = KW

CONDENSER WATER PUMP - CHILLER #1

26 HP x .746 x .85 x 1/.90 x $.045/KWH x 2100 HR x .70* = 12

* MODULATING VALVES REDUCE HP

CONDENSER WATER PUMP - CHILLER #2

26 HP x .746 x .85 x 1/.90 x $.045/KWH x 2100 HR x .70* =

* MODUL VALVES

CONDENSER WATER PUMP - CHILLER #3

STANDBY

CONDENSER WATER PUMP - CHILLER #4

5 HP .746 x .85 x 1/.90 x $.045/KWH x 250 HR/YR x .60* = $24

* MODUL VALVES

SUB TOTAL 244

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Client: MDNR | By: GEM
Project: WATER USE STUDY | Sheet 2 of 3
Comm. No. ~~94~~85.00 | Date 12/11/89

CONDENSER WATER PUMP - CHILLER #5

10 HP × .746 × .85 × 1/.90 × $.045/KWH × 3000 HR/YR × .85* = 808

*MODUL VALVE

CONDENSER WATER PUMP - CHILLER #6

- NONE -

WELL PUMPS

#3 AND #4 = 2800 HRS TOTAL TWO PUMPS

100 HP × .746 × .85 × 1/.90 × $.045/KWH × 2100 HR = $ 6658

"A/C" BOOSTER PUMPS

75 HP × .746 × .85 × 1/.90 × $.045/KWH × 2100 HR = $ 4994

PERIMETER PUMPS - FIVE (5) PUMPS, TYPICAL

10 HP × .746 × .85 × 1/.90 × $.045/KWH × 1000 HR × 5 = 0

SAME UNDER ... CONDITIONS ... 0

2100
2100
1000

STTL 12,460

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B) ANNUAL EQUIPMENT OPERATING COSTS

CHILLER #1
.493 KW/TON x 360 TONS x .70 LOAD x $.045/KWH x 2100 HR = $ 11,

CHILLER #2
.493 KW/TON x 360 TONS x .70 x $.045/KWH x 2100 HR = $ 11,740

CHILLER #3
STANDBY

CHILLER #4
102.9 KW x .60 LOAD x $.045/KWH x 250 HR = $ 695

CHILLER #5
265 KW x .85 LOAD x $.045/KWH x 3000 HR = $ 30,409
40 TONS

CHILLER #6
18 lb/TON·H x 160 TON x 50 HR x $5/1000 lb = $ 720

$5/1000 lb PER GENERAL MILLS, INCLUDING FUEL, BOILER MAIN. SERVICE CONTRACTS, LABOR, DEPRECIATION).

ST TOTAL 55

C) WATER TREATMENT COSTS
PER GENERAL MILLS:
PHOSPHATE COSTS $ 13,300 / YR
CHLORINE COSTS $ 2000 / YR
S, TOTAL 15,3

TOTAL MGY REPORTED 1987: 238

WATER TREATMENT COST
COST PER MGY = 15300 / 238 = 66.27 ≈ $67 / MGY

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Client MDNR By GER
Project GENL MILLS Sheet 1 of 5
Comm. No. 4485.00 Date

CONVERSION - ANNUAL OPER.

CHILLER OPERATION
#1 & 2: CARRIER

NEW MACHINE
319 TONS .6019 KW/TON

REDUCED FROM .493 KW/TON = 22% MORE KW/TON

319 × .602 KW/TON × $.045/KWH × .70 × 2100 HR × 2 = $25407

Add #3 Machine to replace well water

350 ~~tons~~ × .602 KW/TON × .045 × 1000 EQUIV FL HRS $9481
Same as 1000 EXISTING OPER LOAD OF COILS.

#3 STANDBY - 0

#4 NOTE: NEW OPER KW = .790 KW/TON

127 TONS × .790 × .045 × .60 (LOAD) × 250 HR/Y = $677 /YR

#5 TRANE - NO KW DATA
ASSUME 10% MORE KW/TON; .646 KW/TON avg
× 1.1 = NEW MACHINE ⇒ .71 KW/TON

410 TON × .71 × .045 × .85 (LOAD) × 3000 HR/Y = [illegible]

#6 STANDBY - COSTS SAME AS BEFORE = 720

TOTAL

69,689

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CONVERSION - ANNUAL OPER

GENERAL MILLS - GPM OF COOLING TOWER

1288 TR x 3 = 3864 GPM

PUMP SELECTION

BELL & GOSSET SERIES VSCS - 12x14x12½

ASSUME: 100' HEAD

1750 RPM, 120 BHP, 83% EFFIC

PUMPING COSTS

TOWER PUMP

120 BHP x .746 x 1 x 1/.83 x $.045/KWH x 2100 = 10,192

CONDENSER PUMPS NOT USED NOW

CHILLERS 1, 2, 4 & 5 = 0

TOTAL 10,1

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CONVERSION – ANNUAL OPER

TOWER FANS –

TWO FANS @ 40 HP EACH

ASSUME 80% LOAD, 95% EFFIC, 1/2 TIME LOW SPEED

a) HIGH SPD
80 HP x .80 x .746 x 1/.95 x .045 x 1050 = 9906 2373

b) LOW SPD FULL LOAD
20 HP x 1 x .746 x 1/.95 x .045 x 1050 = 6191 1483

16097 385

Z 100 TOTAL

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GEN...

Client: MDNR By: GER
Project: WATER USE STUDY Sheet: 4 of
Comm. No. 4485 Date:

TOWER WATER

ANNUAL OPER COST –

TOWER MAKEUP = EVAP + BLOWDOWN

&

SEWER COSTS = BLOW-DOWN ONLY

@ ASSUMED $1.14 / 1000 GAL

WHERE TOWER OPER HRS = AVERAGE OF ; FULL LOAD HRS + TOTAL OPER HOURS / 2

EVAP

Grand Mar.

@ 1284 × 3 = 3852 GPM

TOWER 10° ΔT → 38.6 EVAP GPM

BLOWDN @ 3 cycles = CONCENTRATION IN CIRC = 3 × CONC IN MAKE-UP

19.4 GPM

SUM 58 GPM

COST

MAKE-UP = 58 GAL/MIN × 60 M/H × ~~1367~~ 2100 HRS × $1.14/1000 gal = $ 3,3..

TOTAL OPER HOURS = (2100, 2100, 3000) / 3 ≈ 2400 HRS

FL H = 1830

AVG ≈ 2100

BLOW DOWN @ avg sewer rate $1.83/1000 gal

19.4 Gal/M × 60 M/H × 2100/1000 × 1.83 = 447..

TOTAL 12,804

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Client MDNR
By GER
Project WATER USE STUDY

Comm. No. 4485.00
Date

TOWER CONVERSION — ANNUAL OPERATION

COST OF WATER TREATMENT

$4318 (SEE CALCULATIONS FOR WATER TREATMENT COST IN GENERAL SECTION OF APPENDIX)

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CAPACITY: PEAK DAY TONS

A) COMPRESSORIZED

PER GEN'L MILLS:

CHILLERS 1, 2, 3 ARE 200% STANDBY.
AT ANY ONE TIME THE LOAD
IS ONLY 328 TONS — PEAK

SEE AIR-SIDE CALC OF CHW LOOP.

CHILLERS 5 & 6 HAVE PEAK BLDG LOAD
OF 405 TONS — PEAK

CHILLER 4 HAS PEAK LOAD SAME AS
CHILLER OF 150 TONS PEAK

SUM = 328 + 405 + 150 = 883 TONS

B) AIRSIDE, WELL WATER COILS (CHILLED WATER
LOAD BASED ON ASSUMED 55/62° = 7°Δ)

C1, C5, C9 = 219 GPM × 7/24 = 63.5 TONS

C31, C17, C18, C20, 21, 22 = 294 GPM × 7/24 = 86 T

C7, C8, C19, 12, 13 (290) 7/24 = 84.5

PERIMETER UNITS
P3 103
P1 + P8 = 225 } (258) 7/24 = 75 TR
P2 + P2A = 190

C4 + C6 = 222 7/24 = 65
C2 + C3 = 92 × 7/24 = 27
1375 401

(36) ... DESIGN TONS TOTAL = ...

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Client: MDNR
By:
Project: GENERAL MILLS

Comm. No.:
Date:

PEAK DAY TONS AND DESIGN GPM:

← CONDENSER SIDE

TONS = GPM ΔT / 30 WHERE; HEAT REJECTION FACTOR OF COMPR HEAT = 1.25 × 24 = 30

CALCULATE GPM (DESIGN) AT 'PEAK DAY' TONS:

CHILLER 1

GPM

$\frac{328 \cdot 30}{20}$ = 492

CHILLER 5

$\frac{405 \cdot 30}{20}$ = 607.5

CHILLER 4

$\frac{150 \cdot 30}{10}$ = 450

WELL WATER COILS

$\frac{401 \cdot 24}{7}$ = 1375

TOTAL 2924.5 GPM

WELL WATER USE - DESIGN, EXISTING SYSTEM

AND

$\frac{GPM}{TON} = \frac{2924.5}{1284}$ = **2.2776 GPM/TON**

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Client ______ By ______
Project GENL MILLS Sheet ______ of ______
Comm. No. ______ Date ______

TOTAL FIRST COSTS FOR CONVERSION

A) CHILLERS 63,600

B) TOWERS 68116

C) PIPE & INSUL 78800

D) PUMP 9010

E) INSTALLATION = B+C+D = 155926 SUBTOTAL = 37545[illegible]

F) 30% CONTINGENCY = 0.30X(A+B+C+D+E) = 112636

TOTAL ESTIMATED CONSTR. COST $ 488,088

G) RECALCULATED 1/26/90

NEW TOTAL FIRST COST ≅ 1,500,000
− 68 116 TOWER
1,431,884

AC = 715,942
TOWER = 68 116
INSTALL = 715,942
TOTAL = $ 1,500,000

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Client
Project GENERAL MILLS
Comm. No.
By
Sheet of
Date

CONVERSION FIRST COSTS

A) A/C EQPT FIRST COSTS - CHANGES

CENTRIFUGAL - CHANGES

1) CARRIER
IMPELLERS 5500 x 2 = 11,000
COND VESSELS 3800 x 2 7600

2) McQUAY
GEARS 15000 x 1 = 15000 (ESTIM. - SEE JORK QUOTE GEAR ~~CHANGE~~ 2600TH
VESSEL (UNKNOWN) ?

3) TRANE
IMPELLER 30,000 x 1 . 30,000
VESSEL — 0

B.) ADD TOWERS — per MARLEY COOLING TOWER (GOGGEN)
68,116

C) ADD PIPING & INSULATION
2364 GPM @ 10 FPS = 12" PIPE
500' @ 12" = 500 x 87.95 = 43975
500' @ 8" = 500 x 55.80 = 27900
250' ~~500'~~ @ 4" 27.70 = 6925
78,800

D) ADD NEW PUMP
$ 9010 Per Bell Gossett
USES 1514 - 3½ 125 HP

E) TOWER INSTALLATION (1987 "MEANS" P226) @ $3.70/TON = 4758 NOT USED
- 1107 ... + ... 30% CONTINGENCY

General Mills, Inc.
James Ford Bell Technical Center
9000 Plymouth Avenue North
Minneapolis, Minnesota 55427

BJO/2/90

January 24, 1990

James Japs, Coordinator
Water Allocation Program
State of Minnesota
Department of Natural Resources
500 Lafayette Road
St. Paul, MN 55155

Dear Mr. Japs:

We have received a draft copy of MDNR CONSUMPTIVE WATER USE STUDY prepared by O-S-M & Assoc., Inc. After reviewing the report, we would like to make some comments regarding the portion of the report concerning General Mills, Inc. They are as follows:

BUILDING TOTAL COOLING LOAD

The total building cooling loads are close, but there is a large difference in the cooling load supplied by well water that is used directly in the coils. The capacity of each system is as follows:

Cooling Water System	O-S-M Report	GMI Calculation
Well Water - direct	401 tons	700 tons
Well Water - chilled	150 tons	150 tons
Circulating Chilled Water	883 tons	760 tons
Total Load	**1,434 tons**	**1,610 tons**

CONVERSION COSTS

The O-S-M Report states that there are two 360 ton chillers at full standby so no new chillers are necessary. The chillers noted are installed in our East Wing Building (separate from the General Office) which houses our corporate computer system. The two new 360 ton Carrier chillers provide cooling to the computer building with a 100% back-up capacity. The third chiller is a 350 ton Dunham Bush unit which is an old, inefficient, and unreliable chiller used only in emergencies.

A recent cost estimate to change over from the well water system includes 3 - 300 ton chillers, cooling towers, pumps, piping and electric power wiring for a cost of $1,500,000. The 3 - 300 ton chillers are for the 700 tons of cooling provided by the well water and for the less efficient operation of our existing chillers when they are converted from well water to cooling tower water for the condensers on the chillers.

January 24, 1990
BJO/2/90

OPERATING COSTS AND LIFE CYCLE COSTS

The new 900 tons of water chillers and associated equipment would change the annual operating cost and life cycle costs as noted in the report. The installation costs would change from $347,362 to $1,500,000 to have General Mills, Inc. corporate office air conditioning system be removed from the well water system.

Sincerely,

John Bjoin

John Bjoin, P.E.
Senior Mechanical Engineer

BJO:PKP

1,500,000
\- 68116 TOWER

= A/C EQPT + INSTALL
(DIVIDED EQUALLY)

= $(715,942 EACH)
+68,116

TOTAL FIRST COSTS

GENERAL MILLS

ORIGINAL CAPACITY, 360 TONS
CHILLERS #1 / #2

VERSION 4.0 - NOVEMBER 1, 1988

SALESMAN CODE : 902
DATE 12/22/89

JOB ID : OSM DNR WATER USE STUDY

ANS PROBLEM ALTERNATES	CH-1 MAX.CAP	CH-1 PERF-TON
UNIT-UNISHEL	19DK76	19DK76
HT.XCH.GROUP	76	76
CMPRSR-MOTOR	313CD	313CL
CLR-CND PASS	2-2	2-2
ALTRNAT.SURF	CND	CND
CLR TUBING	SUPER-B	SUPER-B
CND/SUBC.TBG	TURBOCHL*	TURBOCHL*
CND/SUBC.TBG	10-.028*	10-.028*
SURFACE NBR	12*	12*
VOLTS-HERTZ	480-60	480-60
REFR.NBR-LBS	11-1100	11-1100
COOLING TONS	319	360
IN.KW	192	220
IKW/TON	.603	.610
TOTAL RIG.WT	16500	16580
TOTAL OP.WT	19000	19080
COOLER FLUID	FW	FW
ARI550-FF	STD	STD
CLR ENT.TEMP F	54.60	55.96
CLR LVG.TEMP F	44.00	44.00
FLOW,U.S.GPM	720	720
PD, FT.W.G.	9.5	9.4
CNDNSR FLUID	FW	FW
HT.RJCTN MBH	4484	5070
ARI550-FF	STD	STD
CND LVG.TEMP F	93.32	94.41
CND ENT.TEMP F	85.00	85.00
FLOW,U.S.GPM	1080	1080
PD, FT.W.G.	15.8	15.8
MOTOR IN.KW	192	219
RATED-L.AMP	269	309
O.L.T.AMPS	290	334
L.R.Y.AMPS	507	570
L.R.D.AMPS	1585	1781
CNDNSNG.TEMP F	96.01	97.52
CLR WLL.TEMP F	42.5	42.4
SUCTION TEMP F	40.66	40.44
CLR TUBE VEL F/S	4.60	4.60
CND TUBE VEL F/S	6.63	6.63

EXISTING: 19DK76 312 CD
4 PASS CONDENSER

IMPELLER CHANGE

EXISTING: 312
NEW: 313
COST #5500 PER MACHINE

PASS CHANGE

CHANGE EXISTING 4 PASS CONDE[NSER]
TO A 2 PASS CONDENSER
COST #3800 PER MACHINE

MOTOR CHANGE

EXISTING MOTOR WILL ALLOW 319 TONS ON TOWER. TO BE ABLE TO HAVE 360 TON CAPACI[TY] A NEW MOTOR IS NECESSARY (CL SIZE).

COST: #22500 EACH

DATA FAX

SVL
SCHWAB · VOLLHABER · LUBRATT, INC.
4600 CHURCHILL STREET · ST. PAUL, MINNESOTA 55126 · PHONE: (612) 481-8000

NUMBER OF PAGES TO FOLLOW: 1 DATE: 1-3-90

COMPANY: O S M LOCATION:

ATTENTION: George Rotlenberger DEPARTMENT:

REGARDING: General Mills Chiller Data.

FROM: MATT HOLLAND

Schwab-Vollhaber-Lubratt, Inc.
Fax Number (612) 481-8621

MESSAGE

EXISTING	NEW C55/95
150 TONS	127 TONS
EVAP 51.5/43	51.5/43
COND	COND
450 GPM	450 GPM
60/70	85/93.4
KW/TON .686	KW/TON .790

Attn.
Matt Holland
From Craig Porter
MPLS-SVC.

HARDCOPY MODE SET
READY
JP 000 FE5521
NEB SERV CUS CHIL
FLS
IN
.440.60
12
30,150,'N','C'
FL',150,'HERM','R'
N',35X,4.225,3.927,.274,.877,64.570
0005,.0005
120
D',12,'OLD','N','CU','18','FL',35
STD','048K',673,1
08,2,360
27,127,43,85
END PRINT
READY
HARDCOPY MODE SET
READY

Ran with 43° Lvg. Ev.
and 85° Ent. Co.
@ 127 tons
Also @ 148 tons without
problems
Coil 1F ?

PROGRAMMER: CJP TIME: 15: 2:32 DATE : 01/03/90 GO NO. FE5521-

****
*** "SERV" ONLY TO BE USED TO CHECK EXISTING UNITS ***
*** IN FIELD - NOT FOR USE FOR NEW SELECTIONS ***
****

EVAP TONS	EVAP TIN	EVAP TOUT	EVAP TEMP	COND TIN	COND TOUT	COND TEMP	COMP KW
127.0	51.7	43.0	39.8	85.0	93.4	96.5	100.3

8.9 FT EPD = 12.0 FT CPD COP = 4.45 AMPS = 145 KW/TON = 0.7

THE MARLEY COOLING TOWER CO
Work Sheet

OFFICE Gorgen Co MADE BY Dale Schmalz CHECKED BY ________ DATE 12-22-89

GPM 3864 | QUOTATION: FORMAL ☐ LETTER ☐ VERBAL ☐ | WORK SHEET COPIES TO: K C ________

HW 95 | PARTY QUOTED George Rothenberger

CW 85 | °R ________ | ADDRESS ________

WB 78 | °A ________ | JOB General Mills 1288 Tons

WIND MPH ________ | ADDRESS ________

S MANUAL ________ | ENG'D BY OSM

EQUIPMENT TO SERVE ________

NOTE BELOW - SALES COMMENTS - KEY MEN - TITLES - ADDRESSES - ETC
SHOW TOWER ORIENTATION IF LOCATED WITHIN ENCLOSURE

1932 Gpm. 2 cells.

NC-812.	28330	56660
Flo Values	590	1180
Basin Covers	370	740
Lube Lines	310	620
Motor Out of Airstream	1300	2600
M-1 Vibration Sw.	130	260
Hand Rail & Ladder.		930
		62990
Freight	1403	2806
		65796.

Add For 2-40 HP 2 Speed 1 winding High Efficiency motors.
$2320.48

8110

32,090 Ship wt.
72,240 Operating wt.

#1

NOV 16.

SUPPLEMENTAL INFORMATION TO:
GEOTHERMAL HEATING AND COOLING SURVEY

November 2, 1989

RECEIVED

Permit Number 74-5231 General Mills Inc.
One General Mills Blvd
Golden Valley, MN 55426

1. Well Pump #3:
Variable Speed [ ] yes [X] no

HP 100 GPM 1000 KW Input 74.4

Efficiency Rating 95% (if known)

Average Operation Hours per year 1400

Well Pump #4:
Variable Speed [ ] yes [X] no

HP 100 GPM 1000 KW Input 74.4

Efficiency Rating 95% (if known)

Average Operation Hours per year 1400

2. Chillers :

Chiller #1 Type Carrier #1 Centrifugal

Capacity 360 Tons KW Input .493/Ton at 100% Load

Peak Load 324 Tons Average Hours/Year 2100

each 2100 hrs x .70

Condenser Water

Temperature Entering 55°- 60°

Temperature Leaving 75°-80°

GPM 493

Chiller #2 Type Carrier #2 Centrifugal

Capacity 360 Tons KW Input .493/Ton at 100% load

(46)

MCO 11/13/89

Peak Load 324 Tons Average Hours/Year 2100 @ .7 LOAD PLUS #1

Condenser Water

Temperature Entering 55° - 60°

Temperature Leaving 75° - 80°

GPM 493

Chiller #3 Type Dunham-Bush Rotary Screw

Capacity 350 Tons KW Input N/A

Peak Load 350 Tons Average Hours/Year 0

Condenser Water

Temperature Entering 55° - 60°

Temperature Leaving 80°

GPM 550

STANDBY FOR #1 & 2

Chiller #4 Type Mcquay Centrifugal

Capacity 150 Tons KW Input 102.9 =.686 KW/TON

Peak Load 97.5 Tons Average Hours/Year 250 .55 to .60 LOAD

Condenser Water

Temperature Entering 55°

Temperature Leaving 85°

GPM 450 10° ΔT, i.e. 60° to 70°

150 x 1.25 x 24 / 10 = 450

Chiller #5 Type Trane Centrifugal

Capacity 410 Tons KW Input 265 =.646 KW/TON 55% LOAD

Peak Load 410 Tons Average Hours/Year 3000 75% Load

Condenser Water

Temperature Entering 60° - 65°

Temperature Leaving 80° - 85°

GPM 1143

(At 85° Enter/95.3° Leave)

NO?

AT WELL WATER 60/80

IS 650 GPM P15 IS 650 ✓ GPM

(47)

18 lb/TON.H

STEAM INPUT -

40% LOAD

Chiller #6 Type Carrier (Absorption)

Capacity 160 Tons KW Input 3 KW

Peak Load 160 Tons x.4=64 Average Hours/Year 50

Condenser Water

Temperature Entering 60°

Temperature Leaving 80°

GPM 552

~~Chiller #7 Type ______~~

~~Capacity ______ Tons KW Input ______~~

~~Peak Load ______ Tons Average Hours/Year ______~~

~~Condenser Water~~

~~Temperature Entering ______~~

~~Temperature Leaving ______~~

~~GPM ______~~

Please list the unit numbers above, that are chilling well water only: #4

3. For the closed loop chilled water system, please indicate (for each pump in CW loop) GPM, KW input, HP, Efficiency, and whether it is a fixed or variable volume pump. See Attached

4. Once through Chilled Well Water coils: Please itemize the GPM's and Delta T for each coil. See Attached

5. Closed loop chill water coils: Please itemize the GPM's and Delta T for each coil. See Attached

6. Water treatment costs:

Phosphate Costs	$13,800. Per year
Chlorine Costs	$ 2,000. Per year

QUESTION #3

CLOSED LOOP CHILLED WATER PUMPS

CHILLER #

1, 2, 3

CHILLERS 1, 2 &3

1) E. W. (2) Carriers (1) Dunham Bush has (3) chilled water pumps all: → ONE OPERATES

EVAP
40 H.P. 360 GPM FIXED VOLUME
KW Input 31.5 Effic. 95%

COND PUMP 2 speed 50 HP, Rated 900 GPM @ High ~ 450 GPM @ low speed) two pumps of which only one runs, other standby

5

2) Trane Chiller #5 410 TON 26 HP,

EVAP
P-13
10 H.P. 794 GPM FIXED VOLUME
KW Input 7.4 Effic. 95%

EVAP
P-14
25 H.P. 1114 GPM VARIABLE VOLUME
KW Input 19.6 Effic. 95%

COND PUMP
P-15 10 HP, 650 GPM 95% CONTINUOUS KW unk

6

3) Carrier Absorber #6 160 ton 50 HR/YR

EVAP
P-12
3 H.P. 320 GPM FIXED VOLUME
KW Input 2.3 Effic. 95%

COND
NO PUMP

4

4) CHILLER #4 McQUAY – (250 HR/YR, 150 TON)

COND. WATER PUMP:
5 HP 450 GPM 250 HRS/YR

there is cw pump - interlocked w/ chiller

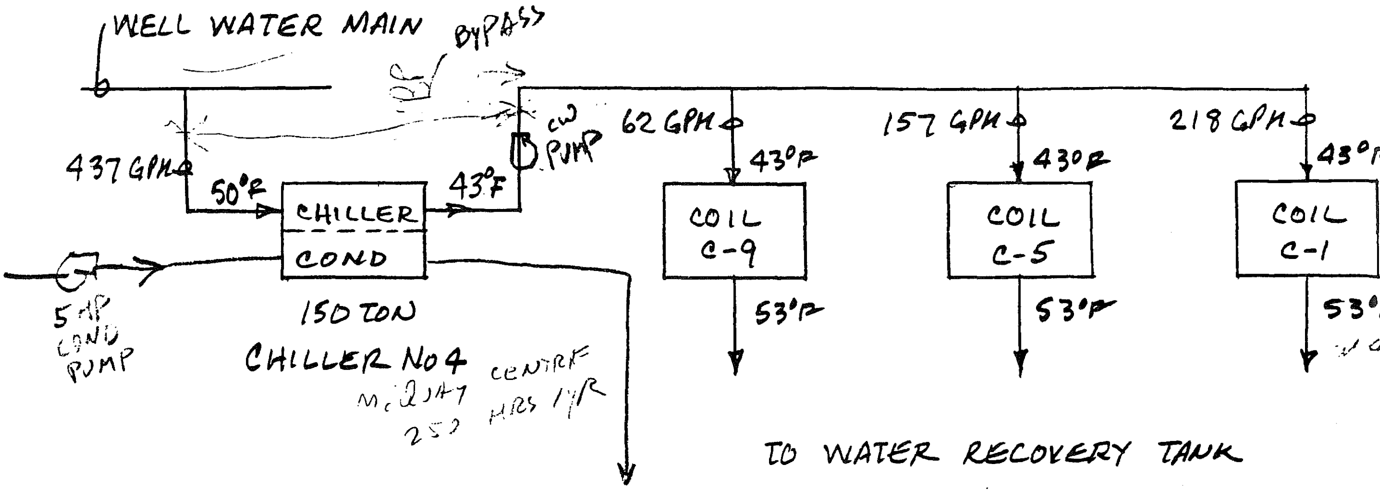
CHILLED WATER PUMP:

7½ HP 302 GPM 250 HRS/YR

QUESTION #4

GEOTHERMAL HEATING AND COOLING SURVEY.

ONCE THRU WELL WATER W/ CHILLER   CHILLER NO 4



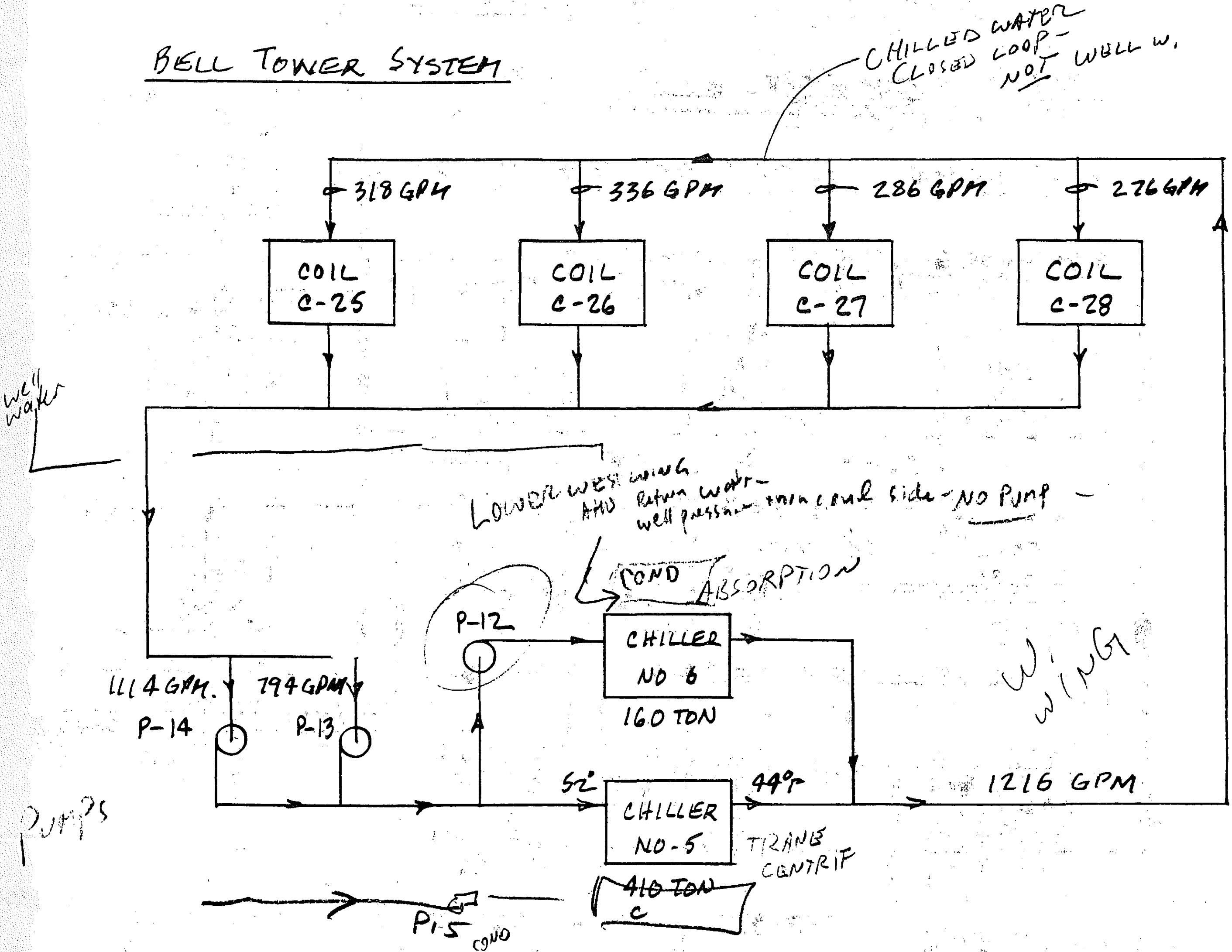
COIL NO	WELL WATER GPM	TEMP IN °F	TEMP OUT °F	RISE °F	COOLING TONS
C-9	62	43°F	53°F	10°F	26
C-5	157	43°F	53°F	10°F	65
C-1	218	43°F	53°F	10°F	91
TOTALS	437				~~182~~ TON 150 TO

THE 150 TON CHILLER (CHILLER NO 4) WAS INSTALLED TO PROVIDE A LOWER WELL WATER TEMPERATURE TO THE COILS. THIS GIVES MORE DEHUMIDIFICATION IN THE SUPPLY AIR TO CRITICAL AREAS WITHIN THE BUILDING.

QUESTION #5

GEOTHERMAL HEATING AND COOLING SURVEY

BELL TOWER SYSTEM



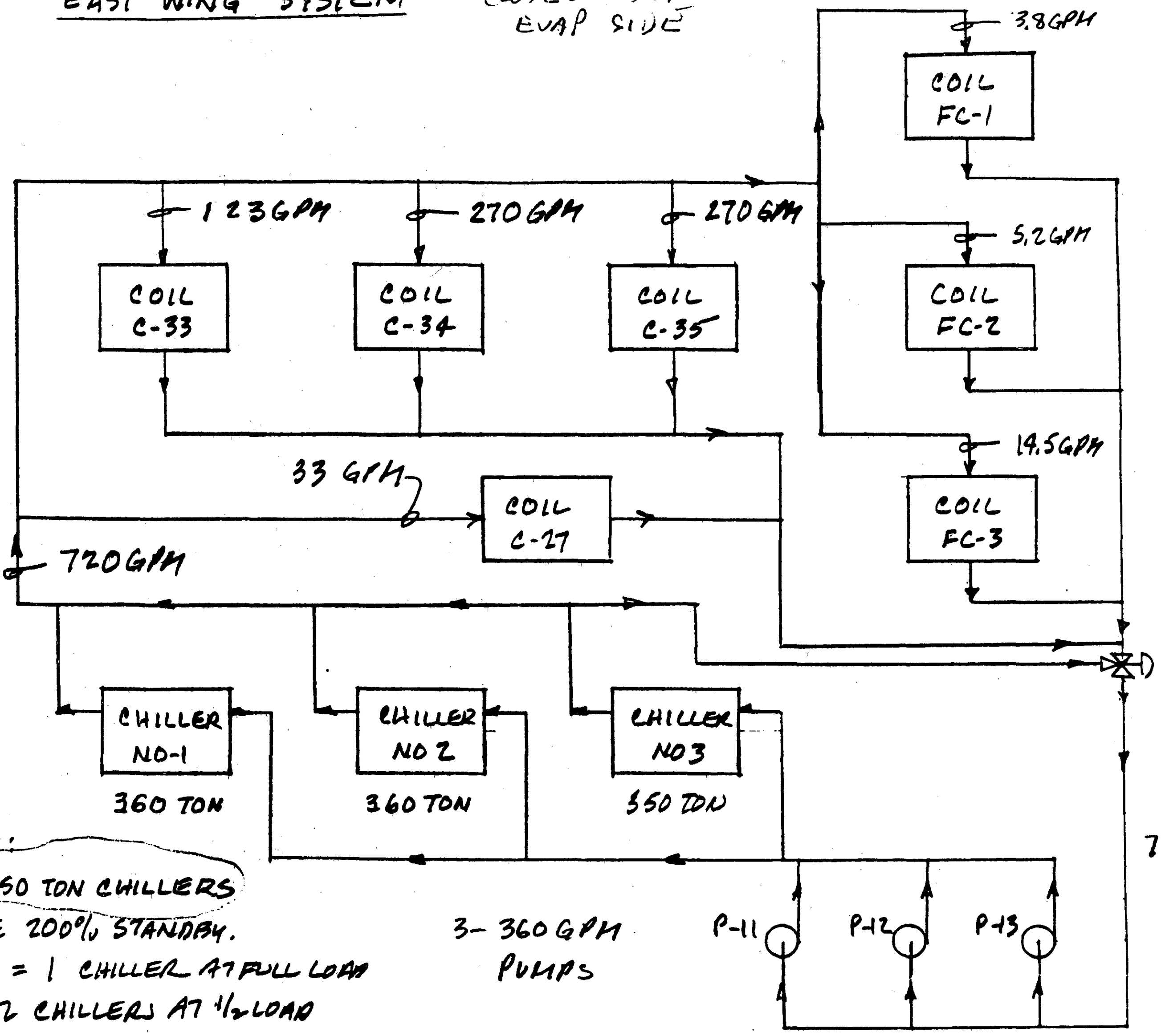
COIL NO	WATER FLOW GPM	TEMP IN °F	TEMP OUT °F	RISE °F	COOLING TONS
C-25	318	44°F	52°F	8°F	106
C-26	336	44°F	52°F	8°F	112
C-27	286	44°F	52°F	8°F	95
C-28	276	44°F	52°F	8°F	92
	1216				405

NORMAL OPERATION, CHILLER NO 5 OPERATES WITH CHILLER NO 6 OFF. DURING PEAK COOLING LOADS, THE STEAM ABSORPTION CHILLER NO 6 IS OPERATED TO PROVIDE ADDITIONAL COOLING CAPACITY FOR A TOTAL COOLING LOAD OF 570 TONS.

QUESTION # 5

GEOTHERMAL HEATING AND COOLING SURVEY

EAST WING SYSTEM – CLOSED LOOP EVAP SIDE

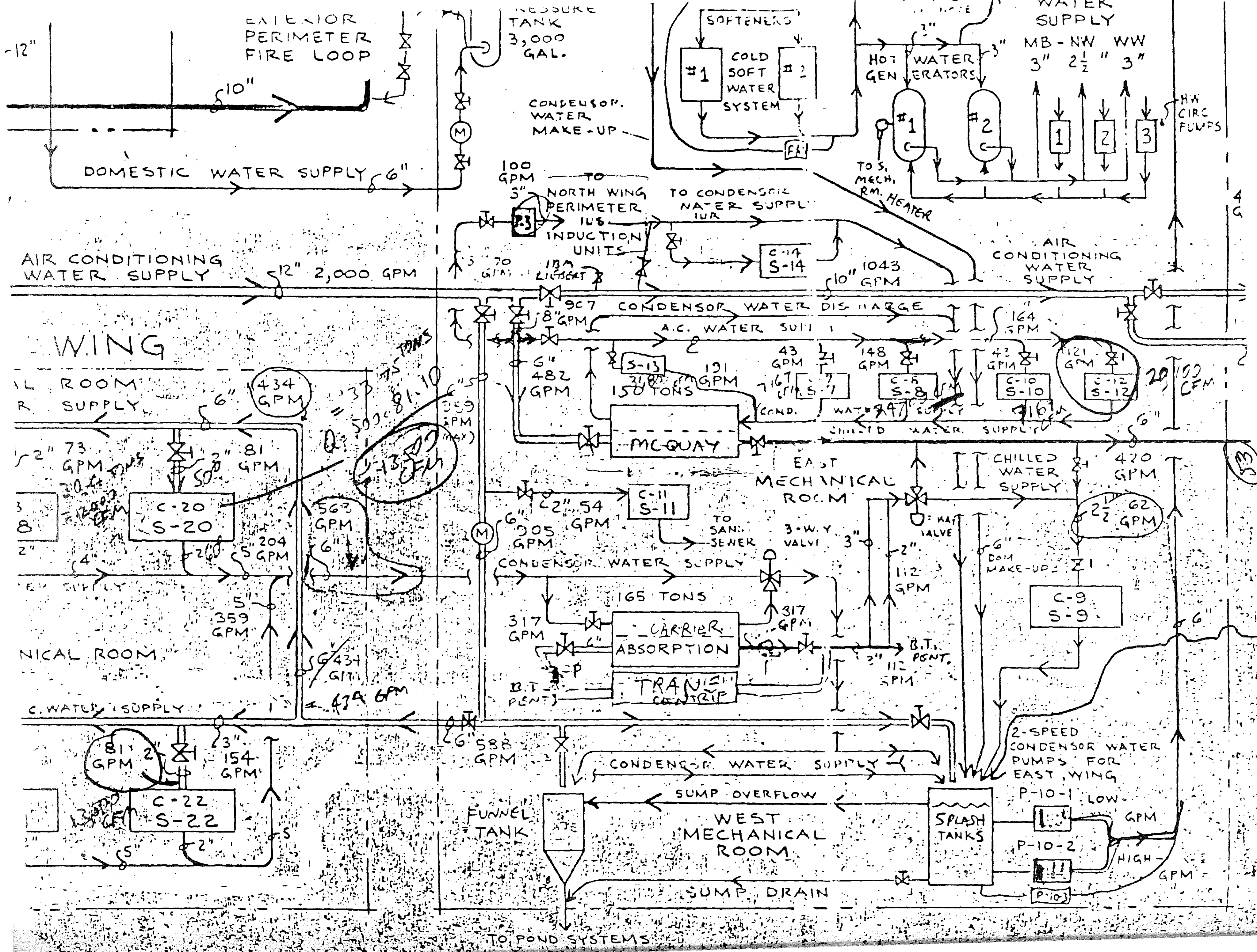


NOTE:
3-350 TON CHILLERS
HAVE 200% STANDBY.
LOAD = 1 CHILLER AT FULL LOAD
OR 2 CHILLERS AT 1/2 LOAD

chillers 1, 2 & 3

chiller #3 is being scheduled standby?

COIL NO	WATER FLOW GPM	TEMP IN °F	TEMP OUT °F	RISE °F	COOLING TONS
C-33	123	42°F	53°F	11°	56
C-34	270	42°F	53°F	11°	123
C-35	270	42°F	53°F	11°	123
FC-1	3.8	42°F	53°F	11°	1.7
FC-2	5.2	42°F	53°F	11°	2.4
FC-3	14.5	42°F	53°F	11°	6.6
C-27	33	42°F	53°F	11°	15.1
TOTALS	720				328



EXTERIOR PERIMETER FIRE LOOP
10"
TANK 3,000 GAL.
SOFTENERS
#1
COLD SOFT WATER SYSTEM
#2
HOT WATER GENERATORS
3"
WATER SUPPLY
MB - NW WW
3" 2½" 3"
#1
#2
1
2
3
HW CIRC PUMPS
CONDENSOR WATER MAKE-UP
DOMESTIC WATER SUPPLY 6"
100 GPM 3"
TO NORTH WING PERIMETER IUS INDUCTION UNITS
TO CONDENSOR WATER SUPPLY
TO S. MECH. RM. HEATER
P-3
C-14 S-14
AIR CONDITIONING WATER SUPPLY
12" 2,000 GPM
70 GPM
IBM LIEBERT
1043 GPM
10"
AIR CONDITIONING WATER SUPPLY
907 GPM
8"
CONDENSOR WATER DISCHARGE
A.C. WATER SUPPLY
164 GPM
WING
ROOM
SUPPLY
434 GPM
6"
6" 482 GPM
S-13
150 TONS
191 GPM
43 GPM
148 GPM
43 GPM
121 GPM
S-7
C-8 S-8
C-10 S-10
C-12 S-12
75 TONS
81.10
359 GPM (MAX)
COND.
CHILLED WATER SUPPLY
MCQUAY
6"
2" 73 GPM
81 GPM
C-20 S-20
EAST MECHANICAL ROOM
CHILLED WATER SUPPLY
420 GPM
C-11 S-11
2" 54 GPM
6" 905 GPM
563 GPM
TO SAN. SEWER
3-WAY VALVE
3"
2"
112 GPM
6" DOM MAKE-UP
2½" 62 GPM
204 GPM
CONDENSOR WATER SUPPLY
165 TONS
C-9 S-9
5" 359 GPM
317 GPM
317 GPM
CARRIER ABSORPTION
B.T. PENT.
NICAL ROOM
434 GPM
TRANE CENTRIF
B.T. PENT.
3" 112 GPM
C. WATER SUPPLY
434 GPM
6" 588 GPM
3" 154 GPM
81 GPM
C-22 S-22
CONDENSOR WATER SUPPLY
2-SPEED CONDENSOR WATER PUMPS FOR EAST WING
FUNNEL TANK
SUMP OVERFLOW
WEST MECHANICAL ROOM
SPLASH TANKS
P-10-1 LOW GPM
P-10-2 HIGH GPM
P-10-3
SUMP DRAIN
TO POND SYSTEMS

OCT 19.

GEOTHERMAL HEATING AND COOLING SURVEY

PERMIT NUMBER 74-5231

PERMITTEE General Mills Inc.

SYSTEM LOCATION Golden Valley, Minnesota

NAMES AND LOCATIONS OF FACILITIES:

Minneapolis General Office

One General Mills Boulevard

Golden Valley, Minnesota 55426

RECEIVED
Orr-Schelen-Mayeron & A
COMM. #
OCT 23 1989

Name	Rec'd	Copy	Name	Re

TOTAL AREA SERVICED: 420,000 (Enclosed) Square feet

WATER SOURCE

Number of wells connected to the system 4

Enclosed is the well information we have on file regarding this installation. Please indicate if this data is accurate and/or submit any additional well data that is available. If no information is enclosed or available, please complete the enclosed Water Well Information form(s).

Are water level measurements taken on the production well(s) or observation well(s)? [ ] Yes [X] No If yes, please submit a summary of the data.

SYSTEM INFORMATION

Number of years since original system was installed: 32

Date system was put on line: Fall of 1957

Is this a once through or closed loop system (describe and attach a simple schematic drawing) ?

Portion is once through - main building, east & west penthouse systems are once through. All other systems are closed loop or double usage in splash tanks for re-use as consensor water and/or lawn irrigation water

(84)

Describe any major system modifications and give the completion date:

Original system: Main Bldg. & North Wing 1957-58 Deep Wells 1 & 2 only. Deep Well #3 added in 1964-65 with 4 story West Wing addition. Deep Well #4 added in 1979 with 6 story addition to West Wing Tower. (Total 10 story tower) Added computerized automation & replaced controls in 1979.

Fall/Winter 88 converted East Wing HVAC to outside air cooling instead of refrigeration cooling. Replaced inefficient Dunham-Bush rotary screw chillers w/new Carrier Centrifugal chillers for summer operation.

Average water temperature:

Heating 50° **intake;** NONE **discharge**
Cooling 50° **intake:** 75° **discharge**

System size rating:

Heating 14,155,000 **(BTU/H)** **Cooling** 1600 **(Tons/H)**

Actual peak load:

Heating 9,900,000 **(BTU)** **Cooling** 1450 **(Tons)**

Energy efficiency of systems:

Number of chillers/~~heat-pumps~~ in system 6
Coefficient of Performance (COP) for heat pump N/A
Average Energy Efficiency Ratio (EER) for heat pump N/A
If no heat pump, chiller efficiency rating 0.49 Kw/ton @max Load for last chiller purchased.
Number of chillers or heat pumps in system 6
Size rating of chillers/~~heat pumps~~ See tabulation below
3 @ 350 T, 1@ 410 T, 1 @ 150 T, and 1 @ 165 T

General Water Use Efficiency:

3.39 (GAL/TON) Cooling-Well Water
Average Efficiency of Water Use 2.37 **(gal/ton) cooling**-Closed Loop
* See Note below on heating 0.00012 **(gal/BTU) heating**
How much water is recirculated? 1800 GPM Closed Loop Cooling, 1200 GPM Condensing
How much water is lost in the system, where is it lost and how is the amount of water loss determined?

All once thru well water used for cooling is lost. Some water is recirculated to chillers condensers and all water goes to the pond system for lawn sprinkling system. Volume of water used varies based on outside temperature conditions for air conditioning.

If cooling towers are part of the system, how many are there, how much evaporative loss occurs in this loop, and how is the amount of water loss determined?

No cooling towers

* NOTE - East Wing at this facility is an all electric building with electric heaters in ductwork, electric baseboard and electric chillers for cooling

What is the design capacity of the towers? N/A
If cooling towers are not present in the system please describe the feasibility of adding towers including any site and/or system limitations.

A study is now being made to evaluate the existing well water air conditioning systems and develop several proposals and cost estimates for improving our systems and to reduce or eliminate the use of well water for cooling.

1000 GAL/MIN x 60M/H x 24H/D x 365D/Y

WATER USAGE

Indicate the percentage of all primary and secondary uses of the water:

2% Heating
-0- Processing
73% Air conditioning
25% Other: Domestic

Average pumpage: 1,000 **gpm;** 24 **hours/day;** 12 **months/year**

Are flow meters used to determine water usage? [X]Yes [ ]No

If meters are not used, describe how the amount of water appropriated is determined.

WATER DISPOSAL

Indicate any water treatment that is done before or after the water goes through the system.

Before Chlorine and Phosphate

None after

What percentage of the water is discharged and what is the water discharged to?

75% Bassett Creek & 2nd usage for irrigation

If water is discharged into a storm sewer indicate the receiving water for the sewer outlet, if known.

Bassett Creek to Mississippi River

List any discharge authorizations required for the system.

Minnesota Pollution Control Agency NPDES Permit No. 0000671, permit reissued 2/8/88, and Metropolitan Sewer Board registration dated May 31, 1974.

Indicate any regulated discharge limitations relating to water temperature, quality or quantity.

Temperature 30C (86f) daily max, total residual chlorine daily maximum effluent limitation of 0.10 mg/l and 4.6 lbs/day for each outfall (2), and pH shall not be less than 6.0 nor greater than 9.0. No floating solids or visible foam, discharges shall not contain oil or other substances in amounts sufficient to create a visible color film on the surface of the receiving waters.

WATER CONSERVATION

Does the system use variable speed pumps? [x] Yes [ ] No
Are any load or system controls used to reduce water requirements by reducing the operating load conditions (i.e. load shedding, temperature set points)?

Set points but no load shedding

List any other measures utilized to reduce water use:

Automatic level control valve on splash tank make-up water valve.

What changes can be done to the system to reduce water use?

Study initiated to determine best methods

What alternatives exist for reuse of the discharge water?

Re-used for condensor water

Re-used for irrigation of lawn

Returned to ground water and to maintain pond levels

Indicate any anticipated future changes in water use and state reasons for projected increases or decreases.

Study initiated to determine best methods of obtaining future decreases in water usage

Please provide us the following information about the person that completed the survey.

Name Merle C. Olson

Title Manager, Facility Systems & Space Planning

Telephone Number 540-3395

Please give the name and phone number of someone that can provide additional information, if different than above.

Contact Person John Bjoin - JFB Mechanical Engineer

Telephone Number 540-2494

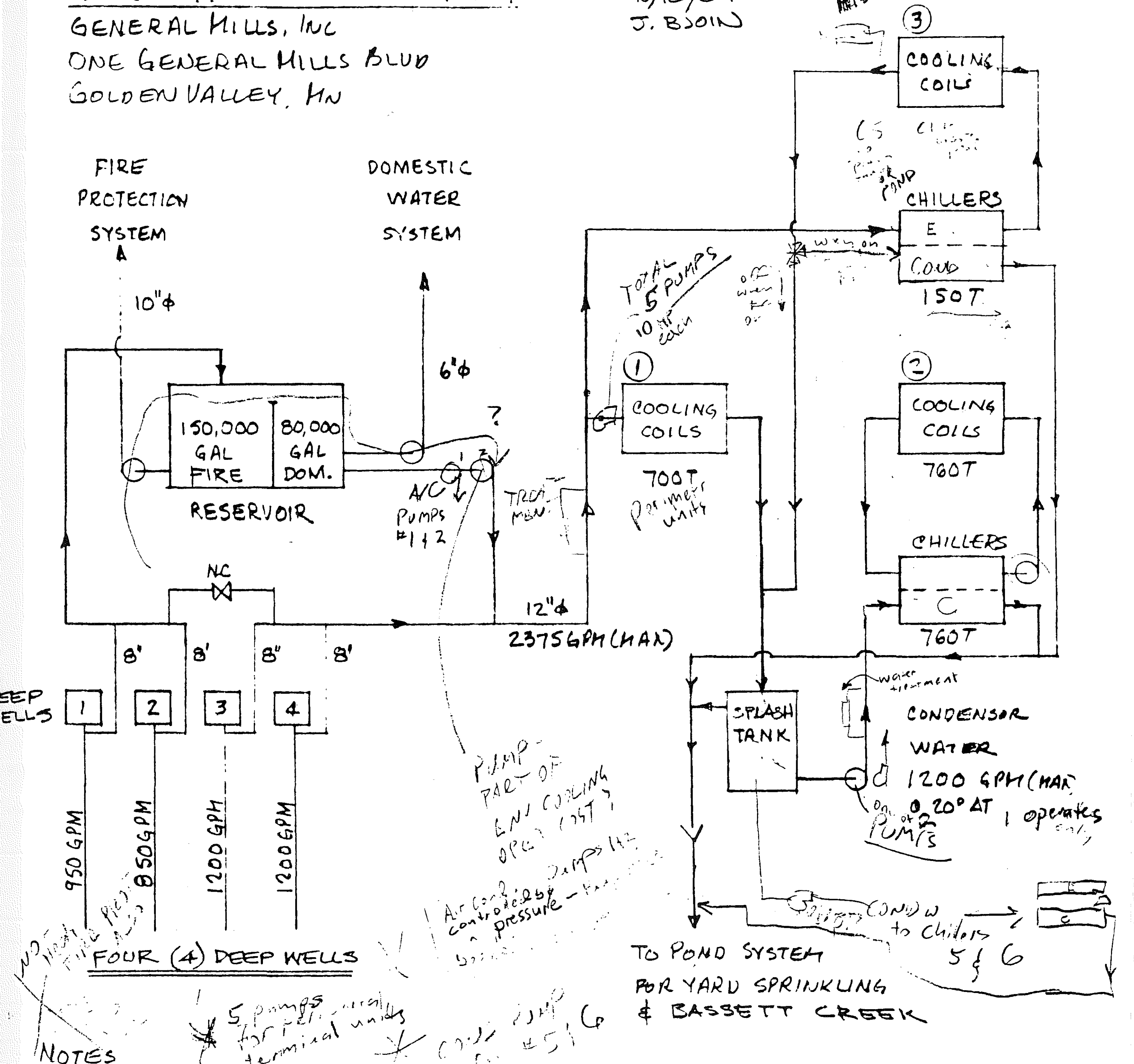
This survey is to be completed and mailed by __September 15, 1989__ to:

Department of Natural Resources - Division of Waters
Attn: Jim Japs
Geothermal Heating and Cooling Survey
Box 32, 500 LaFayette Road
St. Paul, MN 55155-4032

WELL WATER FLOW DIAGRAM

GENERAL MILLS, INC
ONE GENERAL MILLS BLVD
GOLDEN VALLEY, MN

10/18/89
J. BJOIN



NOTES

1. 18 COOLING COILS + PERIMITER INDUCTION UNITS ON WELL WATER FOR MAX FLOW OF 2375 GPM AT 7°F ΔT = 700 TONS (EST)
2. 14 COOLING COILS ON CLOSED LOOP CHILLERS, CONNECTED LOAD 1 @ 165 3 @ 350T AND 1 @ 410T. OPERATING LOAD 1 @ 350 AND 1 @ 410 = 760T
3. 3 COOLING COILS ON ONCE THRU SYSTEM WITH 1 - 150 TON CHILLER TO LOWER WELL WATER TEMP.

SYSTEM SIZE RATING

HEATING - CONNECTED LOAD

CV-1	325 GPM	1625 MBH
CV-2	270 GPM	1350 MBH
CV-3	100 GPM	500 MBH
CV-4	244 GPM	2440 MBH
CV-8	165 GPM	1650 MBH
CV-8A	165 GPM	1650 MBH
CV-6	125 GPM	1260 MBH
CV-7	40 GPM	400 MBH
CV-11	328 GPM	3280 MBH
	1762 GPM	14,155 MBH

ESTIMATED ACTUAL PEAK LOAD

ASSUME MAXIMUM PEAK IS 70% OF CONNECTED

PEAK LOAD = 70% x 14,155 MBH
= 9,900 MBH

COOLING - CONNECTED LOAD

WELL WATER - ONCE THRU 2375 GPM @ 7°F ΔT	=	700 T
CLOSED LOOP - CHILLED WATER	=	760 T
WELL WATER - ONCE THRU - CHILLED	=	150 T
		1610 T

ESTIMATE ACTUAL PEAK LOAD

ASSUME MAXIMUM PEAK IS 90% OF CONNECTED

PEAK LOAD = 90% x 1610
= 1450 TONS

GENERAL WATER USE EFFICIENCY

AVERAGE EFFICIENCY OF WATER USE

WELL WATER $= \frac{2375 \text{ GAL}}{700 \text{ TON}} =$ 3.39 GAL/TON

CLOSED LOOP $= \frac{1800 \text{ GAL}}{760 \text{ TON}} =$ 2.37 GAL/TON

HEATING $= \frac{1762 \text{ GAL}}{14,155,000 \text{ BTU}} =$ 0.00012 GAL/BTU

MINNESOTA Department of Natural Resources Division of Waters

WATER WELL INFORMATION

WELL #

PART A — WELL LOCATION

☒ Owners Name
☐ Authorized Agent General Mills, Inc

Telephone Number:
Home ( )
Work (612) 540-2184

Mailing Address:
Number One General Mills Blvd
Golden Valley, MN 55426

Place an "x" on the grid showing the exact location of your well. The grid is one section (640 acres divided into 1/4, 1/4, 1/4 sections). (160, 40, 10 acres).

NW (X) | NE | SW | SE — 1 MILE

County:	Township Name:	Township No.:	Range Number:	Section:	Fraction:
Hennepin	Golden Valley	117 (N) S	21 E (W)	6	NW 1/4 SE 1/4 NW 1/4

PART B — WELL CONSTRUCTION

Name of Company which Drilled Well:	Date Completed	Drilled Depth:	Present Depth:
Bergerson-Caswell, Inc	1957	478'	478'

CASING

MATERIAL: ☒ Steel ☐ Plastic ☐ Concrete ☐ Wood ☐ Other ______

Height Above(Below) Land Surface: 1 ft.

Diameter: 16 inches

Length: ______ feet

Interval: from ______ feet to ______ feet

DRILLING METHOD: (If known): ☐ Mud Rotary ☐ Air Rotary ☒ Cable Tool ☐ Bored/Augered ☐ Dug ☐ Othe

USE: ☒ Domestic ☐ Livestock ☐ Irrigation ☐ Public Supply ☒ Commercial ☐ Industrial ☐ Other

SCREEN

☐ Yes (if yes, complete all of this section)
☒ No
☐ Open Hole from ______ feet to ______ feet

MATERIAL: ☐ Stainless Steel ☐ Galvanized Steel ☐ Plastic ☐ Other ______

Diameter: ______ inches

Length: ______ feet

Interval: from ______ feet to ______ feet

Non-Pumping Water Level Below(Above) Land Surface:
53 feet
1957 date measured
tape how measured (steel tape, etc.)

PUMP

TYPE: ☐ Submersible ☐ Jet, Shallow ☐ Jet, Deep ☐ Reciprocating ☒ Centrifugal ☐ Other ______

Age: 7 years

Pumping Rate: 800 gpm

Pump Setting — submersible (Below Ground Level) 150 ft.

Drop Pipe Length — non-submersible (Below Ground Level) 150 ft.

Pumping Water Level Below Land Surface:
80 feet
1982 date measured
tape how measured (steel tape, etc.)

Flowing Well: ☐ Yes ☒ No

PART C — WELL CONDITION

Note: Attach additional sheets as needed.

Item	Condition	Comment (describe method of inspection):
CASING:	☐ Cracked ☐ Holes ☐ Filled with Sediments ☐ Incrusted ☒ Other Good	Good condition - visual inspection
SCREEN: (if one exists):	☐ Incrusted ☐ Plugged ☐ Rusted/Corroded ☐ Other ______	N/A
PUMP:	☐ Incrusted ☐ Rusted/Corroded ☐ Electrical ☒ Other Good	Good condition - visual inspection
DROP PIPE:	☐ Rusted/Corroded ☐ Holes/Cracks ☐ Water Marks ☒ Other Good	Good condition - reworked in 1982
DISTRIBUTION:	☐ Plugged Lines ☐ Vacuum in Lines ☒ Other Good	Good condition

Other (describe method of inspection):

PART D — SIGNATURES

Well Owner or Agent:	Date:	Driller:	Date:
[signature]	10/18/89	Carl L Heit [signature]	10/17/

(62)

Department of Natural Resources
Division of Waters
MINNESOTA

WATER WELL INFORMATION

[redacted]

PART A — WELL LOCATION

☒ Owners Name ☐ Authorized Agent: General Mills, Inc	Telephone Number: Home ( ) Work (612) 540-2184
Mailing Address: Number One General Mills Blvd Golden Valley, MN 55426	Place an "x" on the grid showing the exact location of your well. The grid is one section (640 acres divided into 1/4, 1/4, 1/4 sections). (160, 40, 10 acres).

Grid: NW (X marked) | NE | SW | SE — 1/2 MILE — 1 MILE

County:	Township Name:	Township No.	Range Number:	Section:	Fraction:
Hennepin	Golden Valley	117 (N) S	21 E (W)	6	SE 1/4 SW 1/4 NW 1/4

PART B — WELL CONSTRUCTION

Name of Company which Drilled Well:	Date Completed	Drilled Depth:	Present Depth:
Bergerson-Caswell, Inc	1957	465'	465'

CASING

MATERIAL: ☒ Steel ☐ Plastic ☐ Concrete ☐ Wood ☐ Other ______

Height Above(Below) Land Surface: 1 ft.

Diameter: 16 inches

Length: ______ feet

Interval: from ______ feet to ______ feet

DRILLING METHOD: (If known): ☐ Mud Rotary ☐ Air Rotary ☒ Cable Tool ☐ Bored/Augered ☐ Dug ☐ Other ______

USE: ☒ Domestic ☐ Livestock ☐ Irrigation ☐ Public Supply ☒ Commercial ☐ Industrial ☐ Other ______

SCREEN

☐ Yes (if yes, complete all of this section)
☒ No
☐ Open Hole from ______ feet to ______ feet

MATERIAL: ☐ Stainless Steel ☐ Galvanized Steel ☐ Plastic ☐ Other ______

Diameter: ______ inches

Length: ______ feet

Interval: from ______ feet to ______ feet

Non Pumping Water Level Below(Above) Land Surface:
50 feet
1957 date measured
tape how measured (steel tape, etc.)

PUMP

TYPE: ☒ Submersible ☐ Jet, Shallow ☐ Jet, Deep ☐ Reciprocating ☐ Centrifugal ☐ Other ______

Age: 2 years

Pumping Rate: 800 gpm

Pump Setting — submersible (Below Ground Level) 160 ft.

Drop Pipe Length — non-submersible (Below Ground Level) 160 ft.

Pumping Water Level Below Land Surface:
95 feet
1987 date measured
tape how measured (steel tape, etc.)

Flowing Well: ☐ Yes ☒ No

PART C — WELL CONDITION

Note: Attach additional sheets as needed.

CASING: ☐ Cracked ☐ Holes ☐ Filled with Sediments ☐ Incrusted ☒ Other Good	Comment (describe method of inspection): Good condition - video inspection
SCREEN: (if one exists): ☐ Incrusted ☐ Plugged ☐ Rusted/Corroded ☒ Other ______	Comment (describe method of inspection): N/A
PUMP: ☐ Incrusted ☐ Rusted/Corroded ☐ Electrical ☒ Other ______	Comment (describe method of inspection): New in 1987
DROP PIPE: ☐ Rusted/Corroded ☐ Holes/Cracks ☐ Water Marks ☒ Other Good	Comment (describe method of inspection): Good condition - visual inspection
DISTRIBUTION: ☐ Plugged Lines ☐ Vacuum in Lines ☒ Other Good	Comment (describe method of inspection): Good condition - visual inspection

Other (describe method of inspection):

PART D — SIGNATURES

Well Owner or Agent:	Date:	Driller:	Date:
[signature]	10/18/89	Carl L. Hirt [signature]	10/17/89

(63)

MINNESOTA Department of Natural Resources Division of Waters

WATER WELL INFORMATION

PART A — WELL LOCATION

☒ Owners Name
☐ Authorized Agent
General Mills, Inc

Telephone Number:
Home ( )
Work (612) 540-2184

Mailing Address:
Number One General Mills Blvd
Golden Valley, MN 55426

Place an "x" on the grid showing the exact location of your well. The grid is one section (640 acres divided into 1/4, 1/4, 1/4 sections). (160, 40, 10 acres)

NW NE SW SE — 1 MILE

County:	Township Name:	Township No.:	Range Number:	Section:	Fraction:
Hennepin	Golden Valley	117 (N) S	21 E (W)	6	SW 1/4 NE 1/4 NW 1/4

PART B — WELL CONSTRUCTION

Name of Company which Drilled Well:	Date Completed	Drilled Depth:	Present Depth:
Bergerson-Caswell, Inc	1957	452'	452'

CASING

MATERIAL: ☒ Steel ☐ Plastic ☐ Concrete ☐ Wood ☐ Other

Height Above(Below) Land Surface: 1 ft.
Diameter: 16 inches
Length: feet
Interval: from ______ feet to ______ feet

DRILLING METHOD: (If known):
☐ Mud Rotary ☐ Air Rotary ☒ Cable Tool ☐ Bored/Augered

USE:
☐ Domestic ☐ Livestock ☐ Irrigation ☐ Public Supply ☒ Commercial ☐ Industrial

SCREEN

☐ Yes (if yes, complete all of this section)
☒ No
☐ Open Hole from ______ feet to ______ feet

MATERIAL: ☐ Stainless Steel ☐ Galvanized Steel ☐ Plastic ☐ Other ______

Diameter: inches
Length: feet
Interval: from ______ feet to ______ feet

Non-Pumping Water Level Below(Above) Land Surface:
86 feet
1957 date measured
tape how measured (steel tape, etc.)

PUMP

TYPE: ☒ Submersible ☐ Jet, Shallow ☐ Jet, Deep ☐ Reciprocating ☐ Centrifugal ☐ Other

Age: 6 years
Pumping Rate: 1000 gpm
Pump Setting — submersible (Below Ground Level) 165 ft.
Drop Pipe Length — non-submersible (Below Ground Level) 165 ft.

Pumping Water Level Below Land Surface:
120 feet
1983 date measured
tape how measured (steel tape, etc.)

Flowing Well: ☐ Yes ☒ No

PART C — WELL CONDITION

Note: Attach additional sheets as needed

Item	Comment (describe method of inspection):
CASING: ☐ Cracked ☐ Holes ☐ Filled with Sediments ☐ Incrusted ☒ Other Good	Good condition - visual inspection
SCREEN: (if one exists): ☐ Incrusted ☐ Plugged ☐ Rusted/Corroded ☒ Other	N/A
PUMP: ☐ Incrusted ☐ Rusted/Corroded ☐ Electrical ☒ Other Good	Good condition - rebuilt in 1983
DROP PIPE: ☐ Rusted/Corroded ☐ Holes/Cracks ☐ Water Marks ☒ Other Good	Good condition - visual inspection
DISTRIBUTION: ☐ Plugged Lines ☐ Vacuum in Lines ☒ Other Good	Good condition - visual inspection

Other (describe method of inspection):

PART D — SIGNATURES

Well Owner or Agent:	Date:	Driller:	Date:
[signature]	10/18/89	Carl L. Nist [signature]	10/1[illegible]

(64)

...OTA
...al Resources

WATER WELL INFORMATION

WELL #4

WELL LOCATION

...Agent: General Mills, Inc	Telephone Number: Home ( ) Work (612)540-2184
...Address: Number One General Mills Blvd Golden Valley, MN 55426	Place an "x" on the grid showing the exact location of your well. The grid is one section (640 acres divided into 1/4, 1/4, 1/4 sections). (160, 40, 10 acres).

Grid: NW / NE / SW / SE; 1/2 MILE; 1 MILE (X marked in NW quarter)

County	Township Name	Township No.	Range Number	Section	Fraction
Hennepin	Golden Valley	117 (N) S	21 E (W)	6	NW 1/4 NE 1/4 NW 1/4

PART B — WELL CONSTRUCTION

Name of Company which Drilled Well	Date Completed	Drilled Depth	Present Depth
Bergerson-Caswell, Inc	1979	455'	455'

CASING

- MATERIAL: ☒ Steel ☐ Plastic ☐ Concrete ☐ Wood ☐ Other ____
- Height Above (Below) Land Surface: 1 ft
- Diameter: 16 inches
- Length: 271 feet
- Interval: from +1 feet to 270 feet

DRILLING METHOD (If known): ☐ Mud Rotary ☐ Air Rotary ☒ Cable Tool ☐ Bored/Augered ☐ Dug ☐ Other ____

USE: ☐ Domestic ☐ Livestock ☐ Irrigation ☐ Public Supply ☒ Commercial ☐ Industrial ☐ Other ____

SCREEN

- ☐ Yes (if yes, complete all of this section) ☒ No ☐ Open Hole from ____ feet to ____ feet
- MATERIAL: ☐ Stainless Steel ☐ Galvanized Steel ☐ Plastic ☐ Other ____
- Diameter: ____ inches
- Length: ____ feet
- Interval: from ____ feet to ____ feet

Non-Pumping Water Level Below (Above) Land Surface: 73 feet; 1979 date measured; tape how measured (steel tape, etc.)

PUMP

- TYPE: ☒ Submersible ☐ Jet, Shallow ☐ Jet, Deep ☐ Reciprocating ☐ Centrifugal ☐ Other ____
- Age: 1 years
- Pumping Rate: 1000 gpm
- Pump Setting — submersible (Below Ground Level): 165 ft.
- Drop Pipe Length — non-submersible (Below Ground Level): 165 ft.

Pumping Water Level Below Land Surface: 97 feet; 1979 date measured; tape how measured (steel tape, etc.)

Flowing Well: ☐ Yes ☒ No

PART C — WELL CONDITION

Note: Attach additional sheets as needed.

Component	Comment (describe method of inspection)
CASING: ☐ Cracked ☐ Holes ☐ Filled with Sediments ☐ Incrusted ☒ Other Good	Good condition - visual inspection
SCREEN: (if one exists): ☐ Incrusted ☐ Plugged ☐ Rusted/Corroded ☐ Other ____	N/A
PUMP: ☐ Incrusted ☐ Rusted/Corroded ☐ Electrical ☒ Other Good	Good condition - rebuilt in 1988
DROP PIPE: ☐ Rusted/Corroded ☐ Holes/Cracks ☐ Water Marks ☒ Other Good	Good condition - visual inspection
DISTRIBUTION: ☐ Plugged Lines ☐ Vacuum in Lines ☒ Other Good	Good condition - visual inspection

Other (describe method of inspection):

PART D — SIGNATURES

Well Owner or Agent	Date	Driller	Date
[signature]	10/18/89	Carl L. [signature]	10/17/89

(65)

A P P E N D I X

GAVIIDAE COMMONS

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GAVIIDAE

ANNUAL OPERATING COSTS - SUMMARY

A) EXISTING OPERATION

PUMPING	12,838
CHILLERS	5367
HEAT PUMPS	12,487
WATER TREATMENT	12,000
	42,692

B) CONVERSION TO COOLING TOWER

PUMPING (TOWER)		= 11078
CHILLERS (EXIST'G)	6814 + 1969	= 8783
CHILLER (NEW)	3686	= 3686
HEAT PUMPS		= 13,736
WATER MAKEUP + SEWER		6,796
TOWER OPER		1458
WATER TREATMENT		2493
		48,030

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Project: WATER USE STUDY Sheet 2 of 2
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GAVIIDAE

TON-HOUR CALCULATIONS

A) EXISTING DESIGN

CHILLER #	TONS	LOAD*	HRS OPERATION*	TON HOURS
1	265	.943	900	225000
2	265	.943	260	65000
HEAT PUMPS	284	1.0	1000 **	284,000
WELL WATER HX	128	1.0	900	115200
	912 TONS			

* PER GAVIIDAE ** ASSUMED

TOTAL TON HOURS 689,200

B) CONVERSION

CHILLER #	TONS	LOAD	HRS OPER	TON HOURS
1	265	.943		
2	265	.943		
3 (NEW)	128	1.0		
4 HEAT PUMPS	284	1.0		
5				
6				
COILS	0			

TOTAL TON HR 689,200

NOTE: FOR DISTRICT COOLING THE COOLING ANNUAL COSTS AND ANNUAL $/TON HR COST RATIOS ARE BOTH BASED ON 900 FULL LOAD HOURS. MPLS ENERGY CR ESTIMATED A 400 TON ANNUAL LOAD BASED ON CITY CENTER: 400 TONS × 900 FL H = 360,000 FL HRS

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Project CONSUMPTIVE WATER STUDY Sheet 1 of 3

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GAVIIDAE COMMONS

WATER SOURCE HEAT PUMPS : STEAM REQMT

STEAM HEAT EXCH TO SUPPLY SOURCE W. HEAT FOR H.P.'S:

HEAT CALCULATIONS – HOURS OF OPERATION IN HEAT MODE

ASSUME FOR HIGH-RISE BLDG A 15 BTU/SF NET HEAT LOAD

CALC: 30 BTU/SF LOSS – INTERNAL GAINS = NET LOAD

WHERE; 0.5 CFM/SF INTERNAL COOLING × TON/400 CFM × 12000 BTUH/TON = 15 BTU/SF INTERNAL LOAD

THEREFORE: 30 – 15 = 15 BTUH/SF NET HEAT LOAD

125,000 SF × 15 BTUH/SF = 1,875,000 BTUH

HEATING DEGREE DAYS — ASHRAE 1981 CH 28

1) $E = \frac{H_L \times D \times 24}{\Delta t \times K \times V} C_D$

= BTU INPUT REQ'D FOR SEASON.

D = 9382 = Degree Days, 65°

C_D = Adjustment to 65° ...
= .64

H_L = 1,875,000 BTUH

Δt = Design Temp Dif
= (68 – (-16)) = 84°F

K = .6 per ASHRAE Ch. 55

V = Heating value of fuel
= 3.5 COP Heat Pump
= BTUH heat output / BTUH heat input

24 = HRS/DAY

2) KNOW TOTAL BTU/H CAPACITY OF HEAT PUMPS.

$\frac{BTU_{REQD}}{BTU/H \text{ capacity}}$ = HRS.

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STEAM FOR HP SOURCE WATER

$$E = \frac{1{,}875{,}000 \times 8382 \times 24 \times .64}{84 \times .6 \times 3.5}$$

$= 1.3685 \times 10^9$ BTU INPUT $\times$ 3.5 BTUH OUTPUT CAPAC / BTUH INPUT (COP) = 4.7897

2) TOTAL HEATING CAPACITY = 3142100 BTU/H OUTPUT OF 105 HEAT PUMPS.

$$\frac{4.7897 \times 10^9 \text{ BTU}}{3142100 \text{ BTU/H}} = 1.5244 \times 10^3 = \boxed{1524 \text{ HOURS}}$$

USE 1500 HOURS HEATING

TOTAL GPM FOR 105 EXISTING HEAT PUMPS IS BALANCED AT 778 GPM ;
CHECK 778 GPM AGAINST 3,142,100 BTUH
3142100 = 500 GPM ΔT
ΔT = 8.077 OK.

KNOW TOTAL CAPACITY = 3142100 BTU/H

STEAM REQUIREMENT

$$3142100 \frac{\text{BTU}}{\text{H}} \times \frac{\text{lb STEAM}}{1000 \text{ BTU}} = 3142.1 \frac{\text{lbs STM}}{\text{H}} \times 1500 \text{ H}$$

$= 4.7163 \times 10^6$ lbs STM

PER MPLS ENERGY CR, STEAM COST = \$5.51/1000 lbs STM

$$4.7163 \times 10^6 \text{ lbs STM} \times \frac{\$5.51}{1000 \text{ lb STM}} = \$25{,}969 \text{ STEAM COST}$$

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STEAM

CREDIT FOR STEAM COST BASED ON IMPROVED HEAT PUMP COP: 90° SOURCE WATER TO HEAT PUMPS RESULTS IN ~20% MORE CAPACITY. ASSUME PREVIOUS CAPACITY AT 70° SOURCE WATER SUPPLIED THE LOAD ADEQUATELY. TAKE CREDIT ON EXTRA CAPACITY AT 90° SOURCE W:

HEAT PUMPS BOOST HEAT CAPACITY ~25% FROM SOURCE CAPACITY, WITH COMPRESSOR WORK HEAT:

3.1421×10^6 BTU/H $\times .25 = 7.855 \times 10^5$ BTUH

7.855×10^5 BTUH $\times \frac{1 \text{ BTUH elec}}{3.5 \text{ BTUH output}} \times \frac{1 \text{ W}}{3.412 \text{ BTUH elec}} \times \frac{\text{KW}}{1000 \text{ W}}$

$\times 1500 \frac{\text{HR}}{\text{YR}} \times \frac{\$.045}{\text{KWH}} \times .20 \text{ CREDIT} = \$888/\text{YR}$

ANNUAL OPERATING COST OF HEAT PUMPS @ 1500 HRS / SEASON:

A) STEAM COST FOR SOURCE WATER @ 90° = $25,969

B) CAPACITY CREDIT FOR COP @ 90°F VS 70°F: ($888)

C) ELEC COST FOR HEAT PUMPS IN HEATING MODE — ASSUME HEAT PUMPS OPERATE IN SAME MANNER, WHETHER USING WELL W., TOWER W., OR DISTR. HT: = 0

THE COST DIFFERENTIAL WAS CALCULATED AS A HEAT PUMP CREDIT.

TOTAL OPER COST HEAT PUMPS HEATING: 25,081

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GAVIIDAE COMMONS

ANNUAL OPERATING COST – USING WELL WATER

A) PUMPS

WELL PUMP

NOTE: 1) PER GAVIIDAE, WELL PUMP EFFIC IS 84.5%
2) 75 HP PUMP BASED ON INSTALLED 100 HP – 25 HP DEVOTED TO SAKS BLDG

75 HP x .746 KW/HP x .85 LOAD (PUMP CURVE) / .845 EFFIC x $.045/KWH x 3000 HRS*/YR = $7598

* 10 HRS/DAY x 300 DAY/YR = 3000 EITHER HEAT PUMP, CHILLER, WELL WATER HEAT EXCH (FREE) = OPERATING HOURS, (NOT FULL LOAD HRS)

WELL WATER BOOSTER PUMPS – TWO

20 HP x .746 x .85 LOAD / .90 EFFIC x $.045/KWH x 3000 x 2 = $3305

CONDENSER WATER PUMPS – TWO

20 HP x .746 x .85 / .90 x $.045/KWH x 1200 HRS* x .94** x 2 = $143

* PER GAVIIDAE

** MOD. VALVES: LOAD SAME AS CH

CHILLED WATER PUMPS – TWO

CHILLED WATER PUMPAGE SAME IN BOTH WELL W & CONVERSION SYSTEM } = 0

TOTAL PUMP COST = $12,328

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GAVINDAE ANNUAL OPER COSTS - CONT'D - WELL W

B) EQUIPMENT

WATER SOURCE HEAT PUMPS

ASSUME EQUIVALENT FULL LOAD HR × FULL LOAD = (OPER HRS) ∫ LOAD PROFILE

NOTE 1) EER = BTUH COOLING OUTPUT / WATT INPUT — USING WELL WATER (EER PER MANUFACTURER AS INSTALLED)

2) FULL LOAD HOURS: PER ASHRAE = 800-1200 FL HRS
ASSUME ≑ 1000 FL HRS

$$\frac{BTUH}{UNIT} \times \frac{1}{EER} \times \frac{KW}{1000W} \times \frac{\$}{KWH} \times HRS \times QTY = \$/YR$$

$$13,600 \times \frac{1}{11.9} \times \frac{KW}{1000W} \times \frac{\$.045}{KWH} \times \frac{1000\ HR}{YR} \times 7 = \$360$$

$$13,500 \times \frac{1}{11.4} \times \frac{KW}{1000W} \times \frac{\$.045}{KWH} \times 1000 \times 1 = \$73$$

$$27000 \times \frac{1}{12.6} \times \frac{KW}{1000W} \times \frac{\$.045}{KWH} \times 1000 \times 20 = 1928$$

$$31,000 \times \frac{1}{11.7} \times \frac{KW}{1000} \times \frac{\$.045}{KWH} \times 1000 \times 9 = 1073$$

$$36,000 \times \frac{1}{12.3} \times \frac{1}{1000} \times \frac{.045}{KWH} \times 1000 \times 67 = 8825$$

$$61,500 \times \frac{1}{12.1} \times \frac{1}{1000} \times \frac{.045}{KWH} \times 1000 \times 1 = \$228$$

TOTAL = \$ 12487

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GAVIIDAE - ANNUAL OPER, WELL WATER

CHILLER #1

109 KW × 250 PEAK / 265 TOTAL × $.045 / KWH × 900* HR = $4164

*PER GAVIIDAE

CHILLER #2

109 KW × 250 / 265 × $.045 / KWH × 260* HR = $1203

$5367 / YR

TOTAL EQUIPMENT ANNUAL OPER = $17854

C) WATER TREATMENT
PER GAVIIDAE = $12,000 / YR

D) MAINT. & LABOR - ASSUME EQUAL, WELL WATER OR TOWER CONVERSION = 0

SUMMARY ANNUAL OPER. COST - EXISTING OPERATION

A) PUMPS	12,838
B) EQPT	17,854
C) WATER TR	12,000
D) MAINT & LABOR	0
	42,692

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Project CONSUMPTIVE WATER STUDY
Comm. No. 448500
By GBR

Date 1/29/90

GAVIIDAE COMMONS

ANNUAL OPERATING COST - CONVERSION
USING NEW COOLING TOWER

A) PUMPS

TOWER PUMP

912 TONS x 3 GPM/TON @ 10°ΔT = 2736 GPM
BELL & GOSSET PUMP
VSCS 10x12x13 1750 RPM, 2736 GPM, ASSUME 100' HD
= 88 BHP AND 80 % PUMP EFFIC.

PUMP COST - OPER AT 3000 OPERATING HRS (NOT EQUIV. F.L.)
TOWER PUMP 88 BHP x .746 x 1/.80 x $.045/KWH x 3000 = $11078

CONDENSER PUMP
TOWER PUMP INSTEAD = 0

B) EQUIPMENT OPER
CHILLER #1 (NEW CONDITIONS .67 KW/TON
177 KW x 250 PEAK / 265 TTL x $.045/KWH x 900 FLHR = $6814

CHILLER #2
177 KW x 250/265 x .045 x 260 = $1969

NEW 128 TON CHILLER - BASED ON McQUAY WHR 100
91 KW x $.045/KWH x 900 = 3686
18469

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ANNUAL OPER COST - CONVERSION TO TOWER (CONT'D) - GAVIIDAE

C) HEAT PUMPS - WATER SOURCE "CLIMATE MASTER"
EER: PER EQPT MFR REPRESENTATIVE

13,600 x 1/10.7 x KW/1000W x $.045/KWH x 1000 HR x 7 = 400.40

18,500 x 1/10.3 x KW/1000 x .045 x 1000 x 1 = 79.3

27,000 x 1/11.5 x KW/1000 x .045 x 1000 x 20 = 2113

31,000 x 1/10.5 x KW/1000 x .045 x 1000 x 9 = 1196

36000 x 1/11.2 x 1/1000 x .045 x 1000 x 67 = 9691

61,500 x 1/10.8 x 1/1000 x .045 x 1000 x 1 = 256.3

$ 13,736

D) WATER MAKE-UP & SEWER

MAKE-UP WATER COST = EVAP LOSS + BLOWDOWN

SEWER COST = BLOWDOWN

ASSUME: CITY WATER AT AVG MPL + ST. P @ $1.14/1000 G
SEWER AT $1.83/1000 GAL

WHERE: TOWER OPER HRS ≅ AVG FL HR + TOTAL HRS
FOR WATER MU (EVAP DEPENDANT ON OUTDOOR W

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ANNUAL OPER, TOWER CONVERSION, MAKE-UP + BLOWDOWN COSTS
GAVIIDAE
D) CONT'D
EVAP + BLOW-DN
@ 912 TONS, 2736 GPM TOWER, 78° WET BULB
7° APPROACH TO 85/95 WATER

EVAP GPM = 27.5

BLOWDN GPM = 9.0
TOTAL = 36.5 GPM

HRS FOR WATER = $\frac{3000 + 900}{2}$ = 1950 HRS

36.5 GPM × $\frac{60 M}{H}$ × $\frac{1950 HRS}{YR}$ × $\frac{\$1.14}{1000 GAL}$ = $4868

SEWER
9 GPM × 60 × 1950 × $\frac{\$1.83}{1000}$ = $1927
TOTAL = $6796

E) TOWER FANS OPER — MARLEY, ONE 60 HP MTR, ASSUME FAN HP SELECTION BASED ON 70% MOTOR LOAD, 95% EFFIC MOTOR, TWO-SPEED OPERATION, 1/2 TIME AT LOW SPD.
1) HIGH SPD 60 × .746 × $\frac{.70}{.95}$ × $\frac{\$.045}{KWH}$ × 1500* = $1113
2) LOW 13 HP × .746 × $\frac{1.0}{.95}$ × .045 × 1500* = $345
*ASSUME AVG UP TO 3000 OPER FOR YEAR-ROUND HEAT PUMPS ~~@10 HR/DAY × 300 DAYS.~~
TOTAL $1458

F) WATER TREATMENT
SEE SEPARATE SHEET $2493

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GANINAE

DISTRICT COOLING — ANNUAL OPERATING COST

A) PER MPLS ENERGY CTR @ 400 TONS
900 HRS

$\frac{\$112,949}{360,000} = .3137 \frac{\$}{\text{TON HR}}$

B) TO COMARE WITH WELL W/ OPER COSTS AND CONVERSION OPER COSTS, WHERE MAINT, & LABOR COSTS WERE ASSUMED EQUAL AND THEREFORE NOT INCLUDED:

SUBTRACT OUT OF $.3137/TONH THE COST OF MAINTENANCE, ETC:

* BASE	$ .3137 / TON HR
* LABOR	(.0160)
* MAINT & SUPPLIES	(.0117)
* CAPITOL EQPT	(.0610)
	$ .225 / TON HR

FOR COOLING COST COMPARISON.

* COSTS PER MPLS ENERGY CENTER, 12/89 & 1/90

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GAVIIDAE

PEAK LOAD GPM'S AND TONS
COOLING ONLY

A) LOAD

2 CHILLERS
250 TONS @ x2 = 500

HEAT PUMPS 284 TONS

HEAT EXCH (WELL W.) 128 TONS

TTL 912 TONS

B) GPM

WELL WATER HEAT EX. (TONS = GPM ΔT / 24)

CONDENSER SIDE (TONS = GPM ΔT / 30)

CHILLERS

$\frac{500 \times 30}{(70-64)}$ = 938

HEAT PUMPS = 778 (SUMMED ACTUAL GPM's AS BALANCED)

$\frac{284 \times 30}{10.95}$

HEAT EX (WELL W)

$\frac{128 \times 24}{3}$ = 1024

2740 GPM

C) $\frac{GPM}{TON} = \frac{2740}{912}$ = **3.00439** GPM/TON

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Project WATER USE STUDY Sheet 1 of 2

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GAVIIDAE

TOTAL FIRST COSTS - CONVERSION TO COOLING TOWER

A) CHILLERS FIRST COSTS

1) CENTRIFUGAL CHILLERS - YORK.
GEAR CHANGES FOR 85° WATER: 25000 x 2 = $50,000

CONDENSER VESSELS = 0 = 0

2) RECIPROCATING CHILLERS
ADD NEW 128 TON YORK YCWK11 = $32,000

START-UP & BASE 2,000

TOTAL $84,000

B) ADD TOWER
$38,133 PER MARLEY QUOTE $38,133
$38,133 / 912 TONS = $42/TON

C) PUMPS
2750 GPM = B & G PUMP VSCS 10x12x13 $7,510
1750 RPM, 100' HD, 88 BHP

D) PIPE/INSUL
2750 GPM @ 10 FPS = 10" PIPE
250' @ 10" = 250 x $72.35 = 18088
250' @ 8" = 250 x 55.80 = 13950
TOTAL $32,038

E) INSTALLATION
~EQUAL TO EQUIPMENT
16,000 CHILLER + 38133 + 7510 + 32038 = $93,681
SUBTOTAL 255,362

F) CONTINGENCIES 30% = 255,362 x .3 = 76,609

(80) TOTAL $331,971

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GAVIIDAE

TOTAL FIRST COSTS: WITHOUT HEAT/COOL CONVERSION

PIPING
(HX, steam pipes to HX, source water pipes from HX)

3142 lbs/H steam @ 250 psi = 8" pipe

200' (@ 8") $55.80/LF = $11,160
MEANS' CATALOGUE 1985 P. 84

HEAT EXCHANGER - 778 GPM STEAM TO WATER
(Means 1989 p167) $26,700

TOTAL FIRST COST - NEW PIPE & HX, DISTRICT HEAT & COOL = 11160 + 26700 = $37860

TOTAL ANNUAL - FOR LIFE CYCLE COST ANALYSIS
DISTRICT COOL & HEAT

81,000 COOL
25969 HEAT
− 888 HEAT PUMP HEATING MODE COST DIFFERENTIAL
$106,081 ANNUAL OPER COST TOTAL HEAT & COOL

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LEADER IN NEW TECHNOLOGY
FOR AIR CONDITIONING

Applied Systems
York International Corporation
4800 Mustang Circle
New Brighton, MN 55112
Telephone Sales (612) 780-4000
Telephone Service (612) 780-4446
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TWIN CITIES SALES & SERVICE
FACSIMILE TRANSMITTAL

TO: OSM DATE: 12/21/89
ATTN: GEORGE ROTHENBERGER NO. OF PAGES:
FAX NUMBER: 331-3806 FROM: JIM PORATH
SUBJECT: DNR STUDY - GAVIDAE

MESSAGE:

GEORGE,

THE FOLLOWING IS THE INFO ON GAVIDAE - HONEYWELL STINSON WILL BE COMING SOON.

	ORIGINAL CONDITIONS	TOWER CONDITIONS
MODEL	YT B2C3C1 - CJ00	SAME
GEAR	KQ	KW
EVAP	57/43.6, 467GPM, 2PASS	57/43.6, 467GPM, 2
COND	56/69.8, 510GPM, 2PASS	85/94.49, 789GPM, 2 PA
TONS	263	263
KW (KW/TON)	109KW, (.414 KW/TON)	177 KW, (.673 KW/TO

NOTE: THE INTERNAL SPEED INCREASING GEARS WILL HAVE TO BE CHANGED (FROM KQ TO KW) TO UTILIZE 85°ECW. THE CHILLERS WILL NOT WORK WITH THE EXISTING GEAR UNDER THE HIGHER HEAD CONDITIONS OF A COOLING TOWER (85/95). (2) $25,000 EACH

BUDGET PRICE KW GEAR / SERVICE LABOR (TURN-KEY)

Minneapolis Energy Center, Inc.

1060 IDS Center • 80 South 8th Street • Minneapolis, MN 55402
Telephone (612) 349-6066 • Fax (612) 349-6067

From : mec13496067 Dec.29.1989 03:19 PM P0

12/29/89

DEAR GEORGE

I HAVE RESEARCHED ACTUAL LOAD ON CITY CENTER RETAIL AND ARRIVED AT THE FOLLOWING.

GROSS AREA 280,000 SQ FT

NORMAL ANNUAL CONS. 752,000 TON HOURS.

PEAK DEMAND/1000 SQFT = 3.0 TONS.

GAVIIDAE AREA EXCLUSIVE OF SAKS = 125,000 SQFT.

ESTIMATED GAVIIDAE LOAD 3.X125 = 375 TONS

ESTIMATE 400 TONS W/O SAKS. @900FL HRS.

720 TONS W SAKS.

ANNUAL COST.

400 TONS DEMAND	=	$52968.00
360,000 TON HRS/YR	=	26,500.00
ESCALATION @ .093	=	33,480.00
		112,948.00

ANNUAL COST/SQFT = $.90

P# HEAT PUMPS — GAVILAN COMMONS 12/20/8

CLIMATE MASTER	EWT	LWT	EER	TOTAL WATTS	GPM
814-013	70°F	85°F	11.9	1170	2.4
(1 TON)	85°F	95°F	11.0	1250	3.6
<QTY-7>	90°F	105°F	10.1	1320	2.4

814-013 ENTERING CONDITIONS

% GLYCOL = 0
GPM = 2.4
CFM = 450
ENT WAT TEMP - COOLING = 90 ←
ENT DRY TEMP - COOLING = 80
ENT WET BULB - COOLING = 67
ENT WAT TEMP - HEATING = 70
ENT DRY BULB - HEATING = 70

PERFORMANCE FOR MODEL 814-013

COOLING		HEATING	
TOTAL BTUH =	13300	TOTAL BTUH =	15900
TOTAL SBTUH =	9900		
TOTAL WATTS =	1320	TOTAL WATTS =	1350
EER =	10.1	COP =	3.5
HEAT OF REJ =	17805	HEAT OF ABS =	11292
LVG WAT TEMP =	104.8	LVG WAT TEMP =	60.6

PRESSURE DROP (FT WATER) = 11.25

GAVIIDAE COMMONS

814-013 ENTERING CONDITIONS

% GLYCOL = 0
GPM = 3.6
CFM = 450
ENT WAT TEMP - COOLING = 85 ◄
ENT DRY TEMP - COOLING = 80
ENT WET BULB - COOLING = 67
ENT WAT TEMP - HEATING = 70
ENT DRY BULB - HEATING = 70

PERFORMANCE FOR MODEL 814-013

COOLING		HEATING	
TOTAL BTUH =	13700	TOTAL BTUH =	16400
TOTAL SBTUH =	9900		
TOTAL WATTS =	1250	TOTAL WATTS =	1380
EER =	11.0	COP =	3.5
HEAT OF REJ =	17966	HEAT OF ABS =	11690
LVG WAT TEMP =	95.0	LVG WAT TEMP =	63.5

PRESSURE DROP (FT WATER) = 23.35

814-013 ENTERING CONDITIONS

% GLYCOL = 0
GPM = 2.4
CFM = 450
ENT WAT TEMP - COOLING = 70 ◄
ENT DRY TEMP - COOLING = 80
ENT WET BULB - COOLING = 67
ENT WAT TEMP - HEATING = 70
ENT DRY BULB - HEATING = 70

PERFORMANCE FOR MODEL 814-013

COOLING		HEATING	
TOTAL BTUH =	13900	TOTAL BTUH =	15900
TOTAL SBTUH =	9900		
TOTAL WATTS =	1170	TOTAL WATTS =	1350
EER =	11.9	COP =	3.5
HEAT OF REJ =	17893	HEAT OF ABS =	11292
LVG WAT TEMP =	84.9	LVG WAT TEMP =	60.6

PRESSURE DROP (FT WATER) = 11.25

GAVI'DAE COMMONS 12/2

P. # CLIMATE MASTER	EWT	LWT	EER	TOTAL WATTS	GPM
814-019	70°F	85°F	11.4	1640	3.25
(1 1/2 TON)	85°F	95°F	10.5	1770	4.91
<QTY-1>	90°F	105°F	9.7	1870	3.30
814-027	70°F	85°F	12.6	2190	4.70
(2 TON)	85°F	95°F	11.7	2330	6.99
<QTY-20>	90°F	105°F	10.7	2470	4.60
814-031	70°F	85°F	11.7	2720	5.50
(2 1/2 TON)	85°F	95°F	10.8	2900	8.10
<QTY-11>	90°F	105°F	9.8	3080	5.40
814-036	70°F	85°F	12.3	3000	6.30
(3 TON)	85°F	95°F	11.3	3200	9.38
<QTY-68>	90°F	105°F	10.3	3400	6.20
814-042	70°F	85°F	12.4	3420	7.20
(3 1/2 TON)	85°F	95°F	11.4	3640	10.80
	90°F	105°F	10.5	3860	7.20
814-048	70°F	85°F	12.0	4140	8.50
(4 TON)	85°F	95°F	11.0	4400	12.70
	90°F	105°F	10.1	4660	8.40
814-060	70°F	85°F	12.1	5200	10.8
(5 TON)	85°F	95°F	11.2	5550	11.2
<QTY-1>	90°F	105°F	10.3	5850	10.7

THE MARLEY COOLING TOWER CO.
Work Sheet

96B

OFFICE Gorgen Co. MADE BY Dale Schmalz CHECKED BY ________ DATE 12-22-89

GPM 2736

HW 95 — 10°R

CW 85 — 7°A

WB 78

WIND MPH ________

S. MANUAL ________

QUOTATION: FORMAL☐ LETTER☐ VERBAL☐ WORK SHEET COPIES TO: K.C., ________

PARTY QUOTED George Rothenberger

ADDRESS ________

JOB Gavildae 912 Tons.

ADDRESS ________

ENG'D BY OSM

EQUIPMENT TO SERVE ________

NOTE BELOW – SALES COMMENTS – KEY MEN – TITLES – ADDRESSES – ETC.
SHOW TOWER ORIENTATION IF LOCATED WITHIN ENCLOSURE

NC-941

	30,730.
HC Valves	590.
Basin Covers	370
Lube Lines	310.
Motor-Out of Air Stream	1300.
Mt - Vibration Sw.	130.
Hand Rail Ladder	840
	34,270
Freight.	1403.
	35,673.

Add for 1-60 Hp - 2 Speed 1 winding High Eff mtr.
2460.00

TOTAL 36730

17,395 Ship Wt.
39,420 Operating Wt

(87)

GAVIIDAE COMMONS

SUPPLEMENTAL INFORMATION TO:
GEOTHERMAL HEATING AND COOLING SURVEY

November 2, 1989

Permit Number 85-6259
MCC Development
Attn: Fred Atkinson
Gaviidae Common
651 Nicollet Mall
Mpls, MN 55402

1. Please provide a schematic drawing of the system (include summer and winter mode).

2. Well Pump: Variable Speed [ ] yes [X] no

HP 100/125 GPM 1600/2000 KW Input 74.6/93.25 #2 run for emergen

Efficiency Rating 84.5/86 (if known)

2a Well water supply pump 1 operates, 1 standby 20 HP 1600 GPM ?

3. Heat Pumps:

Please indicate the following for each size of unit in the system.

Manufacturer Climate Master Model 814 Series Type Water/air

CONDENS WATER COOLING MODE ΔT

Size							Note
1 Ton	Cooling Capacity 13,600 BTU		Heating Capacity 12,700 BTU				13600 x 1.25 = 500(2.75)ΔT
	Design GPM 2.75		Number of Units 7				ΔT = 12.36
	Total GPM 19.25	COP 3.1	EER 10.7				COND WATER
1.5 Ton	Cooling Capacity 18,500		Heating Capacity 17,100				
	Design GPM 4.00		Number of Units 1 (ONE)	Total			ONE
	GPM 4	COP 3.3	EER 10.3				ΔT = 11.56
2 Ton	Cooling Capacity 27,000		Heating Capacity 23,200				
	Design GPM 6.2		Number of Units 20	Total			ΔT = 10.88
	GPM 124	COP 3.4	EER 11.5				
2.5 Ton	Cooling Capacity 31,000		Heating Capacity 30,800				31,000 x 1.25 = 500
	Design GPM 6.9		Number of Units 9	Total			ΔT = 11.2
	GPM 62.1	COP 3.4	EER 10.5				
3 Ton	Cooling Capacity 36,000		Heating Capacity 33,400				
	Design GPM 8.3		Number of Units 67	Total			ΔT = 10.8
	GPM 556.1	COP 3.5	EER 11.2				
5 Ton	Cooling Capacity 61,500		Heating Capacity 57,100				ΔT = 11.14
	Design GPM 13.8		Number of Units 1	Total			
	GPM 13.1	COP 3.9	EER 10.8				

778.55 GPM

ΔT 105

SUM $\frac{3406}{12}$ MBH = 284 COOLING TONS TOTAL

(88)

4a. PRECOOL OF RETURN WATER (CHILLED WATER FROM BUILDING)
HEAT EXCHANGER
1) CHILLED WATER SIDE
59.8 / 56.5 °F EWT/LWT, 930 GPM = 127.8 TONS ≅ SAY 127 TONS
2) WELL WATER SIDE
53.0 / 56.0 ° EWT/LWT, 1020 GPM = 127.5 TONS

4. **Chillers:**

Type #1 York Centrifugal

Capacity 265 **Tons** **KW input** 109 = .411 KW/TON

Condenser: **Temp In** 54 **F**

Temp Out 70 **F**

GPM 510

Estimated Peak Load 250 **Tons**

Average Hours Operated per year 900

Type #2 York Centrifugal

Capacity 265 **Tons** **KW input** 109

Condenser: **Temp In** 54 **F**

Temp Out 70 **F**

GPM 510

Estimated Peak Load 250 **Tons**

Average Hours Operated per year 260

5a. Water Source Loop Pump 25 HP 340 GPM

5. **Chilled Water Pumps:**

KW Input 25 **Efficiency** ____

HP 25 **GPM** 465

Number of Pumps 2 chilled water pumps and 2 stand-by pumps

6. **Control valves on the Well Water loop:**
[X] 2-way [ ] 3-way

7. **Estimated Operating Costs:**

Heating $ ____

Cooling $ ____

Water Treatment $ 12,000 annually

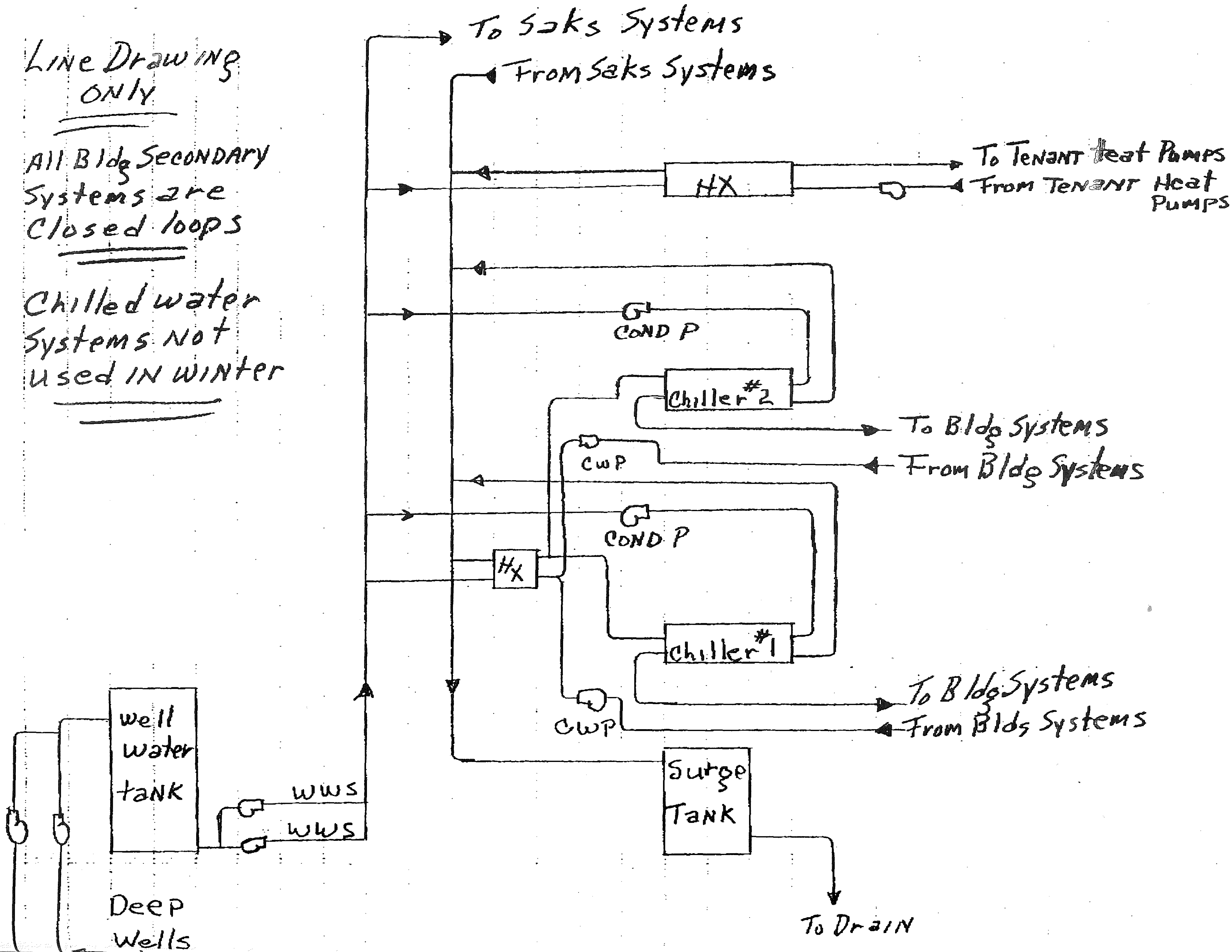
89

NOV 27 '89 16:05 BCE DEVELOPMENT PROPERTIES-MPLS

Line Drawing ONLY

All Bldg Secondary Systems are Closed loops

Chilled water Systems Not used in winter



296-3550

DOCUMENT TRANSMITTAL

ENCLOSED ARE 4 PAGES (INCLUDING COVER PAGE) TO BE DELIVERED TO:

NAME: Jim Japs

FIRM: Minnesota DNR

CITY: St. Paul # 297-2835

FROM: FRED ATKINSON

FIRM: BCED

CITY: Mpls

PLEASE CALL (612) 372-1500 IF THE COMPLETE DOCUMENT IS NOT RECEIVED.

TO REPLY BY RAPIFAX, DIAL (612) 372-1510.

THANK YOU.

MESSAGE (IF ANY): Please find enclosed the information you requested. Please call me at 372-1226 if you have any additional questions.

Thanks
Fred

(91)

SEPT 18.

GEOTHERMAL HEATING AND COOLING SURVEY

PERMIT NUMBER 85-6295

PERMITTEE MCC Development Co., Inc.

SYSTEM LOCATION Gaviidae Common, 651 Nicollet Mall, Mpls., MN 55402

NAMES AND LOCATIONS OF FACILITIES:

Gaviidae Common, 651 Nicollet Mall, Mpls., MN 55402

TOTAL AREA SERVICED: 237,000 Square feet

WATER SOURCE

Number of wells connected to the system 2

Enclosed is the well information we have on file regarding this installation. Please indicate if this data is accurate and/or submit any additional well data that is available. If no information is enclosed or available, please complete the enclosed Water Well Information form(s).

Are water level measurements taken on the production well(s) or observation well(s)? [X] Yes [ ] No If yes, please submit a summary of the data. New system - measuring devise being installed.

SYSTEM INFORMATION

Number of years since original system was installed: ____

Date system was put on line: April 1989

Is this a once through or closed loop system (describe and attach a simple schematic drawing) ?

Once through

Describe any major system modifications and give the completion date:

None, this is a new system

Average water temperature:

Heating 52 intake; (?) discharge (new system)
Cooling 52 intake: 65 discharge

System size rating:

Heating 13600M (BTU/H) Cooling 525 (Tons/H)

Actual peak load:

Heating (?) (BTU) Cooling 450 (Tons)

Energy efficiency of systems:

Number of chillers/heat pumps in system 2 chillers, ~~80~~ 105 heat pumps
Coefficient of Performance (COP) for heat pump 3.1 - 3.5
Average Energy Efficiency Ratio (EER) for heat pump 10.7 - 11.2
If no heat pump, chiller efficiency rating (?)
Number of chillers or heat pumps in system -
Size rating of chillers/heat pumps 265 each 1.5 - 3 tons

General Water Use Efficiency:

Average Efficiency of Water Use 1.93 (gal/ton) cooling
1.93 (gal/BTU) heating
How much water is recirculated? None
How much water is lost in the system, where is it lost and how is the amount of water loss determined?

None

If cooling towers are part of the system, how many are there, how much evaporative loss occurs in this loop, and how is the amount of water loss determined?

N/A

What is the design capacity of the towers? N/A

If cooling towers are not present in the system please describe the feasibility of adding towers including any site and/or system limitations.

____

____

____

____

____

____

____

WATER USAGE

Indicate the percentage of all primary and secondary uses of the water:

____	Heating	100	Air conditioning (in summer)
____	Processing	100	Other: Heat pumps in winter

Average pumpage: 1,000 gpm; 24 hours/day; 12 months/year

Are flow meters used to determine water usage? [X] Yes [ ] No

If meters are not used, describe how the amount of water appropriated is determined.

____

____

____

WATER DISPOSAL

Indicate any water treatment that is done before or after the water goes through the system.

Liquid sodium sulfite #EG-5308 Additional water treatment is being added at this time for bacteria control. These changes will include post treat

What percentage of the water is discharged and what is the water discharged to?

100% - storm sewer

If water is discharged into a storm sewer indicate the receiving water for the sewer outlet, if known.

Mississippi River

List any discharge authorizations required for the system.

N/A

Indicate any regulated discharge limitations relating to water temperature, quality or quantity.

N/A

WATER CONSERVATION

Does the system use variable speed pumps? [ ] Yes [X] No

Are any load or system controls used to reduce water requirements by reducing the operating load conditions (i.e. load shedding, temperature set points)?

We use modulating valve control to reduce the flow of water to the heat exchanger

List any other measures utilized to reduce water use:

This is a new system and we are just learning how it functions.

What changes can be done to the system to reduce water use?

This will have to be studied.

What alternatives exist for reuse of the discharge water?

Same as above.

Indicate any anticipated future changes in water use and state reasons for projected increases or decreases.

At this time the system is too new to know what our future needs will be.

Please provide us the following information about the person that completed the survey.

FAX 372-1570

Name Pat Gannon

Title HVAC Tech.

Telephone Number 372-1600 or 1670

Please give the name and phone number of someone that can provide additional information, if different than above.

Contact Person Fred Atkinson, Operations Manager

Telephone Number 372-1226

This survey is to be completed and mailed by <u>September 15, 1989</u> to:

Department of Natural Resources - Division of Waters
Attn: Jim Japs
Geothermal Heating and Cooling Survey
Box 32, 500 LaFayette Road
St. Paul, MN 55155-4032

Hennepin County

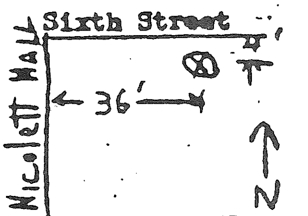
Township Name	Township Number	Range Number	Section No.	Fraction
Minneapolis				

Distance and Direction from Road Intersection or Street Address and City of Well Location

So. Sixth and Nicollet Mall, Mpls., Minn.

Show exact location of well in section grid with "X". Sketch map of well location.

Addition Name — Block Number — Lot Number



1. FORMATION LOG

FORMATION LOG	COLOR	HARDNESS OF FORMATION	FROM	TO
Pitless - Later			0'	12'
Sand and Gravel	Brown		12'	54'
Platteville/Limerock	Gray	Hard	54'	71'
Shale	Gray	Med.	71'	75'
St. Peter Sandrock	Gray	Soft	75'	112'
St. Peter Sandrock	Tan	Med.	112'	241'
Shakopee Limerock	Tan/Pink	Hard	241'	364'
Jordan Sandrock	White	Med.	364'	437'
Jordan Shale & Sandrock	Gray	Med.	437'	461'

Location From Topo
29.24.22 ddc

Use a second sheet, if needed.

15. REMARKS, ELEVATION, SOURCE OF DATA, etc.

RECEIVED
FEB 20 1986
Minn. Dept. of Health GWQS

3. PROPERTY OWNER'S NAME

MCC Development, Inc.
Minneapolis City Center/Phase II

Address 33 So. Sixth Street
Minneapolis, Minnesota 55402

4. WELL DEPTH (completed) 461' ft. Date of Completion Feb., 1986

5. X 1 Cable tool; 2 Hollow rod; 3 Rotary; 4 Reverse; 5 Air; 6 Jetted; 7 Driven; 8 Bored; 9 Power Auger; 10 Dug; 11

6. USE 1 Domestic; 2 Irrigation; 3 Test Well; 4 Public Supply; 5 Municipal; 6 X Air Conditioning; 7 Industry; 8 Commercial; 9

7. CASING X 1 Black; 2 Galv.; 3; 4 Threaded; X 5 Welded; 6

HEIGHT: Above/Below Surface 12 ft. Drive Shoe? Yes X No

Diameter	Depth	Weight	Hole Diam.
30 in. to 42 ft.		118.7 lbs./ft.	29 in. to 112 ft.
24 in. to 100 ft.		94.6 lbs./ft.	23 in. to 262 ft.
18 in. to 250 ft.		70.6 lbs./ft.	17 in. to 461 ft.

8. SCREEN Make None

Type — Dia. — Slot/Gauze — Length — Set between ___ ft. and ___ ft.

Or open hole from 250 ft. to 449 ft.

FITTINGS:

9. STATIC WATER LEVEL 93 ft. below land surface. Date Measured 1/28/86

10. PUMPING LEVEL (below land surface)

109' 8" ft. after 3-1/2 hrs. pumping 2250 g.p.m.

114' 3" ft. after 21 hrs. pumping 2500 g.p.m.

11. WELL HEAD COMPLETION X 1 Pitless adapter /Later; 2 Basement offset; 3 At least 12" above grade

12. Well grouted? X Yes No — 1 Neat Cement; 2 Bentonite; 3 — Cu. Yds. 29-1/2

Depth: from 0 75 ft. to 75 ft.; from 0 ft. to 250 ft.

13. Nearest source of possible contamination 25 feet N direction Sewer type

Well disinfected upon completion? Yes X No

14. PUMP - Later

Date installed — Not installed — Manufacturer's Name — Model Number — HP — Volts — Length of drop pipe — ft. capacity — g.p.m. — Material of drop pipe — Type: 1 Submersible; 2 Jet; 3 L. S. Turbine; 4 Centrifugal; 5 Reciprocating; 6

16. WATER WELL CONTRACTOR'S CERTIFICATION

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

Keys Well Drilling Co. 62012 No.

413 N. Lexington Parkway
St. Paul, Minnesota 55104

Signed [signature] Authorized Representative Date 2/17/86

President

Name of Driller: Russell/Galvin/Horrigan

MINN. DEPT. OF NATURAL RESOURCES COPY

(97)

A P P E N D I X

HONEYWELL AVIONICS

APPENDIX

OSM Orr Schelen Mayeron & Associates, Inc.
2021 East Hennepin Avenue
Minneapolis, MN 55413
612-331-8660
FAX 331-3806
Engineers
Surveyors
Planners

Client DNR
By GER
Project HONEYWELL
Sheet 1 of 1
Comm. No. 4435.00
Date 1/10/90

SUMMARY

ANNUAL OPERATING COSTS - EXISTING WELL WATER OPERATION.

PUMPING COSTS	$ 31,123
WATER TREATMENT COSTS	$ 22,856
COMPESSORIZED EQPT, FIG A1	$ 162,767
LIEBERT UNITS	$ 26,124
TOTAL	$ 242,870

ANNUAL OPERATING COSTS - CONVERSION TO AIR COOLED

PUMPS - MISC

SUPPLY PUMP 40 HP X .85 (Nameplate to BHP) x .746 x 1/.9 x $.045 x 3340 = $ 4236

BOOSTER PUMP .33 HP x .85 x .746 x 1/.9 x .045 x 8736 = $ 92

PUMPAGE - COOLING TOWERS

125 HP x 1.0 x 1/.84 x .746 x $.045/KWH x 3760 HRs/YR = $ 43760 /YR

COOLING TOWER FANS (TWO SPEED) 1/2 TIME AT LOW SPEED

100 HP x .85 x 1/.90 x .746 x $.045/KWH x 8760 x .50 = 13,887

24 HP x .85 x 1/.90 x .746 x $.045/KWH x 8760 x .50 = 3,333

~~CITY WATER + City SEWER~~ SEE FIGURE ATTACHED Pg B of 8 32,261

WATER TREATMENT = 6,959

COMPRESSORIZED EQPT, FIG. A-2 = 233,412

LIEBERT UNITS (item E2a above) = 49,282

TOTAL ANNUAL [illegible] COST = $ 387,2[illegible]

APPENDIX
Fig A-1

HONEYWELL AVIONICS
ANNUAL OPERATING COST OF WELL WATER COOLED COMPRESSORIZED EQPT.
EFFICIENCIES BASED ON 50 DEG F ENTERING CONDENSER WATER TEMP

ITEM	DESCR	WELL WATER USAGE	COOL TONS	ESTIM. LOAD	ESTIM. EER OR (KW/TON, (1)	HR OPER PER YR	ELEC. $/KWH	ANNUAL COST
A115	HEAT PUMP	COND	2	0.8	12.6	0	0.045	$0.00
A111	PKG A/C	COND	5	0.25	10	3744	0.045	$252.72
A112	PKG A/C	COND	5	0.5	10	4992	0.045	$673.92
A122	PKG A/C	COND	7.5	0.5	9.7	8736	0.045	$1,823.75
A105	COND UNIT	COND	75	0.75	0.71	3250	0.045	$5,840.86
A103	COND UNIT	COND	75	0.75	0.71	8736	0.045	$15,700.23
A315	FAN COIL U	CW COIL	1	0.5	1	0	0.045	$0.00
A316	HEAT PUMP	COND	3	0.8	12.3	8736	0.045	$920.48
VAX ROOM	HEAT PUMP	COND	3	1	12.3	8736	0.045	$1,150.60
A205	COND UNIT	COND	10	1	0.85	8736	0.045	$3,341.52
A327	COMP RM U	CW COIL/COND	20	0.5	1	0	0.045	$0.00
A307	COMP RM U	CW COIL/COND	20	0.5	1	0	0.045	$0.00
A309	COMP RM U	CW COIL/COND	20	0.5	1	0	0.045	$0.00
A328	COMP RM U	CW COIL/COND	20	0.5	1	0	0.045	$0.00
A321	COMP RM U	CW COIL/COND	20	0.5	1	0	0.045	$0.00
A322	COMP RM U	CW COIL/COND	20	0.5	1	0	0.045	$0.00
A324	COMP RM U	CW COIL/COND	20	0.5	1	0	0.045	$0.00
A318	PKG A/C	COND	7.5	0.25	9.7	4368	0.045	$455.94
A202	COND UNIT	COND	3	0.5	10	8736	0.045	$707.62
A204	HEAT PUMP	COND	5	0.8	12.1	8736	0.045	$1,559.48
A206	FAN COIL	CW COIL	12.5	0.5	1	0	0.045	$0.00
A317	PKG A/C	COND	15	0.5	9.7	8736	0.045	$3,647.51
A207	CHILLER-RECP	COND	15	0.66	0.744	8736	0.045	$2,895.56
A216	AHU	CW COIL	20	0.5	1	0	0.045	$0.00
A218	AHU	CW COIL	15	0.5	1	0	0.045	$0.00
A219	AHU	CW COIL	15	0.5	1	0	0.045	$0.00
A211	COND UNIT	COND	100	0.5	0.68	4368	0.045	$6,683.04
A520	PKG A/C	COND	6	0.25	10	8736	0.045	$707.62
A521	PKG A/C	COND	6	0.4	10	8736	0.045	$1,132.19
A201	COND UNIT	COND	3	0.66	10	8736	0.045	$934.05
A615	CHILLER-RECP	COND	100	0.5	0.791	1680	0.045	$2,989.98
A621	PKG A/C	COND	15	0.5	9.7	8736	0.045	$3,647.51
A622	COND UNIT	COND	30	0.5	0.7	8736	0.045	$4,127.76
A260	COMP RM U	COND	10	1	9.7	8736	0.045	$4,863.34
A452	FAN COIL	CW COIL	10	0.5	1	0	0.045	$0.00
A101A	COND UNIT	COND	40	0.75	0.71	2730	0.045	$2,616.71
A102	COND UNIT	COND	15	0.75	0.71	2730	0.045	$981.26
A337	MAKE-UP AHU	CW COIL	25	0.5	1	0	0.045	$0.00
A364	AHU	CW COIL	11.5	0	1	0	0.045	$0.00
AC02	CHILLER-RECP	COND	75	0	0.786	0	0.045	$0.00
AC03	CHILLER-RECP	COND	75	0.1	0.786	4368	0.045	$1,158.72
AC04	CHILLER-CENT	COND	500	0.8	0.382	4368	0.045	$30,034.37
AC05	CHILLER-CENT	COND	300	1	0.4133	8736	0.045	$48,742.95
AC06	CHILLER-RECP	COND	130	0.8	0.853	2184	0.045	$8,718.62
AC08	CHILLER-RECP	COND	100	0.1	0.791	4368	0.045	$1,554.79
AC09	CHILLER-RECP	COND	100	0.1	0.791	4368	0.045	$1,554.79
A311	COND UNIT	COND	75	0	0.71	4368	0.045	$0.00
A305	AHU	CW COIL	30	1	1	0	0.045	$0.00
A305A	COND UNIT	COND	30	0	0.62	0	0.045	$0.00
A308	CHILLER-RECP	COND	40	0.6	0.71	4368	0.045	$3,349.38
A443	AHU	CW COIL	20	1	1	0	0.045	$0.00
A220	AHU	CW COIL	20	0.5	1	0	0.045	$0.00
A221	AHU	CW COIL	20	0.5	1	0	0.045	$0.00
AC01	CHILLER-RECP	COND	100	0	0.791	0	0.045	$0.00
						TOTAL		$162,767.25

APPENDIX
Fig A-2

HONEYWELL AVIONICS
ANNUAL OPERATING COST COMPRESSORIZED EQPT - COOLING TOWER OPERATION.
EFFICIENCIES BASED ON 85 / 95 DEG F ENTERING/LEAVING CONDENSER WATER.

ITEM	DESCR	WELL WATER USAGE	COOL TONS	ESTIM. LOAD	ESTIM. EER OR (KW/TON)	HR OPER PER YR	ELEC. $/KWH	ANNUAL COST
A115	HEAT PUMP	COND	2	0.8	11.7	8736	0.045	$645.12
A111	PKG A/C	COND	5	0.25	9	3744	0.045	$280.80
A112	PKG A/C	COND	5	0.5	9	4992	0.045	$748.80
A122	PKG A/C	COND	7.5	0.5	8.7	8736	0.045	$2,033.38
A105	COND UNIT	COND	75	0.75	1.07	3250	0.045	$8,802.42
A103	COND UNIT	COND	75	0.75	1.07	8736	0.045	$23,660.91
A315	FAN COIL U	CW COIL	1	0.5	1	0	0.045	$0.00
A316	HEAT PUMP	COND	3	0.8	11.7	8736	0.045	$967.68
VAX ROOM	HEAT PUMP	COND	3	1	11.7	8736	0.045	$1,209.60
A205	COND UNIT	COND	10	1	1.09	8736	0.045	$4,285.01
A327	COMP RM U	CW COIL/COND	20	0.5	1	0	0.045	$0.00
A307	COMP RM U	CW COIL/COND	20	0.5	1	0	0.045	$0.00
A309	COMP RM U	CW COIL/COND	20	0.5	1	0	0.045	$0.00
A328	COMP RM U	CW COIL/COND	20	0.5	1	0	0.045	$0.00
A321	COMP RM U	CW COIL/COND	20	0.5	1	0	0.045	$0.00
A322	COMP RM U	CW COIL/COND	20	0.5	1	0	0.045	$0.00
A324	COMP RM U	CW COIL/COND	20	0.5	1	0	0.045	$0.00
A318	PKG A/C	COND	7.5	0.25	8.7	4368	0.045	$508.34
A202	COND UNIT	COND	3	0.5	9	8736	0.045	$786.24
A204	HEAT PUMP	COND	5	0.8	11.2	8736	0.045	$1,684.80
A206	FAN COIL	CW COIL	12.5	0.5	1	0	0.045	$0.00
A317	PKG A/C	COND	15	0.5	8.7	8736	0.045	$4,066.76
A207	CHILLER-RECP	COND	15	0.66	0.843	8736	0.045	$3,280.86
A216	AHU	CW COIL	20	0.5	1	0	0.045	$0.00
A218	AHU	CW COIL	15	0.5	1	0	0.045	$0.00
A219	AHU	CW COIL	15	0.5	1	0	0.045	$0.00
A211	COND UNIT	COND	100	0.5	1.07	4368	0.045	$10,515.96
A520	PKG A/C	COND	6	0.25	8.7	8736	0.045	$813.35
A521	PKG A/C	COND	6	0.4	8.7	8736	0.045	$1,301.36
A201	COND UNIT	COND	3	0.66	9	8736	0.045	$1,037.84
A615	CHILLER-RECP	COND	100	0.5	0.891	1680	0.045	$3,367.98
A621	PKG A/C	COND	15	0.5	6.7	8736	0.045	$4,066.76
A622	COND UNIT	COND	30	0.5	0.95	8736	0.045	$5,601.96
A260	COMP RM U	COND	10	1	8.7	8736	0.045	$5,422.34
A452	FAN COIL	CW COIL	10	0.5	1	0	0.045	$0.00
A101A	COND UNIT	COND	40	0.75	1.02	2730	0.045	$3,759.21
A102	COND UNIT	COND	15	0.75	1.07	2730	0.045	$1,478.81
A337	MAKE-UP AHU	CW COIL	25	0.5	1	0	0.045	$0.00
A364	AHU	CW COIL	11.5	0	1	0	0.045	$0.00
AC02	CHILLER-RECP	COND	75	0	0.903	0	0.045	$0.00
AC03	CHILLER-RECP	COND	75	0.1	0.903	4368	0.045	$1,331.20
AC04	CHILLER-CENT	COND	500	0.8	0.6152	4368	0.045	$48,369.48
AC05	CHILLER-CENT	COND	300	1	0.6438	8736	0.045	$75,927.20
AC06	CHILLER-RECP	COND	130	0.8	0.973	2184	0.045	$9,945.15
AC08	CHILLER-RECP	COND	100	0.1	0.891	4368	0.045	$1,751.35
AC09	CHILLER-RECP	COND	100	0.1	0.891	4368	0.045	$1,751.35
A311	COND UNIT	COND	75	0	1.07	4368	0.045	$0.00
A305	AHU	CW COIL	30	1	1	0	0.045	$0.00
A305A	COND UNIT	COND	30	0	0.93	0	0.045	$0.00
A308	CHILLER-RECP	COND	40	0.6	0.85	4368	0.045	$4,009.82
A443	AHU	CW COIL	20	1	1	0	0.045	$0.00
A220	AHU	CW COIL	20	0.5	1	0	0.045	$0.00
A221	AHU	CW COIL	20	0.5	1	0	0.045	$0.00
AC01	CHILLER-RECP	COND	100	0	0.891	0	0.045	$0.00
						TOTAL		$233,411.85

APPENDIX
Fig A-3

HONEYWELL AVIONICS
COOLING TOWER GPM
CONVERSION TO COOLING TOWERS
CONDENSING TEMPERATURES 85/95 EWT/LWT DEG F

ITEM	DESCR	WELL WATER USAGE	COOL TONS	ESTIM. LOAD	TOTAL
A115	HEAT PUMP	COND	2	0.8	1.6
A111	PKG A/C	COND	5	0.5	2.5
A112	PKG A/C	COND	5	0.5	2.5
A122	PKG A/C	COND	7.5	0.5	3.75
A105	COND UNIT	COND	75	0.75	56.25
A103	COND UNIT	COND	75	0.75	56.25
A316	HEAT PUMP	COND	3	0.8	2.4
VAX ROOM	HEAT PUMP	COND	3	1	3
A205	COND UNIT	COND	10	1	10
A318	PKG A/C	COND	7.5	0.1	0.75
A202	COND UNIT	COND	3	1	3
A204	HEAT PUMP	COND	5	1	5
A317	PKG A/C	COND	15	1	15
A207	CHILLER-RECP	COND	15	1	15
A211	COND UNIT	COND	100	0.5	50
A520	PKG A/C	COND	6	0.5	3
A521	PKG A/C	COND	6	1	6
A201	COND UNIT	COND	3	1	3
A615	CHILLER-RECP	COND	100	0	0
A621	PKG A/C	COND	15	1	15
A622	COND UNIT	COND	30	0.75	22.5
A260	COMP RM U	COND	10	1	10
A101A	COND UNIT	COND	40	0.75	30
A102	COND UNIT	COND	15	0.75	11.25
AC02	CHILLER-RECP	COND	75	0.25	18.75
AC03	CHILLER-RECP	COND	75	0.25	18.75
AC04	CHILLER-CENT	COND	500	1	500
AC05	CHILLER-CENT	COND	300	1	300
AC06	CHILLER-RECP	COND	130	0.5	65
AC08	CHILLER-RECP	COND	100	0.25	25
AC09	CHILLER-RECP	COND	100	0	0
A311	COND UNIT	COND	75	1	75
A305A	COND UNIT	COND	30	0	0
A308	CHILLER-RECP	COND	40	0.5	20
A306	COND UNIT	COND	0	0	0
AC01	CHILLER-RECP	COND	100	0	0
					0

TOTAL TONS. ADJUSTED 1350.25

NOTE: COND WATER TYPICALLY CONTROLED WITH TWO-WAY PENN VALVES - TOWER REQMT ABOV

APPENDIX
A-4

HONEYWELL AVIONICS
ENVIRONMENTAL WELL WATER USAGE
MILLION GALLONS PER YEAR

ITEM	DESCR	WELL WATER USAGE	COOL TONS	HEAT REJ FACTOR	ESTIM. LOAD	ESTIM. TD	HR OPER PER YR	TOTAL MGY
A115	HEAT PUMP	COND	2	1.25	0.25	25	8736	0.31
A111	PKG A/C	COND	5	1.25	0.25	25	3744	0.34
A112	PKG A/C	COND	5	1.25	0.25	25	4992	0.45
A122	PKG A/C	COND	7.5	1.25	0.25	25	8736	1.18
A105	COND UNIT	COND	75	1.25	0.3	25	3250	5.27
A103	COND UNIT	COND	75	1.25	0.3	25	3250	5.27
A315	FAN COIL U	CW COIL	1	1	0.25	15	8736	0.21
A316	HEAT PUMP	COND	3	1.25	0.25	25	8736	0.47
VAX ROOM	HEAT PUMP	COND	3	1.25	0.25	25	8736	0.47
A205	COND UNIT	COND	10	1.25	0.3	25	8736	1.89
A327	COMP RM U	CW COIL/COND	20	1.25	0.5	30	8736	5.24
A307	COMP RM U	CW COIL/COND	20	1.25	0.5	30	8736	5.24
A309	COMP RM U	CW COIL/COND	20	1.25	0.5	30	8736	5.24
A328	COMP RM U	CW COIL/COND	20	1.25	0.5	30	8736	5.24
A321	COMP RM U	CW COIL/COND	20	1.25	0.5	30	8736	5.24
A322	COMP RM U	CW COIL/COND	20	1.25	0.5	30	8736	5.24
A324	COMP RM U	CW COIL/COND	20	1.25	0.5	30	8736	5.24
A318	PKG A/C	COND	7.5	1.25	0.1	25	4368	0.24
A202	COND UNIT	COND	3	1.25	0.25	25	8736	0.47
A204	HEAT PUMP	COND	5	1.25	0.25	25	8736	0.79
A206	FAN COIL	CW COIL	12.5	1	0.3	15	8736	3.14
A317	PKG A/C	COND	15	1.25	0.25	25	8736	2.36
A207	CHILLER-RECP	COND	15	1.25	0.1	25	8736	0.94
A216	AHU	CW COIL	20	1	0.3	15	4368	2.52
A218	AHU	CW COIL	15	1	0.3	15	1400	0.60
A219	AHU	CW COIL	15	1	0.3	15	2496	1.08
A211	COND UNIT	COND	100	1.25	0.3	25	4368	9.43
A520	PKG A/C	COND	6	1.25	0.25	25	8736	0.94
A521	PKG A/C	COND	6	1.25	0.25	25	8736	0.94
A201	COND UNIT	COND	3	1.25	0.3	25	8736	0.57
A615	CHILLER-RECP	COND	100	1.25	0.3	25	1680	3.63
A621	PKG A/C	COND	15	1.25	0.25	25	8736	2.36
A622	COND UNIT	COND	30	1.25	0.3	25	8736	5.66
A260	COMP RM U	COND	10	1.25	0.5	25	8736	3.14
A452	FAN COIL	CW COIL	10	1	0.25	15	8736	2.10
A101A	COND UNIT	COND	40	1.25	0.3	25	2730	2.36
A102	COND UNIT	COND	15	1.25	0.3	25	2730	0.88
A337	MAKE-UP AHU	CW COIL	25	1	0.3	15	8736	6.29
A364	AHU	CW COIL	11.5	1	0	15	8736	0.00
AC02	CHILLER-RECP	COND	75	1.25	0	25	0	0.00
AC03	CHILLER-RECP	COND	75	1.25	0.1	20	4368	2.95
AC04	CHILLER-CENT	COND	500	1.25	0.65	25	4368	102.21
AC05	CHILLER-CENT	COND	300	1.25	0.6	25	8736	113.22
AC06	CHILLER-RECP	COND	130	1.25	0.3	25	2184	6.13
AC08	CHILLER-RECP	COND	100	1.25	0.1	25	4368	3.14
AC09	CHILLER-RECP	COND	100	1.25	0.1	25	4368	3.14
A311	COND UNIT	COND	75	1.25	0	25	4368	0.00
A305	AHU	CW COIL	30	1	0.3	15	4368	3.77
A305A	COND UNIT	COND	30	1.25	0	1	0	0.00
A308	CHILLER-RECP	COND	40	1.25	0.25	25	4368	3.14
A306	COND UNIT	COND	0	1.25	0	1	0	0.00
A443	AHU	CW COIL	20	1	0.3	15	4368	2.52
A220	AHU	CW COIL	20	1	0.3	15	1560	0.90
A221	AHU	CW COIL	20	1	0.3	15	3744	2.16
AC01	CHILLER-RECP	COND	100	1.25	0	25	0	0.00
							TOTAL	346.28

APPENDIX
A-5

HONEYWELL AVIONICS
ENVIRONMENTAL WELL WATER USAGE
TOTAL PEAK CAPACITY
AND DESGN GPM

ITEM	DESCR	WELL WATER USAGE	COOL TONS	ESTIM. LOAD	TONS	HR OPER PER YR	ANNUAL TON-HR	ESTIM TD	GPM
A115	HEAT PUMP	COND	2	0.8	1.6	8736	13977.60	25	1.92
A111	PKG A/C	COND	5	0.5	2.5	3744	9360.00	25	3
A112	PKG A/C	COND	5	0.5	2.5	4992	12480.00	25	3
A122	PKG A/C	COND	7.5	0.5	3.75	8736	32760.00	25	4.5
A105	COND UNIT	COND	75	0.5	37.5	3250	121875.00	25	45
A103	COND UNIT	COND	75	0.5	37.5	8736	327600.00	25	45
A315	FAN COIL U	CW COIL	1	0.5	0.5	8736	4368.00	15	0.8
A316	HEAT PUMP	COND	3	0.8	2.4	8736	20966.40	25	2.88
VAX ROOM	HEAT PUMP	COND	3	1	3	8736	26208.00	25	3.6
A205	COND UNIT	COND	10	1	10	8736	87360.00	25	12
A327	COMP RM U	CW COIL/COND	20	1	20	8736	174720.00	30	16
A307	COMP RM U	CW COIL/COND	20	1	20	8736	174720.00	30	16
A309	COMP RM U	CW COIL/COND	20	1	20	8736	174720.00	30	16
A328	COMP RM U	CW COIL/COND	20	1	20	8736	174720.00	30	16
A321	COMP RM U	CW COIL/COND	20	1	20	8736	174720.00	30	16
A322	COMP RM U	CW COIL/COND	20	1	20	8736	174720.00	30	16
A324	COMP RM U	CW COIL/COND	20	1	20	8736	174720.00	30	16
A318	PKG A/C	COND	7.5	0.5	3.75	4368	16380.00	25	4.5
A202	COND UNIT	COND	3	0.5	1.5	8736	13104.00	25	1.8
A204	HEAT PUMP	COND	5	0.5	2.5	8736	21840.00	25	3
A206	FAN COIL	CW COIL	12.5	0.5	6.25	8736	54600.00	15	10
A317	PKG A/C	COND	15	0.5	7.5	8736	65520.00	25	9
A207	CHILLER-RECP	COND	15	0.66	9.9	8736	86486.40	25	11.88
A216	AHU	CW COIL	20	0.5	10	4368	43680.00	15	16
A218	AHU	CW COIL	15	0.5	7.5	1400	10500.00	15	12
A219	AHU	CW COIL	15	0.5	7.5	2496	18720.00	15	12
A211	COND UNIT	COND	100	0.5	50	4368	218400.00	25	60
A520	PKG A/C	COND	6	0.5	3	8736	26208.00	25	3.6
A521	PKG A/C	COND	6	0.5	3	8736	26208.00	25	3.6
A201	COND UNIT	COND	3	0.66	1.98	8736	17297.28	25	2.376
A615	CHILLER-RECP	COND	100	0.5	50	1680	84000.00	25	60
A621	PKG A/C	COND	15	0.5	7.5	8736	65520.00	25	9
A622	COND UNIT	COND	30	0.5	15	8736	131040.00	25	18
A260	COMP RM U	COND	10	1	10	8736	87360.00	25	12
A452	FAN COIL	CW COIL	10	0.5	5	8736	43680.00	15	8
A101A	COND UNIT	COND	40	0.75	30	2730	81900.00	25	36
A102	COND UNIT	COND	15	0.75	11.25	2730	30712.50	25	13.5
A337	MAKE-UP AHU	CW COIL	25	0.5	12.5	8736	109200.00	15	20
A364	AHU	CW COIL	11.5	0	0	8736	0.00	15	0
AC02	CHILLER-RECP	COND	75	0	0	0	0.00	25	0
AC03	CHILLER-RECP	COND	75	0.1	7.5	4368	32760.00	20	11.25
AC04	CHILLER-CENT	COND	500	1	500	4368	2184000.00	25	600
AC05	CHILLER-CENT	COND	300	1	300	8736	2620800.00	25	360
AC06	CHILLER-RECP	COND	130	0.8	104	2184	227136.00	25	124.8
AC08	CHILLER-RECP	COND	100	0.1	10	4368	43680.00	25	12
AC09	CHILLER-RECP	COND	100	0.1	10	4368	43680.00	25	12
A311	COND UNIT	COND	75	0	0	4368	0.00	25	0
A305	AHU	CW COIL	30	0.5	15	4368	65520.00	15	24
A305A	COND UNIT	COND	30	0	0	0	0.00	1	0
A308	CHILLER-RECP	COND	40	0.6	24	4368	104832.00	25	28.8
A306	COND UNIT	COND	0	0	0	0	0.00	1	0
A443	AHU	CW COIL	20	1	20	4368	87360.00	15	32
A220	AHU	CW COIL	20	0.5	10	1560	15600.00	15	16
A221	AHU	CW COIL	20	0.5	10	3744	37440.00	15	16
AC01	CHILLER-RECP	COND	100	0	0	0	0.00	25	0
					0		0.00	1	0

TOTAL TONS 1507.38 TOTAL TON-HR 8595159.18 TOTAL 1796.8
TON-HR/10(6) 8.595

	M	N	O	P	Q	R	S	T	U
78					Est. Total Yearly Well Water Usage (Gal/Yr.)			363,154,426	
79									
80					Total Well Water usage 88-89 (Gal/Yr)			423,768,000	
81									
82					% Well Water for Comfort/Environmental			86	
83									
84									
85					Total AC04, AC05 & DFS Computer rooms			255,462,480	
86									
87					% Of total A/C usage			70	
88									
89					Total of 52 Week loads (Gal/Yr)			287,518,795	
90									
91					% Of total A/C usage			89	

Row		Tons	GPM/Ton	Hrs/Day	Days/Wk	Wks/Yr	Load Factor	Min/hr	Gal/Yr
1									
2									
3									
4		Tons	GPM/Ton	Hrs/Day	Days/Wk	Wks/Yr	Load Factor	Min/hr	Gal/Yr
5				24	7	52			
6				12	6	52			
7	A113	5	0.7	16	6	52	0.25	60	262,080
8									
9	A122	7.5	0.7	24	7	52	0.25	60	[illegible]
10		75	0.7	12.5	5	52	0.25	60	[illegible]
11		75	0.7	24	7	52	0.3	60	[illegible]
12									
13		5	2.4	24	7	52	0.25	60	1,572,480
14		2	0.7	24	7	52	0.5	60	366,912
15		2.5	0.7	24	7	52	0.5	60	458,640
16		7.5	0.7	24	7	52	0.25	60	687,960
17									
18		20	1.75	24	7	52	0.5	60	9,172,800
19		20	1.75	24	7	52	0.5	60	9,172,800
20		20	1.75	24	7	52	0.5	60	9,172,800
21		20	1.75	24	7	52	0.5	60	9,172,800
22		20	1.75	24	7	52	0.5	60	9,172,800
23									
24		20	1.75	24	7	52	0.5	60	9,172,800
25		20	1.75	24	7	52	0.5	60	9,172,800
26		8	0.7	24	7	52	0.1	60	293,530
27									
28		3	0.7	24	7	52	0.3	60	330,221
29		5	0.7	24	7	52	0.3	60	550,368
30		12.5	2.4	24	7	52	0.3	60	4,717,440
31		15	0.7	24	7	52	0.25	60	1,375,920
32									
33		15	0.7	24	7	52	0.25	60	1,375,920
34		75	2.4	24	7	26	0.3	60	14,152,320
35		75	2.4	11	5	26	0.3	60	4,633,200
36		75	2.4	16	6	26	0.3	60	8,087,040
37		100	0.7	24	7	26	0.3	60	5,503,680
38									
39		5	0.7	24	7	52	0.3	60	550,368
40		5	0.7	24	7	52	0.3	60	550,368
41		3	0.7	24	7	52	0.3	60	330,221
42									
43		100	0.7	24	7	6	0.3	60	1,270,080
44		15	0.7	24	7	52	0.3	60	1,651,104
45		25	0.7	24	7	52	0.3	60	2,751,840
46									
47	A262	1[illegible]	0.7	24	7	52	0.75	60	2,751,840
48		10	2.4	24	7	52	0.3	60	3,773,952
49									
50		40	0.7	12	5	26	0.3	60	76[illegible],240
51		15	0.7	12	5	26	0.5	60	29[illegible],840
52									
53		25	2.4	12	5	26	0.3	60	[illegible],684,800
54		10	2.4	24	7	52	0.5	60	[illegible],547,904
55									
56		75	0.7					60	0
57		75	0.7					60	0
58		500	0.7	24	7	39	0.75	60	103,194,000
59		330	0.7	24	7	52	0.8	60	88,[illegible]
60									
61		130	0.7					60	0
62		100	0.7					60	0
63		100	0.7					60	0
64		75	0.7					60	0
65									
66		25	2.4	24	7	26	0.3	60	4,717,440
67		30	0.7				0.3	60	0
68		40	0.7	24	7	2[illegible]	0.3	60	2,20[illegible],472
69		0	0.7					60	0
70									
71	~~A443~~	20	2.4	24	7	26	0.5	60	[illegible],773,952
72									
73	A220	75	2.4	12	5	26	0.3	60	5,054,400
74	A221	75	2.4	24	6	26	0.3	60	1[illegible],130,56[illegible]
75									
76	A109	100	0.7						
77									

Month	[illegible] Water (gal)	[illegible] (gal)	% Water	Total MG
Oct-86	2144	7466	0.2[illegible]	31.40
nov	1256	4224	0.3[illegible]	21.852
dec	2773	86[illegible]	0.3[illegible]	26.481
Jan-87	710	5284	0.[illegible]	22.3[illegible]
feb	1[illegible]	47[illegible]	0.35	20.616
mar	1532	5491	0.28	28.550
apr	1553	5520	0.28	26.3[illegible]
may	662	2164	0.31	42.882
june	15[illegible]	4755	0.32	53.7[illegible]
july	1666	3714	0.45	51.882
august	2663	2446	1.0[illegible]	53.8[illegible]
sept	1765	2592	0.6[illegible]	43.18[illegible]

Total MG WELL WATER

423768 MGY

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Project CONSUMPTIVE WATER USE Sheet 1 of 8

Comm. No. 4495.00 Date 12/20/89

HONEYWELL AVIONICS - WELL WATER OPERATING COSTS

A) PUMPING COSTS - ANNUAL

NOTE: BASED ON HONEYWELL DATA, ENVIRONMENTAL COOLING ACCOUNTS FOR 85 % OF TOTAL PUMPAGE. THE WELL PUMP HORSEPOWER AND TOTAL MGY IS FACTORED BY THIS PERCENTAGE.

WELL PUMP #1

$110 \text{ HP} \times .85 \times .746 \times .85 \times \frac{1}{.90} \times \frac{\$.045}{\text{KWH}} \times \frac{8760}{2} = \$ \frac{12984}{\text{YR}}$

WELL PUMP #2

$117 \text{ HP} \times .85 \times .746 \times .85 \times \frac{1}{.90} \times \frac{\$.045}{\text{KWH}} \times \frac{8760}{2} = \$ \frac{13811}{\text{YR}}$

SUPPLY PUMP

$40 \text{ HP} \times .746 \times .85 \times \frac{1}{.90} \times \frac{\$.045}{\text{KWH}} \times 3343 = \frac{4236}{\text{YR}}$

BOOSTER PUMP

$.33 \text{ HP} \times .746 \times .85 \times \frac{1}{.90} \times \frac{\$.045}{\text{KWH}} \times 8736 = \$ 92$

TOTAL PUMPAGE COST = $ 31,123

B) WATER TREATMENT

$* \; 346.3 \text{ MGY} \times \frac{\$ 66^{**}}{\text{MGY}} = \$ \frac{22,856}{\text{YR}}$

* BASED ON SPREADSHEET CALCULATION

** BASED ON GENERAL MILLS COST/MG EXPERIENCE

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Project HONEYWELL Sheet 2 of 8
Comm. No. Date 12/20/89

C) UNIT EFFICIENCIES OF WATER COOLED EQUIPMENT

IN ORDER TO ESTABLISH ANNUAL OPERATING COST, THE KW INPUT OF EQUIPMENT IS DESIRED.

EER = BTUH/W

TYPE	TONS	MFR REFERENCE		SOURCE	EER @ 50/75	EER @ 85/95
PKG	5	CARRIER	SW60	FEB, 1989 ARI	10.0	9.0
A/C	7.5		SW90	"	9.7	8.7
UNITS	10		SW120	"	↓	8.7
	15		( )	—	↓	8.7
			*ASSUMED			

	TONS	MFR	SOURCE	EER @ 50/75	EER @ 85/95
HEAT	1.5	CLIMATE MASTER		11.4	10.5
PUMP	2	SERIES 814	T.A. PERRY &	12.6	11.7
	3		ASSOC.	12.3	11.3
	5		-REP	12.1	11.2

TYPE	TONS	MFR	SOURCE	EER @ 50/75	EER @ 85/95
COMPUTER	2	* LIEBERT FE2406	DATA CENTER		
ROOM	20		SYSTEMS (LIEBERT REP)	10.9	8.6
UNITS					

*NOTE: UNITS OPERATE ON WELL-WATER OR GLYCOL FREE-COOLING, 75% OF TIME. DX OPERATION AT 25% OF ANNUAL OPERATION IS WITH EER AS SHOWN.

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Project ______ Sheet 3 of 8

Comm. No. ______ Date 12/20/89

C) UNIT EFFICIENCIES CONT'D

CONDENSING UNITS

Existing condensing units are assumed to be 10 to 15 years old. Typical water-cooled condensing units are belt-driven. The make and model used for reference are Carrier model 5H compressor/09RH condensor. Compressors operate at 1750 RPM on R-22 refrigerant. KW per ton efficiency is based on the following equation:

$$BHP \times \frac{.746\ KW}{HP} \times \frac{1}{.90\ EFFIC.} \times \frac{1}{TON} = KW/TON.$$

CARRIER UNIT	40° SST, 60°/85° CWT			45° SST, 85°/95° CWT			CAP. FACTOR (TONS/TONS)
	TONS	BHP	KW/TON	TONS	BHP	KW/TON	
5F20	8.7	8.9	.85	8.3	10.9	1.09	.95
5F30	14.0	12.0	.71	12.6	16.2	1.07	.90
5F40	18.6	15.9	.71	16.7	21.6	1.07	.90
F60/5F60	28.0	23.6	.70	25.1	32.2	1.06	.90
F60/09RH027	29.2	21.7	.62	26.3	29.6	.93	.90
40/09RH027	44.2	37.6	.71	39.9	49.0	1.02	.90
66/09RH084	83.2	70.9	.71	73.9	95.5	1.07	.89
86/09RH097	112.5	92.0	.68	98.6	126.8	1.07	.88

NOTE: SST - Saturated Suction Temperature
CWT - Condenser Water Temperature
TONS - Capacity in tons (@ 12000 BTU/H per TON)
BHP - Brake Horsepower
KW/TON - Electrical input versus cooling capacity output

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C) UNIT EFFICIENCIES CONT'D

CHILLERS - RECIPROCATING

The existing chillers are assumed to be 10-15 years old. Reciprocating Chillers utilize fully hermetic or semi-hermetic compressors, and are water cooled. Ratings are based on Carrier model 30 HK. Operating conditions are extrapolated at 50°F condenser entering water temperature and are based on 44°F leaving chilled water temperature.

50°/78° CWT, 44° LCWT			85/95 CWT, 44° LCWT			
TONS	KW	KW/TON	TONS	KW	KW/TON	CAP. FACTOR (TONS/TONS)
16.8	12.5	.744	15.9	13.4	.843	.95
72.2	56.8	.786	68.1	61.5	.903	.94
101.6	80.4	.791	96.7	86.2	.891	.95
136.8	116.8	.853	129.1	125.6	.973	.94

Note: CWT - condenser water temperature
LCWT - leaving chilled water temperature

CHILLERS - CENTRIFUGAL

The existing centrifugal chillers are open-drive, York model YT. Design conditions of 55°F entering condenser water temperature are based on specifications for the units as installed in 1987. Performance experience indicates condenser entering temperatures of 50°F. The design data has been provided by YORK International, computer simulation specifically for the units as installed at Honeywell Avionics.

55/71 CWT, 44° LCWT			85/95 CWT, 44° LCWT			
TONS	KW	KW/TON	TONS	KW	KW/TON	CAP FACTOR
300	124	.4133	292	188	.6438	.973
500	191	.382	447	275	.6152	.894

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D) OPERATING COSTS OF EXISTING WELL-WATER COOLED EQUIPMENT.

SEE FIGURE (A-1),

The Following formula was used for calculating operating costs based on EER's for well-water cooled equipment as shown in item (B) above:

$$\text{TONS} \times \text{LOAD} \times \frac{1}{\text{EER}} \times \frac{12000\ \text{BTUH}}{\text{TON}} \times \frac{\text{KW}}{1000\,\text{W}} \times \frac{\$.045}{\text{KWH}} \times \frac{\text{HRS}}{\text{YR}} = \frac{\$}{\text{YR}}$$

; Where EER = BTUH/WATT

E) OPERATING COSTS OF LIEBERT COMPUTER ROOM UNITS

1) There are seven Liebert units, 20 tons each, which have both a cold water coil and a direct expansion refrigeration coil. 75% of operation is estimated to be under cold water "free cooling" operation. Total operation hours are 8760 HOURS/YR. The "free cooling" mode requires a 7.5 HP fan motor.

FREE COOLING:

$$7.5\,\text{HP} \times \frac{.85}{.9} \times .746 \times \frac{\$.045}{\text{KWH}} \times 8760 \times .75 = \$\ \frac{1562}{\text{YR}}$$

DX MODE @ 10.9 EER:

$$20\ \text{TONS} \times \frac{1}{10.9\ \text{EER}} \times \frac{12000\ \text{TON}}{\text{BTUH}} \times \frac{\text{KW}}{1000\,\text{W}} \times \frac{\$.045}{\text{KWH}} \times 8760 \times .25 = \$\ \frac{2170}{\text{YR}}$$

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Project ______ Sheet 6 of 8
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COMPUTER ROOM UNITS, CONT'D
TOTAL OPERATING COSTS, 7 UNITS @ 50° WELL WATER:

$7 \times \frac{\$1562}{YR} + 7 \times \frac{\$2170}{YR} = \frac{\$26124}{YR}$

2) CONVERSION FROM WELL WATER TO GLYCOL "FREE COOLING" DRY COOLERS AT 40% GLYCOL – OPERATING COSTS

The seven Liebert units will require a conversion to dry coolers, roof mounted and air cooled, operating in a free cooling mode on 40% glycol for assumed 75% operation and with direct expansion for 25% of total 8760 hours operation.
In addition, operating costs of condensor fans and glycol pumps must be added in:

a) LIEBERT CO has provided annual operating costs, total, at \$.06/KWH PER unit, based on operating experience for Minneapolis, MN as:

$\frac{\$9387}{YR} \times \frac{.045}{.060} \times 7 \text{ UNITS} = \frac{\$49282}{YR}$ @ .045\$/KWH

b) (CALCULATED) TOTAL SEVEN UNITS
i) FREE COOLING: \$1562/YR × 7 = 10934

ii) DX MODE AT 8.6 EER:
$20 \text{ TONS} \times \frac{1}{8.6 \text{ EER}} \times \frac{12000 T}{EI} \times \frac{KW}{1000 W} \times \frac{\$.045}{KWH} \times 8760 \times .25 \times 7 = \frac{\$19252}{YR}$

iii) CONDENSOR
$2.25 \text{ HP} \times \frac{.85}{.90} \times .746 \times .045 \times 8760 \times 7 = \$4374$

iiii) Glycol Pump $3 \text{ HP} \times \frac{.85}{.9} \times .746 \times .045 \times 8760 \times 7 = \$5832$

TOTAL OPER COST WITH NEW DRY COOLERS: \$40392/YR

c) CONCLUSION: USE \$49,282 ANNUAL OPER, CONVERSION TO DRY COOLERS

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HONEYWELL: GPM OF COOLING TOWER

SEE FIGURE A-3

$$TONS = \frac{GPM\ \Delta T}{30}$$; GPM = CONDENSOR GPM

ΔT = 10 DEG F

30 = 24 x 1.25 HEAT REJ. FACTOR

$GPM = TONS \times 30 \times \frac{1}{10} = TONS \times 3$; TONS = 1350 (FIG A-

GPM = 1350 x 3 = 4050 GPM

TOWER PUMP SELECTION

BELL & GOSSET SERIES VSCS 12x14x12½ @ 1750 RPM

ASSUME: 100' HEAD

125 BHP, 84% EFFIC.

PUMPING COST

TOWER PUMP

$125 \times \frac{1}{.84} \times .746 \times .045 \times 1760$ 43 762

SUPPLY PUMP

$40\ HP \times .746 \times .85 \times \frac{1}{.9} \times .045 \times 3340 = 4236$

BOOSTER PUMP

$22\ HP \times .746 \times .85 \times \frac{1}{.9} \times .045 \times 8736 = 92$

[illegible]

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HONEYWELL

TOWER — ANNUAL OPER. COST
TOWER MAKE-UP = EVAP + BLOWDOWN

SEWER COSTS = BLOWDOWN ONLY

@ ASSUMED $1.14 / 1000 GAL CITY W
1.83 / 1000 SEWER

EVAP + BLOWDOWN

4500 GPM SYSTEM : BETZ CO. CALCULATOR
EVAP + BLOWDN = 40.5
20.5
61.0 GPM

OPER HRS = 8760
FL HRS = ~2000
SUM / 2 = 5380 USE 5000 HRS

61 GAL/M × 60 M/H × 5000 × $1.14/1000 = $20,865

BLOWDOWN (SEWER)

20.5 G/M × 60 × 5000 × $1.83/1000 = $11396

TOTAL MU & SEWER = $32261

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Client MDNR
Project HONEYWELL
Comm. No. 4435.00

By

Date 2/1/90

TOWER FIRST COSTS

A) CONDENSER-SIDE: CHANGES

CHILLERS	66,000		- GEAR & VESSEL CHG'S ON YORK UT ONLY
TOWER	70,000	} 282,008	
PIPE/INSUL	202,018		
PUMP	9,990		
INSTALL	282,008		
SUBTOTAL		630,016	
CONTINGENCY X 1.30		= 819,020	
		$ 1,449,036	

B) CHILLED WATER-SIDE: CHANGES
ADDITIONAL FIRST COST FOR CONVERSION OF WELL WATER TO CHILLED WATER —

A) CHILLERS — REPLACE RECIPROCATING CHILLERS. EXISTING UNITS AT END OF SERVICE LIFE

B) PIPING & INSUL

ESTIM COST $ 2,500,000

C) TOTAL FIRST COSTS = Σ A + B

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Client ______ By ______
Project HONEYWELL Sheet 2 of 3
Comm. No. ______ Date ______

CONVERSION FIRST COSTS

A) A/C EQPT FIRST COSTS – CHANGES

1) CENTRIFUGAL CHANGES – YORK YT
GEARS 25,000 × 2 = $50,000

CONDENSER VESSELS = 16,000
8,000 × 2

$ 66,000

2) RECIPROCATING CHANGES
ADD MACHINES TO SUPPLEMENT

B.) ADD TOWERS
$69,996 –

C) ADD PIPING & INSULATION – CONDENSER SIDE ONLY

50'	14"	× 102.15	$ 5108
400'	12"	87.95	35,180
1800'	@ 10"	72.35	130,230
450' ~~400'~~	@ 6"	42.30	19,035
450'	100 TNS = 300 GPM 4"	$ 27.70	12,465

$ 202,018

D) PUMPS 125 BH = 150 HP

$ 9990

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PIPE & INSUL

Client: MDNR
By:
Project: HONEYWELL

Comm. No.: 4435.00
Date:

SCHED 40	PIPE "MEANS" 1989 - WELDED		INSUL	TOTAL
2½	$15.05/FT	+	1" INSUL $4.97 =	$20.02/LF
			FIBERGLASS W/ JACKET	
4"	$21		1917# $6.70	$27.70
6"	$34		$8.30	$42.30
8"	$45		10.80	55.80
10	60		12.35	72.35
12	74		13.95	87.95
14	87		15.15	102.15

HONEYWELL

RECEIVED
Orr-Schelen-Mayeron & Assoc.

COMM. # ________

FEB 01 1990

915
GER

Honeywell

January 30, 1990

Orr Schelen Mayeron & Associates
Attn: George Rothenberger
2021 East Hennepin Ave
Minneapolis, MN 55413

Re: Well Water/Cooling Coil Conversion Costs

Dear Mr. Rothenberger:

Our estimated cost for conversion of the Cooling Coils in the Stinson/Ridgway Facility, presently being served directly by well water, is $2,000,000 - $3,000,000. This is based somewhat on the $1,400,000 you estimated for conversion of the chillers to a cooling tower and rough guessing - likely additional chiller capacity will be required (existing Recip. units are for stand-by/peaking and generally not in excellent condition), plus there may be many unknowns.

Sincerely,

Paul S. Binek
Manager Facility Services
Honeywell, Inc
1433 Stinson Blvd MN17-1510
Minneapolis, MN 55413
(612) 378-4838

Applied Systems
York International Corporation
4800 Mustang Circle
New Brighton, MN 55112
Telephone Sales (612) 780-4000
Telephone Service (612) 780-4446
FAX (612) 780-0643

YORK
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TWIN CITIES SALES & SERVICE
FACSIMILE TRANSMITTAL

TO: OSM DATE: 12/21/89

ATTN: GEORGE ROTHENBERGER NO. OF PAGES:

FAX NUMBER: 331-3806 FROM: JIM PORATH

SUBJECT: DNR STUDY - HONEYWELL, STINSON

MESSAGE: GEORGE,

	ORIGINAL CONDITIONS	TOWER CONDITIONS
MODEL	YTD3D3C1-CJDO	SAME
GEAR	KS	KW
EVAP	56/44, 600 GPM	55.6/44, 600 GPM
COND	55/71, GPM, 3 PASS	85/94.18, 900 GPM, 2 PA
TONS	300	292
KW	124	188
MODEL	YTH3J3E1-CNDO	SAME
GEAR	HN	HV
EVAP	56/44, 1000 GPM	55.60/44, 1000 GPM
COND	55/72.8, GPM, 3 PASS	85/93.4, 1500 GPM, 2 P
TONS	500	447
KW	191	275

- THE 300 TON UNIT WILL NEED A GEAR CHANGE AND THE COND. CONVERTED FROM 3 PASS TO 2 PASS

- THE 500 TON UNIT WILL BE THE SAME CHANGES AS ABOVE

* GEAR CHANGE BUDGET PRICE = $25,000 EACH
PASS ARRANGEMENT BUDGET PRICE = $8,000 EACH

THE MARLEY COOLING TOWER CO.
Work Sheet

5-1968

OFFICE ______ MADE BY Dale Schmalz CHECKED BY ______ DATE 12-22-89

GPM 4584

HW 95

CW 85 10 °R

WB 78 7 °A

WIND MPH ______

S. MANUAL ______

QUOTATION: FORMAL ☐ LETTER ☐ VERBAL ☐ WORK SHEET COPIES TO: K.C., ______

PARTY QUOTED George Rothenberger

ADDRESS ______

JOB Honewell Avionics 1528 tons

ADDRESS ______

ENG'D BY OSM.

EQUIPMENT TO SERVE ______

NOTE BELOW – SALES COMMENTS – KEY MEN – TITLES – ADDRESSES – ETC.
SHOW TOWER ORIENTATION IF LOCATED WITHIN ENCLOSURE

2293 Gpm. 2-Cells.

NC 832 -	28700	57,400
HC Valve	590	1180
Basin Covers	370	740
Lube Lines	310	620
Motor Out of Airstream	1300	2600
M-1 Vibration Sw.	130	260
Hand Rail & Ladder		930
		63,730
Freight	1403	2806.
		66,536.

Add For 2- 50 HP 2 Speed 1 Winging High Efficiency Motors. $3460.00

TOTAL 69996

32,510 lbs Ship wt.
72,680 lbs Operating.

120

Liebert Corporation
1050 Dearborn Drive, Columbus, OH 43229
Environmental Energy Analysis
DNR STUDY: 20 TR. LIEBERTS

Summary

20 TONS

The energy cost of 1 FE 240G (60Hz) units for one year is $9,387

A Breakdown of these energy costs is as follows:

FREE Cooling

Evap Fan Motor(s)	2,936 *
Compressor(s)	3,115 *
Humidifier(s)	1,281
Reheat(s)	0
Drycooler(s)	881
Glycol Pump(s)	1,174
Total	$9,387 @ $.06/KWH

Design criteria for this analysis:

Region: Minneapolis, Minnesota

Room Drybulb	72 F
Room Relative Humidity	50 %
Design Ambient	95 F
Total Load @ Design Ambient ..	~~170000 BTUH~~
Sensible Load @ Design Ambient	170000 BTUH

Unit Data:

Model	FE 240G (60Hz)
Air Flow / Unit	10200 CFM
Main Fan Motor	7.50 HP ◁ FREE COOLING
Number of Units	1
Quantity of Compressors	2
Compressor KW	(Note 1)
Humidifier Capacity	22.1 lb/hr
Humidifier KW	9.6
Reheat KW	30.0
Glycol Pump Motor	3.00 HP
Drycooler Fan Motor	2.25 HP

Notes:

1) Compressor KW as well as unit capacity varies with ambient conditions.

These ratios reflect the opinion of Liebert Corporation engineers based on available published catalog information.

Liebert Corporation
1050 Dearborn Drive, Columbus, OH 43229
Environmental Energy Analysis

12/22/198
Page: 1

ummary

he energy cost of 1 FH 267W (60Hz) units for one year is $12,722

_Breakdown of these energy costs is as follows:

WATER Cooled
DX only

vap Fan Motor(s)	~~1,957~~ $2236.00
ompressor(s)	6,528
umidifier(s)	4,237
eheat(s)	0
	----------
otal	$12,722 @.06 KWH

esign criteria for this analysis:

egion: Minneapolis, Minnesota

oom Drybulb	72 F
oom Relative Humidity	50 %
esign Ambient	95 F
otal Load @ Design Ambient ..	170000 BTUH
ensible Load @ Design Ambient	170000 BTUH

nit Data:

odel	FH 267W (60Hz)
ir Flow / Unit	10200 CFM
ain Fan Motor	5.00 HP
umber of Units	1
uantity of Compressors	2
ompressor KW	(Note 1)
umidifier Capacity	22.1 lb/hr
umidifier KW	9.6
eheat KW	30.0

otes:

1) Compressor KW as well as unit capacity varies with ambient conditions.

These ratios reflect the opinion of Liebert Corporation engineers based on available published catalog information.

NOTE:

I NOTICED OTHER LIEBERT UNITS ON THE EQUIPMENT SCHEDULE.

THE LIEBERT FAN COIL WILL NEED TO BE PIPED TO A CHILLER (IF NOT ALREADY) OR REPLACED WITH A DX UNIT.

I DID NOT KNOW IF THIS WAS IMPORTANT TO NOTE BUT I DID ANYWAY!

DEC 3

ORR-SCHELEN-MAYERON & ASSOCIATES, INC. MINNEAPOLIS

GEOTHERMAL HEATING AND COOLING SURVEY

PERMIT NUMBER 75-6231

PERMITTEE Honeywell Military Avionics Division

SYSTEM LOCATION 1433 Stinson Blvd Minneapolis, MN 55413

NAMES AND LOCATIONS OF FACILITIES:

Same As Above

TOTAL AREA SERVICED: 525,000 **Square feet** consisting of 8 separately constructed and joined buildings over a period of 20 years. All HVAC/ water supply systems being installed/modified/joined together during the 40 years of existence of the facility as continuous manufacturing change have dictated.

WATER SOURCE

Number of wells connected to the system 2

Enclosed is the well information we have on file regarding this installation. Please indicate if this data is accurate and/or submit any additional well data that is available. If no information is enclosed or available, please complete the enclosed Water Well Information form(s).

Are water level measurements taken on the production well(s) or observation well(s)? [ ] Yes [x] No If yes, please submit a summary of the data.

SYSTEM INFORMATION

Number of years since original system was installed: 40 years.

Date ~~system was~~ systems were put on line: 1950's/ '60's/ '70's/ '80's

Is this a once through or closed loop system (describe and attach a simple schematic drawing) ?

The well and its associated water piping system is a complex system serving: 1) environmental/comfort cooling system heat rejection, 2) Process equipment heat rejection. 3) Non potable plumbing system water (Water closet, urinals, Bldg Maintenance, etc.) 4) Lawn Irrigation system water. 5. Fire sprinkler system backup. 6) Closed loop heating and cooling system water makeup. The well water distribution system incorporates both "once thru" and multiple or "series" use of the water. It also serves as make-up for closed loop heating & cooling systems.

(124)

Describe any major system modifications and give the completion date:

The well water distribution system is a dynamic system to which modifications are made due to process, economic and legistlative requirements on a continuing basis.

Average water temperature: Overall system: 50 degrees intake to equipment - 55 degrees discharge to storm sewer

Heating ________ **intake;** ________ **discharge**
Cooling ________ **intake:** ________ **discharge**

System size rating: Facility is made up of numerous systems (55) of all type and usage with actual operating conditions/specifications unavailable.

Heating ________ **(BTU/H)** **Cooling** ________ **(Tons/H)**

Actual peak load:

Heating ________ **(BTU)** **Cooling** ________ **(Tons)**

Energy efficiency of systems:

Number of chillers/heat pumps in system 44
Coefficient of Performance (COP) for heat pump ________
Average Energy Efficiency Ratio (EER) for heat pump ________
If no heat pump, chiller efficiency rating ________
Number of chillers or heat pumps in system ________
Size rating of chillers/heat pumps ________

General Water Use Efficiency:

Average Efficiency of Water Use ________(gal/ton) cooling
________(gal/BTU) heating
How much water is recirculated? ________
How much water is lost in the system, where is it lost and how is the amount of water loss determined?

If cooling towers are part of the system, how many are there, how much evaporative loss occurs in this loop, and how is the amount of water loss determined?

Two cooling towers are utilized in one of the systems.
Loss unknown

What is the design capacity of the towers? 165 ton
If cooling towers are not present in the system please describe the feasibility of adding towers including any site and/or system limitations.

1) Adding towers will require extensive building structural work in most areas. 2) Conversion to towers will likely reduce manysystems capacity below required. Only the latest two chiller systems installations have been designed for future conversion to cooling towers.

7:2

WATER USAGE

Indicate the percentage of all primary and secondary uses of the water: N/A

X Heating
X Air conditioning
X Processing
X Other: ~~Plumbing/Bldg Maintenance~~/ Lawn Irrigation

Average pumpage: 700 **gpm;** 24 **hours/day;** 12 **months/year**

Are flow meters used to determine water usage? [X] **Yes** [ ] **No**

If meters are not used, describe how the amount of water appropriated is determined.

N/A

WATER DISPOSAL

Indicate any water treatment that is done before or after the water goes through the system.

Chlorination at wells

What percentage of the water is discharged and what is the water discharged to?

100% discharged to storm sewer, sanitary sewer, to lawn for irrigation, to ambient air (evaporation and two cooling towers)

If water is discharged into a storm sewer indicate the receiving water for the sewer outlet, if known.

To City of Minneapolis Storm & Sanitary Sewer system. Receiving water unknown.

List any discharge authorizations required for the system.

NPDES permit non contact cooling water (MN0042641)

DNR Water Permit (268mm gal/yr)

Indicate any regulated discharge limitations relating to water temperature, quality or quantity.

1MM gal/day, 85 degrees F. 2mg/liter total residual chlorine,

6.0 to 9.0 ph

WATER CONSERVATION

Does the system use variable speed pumps? [ ] Yes [X] No
Are any load or system controls used to reduce water requirements by reducing the operating load conditions (i.e. load shedding, temperature set points)?

A Honeywell Delta 1000 Energy Control System is used to control load conditions.

List any other measures utilized to reduce water use:

- Multiple series use and cooling tower (1 system)
- Reduced individual "chiller systems" by "Looping" units together to increase efficiency and convert reciprocating units to centrifugal units

What changes can be done to the system to reduce water use?

1) Install cooling towers on other systems. Install additional chiller cold water loops w/additional chiller capacity.

What alternatives exist for reuse of the discharge water?

Limited reuse alternatives available.

Indicate any anticipated future changes in water use and state reasons for projected increases or decreases.

Limited increase due to increase production plans - increased A/C needs expected to be supplied via chiller/cooling tower systems.

Please provide us the following information about the person that completed the survey.

Name Paul Binek

Title Manager Facility Services

Telephone Number 378-4838

Please give the name and phone number of someone that can provide additional information, if different than above.

Contact Person Clark Nelson

Telephone Number 378-4127

This survey is to be completed and mailed by September 15, 1989 to:

Department of Natural Resources - Division of Waters
Attn: Jim Japs
Geothermal Heating and Cooling Survey
Box 32, 500 LaFayette Road
St. Paul, MN 55155-4032

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A P P E N D I X

METHODIST HOSPITAL

OSM Orr Schelen Mayeron & Associates, Inc.
2021 East Hennepin Avenue
Minneapolis, MN 55413
612-331-8660
FAX 331-3806
Engineers
Surveyors
Planners

Client MDNR By GER
Project WATER USE STUDY Sheet 1 of 2
Comm. No. 4485 Date 2/90

METHODIST HOSPITAL

— SUMMARY —

ANNUAL OPERATING COSTS

A) EXISTING

PUMPING	53501
CHILLERS	126658
WATER TREATMENT	24145
TOTAL	204,304

B) CONVERSION

PUMPING	16,156
CHILLERS	120,919 *
TOWER	4,948
WATER TREATMENT	5,245
WATER MAKEUP & SEWER	12,804
	160,072

* CHILLERS CONVERTED FROM .93 & .91 KW/TON TO .72 and .74 KW/TON FOR 650 & 325 TON MACHINES, RESPECTIVELY. RESULTANT ANNUAL OPER COST IS DECREASED.

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Client MDNR By GER
Project WATER USE STUDY Sheet 2 of 2
Comm. No. 4435 Date 2/90

METHODIST
TON-HOUR CALCULATIONS

A) EXISTING DESIGN

CHILLER #	TONS	LOAD*	HRS OPERATION*	TON HOURS
1	650	.95	3500	2161250
2	325	.90	3000	877500
3				
4				
5				
6				
COILS	488	.50	3000	732000

TOTAL TON HOURS 3,770,750

B) CONVERSION

CHILLER #	TONS	LOAD	HRS OPER	TON HOURS
1				SAME
2				
3				
4				
5				
6				
COILS				

TOTAL TON HR SAME

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Client: MDNR By: GER
Project: METHODIST HOSPITAL Sheet 1 of 1
Comm. No. 4485 Date:

A) METHODIST: PEAK DAY LOAD

			PEAK TONS
CHILLER # 1	610 TONS	=	610
CHILLER # 2	293 TONS	=	293

WELL WATER
S-1, S-2, S-3 } 607 GPM
S-7, S-8, S-12 } 800 GPM

$\times \frac{8.33°}{24}$ = 488 TONS × .5 BLDG DIVERSITY = 244
(BLDG NEVER SHUTS DOWN, NO JULY 5 "PULL DOWN" REQ'D)

TOTAL 1147

B) PEAK GPM @ DESIGN PEAK DAY LOAD

TONS = $\frac{GPM\ \Delta T}{24}$ ← (WELL WATER) OR TONS = $\frac{GPM\ \Delta T}{24 \times 1.25}$ ← (COMPR. HEAT REJECTION)

$\frac{610 \times 30}{10}$ = 1830

$\frac{293 \times 30}{10}$ = 879

$\frac{244 \times 24}{8.33}$ = 703

TOTAL 3412 GPM

C) GPM/TON — DESIGN "PEAK DAY"

$\frac{3412}{1147}$ = 2.9747 GPM/T

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Client: MDNR — By: GER
Project: WATER USE STUDY — Sheet 1 of 2
Comm. No. — Date: 12/11/99

METHODIST HOSPITAL - WELL WATER OPERATING COSTS

A) ANNUAL PUMPING COSTS

WELL PUMP

$125\ HP \times .746 \times .85 \times \frac{1}{.90} \times \frac{\$.045}{KWH} \times 3500\ \frac{HRS}{YR} = \frac{\$13870}{YR}$

BOOSTER PUMPS - WELL WATER SUPPLY - TWO (2)

$75\ HP \times .746 \times .85 \times \frac{1}{.90} \times \frac{\$.045}{KWH} \times 3500\ HRS \times 2 = \$16,645$

CHECK: BOOSTER PUMPS ; HEAD IS KNOWN

$\left(\frac{820\ GPM \times 240'\ HD}{5300 \times .8 \times .9}\right) \times \frac{\$.045}{KWH} \times 3500\ HRS \times 2 = \$16245$

USE: $\frac{\$16,645}{YR}$

CONDENSER WATER PUMP - CHILLER #1

$40\ HP \times .746 \times .85 \times \frac{1}{.90} \times \frac{\$.045}{KWH} \times 3500\ \frac{HR}{YR} = \frac{\$4439}{YR}$

CONDENSER WATER PUMP - CHILLER #2

$20\ HP \times .746 \times .85 \times \frac{1}{.90} \times \frac{\$.045}{KWH} \times 3000\ \frac{HR}{YR} = \frac{\$1902}{YR}$

PUMPS TOTAL 53,501

B) ANNUAL EQUIPMENT OPERATING COSTS

CHILLER #1

$605.9\ KW \times .95\ LOAD \times 3500\ \frac{HR}{YR} \times \frac{\$.045}{KWH} = \frac{\$90,658}{YR}$

CONTINUED

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CHILLER #2

296.3 KW × .90 LOAD × 3000 HRS × $.045/KWH = $36,000/YR

CHILERS TOTAL 126,658

c) WATER TREATMENT

PER METHODIST HOSPITAL:

$ 24,145/YR

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Client MDNR
By
Project METHODIST HOSP
Sheet 1 of 5
Comm. No.
Date 1/3/90

CONVERSION - TOWER OPER COST - ANNUAL

DATA FROM CARRIER 1/3/90:

CHILLER #1

$.045/KWH x 650T x .722 KW/TON x .95 LOAD x 3500 HR = 70219

CHILLER #2

$.045/KWH x 325T x .7385 x .90 x 3000 = 29162

CHILLER #3

WAS WELL WATER - ADD CHILLER

244 TONS

244 x .654 KW/TON x .045 x 3000 = 21,538

TOTAL CHILLERS $120,919

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Client DNR By
Project METHODIST HOSP Sheet 2 of 5
Comm. No. Date

ANNUAL OPER — TOWER

GPM = 1147 x 3 = 3441 GPM

PUMP SELECTION

BELL & GOSSET
SERIES VSCS 10X12X13
100' HD 1750 RPM

110 BHP, 80% PUMP EFFIC

PUMP COST – ANNUAL

$$110 \text{ BHP} \times .746 \times \frac{1}{.80} \times \frac{\$.045}{\text{KWH}} \times 3500 = \$16156$$

COND PUMPS = 0 – TOWER P ABOVE = 0

\$16156

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Project METHODIST
Comm. No.
By

Date

TOWER FANS — ANNUAL OPER

3441 GPM

HIGH SPD 80 HP x.8 x.746 1/.95 (effic) x.045 $/KWH x 1750 HRS = 3958

LOW SPD 20 HP x.8 x.746 1/.95 .045 1750 = 990

TOTAL $ 4948

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Mayeron &
Associates, Inc

[illegible] East Hennepin Avenue
Minneapolis MN [illegible]
[illegible]
Fax [illegible]

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Client METHODIST | By | Sheet 4 of 5
Project | Date
Comm. No.

ANNUAL OPER COST –
TOWER MAKEUP = EVAP + BLOWDOWN
&
SEWER COSTS = BLOW-DOWN ONLY

@ ASSUMED $1.14 / 1000 GAL

WHERE TOWER OPER HRS = AVERAGE OF:

$$\frac{\text{FULL LOAD HRS} + \text{TOTAL OPER HOURS}}{2}$$

EVAP + BLOW-DN

Methodist @ 1147 tons × 3 = 3441 GPM system
Use 3864 GPM data

EVAP = 38.6 GPM
Blowdn = 19.4
58.0 GPM

NOTE: THIS IS A HOSPITAL AND TOWER OPER HOURS WERE CALCULATED TO BE AVG OF TOTAL OPER HRS and FULL LOAD equiv

HRS TOTAL OPER = 3000	} 2100 HRS
FL H = 1200	

$$58 \times 60\frac{M}{H} \times 2100 \times \frac{1.14}{1000} = \$8331 \text{ water}$$

BLOW DN

$$19.4 \times 60 \times 2100 \times \frac{1.83}{1000} = 4473 \text{ sewer}$$

TTL $12804 — TOTAL MU + blowdown sewer

(138)

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Client: DNR
By:
Project: METHODIST
Sheet 5 of 5
Comm. No. 4485
Date:

WATER TREATMENT

$ 5265

SEE WATER TREATMT CALC SHEET

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Client MDNR By GER
Project WATER USE STUDY Sheet 1 of 2
Comm. No. 9485.00 Date

METHODIST HOSPITAL

CONVERSION FIRST COSTS

CHILLERS - COND VESSELS & IMPELLERS	$ 52,000
TOWER	68 116
PUMP - TWR WATER	9010
PIPE - COND SIDE	27000
INSTALLATION	104126
30% CONTINGENCY	78076
TOTAL	$ 338,328

104126

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Client: MOHR By: GER
Project: METHODIST Sheet 2 of 2
Comm. No. 4485.00 Date

CONVERSION FIRST COSTS

A) A/C EQPT FIRST COSTS – CHANGES

1) CENTRIFUGAL CHANGES – CARRIER
650 T~~[illegible]~~ IMPELLER – DUAL IMPELLERS $ 17,000
325 TON MACHINE – IMPELLER OK 0
CONDENSER VESSELS: BOTH UNITS
FIELD CHANGE – NEW TUBE BUNDLES – = 35,000
2) RECIPROCATING CHANGES
ADD MACHINES TO SUPPLEMENT $ 52,000

B) ADD TOWERS

$ 68,116

C) ADD PIPING & INSULATION

2750 GPM = 10" PIPE

250' × 72.35 = 18088
150 × 55.80 = 8370
[illegible]458?

D) PUMPS 125 HP 100 BHP $ 9010

(141)

THE MARLEY COOLING TOWER CO.
Work Sheet

OFFICE Gorgen Co. MADE BY Dale Schmalz CHECKED BY ________ DATE 12-22-89

GPM 2790	QUOTATION: FORMAL ☐ LETTER ☐ VERBAL ☐ WORK SHEET COPIES TO: K.C.,
HW 95	PARTY QUOTED George Rothenberger.
CW 85 10 °R	ADDRESS 1147
WB 77.8 7.2 °A	JOB methodist Hospital ~~930~~ Tons.
WIND MPH	ADDRESS
S. MANUAL	ENG'D BY OSM

EQUIPMENT TO SERVE

NOTE BELOW SALES COMMENTS – KEY MEN – TITLES – ADDRESSES – ETC.
SHOW TOWER ORIENTATION IF LOCATED WITHIN ENCLOSURE

-196B

Used
95-85-77.8 WB.

NC 941-	30,730
HC Valves	590
Basin Covers	370
Lube Lines	310
motor Out of Airstream	1300
M-1 VibrationSw.	130
Hand Rail & Ladder	840
	34,270
Freight	1403
	35673

SEE GREENSPRING MERCY 2/1/90 TOWER

Add For 1-60 HP- 2 Speed 1 Winding High Efficiency motor. 2460.00

TOTAL 38133

17,395 Ship Wt
39,420 Operating Wt.

(142)

SUPPLEMENTAL INFORMATION TO:
GEOTHERMAL HEATING AND COOLING SURVEY

NOV 27

November 2, 1989

Permit Number 85-6010 Methodist Hospital
6500 Excelsior Blvd.
St. Louis Park, MN 55426

1. Well Pump: Variable Speed [✓] yes [ ] no

HP 125 GPM 1650 (MAX) KW Input 124.50

Efficiency Rating ________ (if known)

Average Operation Hours per year 3500

2. Chillers:

Chiller #1 CARRIER

= .932 KW/T

USE 95% LOA

Capacity 650 Tons 97% KW Input 605.9

Peak Load 630 Tons Average Hours/Year 3500

Condenser Water

Temperature Entering 62

Temperature Leaving 72

GPM 1950

= FULL LOAD
650 TONS
@ 1.25 HRF

Chiller #2 CARRIER

= .9117 KW/TON

USE! ASSUMED 90% LOAD

Capacity 325 Tons LOAD 92.3% KW Input 296.3

Peak Load 300 Tons Average Hours/Year 3000

Condenser Water

Temperature Entering 62

Temperature Leaving 72

GPM 900

= 12% LOAD
300 TONS

(143)

Chiller #3

Capacity 650 Tons KW Input 425

Peak Load 630 Tons Average Hours/Year 3000

Condenser Water

Temperature Entering 72

Temperature Leaving 82

GPM 1875

3. Cooling Tower:

Pump HP 60 GPM 1875

KW Input 60.6 Hours per Year Operated 3000

Fan Motor HP 50 KW Input 47.3

Which Chiller Number (above) is this used with? 3

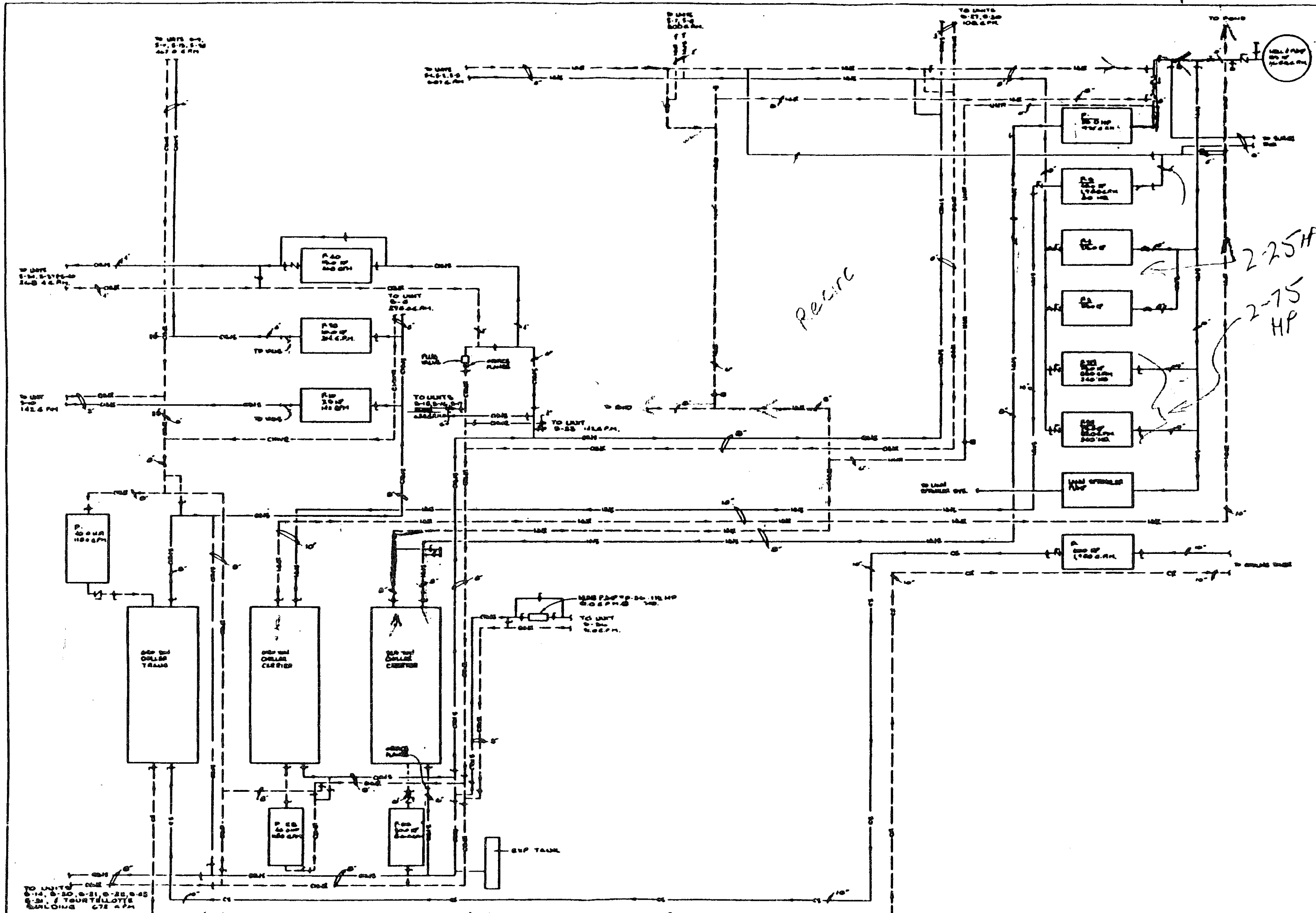
4. On the drawing you submitted, please indicate for the pumps shown, KW input or efficiency.

5. Please verify that AHU S-1, 2, 3, 7, & 8, are the only units with well water cooling coils. Please indicate whether these are precooling coils or primary cooling. List the entering and leaving water temperatures or the change in temperature for the well water coils:

	In	Out	Change
S - 1	51	58	7
S - 2	51	60	9
S - 3	51	60	9
S - 7	51	57	7
S - 8	51	60	9
S - 12	51	60	9

6. Water treatment costs: $24,145.00

Ques. 5: 6 units as listed use well water only for primary cooling. We have no precooling.



FLOW DIAGRAM
EXISTING CHILLED WATER SYSTEM
-EQUIPMENT ROOM AREA

FIGURE 2

Methodist Hospital
CHILLED WATER SYSTEM ANALYSIS

FLOW DIAGRAM
EXISTING CHILLED WATER SYSTEM
-EQUIPMENT ROOM AREA

DE-1

Methodist Hospital

SEPT 0 6. 89

5 September 1989

Mr. James Japs
Water Appropriation Program Coordinator
Department of Natural Resources
500 Lafayette Road
St. Paul, MN 55155

Dear Mr. Japs:

Please find enclosed the completed Geothermal Heating and Cooling Survey you requested. If I can be of any other service, please let me know.

Sincerely,

Victor J. Polich, Jr.
Director
Engineering and Maintenance

VJP/jmk

1 Encl.

cc: Bernie Eikmeier

GEOTHERMAL HEATING AND COOLING SURVEY

PERMIT NUMBER 85-6010

PERMITTEE Methodist Hospital

SYSTEM LOCATION 6500 Excelsior Blvd., St. Louis Park, MN 55426

NAMES AND LOCATIONS OF FACILITIES:

Methodist Hospital

6500 Excelsior Blvd.

St. Louis Park, MN 55426

TOTAL AREA SERVICED: 560,000 Square feet

WATER SOURCE

Number of wells connected to the system 1

Enclosed is the well information we have on file regarding this installation. Please indicate if this data is accurate and/or submit any additional well data that is available. If no information is enclosed or available, please complete the enclosed Water Well Information form(s).

Are water level measurements taken on the production well(s) or observation well(s)? [ ] Yes [x] No If yes, please submit a summary of the data.

SYSTEM INFORMATION

Number of years since original system was installed: 31

Date system was put on line: Summer 1959

Is this a once through or closed loop system (describe and attach a simple schematic drawing) ?

Once through cooling system. Water pumped from the deep well is circulated through cooling coils in air handling units. Water from the air handlers is circulated to the condensers of two chillers. From the chillers, water is discharged to the Minnehaha Creek and used for irrigation of lawns on campus.

(147)

Describe any major system modifications and give the completion date:

No major modifications. Pump size increased in 1973 to present 125hp.

Since then, air handling units relying on well water have decreased in number.

Average water temperature:

Heating ________ intake; ________ discharge
Cooling 51°F intake: 70° discharge

System size rating:

Heating N/A (BTU/H) Cooling 2269 (Tons/H)

Actual peak load:

Heating ________ (BTU) Cooling est. 2100 (Tons)

Energy efficiency of systems:

Number of chillers/heat pumps in system 3
Coefficient of Performance (COP) for heat pump ________
Average Energy Efficiency Ratio (EER) for heat pump ________
If no heat pump, chiller efficiency rating 83%
Number of chillers or heat pumps in system 3
Size rating of chillers/heat pumps 650 tons - 650 tons - 325 tons

General Water Use Efficiency:

Average Efficiency of Water Use 49% (gal/ton) cooling
________ (gal/BTU) heating
How much water is recirculated? chilled loop - all, once through - none
How much water is lost in the system, where is it lost and how is the amount of water loss determined?

N/A

If cooling towers are part of the system, how many are there, how much evaporative loss occurs in this loop, and how is the amount of water loss determined?

1 cooling tower, four cycle operation evaporative rate 25% determined by make up minus blowdown.

What is the design capacity of the towers? 750 tons
If cooling towers are not present in the system please describe the feasibility of adding towers including any site and/or system limitations.

______

______

______

______

______

______

______

WATER USAGE

Indicate the percentage of all primary and secondary uses of the water:

____ Heating X Air conditioning
____ Processing ____ Other: ______

Average pumpage: ______ gpm; ______ hours/day; ______ months/year

Are flow meters used to determine water usage? [X] Yes [ ] No

If meters are not used, describe how the amount of water appropriated is determined.

______

______

______

WATER DISPOSAL

Indicate any water treatment that is done before or after the water goes through the system.

Pretreatment chlorine ≤ .03 mg/L, Chemtex product, C-130 corrosion inhibitor

______

What percentage of the water is discharged and what is the water discharged to?

100% - 20 percent to lawn sprinklers, 80 percent to Minnehaha Creek

If water is discharged into a storm sewer indicate the receiving water for the sewer outlet, if known.

NO STORM SEWER - Direct discharge to Minnehaha Creek

List any discharge authorizations required for the system.

NPDS Permit #MN0002470

Indicate any regulated discharge limitations relating to water temperature, quality or quantity.

Flow - no restriction

Temp - max. 86°F

Total residual chlorine - .03 mg/L, ave., .05 mg/L max.

WATER CONSERVATION

Does the system use variable speed pumps? [X] Yes [ ] No
Are any load or system controls used to reduce water requirements by reducing the operating load conditions (i.e. load shedding, temperature set points)?

Yes. All air handling units are temperature controlled to throttle down water use upon temperature satisfaction.

List any other measures utilized to reduce water use:

Water discharged from air handling units is cycled through chiller condensers prior to dumping.

What changes can be done to the system to reduce water use?

Convert entire hospital to closed loop chilled water system.

What alternatives exist for reuse of the discharge water?

No present alternatives to reuse. This well is part of the containment lens that is being used to prevent spreadof pollutants from the Rielly tar plant in St. Louis Park. A 99 year pumping plan requires the operation of this well for containment purposes.

Indicate any anticipated future changes in water use and state reasons for projected increases or decreases.

Anticipate converting to closed loop. However, we want to use well water for condensing water in the chillers.

Please provide us the following information about the person that completed the survey.

Name B. D. Eikmeier

Title Plant Operations Supervisor

Telephone Number 932-5106

Please give the name and phone number of someone that can provide additional information, if different than above.

Contact Person Victor J. Polich, Jr., Director of Eng. & Maint.

Telephone Number (612) 932-5103

This survey is to be completed and mailed by September 15, 1989 to:

Department of Natural Resources - Division of Waters
Attn: Jim Japs
Geothermal Heating and Cooling Survey
Box 32, 500 LaFayette Road
St. Paul, MN 55155-4032

85-6010

Appn. No. 66-5517

MINNESOTA CONSERVATION DEPARTMENT
DIVISION OF WATERS

STATEMENT ON APPROPRIATION OF WATER

Before January 1, 1966, mail report to Director, Division of Waters, Centennial Office Bldg., St. Paul, Minnesota 55101.

Location of appropriation 6500 Excelsior Blvd.

City or Town ____ County ____

County Rd #3

Describe further by Lot, Block ...

Sec. 20
Twp. 117
Range 21

Owner (Asbury Methodist Hospital)

Address

Person in Charge: ____, Adm. M. E. Nordstrom, Chairman of the Board; C. G. Rotherford, President

Ground Water (List each well separately)

Depth of well, ft.	485
Diameter of casing, in.	20"
Date of completion	1960
Driller	
Address	
Rated capacity of pump	1200 gpm
Usual pumping rate	
Water level, pumping (Feet below land surface)	
Water level, not pumping (Feet below land surface)	

Surface Water

Source of water ____ (Name of lake or stream)

Number of pumps ____

Rated capacity of pumps ____

Date appropriation was first begun ____

The above installation is now equipped with Flow meter ____ Timing device ____ Neither ____

The water appropriated is used for ____

All water withdrawn is either returned to the lawn-ground area or put into Minnehaha Creek. ~~xxxx~~ No water is put into sewer drains. We were one of the first to return water to the ground area.

Allowable approp. (permits only) ____

Terminated ____

Temporary (SP or SR) ____

Well log ____

This statement is filed with the Commissioner of Conservation in compliance with the requirements of Law 1965, Chapter 797, Section 1. The statements herein are true and correct representation of the facts to the best of my knowledge.

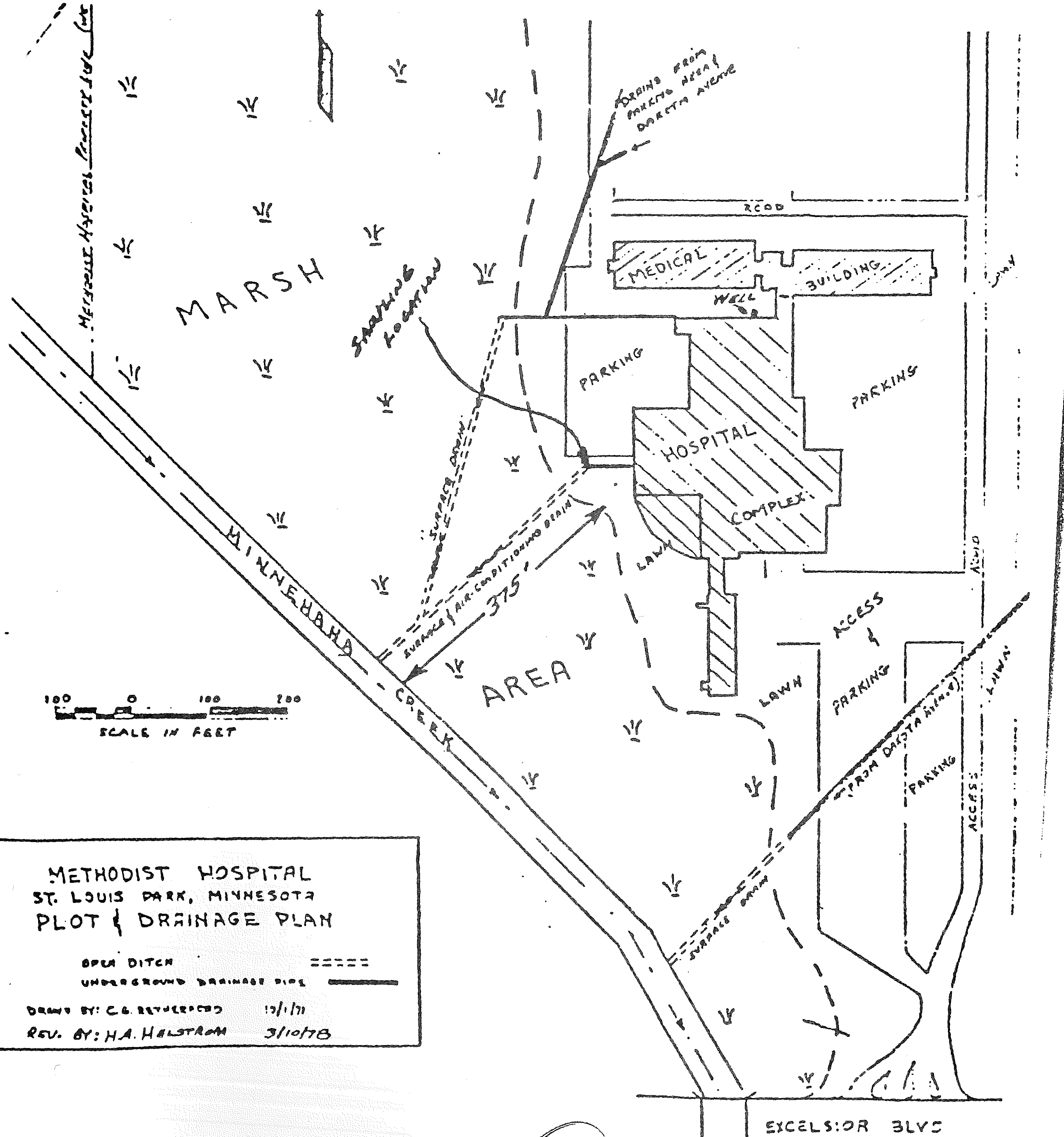
Signed [signature]

Title ____

Date ____

85-6010

(152)


MARSH
MINNEHAHA CREEK
AREA
SAMPLING LOCATION
DRAINS FROM PARKING AREA & DAKOTA AVENUE
ROAD
MEDICAL BUILDING
WELL
PARKING
HOSPITAL COMPLEX
LAWN
SURFACE DRAIN
SURFACE & AIR-CONDITIONING DRAIN
375
ACCESS
FROM DAKOTA AVENUE
EXCELSIOR BLVD
100 0 100 200
SCALE IN FEET
METHODIST HOSPITAL
ST. LOUIS PARK, MINNESOTA
PLOT & DRAINAGE PLAN
OPEN DITCH
UNDERGROUND DRAINAGE PIPE
DRAWN BY: C.G. RETHERFORD 12/1/71
REV. BY: H.A. HALSTROM 3/10/78