CONSERVATION

DR. 778

GRID-CONNECTED INTEGRATED COMMUNITY ENERGY SYSTEM

Phase II, Stage 1, Final Report

Conceptual Design, Demand and Fuel Projections and Cost Analysis

MASTER

March 8, 1978

Work Performed Under Contract No. EC-77-C-02-4210

University of Minnesota
Physical Plant
Minneapolis, Minnesota

U. S. DEPARTMENT OF ENERGY

Division of Buildings and Community Systems

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GRID-CONNECTED INTEGRATED
COMMUNITY ENERGY SYSTEM

PHASE II
STAGE 1 FINAL REPORT

CONCEPTUAL DESIGN, DEMAND AND
FUEL PROJECTIONS AND COST ANALYSIS

March 8, 1978

UNIVERSITY OF MINNESOTA PHYSICAL PLANT
319 15TH AVE. S.E.
MINNEAPOLIS, MINNESOTA 55455
612-373-4521

Prepared For

The U. S. Department of Energy
Under Contract No. EC-77-C-02-4210

PHASE II - VOLUME 2

CONCEPTUAL DESIGN, DEMAND AND
FUEL PROJECTIONS AND COST ANALYSIS

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The following document presents the concept selection design agreed upon by the University and Helmick and Lutz. The basis established here will be updated for the Phase II, Stage 2 preliminary design.

GRID CONNECTED INTEGRATED
COMMUNITY ENERGY SYSTEM

PHASE II

STAGE 1 FINAL REPORT

March 8, 1978

CONCEPTUAL DESIGN, DEMAND AND
FUEL PROJECTIONS AND COST ANALYSIS

Prepared by -

Helmick & Lutz Company
Engineers
1315 Glenwood Avenue
Minneapolis, Minnesota 55405

Prepared for -

University of Minnesota
Physical Plant
319 15th Avenue Southeast
Minneapolis, Minnesota 55455

PREPARED FOR
U.S. DEPARTMENT OF ENERGY
UNDER CONTRACT NO. EC-77-C-02-4210

HELMICK & LUTZ COMPANY

ENGINEERS

1313 GLENWOOD AVENUE

MINNEAPOLIS, MINNESOTA 55405

TELEPHONE 377-5070

November 8, 1977

University of Minnesota
Physical Plant Maintenance and Operations
Room 200 Shops Building
319 15th Avenue Southeast
Minneapolis, Minnesota 55455

Attention: Mr. W. E. Soderberg
Director

Re: Grid Connected Integrated Community Energy System
Phase II Preliminary Report

Gentlemen:

This report outlines systems selection to develop the Grid ICES and includes the Basic Plan and three Options.

The basic plan considers the University Minneapolis Campus as the community thermal load to be served by steam generated from Western coal with electric power produced as a by-product.

Estimated cost, Steam Generation	\$15,744,800
Estimated cost, Electric Generation	<u>\$ 2,620,800</u>
Total, Basic Plan	\$18,365,600
Annual saving, fuel cost	\$ 942,533
Annual return, electric power	\$ 648,930

Option I provides thermal service to Fairview and St. Mary's Hospitals and Augsburg College. Provision of this service would displace existing heating systems now using natural gas and fuel oil.

Estimated cost, Option I	\$ 1,845,760, gross
Added electric revenue	\$ 56,420, annual
Added coal fuel cost	\$ 426,030, annual
Gas and oil fuel saving	\$ 782,728, annual

Option II includes installation of an Andco-Torrax pyrolysis system for environmentally sound disposal of solid waste, including contaminated

Hospital wastes. Additional steam is generated from waste heat produced by the system.

Estimated cost, Option II	\$ 7,300,000
Annual fuel and electric benefit	\$ 331,024

Option III considers conversion of the West Bank Campus from high pressure steam distribution to hot water distribution. This would be a demonstration system for future expansion at improved heat rates with minimum losses and extended system range.

Estimated cost, Option III	\$ 1,422,400
Annual fuel and electric benefit	\$ 79,700

Thermal load of the community was based on actual records over the past three years and projected based on space requirements for the 1980-1981 period. All costs and benefits are calculated at 1977 prices.

Implementation of the Energy System includes installation of coal unloading for partial unit train shipment, rehabilitation of the Southeast Generating Station, interconnection of the Southeast Station and the University Heating Plant, and installation of a non-condensing, extraction Turbine-generator.

Environmental systems would be provided for coal dust collection and suppression, coal storage drainage grit removal and sanitary disposal, enclosed ash disposal with dustless unloading, and flue gas particulate collection systems for both the Southeast Station and University Heating Plant. These systems represent \$5,000,000 of the total budget.

Submitted with this report, but separately bound, is the Draft Environmental Assessment outline.

Yours very truly,

HELMICK & LUTZ COMPANY

George W. Burke

GWB:jmn

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CONSULTANTS CONCEPT SELECTION DESIGN

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2.0.1 PROJECT REVIEW

The Phase I Report, Grid ICES, presented the broad alternatives and implications for development of an energy system satisfying thermal demand with the co-generation of electric power, all predicated on the use of solid fuels.

Participants of the system are the University of Minnesota, operator and primary thermal user, and Northern States Power Company, primary electrical user; with St. Mary's Hospital, Fairview Hospital, and Augsburg College as Add-on Customers for the thermal service (Option I).

Included for consideration are the Options of (II) solid waste disposal by the Pyrolysis Method, with heat recovery, and (III) conversion of a portion of the thermal system from steam to hot water distribution to increase co-generation capability and as a demonstration system for future expansion.

This report presents the conceptual design of the energy system and each Option, with the economic implications identified so that selection of the final system can be made.

Draft outline of the Environmental Assessment for the project is submitted as a separate report.

2.0.2 BASIC SYSTEM - UNIVERSITY OF MINNESOTA

The Minneapolis Campus is served by a central heating plant using coal, oil and gas fuels. Steam is generated at 200 psig saturated and distributed at 200 psig and 15 psig.

Availability of natural gas has declined to the point that it will be discontinued. The cost of fuel oil requires its use as a standby fuel. Therefore coal will become the primary fuel.

The University has negotiated an agreement to secure partial unit-train shipments of Western sub-bituminous coal (8600 BTU/pound) at a favorable cost. Utilization of this coal will require a new rail unloading system and a de-rating of existing coal fired boiler equipment.

Current steam load will exceed existing boiler capacity on Western coal and expansion space is not available at the current plant site. Therefore the University has purchased the 'Southeast Generating Station' from Northern States Power Co.. This station is 3000 feet west of the University plant and has three usable boilers, two of which can be rehabilitated for coal firing. All electrical generating equipment has been removed and the available building space is adaptable for expansion to a cogenerating facility. It is particularly suited for by-product generation since the boiler equipment

at Southeast is designed for steam generation at a nominal level of 450 psig 750°F, permitting consideration of a non-condensing turbine to supply the existing 200 psig and 15 psig distribution systems.

Accordingly the basic system plan has been developed as outlined below.

- A. Interconnect the Southeast Generating Station and the Minneapolis Campus Heating Plant to form a Community energy center.
- B. Install a rail, coal unloading system to permit use of low cost, low BTU, low sulfur Western coal as the primary fuel.
- C. Rehabilitate the Southeast Station as a base loaded, coal fired plant with proper environmental controls.
- D. Install a non-condensing turbine-generator to provide electric power as a by-product of the thermal load.
- E. Enter into an agreement with Northern States Power Co. for the sale of the available electric power.

The Southeast Generating Station will have a capability of 235,000 pounds per hour steam rate on coal firing and would operate year around. An existing boiler, oil fueled, has a capability of 160,000 pounds per hour and would be used for standby capacity. All steam would be reduced to 180 and 20 pounds pressure through an

automatic extraction non-condensing turbine. The reduced steam headers and a condensate return line would be interconnected to existing systems in the Minneapolis Heating Plant.

The University Heating Plant would operate six months each year (October through March) when thermal demand normally exceeds the capability of the Southeast Station. Existing coal fired equipment would operate at 180 psig nominal pressure into a common header system with the 180 psig extracted steam. A minimum pressure of 175 psig would be maintained to satisfy load requirements.

2.0.3 SYSTEM OPTIONS

A. Option I - Add-on Customers

Adjacent to the West Bank Campus of the University are Fairview and St. Mary's Hospitals; across from the hospitals is Augsburg College.

The three institutions have agreed to join the energy community and would purchase steam from the system. Their heating systems, oil and gas fired, would be shut down and removed.

St. Mary's Hospital Heating Plant provides steam both for itself and Fairview. Steam is generated at 150 psig nominal with interruptible natural gas and No. 6 fuel oil.

Augsburg College operates three low pressure steam boiler rooms on interruptible natural gas and No. 4 or No. 5 fuel oil.

A connecting tunnel would be constructed from the nearest University building (Middlebrook Hall) to the vicinity of St. Mary's Heating Plant. Augsburg would be fed with direct buried steam and condensate line extensions.

Each steam customer would be separately metered and billed under contract agreements presented with this report.

B. Option II - Solid Waste Pyrolysis

The University presently operates two 50 ton per day incinerators for the disposal of its normal solid waste and all University Hospital contaminated waste. No alternate disposal means is available for the contaminated waste portion.

Operation of the incinerators is in violation with current standards for air quality and ash disposal.

Investigation of Hospital waste disposal in the Minneapolis-St. Paul Metropolitan Area indicates a great need for a system that would provide environmentally sound disposal of contaminated materials. A successfully developed system is offered by Andco-Torrax in the form of a gas generating pyrolysis unit followed by secondary combustion of the off-gas. Waste products from this system are a water cooled, sterile frit material and a hot gas with sufficient energy content for the generation of steam as a by-product.

Space exists in the Southeast Station to accommodate the Pyrolysis system and waste heat boiler. Based on a survey of Hospital waste availability, the unit size would be 100 tons per day, with the expected average input of 80 tons per day. This would result in the availability of 26,000 pounds per hour of steam at 450 psig 750°F from waste heat.

As a back-up facility to the Pyrolysis system, the existing Incinerators would be up-graded to provide environmental compliance.

C. Option III - Hot Water Distribution

All buildings on the University West Bank Campus are heated by circulating hot water and cooled by steam adsorbtion generated chilled water, both systems tied to the high pressure steam (180 psig) system.

The primary heat exchanges could be changed or converted to a lower energy level, hot water system. Generation of hot water at the heating plant would use a higher ratio of turbine-generator exhaust steam, increasing by-product electric power.

Establishment of a hot water distribution loop would provide for more economic future load growth. Campus growth (new buildings) would be on the West Bank and multiple dwelling housing is adjacent to this campus area.

Hot water distribution, in addition to maximizing by-product generation, provides minimum system losses and maintenance, flexibility of design, and increases the range of thermal service.

2.0.4 THERMAL LOAD DURATION

A. Basic Plan - University of Minnesota

Tabulated below are the actual steam demands for 1975 - 1977 and the projected demand for years 1978 - 1981.

<u>Year</u>	<u>Total Steam (Millions #)</u>	<u>Ave. Demand (1000 #)</u>	<u>Peak (1000 #)</u>	<u>Building Space</u>
1975	1,833	209	400	9,957,000
1976	1,834	209	410	10,068,000
1977	1,700	194	460	10,151,000
1978	1,750	200	400	10,970,000
1979	1,750	200	400	10,970,000
1980	1,785	204	408	11,127,000
1981	1,900	217	435	11,725,000

Heating plant loads are noted hourly and computer logged permitting print-out of Steam Load Duration Curves, as enclosed.

For the purposes of this study, curves for the following two periods are used.

October - March, Heating Season
April - September, Cooling Season

Curve Analysis

Heating Season - 110,000 #/hr., minimum
(1976 - 1977) 245,500 #/hr., average
460,000 #/hr., peak

Cooling Season - 80,000 #/hr., minimum
148,400 #/hr., average
260,000 #/hr., peak

The above curves were projected to 1980 - 1981 load for Heat Balance study. It should be noted that the curves include gross steam requirements, at both high and low pressure levels.

Although not separately metered, the low pressure system (15 psig) feeds 10% of heated space.

B. Option I - Add-on Customers

The St. Mary's Hospital plant load includes Fairview Hospital thermal load. This load portion is also hourly metered and computer logged to permit duration curve presentation as enclosed.

Augsburg College meters only fuel usage, but based on gross square feet and fuel use, load data was calculated and plotted.

C. Combined System Load

Adding St. Mary's Fairview and Augsburg to the University system will result in total load as projected below.

<u>Year</u>	<u>Total Steam (Millions #)</u>	<u>Ave. Demand (1000 #)</u>	<u>Peak (1000 #)</u>	<u>Building Space</u>
1980	2,070	236	480	12,842,000
1981	2,206	252	505	13,740,000

Steam load duration curves are included which show the combined load of the Option I system.

As stated previously, the Cooling Season (April - September) load would be satisfied by the Southeast Generating Station. The Heating Season (October - March) load would require operating the University Heating Plant as a peaking unit with the Southeast Station.

MINNEAPOLIS CAMPUS STEAM LOAD DURATION CURVE
FOR APR. - SEPT. 1976-1977

ST. MARYS-FAIRVIEW STEAM LOAD DURATION CURVE
FOR MONTHS OCT. - MAR. 1976-1977

ST. MARYS-FAIRVIEW STEAM LOAD DURATION CURVE
FOR APR. - SEPT. 1976-1977

2.0.5 SYSTEM SELECTION

Three primary considerations of either the Basic Plan or combined Option I Plan are as follow:

- A. The minimum steam service pressure required at any use point of the high pressure system is 125 psig.
- B. The existing low pressure system requires 10% of base system load at a minimum plant header pressure of 15 psig.
- C. The existing boilers in the Southeast Generating Station are designed for feedwater temperature of 250°F, saturation temperature of 15 psig steam.

The line diagram of the steam system was developed, identifying all load points, main sizes and distances between service risers.

Pressure drop calculations at maximum use indicate a maximum pressure drop of 50 psig to any steam service. This will require maintaining a minimum header pressure of 175 psig at the University Heating Plant. This also corresponds to the lowest operating pressure of the existing 200 psig boilers.

Therefore, the extraction steam pressure level of the proposed turbine-generator is 180 psig nominal (adjustable over a 10% range) to serve the primary load at 175 psig.

Since the University Heating Plant will not operate during the summer season, the low pressure system must be either pressure reduced from

175 psig or supplied by a turbine back-pressure level of 20 psig. This level (20 psig) also corresponds to the required pressure for the deaerating heater on the Southeast Station feedwater supply. Therefore the non-condensing exhaust of the turbine-generator is set at 20 psig nominal.

Interconnection of the Southeast Station to the University Heating Plant would consist of a 180 psig header, a 20 psig header and a condensate return line. All connected to the existing header distribution system to yield a commonly operated energy center. The total capacity of the system is tabulated on the following page.

Expected peak load range can be satisfied with coal produced steam, and oil fired capacity will be used only on a standby or emergency basis.

2.0.6 HEAT BALANCE STUDY

The basic system and options are presented in line diagram form illustrating the primary flow scheme of the combined energy system. Each option is energy (heat) balanced for each operating load condition, Heating and Cooling seasons. Maximum (peak) conditions are projected above expected loads by 10% to assure system component selection to satisfy severe winter loading.

Basic parameters, established from the University's operating history, were set as follows:

Boiler blowdown	-	3% average
Makeup water rate	-	10% of boiler flow

Utilizing minimum, average and projected maximum load conditions from the Steam Load Duration Curves the various Heat Balances are shown on drawing 625 HB, Heat Balance and Operating Loads. At 80% boiler efficiency, total annual fuel consumption is calculated. Under Option II, Pyrolysis, the steam flows are credited by 26,000 #/hr. from Waste Heat reducing fuel consumption.

Gross KWH production as a by-product of system steam load is based on 73% efficiency related to theoretical steam rates from 450 psig 750°F to 180 psig and 20 psig respectively. This efficiency establishes expected outlet enthalpy at each pressure level. The differential enthalpy multiplied by section flow establishes gross KWH

production, affected only by generator efficiency. Fuel chargeable to generation or heat rate of the system with respect to electrical output is 3413 BTU/KWH divided by the product of boiler efficiency (80%) and generator efficiency (95%), or 4490 BTU/KWH on a fuel basis.

The Heat Balance study establishes the economic probability of the system. Calculated quantities on an annual basis and their effective fuel and power cost savings are shown on the following tables. Each option is derived on an incremental basis from the preceding option. Economic evaluation is made in a separate report.

Current (1977) costs used in computing power and fuel savings are as follow.

Fuels

Western Coal	\$17/ton
Eastern Coal	\$36/ton
Ash Disposal	\$5.75/ton, ash
No. 2 Fuel Oil	36.5¢/gal.
No. 6 Fuel Oil	35¢/gal.
Natural Gas	\$1.50/MCF, interruptible

Electric Rates

Purchased Power	\$0.0272/KWH
Cogenerated Power	
(estimated based on agreement with NSP)	
On peak	\$.02/KWH
Off peak	\$.018/KWH

Dollar savings are shown only on a current basis. No attempt is made to project savings (exponentially) over the service life of the system. Such a projection would obviously illustrate a greater return on initial investment.

PLANT CAPABILITY

I. Southeast Generating Station (450 psig 750°F)

<u>Boiler No.</u>	<u>Coal (8600 BTU/#)</u>	<u>No. 2 Oil</u>
1	---	160,000 #/hr.
3	108,000 #/hr.	---
4	128,000 #/hr.	---
	<u>236,000 #/hr.</u>	<u>160,000 #/hr.</u>

Turbine-Generator (Capability)

Throttle Capability -	350,000 #/hr.
180 psig Extraction -	0 to 330,000 #/hr.
20 psig Exhaust -	8000 to 140,000 #/hr.
Turbine rating, pressure rise point -	7,500 KW
Turbine rating, max output -	12,750 KW
Generator rating -	12,500 KW 0.85 PF
	13,800 volts

II. University Heating Plant

<u>Boiler No.</u>	<u>Coal (8600 BTU/#)</u>	<u>Oil</u>
1	60,000 #/hr.	
2	60,000	
3	60,000	
4	75,000	
5	94,000	
6		200,000
12	68,000	
	<u>417,000 #/hr.</u>	<u>200,000 #/hr.</u>

III. Total System

	<u>Coal</u>	<u>Oil</u>
Southeast Station	236,000 #/hr.	160,000 #/hr.
University Plant	<u>417,000</u>	<u>200,000</u>
	653,000 #/hr.	360,000 #/hr.

Projected Peak Community Load -

Expected range = 505,000 to 555,000 #/hr.

HEAT BALANCE QUANTITIES (ANNUAL BASIS)

	<u>Basic</u>	<u>Option I</u>	<u>Option II</u>	<u>Option III</u>
1. #Steam Gen.	1875 x 10 ⁶	2199 x 10 ⁶	2199 x 10 ⁶	2199 x 10 ⁶
2. Fuel Use	156,500 T.	182,000 T.	163,500 T.	163,500 T.
3. Gross KWH	46,231,000	50,440,000	52,091,000	56,401,000
4. Plant Load (KWH)	7,446,000	7,880,000	11,880,000	12,530,000
5. Net, KWH	38,785,000	42,560,000	40,211,000	43,871,000
6. Pool Credit @ 90% Avail.	34,910,000	38,300,000	36,190,000	39,485,000
a. Pool KW	3,985	4,372	4,131	4,507
b. KWH, On Peak	14,380,000	15,780,000	14,910,000	16,265,000
c. KWH, Off Peak	20,530,000	22,520,000	21,280,000	23,220,000
7. Coal to Gen. @ 4490 BTU/KWH (Gross KWH)	12,070 T.	13,170 T.	13,600 T.	14,725 T.
8. Coal To Steam Dist.	144,430 T.	168,830 T.	149,900 T.	148,775 T.
9. BPP * (SE Sta) $\frac{\text{KWH}}{\text{MBTU}}$	23.11	22.64	22.64	26.34
	$\frac{\text{KWH}}{1000\#}$	27.16	27.16	31.6

* BPP = By-product power rate

FUEL & POWER COST SAVINGS

I. Basic Plan

A. Electric Generation

1. Credits

(Peak, Out)	14,380,000 X .02	=	\$287,600
(Off Peak)	20,530,000 X .018	=	369,540
(Plant Power)	7,446,000 X .0272	=	<u>202,530</u>
			\$859,670 +

2. Debit

(Fuel)	12,070 T X \$17.00	=	205,190
(Ashes)	12,070 X .08 X \$5.75	=	<u>5,550</u>
			\$210,740 -
Gross Gain			\$648,930

B. Steam Distribution

1. Fuel Cost	144,430 T @ \$17.00	=	\$2,455,310
2. Ash Cost (Handling)	144,430 T @ .08 X 5.75	=	<u>66,440</u>
			\$2,521,750, Gross, Fuel

3. Gross BTU = $2,484,200 \times 10^6$

4. Equiv. BTU
(X 80)

(83) = $2,394,405 \times 10^6$

5. Equiv. Tons @ 12,600 BTU/# = 95,016

6. Equiv. Cost

$95,016 \times \$36 = \$3,420,575$

$95,016 \times .08 \times 5.75 = \underline{43,707}$

$\$3,464,283$, Equiv. Fuel

7. Fuel Savings - \$942,533, Gross/Yr.

II. Option I

(Incremental Basis)

A. Electric Generation

(15,780,000 - 14,380,000) .02	=	\$28,000 +
(22,520,000 - 20,530,000) .018	=	35,820 +
(7,880,000 - 7,446,000) .0272	=	11,800 +

Fuel (13,170 - 12,070) 17	=	18,700 -
Ashes (13,170 - 12,070) .08 X 5.75	=	<u>500 -</u>

Gross Gain	=	\$56,420
------------	---	----------

B. Steam Distribution

1. Fuel Cost

(168,830 - 144,430) 17	=	\$414,800, Coal
(168,830 - 144,430) .08 X 5.75	=	<u>11,230, Ashes</u>

Added Fuel Cost	=	\$426,030
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2. Gross BTU, Added

(168,830 - 144,430) 17.2	=	419,680 X 10 ⁶ BTU
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3. Equiv. BTU

1/2 Oil @ \$2.37/10 ⁶	=	404,510 X 10 ⁶
1/2 Gas @ \$1.50/10 ⁶	=	\$479,345
Equiv. Fuel Cost	=	<u>303,383</u>
	=	\$782,728

4. Fuel Savings	=	\$345,698/Year
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C. Gross, Fuel & Power Gain	=	\$413,118
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III. Option II (Incremental)

A. Electric Generation

(14,910,000 - 15,780,000) .02	=	- \$ 17,400
(21,280,000 - 22,520,000) .018	=	- 22,320
(11,880,000 - 7,880,000) .0272	=	+ 108,800

Fuel (13,600 - 13,170) 17	=	- 7,310
Ashes (13,600 - 13,170) .08 X 5.75	=	- <u>200</u>

Gross Gain	=	\$ 61,570
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B. Steam Distribution

1. Fuel Cost (Gain)

(168,830 - 149,900) 17	=	\$321,810
(168,830 - 149,900) .08 X 5.75	=	<u>8,710</u>

Gain	=	\$330,520
------	---	-----------

2. Fuel Charges

No. 2 Fuel Oil, Used	=	\$ 53,016
Frit (28,000) .05 X 5.75	=	<u>8,050</u>

Loss		\$ 61,066
------	--	-----------

C. Fuel & Power Gain		\$331,024
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IV. Option III (Incremental)

A. Electric Generation

(16,265,000 - 14,910,000) .02	=	+ \$ 21,100
(23,220,000 - 21,280,000) .018	=	+ 34,920
(12,530,000 - 11,880,000) .0272	=	+ 17,680

Fuel (14,725 - 13,600) 17	=	- 18,125
Ashes (14,725 - 13,600) .08 X 5.75	=	- <u>515</u>

Gain	=	\$ 61,060
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B. Steam Distribution

Fuel and Ash Gain	=	\$ 18,640
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C. Gross Gain	=	\$ 79,700
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BASIC PLAN, OPTION I & OPTION II

OPTION III

BASIC PLAN				OPTION I				OPTION II				OPTION III			
COOLING SEASON (APRIL-SEPT.)				HTG. SEASON (OCT.-MARCH)				COOLING SEASON (APRIL-SEPT.)				HTG. SEASON (OCT.-MARCH)			
STEAM REQ'D. x 1000	MIN.	AVE.	MAX.	MIN.	AVE.	MAX.		STEAM REQ'D. x 1000	MIN.	AVE.	MAX.	MIN.	AVE.	MAX.	
180°	18	145	447	97	243	447		180°	17	143	304	106	273	497	
15°	0	15	25	10	25	45		15°	0	15	25	21	43	80	
TOTAL GEN.	85	160	278	107	268	492		TOTAL GEN.	100	186	329	127	316	577	
SYSTEM LOADING x 1000								SYSTEM LOADING x 1000							
F ₁ (S.E. STA.)	85	160	278	107	268	492		F ₁ (S.E. STA.)	100	186	329	127	316	577	
F ₂ (MPLS. PLT.)	0	0	0	15	58	257		F ₂ (MPLS. PLT.)	0	0	0	15	81	317	
KW GEN. (by heat balance)	2400	4445	7723	2627	6110	7762		KW GEN. (by heat balance)	2732	5088	8994	3126	6005	8523	
OPERATING HOURS	—	4380		—	4380			OPERATING HOURS	—	4380		—	4380		
FUEL REQ'D.								FUEL REQ'D.							
S.E. STATION	59670	TONS, 8600 BTU/lb		78320	TONS, 8600 BTU/lb			S.E. STATION	59670	TONS, 8600 BTU/lb		77945	TONS, 8600 BTU/lb		
MPLS. PLANT	0	"	"	18310	"	"		MPLS. PLANT	0	"	"	25885	"	"	
KW AT AVE. LOAD	—	4445		—	6110			KW AT AVE. LOAD	—	5088		—	6005		
LESS PLANT LOAD	—	1065		—	1083			LESS PLANT LOAD	—	1578		—	1578		
NET KW	—	3380		—	5027			NET KW	—	3513		—	4427		
KWH AVAILABLE	—	14,805,000		—	24,094,000			KWH AVAILABLE	—	15,386,000		—	22,905,000		
TOTAL ANNUAL BASIS				TOTAL ANNUAL BASIS				TOTAL ANNUAL BASIS				TOTAL ANNUAL BASIS			
FUEL - SOUTHEAST	59670	TONS, COOLING SEASON		59670	TONS, COOLING SEASON			FUEL - SOUTHEAST	59670	TONS, COOLING SEASON		59670	TONS, COOLING SEASON		
	78320	TONS, HEATING SEASON		78320	TONS, HEATING SEASON				77945	TONS, HEATING SEASON		77945	TONS, HEATING SEASON		
SUB.	137,990	TONS		SUB.	137,990	TONS		SUB.	137,990	TONS		SUB.	137,990	TONS	
MPLS. PLANT	18310	TONS, HEATING SEASON		MPLS. PLANT	30380	TONS, HEATING SEASON		MPLS. PLANT	25885	TONS, HEATING SEASON		MPLS. PLANT	25885	TONS, HEATING SEASON	
TOTAL	156,300	TONS, 8600 BTU/lb		TOTAL	168,370	TONS, 8600 BTU/lb		TOTAL	163,875	TONS, 8600 BTU/lb		TOTAL	163,875	TONS, 8600 BTU/lb	
KWH AVAILABLE	—	14,805,000 KWH, COOLING SEASON		KWH AVAILABLE	—	17,386,000 KWH, COOLING SEASON		KWH AVAILABLE	—	15,386,000 KWH, COOLING SEASON		KWH AVAILABLE	—	17,713,000 KWH, COOLING SEASON	
	—	24,094,000 KWH, HEATING SEASON			—	24,094,000 KWH, HEATING SEASON			—	22,905,000 KWH, HEATING SEASON			—	22,905,000 KWH, HEATING SEASON	
TOTAL	—	38,900,000 KWH		TOTAL	—	41,480,000 KWH		TOTAL	—	38,291,000 KWH		TOTAL	—	40,618,000 KWH	
STEAM GENERATOR	—	700,000,000 LBS., COOLING SEASON		STEAM GENERATOR	—	815,000,000 LBS., COOLING SEASON		STEAM GENERATOR	—	815,000,000 LBS., COOLING SEASON		STEAM GENERATOR	—	815,000,000 LBS., COOLING SEASON	
	—	1,740,000,000 LBS., HEATING SEASON			—	1,840,000,000 LBS., HEATING SEASON			—	1,840,000,000 LBS., HEATING SEASON			—	1,840,000,000 LBS., HEATING SEASON	
TOTAL	—	2,440,000,000 LBS.		TOTAL	—	2,655,000,000 LBS.		TOTAL	—	2,680,000,000 LBS.		TOTAL	—	2,680,000,000 LBS.	

2.0.7 SYSTEMS DESIGN

Implementation of the project and selected options will require consideration of the various sub-systems as shown on the Project Systems Design Outline which follows.

Conceptual design has been established for the following:

A. Coal Handling

1. Capacity - 40 cars 105 tons each per 10 hour shift
2. Trackage to accommodate cars on a single switch basis
3. Bottom car dump hopper and outfeed at 800 TPH
4. Transfer conveyor capability - 600 TPH
5. Dual transfer provision to
 - a. University Heating Plant
 - b. Southeast Generating Station
6. Enclosed car unloading station and fully enclosed, multi-purpose conveyor gallery
7. Dust collection and dust suppression spray systems
8. Separate coal storage drainage system with grit removal

B. Boiler Rework (Southeast)

1. New coal conveyor system for existing bunkers
2. New coal scales and coal feeders
3. Replacement of obsolete electric drives
4. New burners (No. 3 Boiler)
5. New Control systems

C. Feedwater System (Southeast)

1. Makeup water treating

100 gpm hot process softener, hot zeolite and filters

2. Condensate treating

600 gpm Filterex system

3. Blowdown

Continuous blowdown receiver with flash steam and waste heat recovery

4. 300,000#/hr. deaerating heater and storage tank

5. Three - 150 gpm 1300 ft. head boiler feed pumps

D. Air Pollution Control

1. One - 110,000 ACFM capacity fabric filter baghouse, 500°F

maximum temperature, 2 to 1 air - cloth ratio

2. Auxiliary Induced Draft Fan

E. Ash Handling

1. Steam jet vacuum type, enclosed pipe system with air wash outlet

2. Air lock, valved entry from boiler hoppers and baghouse hoppers

3. Tile receiving silo with dustless unloader

F. Turbine-Generator

1. 350,000#/hr. throttle flow at 450 psig 750° capability

2. Non-condensing, 20 psig exhaust

3. Single automatic extraction at 180 psig

4. 12,500 KW air cooled generator at 3 phase 60 cycle 13800 volts

G. 13.8 KV Primary Electric System

1. 500 MVA interrupting capacity
2. Primary, selective distribution system
3. Generator and tie provisions to NSPCo with synchronizing, synchro-check relaying, and reverse fault relaying
4. Bus and generator differential relay protection
5. Current limited ground fault system

Appropriate drawings and line diagrams established to date are presented in a separate design review package.

In regard to primary electrical connection, it should be noted that the Southeast Generating Station would receive inplant power requirements from installed generation. Excess KWH would be distributed to Northern States Power Co. under a cogeneration pool agreement, submitted in a separate report.

PROJECT SYSTEMS
DESIGN OUTLINE

A. Basic Plan

1. Plant Interconnections
 - a. Steam & Condensate
 - b. High Voltage Electric
 - c. Oil line (No. 2 oil)
 - d. Coal handling (to bunker)
2. S.E. Utilities
 - a. Water
 - b. Sewer
 - (1) Lift Station
 - (2) Grit Basin
3. S.E. Fuel Handling
 - a. Coal storage remodeling and conveyors to bunker
 - b. Oil storage and pump set (No. 2 oil)
4. S.E. Plant Systems
 - a. Boiler rework
 - b. Condensate system
 - c. Makeup water treating
 - d. Feedwater deaerator and pumps
 - e. Steam piping
 - f. Plant electric system
 - (1) Drive changes
 - g. Emergency systems
 - h. Pollution control - Baghouse (Breeching changes, etc.)
 - i. Ash Handling
 - j. Compressed air
5. S.E. Plant Remodeling
 - a. Exterior work
 - (1) General
 - (2) Lighting
 - b. Interior revisions
 - c. Roof repair
6. S.E. Plant Generation
 - a. Turbine Generator
 - (1) Foundation
 - (2) Erection
 - (3) Piping

- b. Switchgear
 - (1) Wiring
 - (2) Controls
- c. Instrumentation
 - Steam Metering

- 7. S.E. Plant Instrumentation
 - a. Boiler Controls
 - (1) Instrument air comp.
 - (2) Air Piping
 - (3) Electric wiring
 - b. Steam and Condensate Metering
 - c. Computer Interface
 - (1) Fuel
 - (2) Steam and Condensate
 - (3) KWH

- 8. University (Minneapolis) Heating Plant
 - a. Baghouses (under contract)
 - b. Incinerator Remodeling

B. Option I - Add-On's

- 1. Tunnel (University of Minnesota)
- 2. Steam and Condensate Piping (to St. Mary's)
- 3. Metering
 - a. St. Mary's
 - b. Fairview
 - c. Augsburg
 - d. University of Minnesota (total)
- 4. Tunnel Lighting
- 5. Steam and Condensate to Augsburg
- 6. Augsburg Distribution and PRV's

C. Option II - Pyrolysis

- 1. Andco System delivered and erected
- 2. Waste Heat Boiler
- 3. Induced Draft Fan and Drive

4. Boiler Instrumentation and controls
5. Refuse crane and auxiliaries
6. Equipment erection (not including Andco)
7. General construction including slag tank
8. Fly ash system
9. Baghouse addition (pollution control)
10. Mechanical construction
11. Electrical construction

D. Option III - Hot Water

1. Upgrade Low Pressure Header
2. Hot Water Generating System
 - a. Heat Exchanges
 - b. Pumps (Variable speed)
 - c. Receiver and Expansion
 - d. Water treatment
 - e. Electric wiring
3. Hot Water Loop Piping
4. Hot Water Instrumentation and Metering
5. Building Heating System Changes

2.0.8 OPTION II - PYROLYSIS

This system is treated separately in the following feasibility study.

Since this option is of specific interest to various governmental agencies, expanded considerations at various waste tonnages are being made separately.

The capital budget included in this report considers only the smaller pyrolysis system (80 TPD waste flow) and the upgrading necessary for the University incinerators.

OPTION II PYROLYSIS

Operating Costs

Operating costs are based on the pyrolysis unit operating at a refuse feed rate of 80 tons per day for 350 days, 15 days being allocated for down time and overhaul. The annual refuse handled by the system will be:

$$80 \times 350 = 28,000 \text{ tons per year.}$$

Operating costs include the following:

- Labor
- Fuel Oil
- Electric Power
- City Water
- Maintenance and Repair

Labor Cost

The following personnel schedule assumes a three shift operation per day with a swing shift for vacations, holidays, 40 hour week, etc. Overall staffing of the S.E. plant has been assessed to determine the personnel chargeable to the pyrolysis system. Proposed shift charges appear below.

	Shift			
	1	2	3	Swing
Principal Operator	1	1	1	1.3
Junior Operator	1.5	1.5	1.5	.65
Crane Operator	1	1	1	1.3

Operating labor costs have been based on the following wage rate schedule.

<u>Designation</u>	<u>Type</u>	<u>Base Rate</u>	<u>Fringes</u>	<u>Vac., Sick Leave & Hol.</u>	<u>Total</u>	<u>Annual</u>
Principal Operator	Civil Serv.	\$7.89	\$1.56	\$1.16	\$10.61	\$22,069
Jr. Operator	Civil Serv.	6.93	1.37	1.02	9.32	19,386
Crane Operator	Civil Serve.	7.62	1.51	1.12	10.25	21,320

The total labor will be:

$$22,069 \times 4.3 + 19,386 \times 5.15 + 21,320 \times 4.3$$

$$94,897 + 99,838 + 91,676 = \$286,411$$

The labor cost per ton will be:

$$\frac{286,411}{28,000} = \$10.23 \text{ per ton}$$

Fuel Oil

Fuel Oil (No. 2) requirements have been estimated by Andco and appear below.

One start-up per year and 350 days of normal operation has been budgeted.

Fuel Oil Requirements for Start-Up

<u>Item</u>	<u>Start-up Time Hours</u>	<u>Rate of Flow GPH</u>	<u>Total Flow Gal.</u>
Cowpers - burner	120	39.60	4752
S.C.C. - burner	16	47.52	760
S.C.C. - slag burner	10	7.92	79
Tuyeres (8 in number)	10	50.69	507
Gasifier - slag burner	24	6.60	158
Hearth - burners	12	52.80	634
TOTAL			6890

Fuel Oil Requirements for Normal Operation

<u>Item</u>	<u>Daily Requirement Gal.</u>
Gasifier	179.75
S.C.C.	215.57
TOTAL	395.32

Annual fuel oil requirements will be $6890 + 395.32 \times 350 = 145,250$ gallons. At a price of \$.365 per gallon, the annual cost of fuel oil will be \$53,016 and the cost per ton of refuse will be $\frac{53,016}{28,000} = \1.89 .

Electric Power

Electric power requirements have been estimated by Andco and appear below. Estimates are based on a refuse rate of 100 tons per day and have been assumed to be proportionate at 80 tons per day.

<u>Item</u>	<u>Motor Size</u> <u>HP</u>	<u>Power Demand</u> <u>KW</u>	<u>Power Req. -KWH</u> <u>Per ton of refuse</u>
Primary air fan	100	75.00	18.00
Secondary air fan	75	56.25	13.50
Induced draft fan	500	375.00	43.50
Andco feed system	5	3.75	.18
Vibrating feeder	20	15.00	1.08
Slag conveyor - belt	4	3.00	.72
Slag conveyor - bucket	4	3.00	.72
Slag grapple - bucket	2	1.50	.36
Heat exchanges (2)	50	37.50	9.00
Closed circuit cooling pump	50	37.50	9.00
Open circuit cooling pump	100	75.00	18.00
Slag quench reservoir pump	20	15.00	3.60
Instrument air compressor			1.35
Controls (120 volt)		10.00	2.40
Burner fans (total)	15	11.25	2.70
TOTAL			124.11

With an electric energy rate of \$.0272 per KWHR, the electric power cost per ton of refuse will be $124.11 \times .0272 = \$3.37$.

City Water & Sewer

Water make-up requirements for normal operations have been estimated by Andco to be 25 gpm for the open water loop and 25 gpm for the closed loop

or a total of 50 gpm for the system. Daily water make-up will be 50 X 60 X 24
 = 72,000 gallons. At a refuse rate of 80 tons per day and a water cost of
 \$.088 per 1000 gallons, the cost of make-up water will be:

$$\frac{72,000}{80} \times \frac{.088}{1000} = \text{\$.08 per ton of refuse.}$$

Maintenance and Repair

Andco has estimated the annual cost of maintenance and repair to be \$106,000
 for the frame size of 132 T/day. At a refuse rate of 46,200 tons per year, the
 cost of maintenance and repair will be:

$$\frac{106,000}{46,200} = \text{\$2.30 per ton.}$$

The cost of maintenance and repair for the 100 T/day unit is assumed to be:

$$106,000 \times \frac{4,105,000}{4,894,000} = \text{\$88,900}$$

and the cost per ton will be:

$$\frac{88,900}{28,000} = \text{\$3.18 per ton of refuse.}$$

Summary

Total operating costs are summarized below.

<u>Item</u>	<u>Estimated Cost</u> <u>\\$/Ton Refuse</u>
Labor	\$10.23
Fuel Oil	1.89
Electric Power	3.37
City Water & Sewer	.08
Maintenance & Repair	<u>3.18</u>
TOTAL	\$18.75

Slag Recovery

The credit for the slag from this process has not been calculated because neither the market nor the product value is available at this time. Further study has not been considered within the scope of this report. It has been assumed that the value of the product would pay for the hauling so no charge has been made for slag removal.

Energy Recovery

A waste heat boiler has been included with the pyrolysis system to recover energy in the form of steam that will be supplied to the 450 psig header. Gas from the secondary combustion chamber at a temperature of 2300°F will be admitted to the waste heat boiler, super heater, and economizer where the temperature will be reduced to 460°F at the economizer outlet. With steam conditions of 450 psig, 725°F and feedwater at 250°F, steam will be produced at a rate of 26,000 pounds per hour at a refuse rate of 80 tons per day. The refuse is assumed to have a HHV of 6993 BTU per pound.

Daily steam production will be $\frac{26,000 \times 24}{1000} = 624,000$ pounds per day

or $\frac{624}{80} = 7.8 \times 1000$ pounds of steam per ton of refuse. The average

fuel cost of steam generated by Boiler No. 3 and Boiler No. 4 is estimated to be \$1.66 per 1000 pounds.

The value of steam generated is $1.66 \times 7.8 = \$12.95/\text{ton}$ of refuse.

Estimated Capital Cost

The following budget estimate is based on an Andco unit rate 100 ± 30 percent tons of refuse per day. The unit will be located in the area of the S.E. plant east of Boiler No. 4. A refuse pit has been sized for 3 day storage. A bridge crane with cab will handle normal waste and also "red bag" hospital waste. The gas clean-up will be done in the baghouse that will also clean the gas for Boiler No. 3 and Boiler No. 4. The proportionate burden has been included for the pyrolysis unit. Estimated costs are "order of magnitude" based on 1977 prices. The general arrangement of equipment has been shown on Helmick & Lutz Company drawing 625 - Task 11.

2.0.9 OPTION III - HOT WATER DISTRIBUTION

As previously outlined, consideration of the installation of Hot Water will be made only for the West Bank Campus

Separate load study of this area indicates that summer load is 23% of total campus load, while winter load is 14% of total campus load. This is caused by the large steam adsorbtion, chilled water capacity on the West Bank.

To satisfy load conditions of the adsorbtion units and to minimize loop flow (and pumping cost), a system with 300°F outlet capability is required. Based on maintaining return temperature at 160°F, maximum loop flow of approximately 1000 gpm is calculated.

System generating equipment would include a series heat exchanger arrangement including four separate elements -

- A. 20 psig steam to hot water (240°F)
- B. 20 psig condensate cooler, water to water
- C. 180 psig steam to hot water (300°F)
- D. 180 psig condensate cooler, water to water

The latter two elements (associated with 180 psig steam) would be provided with valved by-passes, enabling operation at 240°F during expected low load periods.

Return water temperature control would be regulated by variable speed pump drive control. Final outlet temperature control would be

provided by steam supply valve control.

Basic arrangement and energy transfer rates are shown on the Heat Balance diagram, 625 HB, Option III.

2.0.10 UP-DATED CAPITAL COST BUDGET

A. Basic Plan - Steam Generation

1. Plant Interconnections			
a. Piping	\$1,025,000		
b. No. 2 Oil Line	50,000		
c. Coal Handling	<u>3,250,000</u>		
	\$4,325,000	+12%* =	\$4,844,000
2. Southeast Station Utilities			
a. Water Main	\$ 25,000		
b. Sewers	<u>195,000</u>		
	\$ 220,000	+12% =	\$ 246,400
3. Southeast Fuel Systems			
a. Coal Storage Remodeling	\$ 690,000		
b. Coal Retrieval System	490,000		
c. Truck Loading System	40,000		
d. Bunker Conveyors, Scales and Feeders	290,000		
e. Fuel Oil Storage	<u>40,000</u>		
	\$1,550,000	+12% =	\$1,736,000
4. Southeast Plant Systems			
a. Boiler Rework	\$ 350,000		
b. Condensate Treating	120,000		
c. Makeup Water Treating	190,000		
d. Deaerator and Feed Pumps	120,000		
e. Plant Piping	750,000		
f. Plant Electric System	475,000		
g. Emergency System	25,000		
h. Pollution Control	1,550,000		
i. Ash Handling	<u>510,000</u>		
	\$4,090,000	+12% =	\$4,580,800
5. Southeast Remodeling			
a. Exterior Work	\$ 815,000		
b. Roof Repair	<u>60,000</u>		
	\$ 875,000	+12% =	\$ 980,000
6. Southeast Plant Instrumentation			
a. Boiler and System Control	\$ 120,000		
b. Air Piping and Compressor	55,000		
c. Electric Wiring	30,000		
d. Computer Interface	<u>25,000</u>		
	\$ 230,000	+12% =	\$ 257,600

7.	University Heating Plant Pollution Control (under contract)	\$2,600,000	
8.	Southeast Plant Acquisition	<u>500,000</u>	
	Sub-Total, Steam Generation		\$15,744,800
B.	Basic Plan - Electric Generation		
1.	Turbine-Generator	\$1,550,000	
a.	Foundation	50,000	
b.	Erection	150,000	
c.	Piping	250,000	
2.	Switchgear and Wiring	305,000	
3.	Instrumentation	<u>350,00</u>	
		\$2,340,000	+12% = \$ 2,620,800
	Total, Basic Plan		\$18,365,600
C.	Option I - Add-On Customers		
1.	Tunnel Construction	\$ 918,000	
2.	Piping (tunnel)	300,000	
3.	Tunnel Lighting	15,000	
4.	Metering	15,000	
5.	Augsburg Primary Steam	130,000	
6.	Augsburg Distribution	<u>270,000</u>	
	Total, Capital Cost		\$ 1,648,000
	Engineering & Contingencies (12%)		<u>197,760</u>
	Total, Option I		\$ 1,845,760

D. Option II, Pyrolysis

1. Andco System Delivered & Erected (includes Engineering & Contingencies)	\$ 4,105,000	
2. Waste Heat Boiler	387,000	
3. Induced Draft Fan and V. Speed Drive	128,000	
4. Boiler Instruments and Controls	30,000	
5. Gas Clean-Up Equipment, Delivered and Erected	565,000	
6. Refuse Crane and Auxiliaries	60,000	
7. Equipment Erection (not including Andco)	60,000	
8. Fly Ash System	10,000	
9. General Construction, including Slag Tank	980,000	
10. Mechanical Construction	172,000	
11. Electrical Construction	210,000	
12. Up-Grade Incinerators	<u>250,000</u>	
Total Capital Cost		\$ 6,957,000
Engineering and Contingencies (12%)		<u>343,000</u>
Total, Option II		\$ 7,300,000

E. Option III, Hot Water Distribution

1. Upgrade Steam Main	\$ 135,000	
2. Hot Water Heat Exchangers, Tankage and Pumps	225,000	
3. Hot Water Loop	560,000	
4. System Controls	30,000	
5. Building System Changes	<u>320,000</u>	
Total Capital Cost		\$ 1,270,000
Engineering and Contingencies (12%)		<u>152,400</u>
Total, Option III		\$ 1,422,400

F. Budget Summary

1. Basic Plan	\$18,365,600
2. Option I	1,845,760
3. Option II	7,300,000
4. Option III	<u>1,422,400</u>
Gross Cost	\$28,932,760

*12% used for Engineering and Contingencies

2.0.11 OTHER CONSIDERATIONS

In formulating the systems selection as proposed in this report, other approaches were considered as follow.

A. Coal Handling

The system selected includes track space for 40 - 55' long cars, or 2200' of single track to enable unloading with one rail switch. This will require accommodation of cars on the railroad's part of like track space.

Should switching be required to minimize track space, the unloading facility would be moved midway and double tracks (1100' long) considered for car storage. Actual track length and conveyor length would remain essentially the same, however, additional switches and switching time would be required.

Any scheme to minimize investment in coal unloading on site involves transfer and storage charges which would negate the benefit of partial unit train price structure. That is, the facility must be able to unload and turn around forty cars in a 24 hour period.

B. Electric Generation

Two choices exist for selection of the turbine generator, non-condensing operation from 450# to 180# (SNC) or non-condensing operation from 450# to 20# with extraction at 180# (SAENC). The latter system was selected to optimize generation and to provide flexibility of future operation when considering hot water district heating.

Based on projected annual load of the basic system (thermal) the following illustrates the difference in available gross KWH.

<u>Turbine</u>	<u>Average KWH</u>	<u>Gross Annual KWH</u>
SNC	4030	35,300,000
SAENC	5275	46,200,000

At 90% availability the SAENC turbine provides 10,000,000 KWH more per year to the pool. At an average return of \$.019/KW this amounts to \$190,000 per year.

The SNC turbine would cost less, approximately \$350,000 and the 20 psig header between plants would not be required, approximately \$210,000; or an estimated additional cost of \$560,000 for the SAENC turbine.

With a payback of three years and system flexibility for future loads, the SAENC unit was selected.

C. Pyrolysis (Option II)

System presentation in this report considers only a unit size selection of 100 tons waste per day, nominal. Obviously the cost effectiveness is not adequate for the capital involved.

A complete separate report regarding alternatives and unit sizing based on available Hospital and conventional wastes is submitted with this report.

D. Hot Water Distribution (Option III)

Within the hot water option, consideration of thermal storage was made to attempt to further optimize generation and to serve as a peak shaving device. Storage capacity would require the capability of storing hot water at 350°F or at 125 psig, a code type pressure vessel or vessels. The quantity of storage is a function of the heat content to permit system temperature decay from a level of 300° to 260° with a constant supply of 240° water generated with 20# steam, over a time period of 14 hours (peak period). The system would be regenerated off-peak with 180# steam.

Average thermal load of the West Bank hot water system is 40×10^6 BTU/hr. or 560×10^6 BTU over the 14 hour peak period. At 280° average supply and 160° constant return this represents use of

4.67×10^6 # of water. Heat input from 20# steam (160° to 240°) would be 374×10^6 BTU. Stored water would supply 560 - 374, or 186×10^6 BTU over a decay range of 350° to 260° or 90°. This would require storage of 2,000,000# or 270,000 gallons of 350° water. This equates to ten tanks, each 10 feet in diameter by 50 feet long, built to 150 psig code specification, or in excess of \$500,000 tankage cost.

Therefore, there is no justification possible for a thermal storage system.

It would be much more beneficial to control the proposed series heat exchanger with variable outlet temperature (300° to 260°) - lower peak period temperature equates to greater system flow, increasing 20# steam flow, and increasing generation.

2.0.12 TECHNICAL APPENDIX

<u>Drawing</u>	<u>Title</u>
625-A	Existing Operating Floor Plan, Southeast Sta.
625-B	Existing Basement Floor Plan, Southeast Sta.
625-C	Existing Building Section, Boiler #3
625-D	Existing Building Section, Boiler #4
625-E	Proposed Operating Floor Plan
625-F	Proposed Basement Floor Plan
625-G	Proposed Site Plan
625-H	Proposed Plot Plan - Sheet I
625-I	Proposed Plot Plan - Sheet II
625-J	Proposed Plot Plan - Sheet III
625-FS1	Flow Sheet - S.E. Plant - Boilers & T.G.
625-FS2	Flow Sheet - S.E. Plant - Pyrolysis
625-FS3	Flow Sheet - S.E. Plant - Feedwater
625-FS4	Flow Sheet - University Plant
625-FS5	Steam Distribution Diagram - Sheet I
625-FS6	Steam Distribution Diagram - Sheet II
625-FS7	Steam Distribution Diagram - Sheet III
625-FS8	Steam Distribution Diagram - Sheet IV
625-FS8A	Metering - Add On Customers
625-E1	13.8 KV Distribution Line Diagram

BARBARA SECTION LEARNING WEST TANK POWER #3 LIST COLLECTOR EQUIPMENT

BUILDING SECTION LOOKING WEST TOW. POWER #3

Owner	Date	Rev	Remarks	Scale
U.S. G.S.	11-1-75		FOR RECORD	1/4" = 1'-0"
			UNIVERSITY OF MINNESOTA MINNEAPOLIS, MINNESOTA	
			GRID CEE STUDY	
			EXISTING BUILDING SECTION - ECILER #3	625
			Helmick & Lutz Engineers Minneapolis, Minnesota	C

OPERATING FLOOR PLAN - PROPOSED 1/8\"/>

UNIVERSITY OF MINNESOTA MINNEAPOLIS, MINNESOTA				1/8\"/>
PROPOSED OPERATING FLOOR PLAN				625
Melnick & Lutz Engineers Minneapolis, Minnesota				E

Rev.	Date	By	Check	Notes	Scale
1	11-1-74			FOR REVIEW	1"=20'
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UNIVERSITY OF MINNESOTA
MINNEAPOLIS, MINNESOTA
GRID ICS STUDY
PROPOSED SITE PLAN
Helmeck & Lutz, Engineers
Minneapolis, Minnesota

- ===== CONVEYOR RAILS GALLERY ABOVE GRADE
- ===== CONVEYOR RAILS GALLERY BELOW GRADE OR UNDER BRIDGE
- ===== NEW TRACK OR EXIST. TRACK TO BE RECONSTRUCTED
- ===== EXIST. R.R. TRACKS

DATE	BY	CHKD	APPROVED	UNIVERSITY OF MINNESOTA MINNEAPOLIS, MINNESOTA	1:50'
6.1.1.1.1	11-1-77		FOR REPORT	GRID 1000 STUDY	625
				PROPOSED RAIL PLAN - SHEET I	H
				Helmick & Lutz Engineers Minneapolis, Minnesota

CONVEYOR/PIPING GALLERY ABOVE GRADE
 CONVEYOR/PIPING GALLERY BELOW GRADE OR UNDER BRIDGE
 NEW TRACK OR EXIST. TRACK TO BE REBUILT
 EXIST. RR TRACKS

UNIVERSITY OF MINNESOTA MINNEAPOLIS, MINNESOTA				1"=50'
GRADICES STUDY				
PROPOSED PLANT PLAN - SHEET II				625
Helmick & Lutz Engineers Minneapolis, Minnesota				I

Rev.	By	Date	Description	UNIVERSITY OF MINNESOTA MINNEAPOLIS, MINNESOTA	Scale 1"=20'
1	J.H.L.	7-1-77	FOR REPEAT		
GRADICES STUDY				PROPOSED PLOT PLAN - SHEET III	625
Holmick & Lutz				Engineers	Minneapolis, Minnesota

Rev.	Date	By	Revised	UNIVERSITY OF MINNESOTA MINNEAPOLIS, MINNESOTA	Rev.
1	11-1-77		FOR REPORT	GRID 1253 STUDY	NONE
				FLOW SHEET- SE. PLANT- BOILERS & T.G.	625
				Helmick & Lutz Engineers Minneapolis, Minnesota	FS-1

Rev	By	Rev	Notes	UNIVERSITY OF MINNESOTA	Rev
1	11-1-77		FOR REPORT	MINNEAPOLIS, MINNESOTA	NONE
				GRID 1 C & S STUDY	
				FLOW SHEET-SE PLANT-PYROLYSIS SYS	625
				Helmick & Lutz Engineers Minneapolis, Minnesota	FS-2

CONDENSATE TREATMENT SYSTEM (FILTEREX)

HOT ZEOLITE SOFTENERS

UNIVERSITY OF MINNESOTA MINNEAPOLIS, MINNESOTA	NONE
GRID 1 C 3, STUDY	
FLOW SHEET - SE. PLANT - FEEDWATER	625 FS-3
Helnick & Lutz Engineers Minneapolis, Minnesota

KEYS:
 RISER DESIGNATION - AUDITORIUM
 PEAK STEAM LOAD - 4000#/hr. (BASED ON 40#/hr/1000 sq. ft. OF BUILDING AREA)
 RISER NUMBER - # 3
 X (DISTANCE BETWEEN CROSSES IN FT.) X

Drawn	Rev.	Rev.	Rev.	Rev.	UNIVERSITY OF MINNESOTA MINNEAPOLIS, MINNESOTA	NONE
Proj. H-1-1					Grav. & Steam	
					STEAM DISTRIBUTION DIAGRAM-SHT. I	525
					Helmick & Lutz Engineers	FS-5
					Minneapolis, Minnesota	

5. GENERATING STATION

KEY:
NSEA DESIGNATION - AUDITORIUM
PEAR STEAM LOAD - 4000%hr. (BASED ON 40%hr/1000 sq. ft. of BUILDING AREA)
RISER NUMBER - 3
X (DISTANCE BETWEEN CROSSES IN FEET) X

DATE	REV.	REMARKS	UNIVERSITY OF MINNESOTA MINNEAPOLIS, MINNESOTA	SCALE
11-11-51	1	FOR RECORD	CIVIL ENGINEERING	NONE
			STEAM DISTRIBUTION DIAGRAM - SHEET II	625
			Heating & Air Conditioning Engineering	FS-6

FOR REPORT 11-177		DRAWN 11-177	
REVISIONS		APPROVED 11-177	
DATE	DATE	DATE	DATE
11-177	11-177	11-177	11-177
MINNEAPOLIS		MINNESOTA	
ST. MARY'S CONDENSATE PIPING & METERING		SCALE NONE	
ADD-ON CUSTOMERS 73		NO. 625-FS-84	
		REV.

INSTRUMENT KEY:

①, ②, & ③ ORIFICE PLATE WITH 120" H₂O DIFFERENTIAL, ELECTRONIC TRANSMITTERS—BAILEY TYPE CC²1253 A, TRANSMITTING TO A STRIP CHART RECORDER—BAILEY TYPE SR1310

④, ⑤, & ⑥ CADILLAC CONDENSATE METERS

The following report prepared by the University's Department of Physical Planning details the conceptual design of the heat tunnel from the University's West Bank Campus Middlebrook Hall to St. Mary's Hospital.

The steam line concept from St. Mary's to Augsburg College and the steam lines in the concept design of the aforementioned heat tunnel are included in the Helmick and Lutz concept design.

The heat tunnel and lines from St. Mary's to Fairview Hospital is existing and requires reconnection to the new aforementioned steam lines from Middlebrook to St. Mary's.

GRID CONNECTED INTEGRATED
COMMUNITY ENERGY SYSTEM

PHASE II

STAGE 1 FINAL REPORT
March 8, 1978

CONCEPTUAL DESIGN AND STUDY FOR
CONSTRUCTION OF A STEAM TUNNEL

Prepared by -
O. J. Nelson
Physical Planning Office
Engineering and Construction Division
Civil Engineering Section
University of Minnesota

Prepared for -
University of Minnesota
Physical Plant
319 15th Avenue Southeast
Minneapolis, Minnesota 55455

PREPARED FOR
U.S. DEPARTMENT OF ENERGY
UNDER CONTRACT NO. EC-77-C-02-4210

I INTRODUCTION

The purpose of this report is to present a preliminary design of the tunnel including the alignment and typical sections. Also included is an updated cost estimate, easements required, regulations we must adhere to and a specification outline.

II SCOPE OF WORK

The work to be performed would consist of a concrete lined tunnel 1300 ft. long, 7 ft. wide and 7-1/2 ft. high; three expansion chambers; 5 ft. diameter concrete lined shaft approximately 90 ft. deep that will connect the tunnel to St. Mary's Hospital Heating Plant; and a steam meter chamber near the top of the shaft.

III DESIGN

The tunnel will be constructed in St. Peter sandstone that underlies the Platville limestone. The limestone provides an overhead support for the tunnel, therefore the concrete liner need not be reinforced. The liner will be 5 inches thick and will also serve as a means of imbedment for unistruts that support the pipe racks and also the pipe anchors.

The shaft will be excavated through the Glacial drift to the limestone and supported by corrugated metal liner plates. It will then be mined through the limestone, the glenwood shale beds and into the sandstone without side support. A nonreinforced concrete liner base will be poured in the sandstone up to the glenwood shale. From there to the surface it will be lined with 60 inch reinforced concrete pipe to the surface. The void behind the pipe liner will be filled with gravel. Ground water entering the gravel void will be piped into the shaft and drained along the tunnel floor and into a storm sewer.

Pipe expansion chambers will be constructed at approximately 400 ft. spacing along the tunnel. They will be concrete lined. The dimensions of the chambers will be determined by the size of the heat pipes.

The tunnels will have permanent type lighting. Explosion proof power outlets will be provided at intervals for maintenance purposes.

A steam metering chamber will be constructed at the top of the shaft at St. Mary's Hospital. The chamber will be sized to house a steam orifice and a condensate meter for each user, Fairview Hospital, St. Mary's Hospital and Augsburg College. A University of Minnesota master steam and condensate meter will also be located in the chamber.

IV EASEMENTS AND ENCROACHMENTS

The tunnel alignment as shown on the attached plan is located under property owned by the University of Minnesota, the City of Minneapolis, Fairview Hospital and St. Mary's Hospital.

Easements will be obtained from Fairview and St. Mary's Hospitals. Permission from the City of Minneapolis to encroach on street right-of-way will be requested. The right of encroachment is granted thru a City Council resolution.

V REGULATIONS

The specifications for this project will include the following regulations:

Minnesota Uniform Building Code

The Regents of the University of Minnesota have formally adopted the Minnesota Uniform Building Code and have established a building department within the Office of Physical Planning. The University has been declared a municipality and has taken responsibility for enforcing and interpreting the Code.

Equal Opportunity and Affirmative Action Program

The University requires that all contractors, sub-contractors and suppliers of goods and services take affirmative action to comply with the University program.

Minimum Wage Rates

The University requires that the contractors and his sub-contractors shall pay to their respective laborers and mechanics employed directly on the work site at least the wage rate then prevailing in the area of the project.

Other

A provision will be included in the specifications that all laws, ordinances, rules and regulations bearing on the conduct of the work must be complied with.

VI. COST ESTIMATES

A. Contract Costs

1. Concrete lined tunnel in sandstone 7'W X 7.5'H,
1300 LF @ \$480/LF =	624,000
2. Expansion Chambers 3 @ \$16,000 =	48,000
3. Shaft at S.Marys Hospital Steam Plant 60" I.D.,
90 LF at \$950/LF =	85,500
4. Tunnel lighting and power 1300 LF at \$25/LF =	32,500
5. Meter chamber at St. Marys Hospital Steam Plant	35,000

6. Work access shaft	12,000
7. Contingencies 5%	41,850
Total Contract Cost	878,850
B. Non Contract Cost	
1. Design	12,450
2. Construction Management	16,700
3. Site Restoration	10,000
Total Non Contract Cost	39,150
Total Cost	918,000

These costs reflect an escalation factor for time of construction into 1980.

VII. SPECIFICATION OUTLINE

General Conditions

The General Conditions will be the University Standard long form.

General Requirements

- A. Work by Others: Site restoration will be done by other University Contractors
- B. Date of Commencing Work: Work shall begin within ten calendar days after issuance of written notice to proceed.
- C. Completion Date: All work shall be completed within 10 months.
- D. Existing Structures: All structures, utilities and surface features, except those noted on the plans to be removed, shall be protected from damage. Any damage incurred shall be repaired by the contractor.
- E. Testing Laboratory Services: All materials shall be subject to inspection. The University will pay for testing. If re-testing is necessary the contractor will pay for these tests.
- F. Temporary Fences: The contractor shall construct a chainlink fence around the construction site at the Middlebrook Hall shaft and at the access shaft site.

Sitework

- A. Excavation and Backfilling
Material excavated for the meter chamber shall not be stored at the site. The contractor shall make his own arrangements to store the material needed for backfill elsewhere.

B. Trenching, Backfill and Compacting

Compaction immediately around manholes, foundation walls and other structures shall be done in such a manner that the structures are not damaged.

Backfill under paved areas shall be compacted to 98% relative density as tested by the methods of ASTM D 698.

C. Tunnel Excavation

The contractor may use either mechanical or hydraulic methods to remove the materials from the tunnel. The method used shall be approved by the owner.

The tunnel lining shall be 5" thick with no rock points extending into the lining area.

D. Tunnel Materials

1. Reinforcing Steel:

All reinforcing steel shall be new billet stock intermediate grade deformed bars conforming to ASTM A-15-5 and ASTM A 3-5-53T.

2. Lumber:

Lumber used for lagging shall be full size hardwood, with minimum extreme bending stress of 1500 PSI.

3. Concrete Inserts:

Concrete inserts shall be galvanized "unistrut" P-3000 series or equal.

4. Structural - Steel:

Structural steel angles, beams, etc., shall conform to ASTM A36 specifications. All fabrication shall be done in accordance with the "Code of Standard Practice" of the A.I.S.C.

5. Misc. Metals:

Grating shall be welded steel bar grate, type GW of the Gary Grating Co. or approved equal, and shall be primed and painted.

6. Trench plates, ladders, pipe supports, and anchor plates shall be fabricated of ASTM A36 steel or equivalent as shown on the drawings. All steel shall be primed and painted except the front face of anchor plates, which shall be bare metal.

7. Welding:

All welding shall be done by certified welders in accordance with the "Code for welding in Buildings" of the A.W.S.

8. Electrical - Tunnel Lighting:

All wiring shall be installed in rigid steel conduit with water tight connections. All conduit and fittings shall be galvanized or sherardized.

Outlet boxes shall be heavy malleable steel or cast aluminum boxes not less than 4" size, and shall be waterproof.

All switches and receptacles shall be specification grade U.L. approved devices, and shall be rated 20 amperes at 120/277 volts.

All wire used for tunnel lighting shall be NEC standard U.L. labeled, 500 volt insulated, type THWN-THHN with stranded copper conductor.

Lighting fixtures shall be incandescent with screw shell sockets, vaportight and gasketed, equal to appleton #GSK-LR20.

E. Tunnel Supports

Tunnel supports will be required if unstable rock is encountered during mining. The contractor shall not install supports without the permission of the engineer. The contractor shall submit a support design for the Engineer's approval. Supports will be paid for under the unit price bid.

F. Access Shaft

Steel pipe used for the drill holes shall be yolo steel pipe with a minimum wall thickness of .344 inches.

The annular space between the steel pipe and the rock stratas shall be pressure grouted to prevent ground water from entering the sandstone.

The access shaft shall be abandoned and sealed with concrete upon completion of the tunnel.

G. Shaft Excavation

The shaft excavation through the approximate 50Ft. of glacial till shall be contained with steel liner plate.

The excavation of the 30Ft. of limestone shall be accomplished by coring or explosives. Explosives may be used only with the approval of the Engineer. The contractor will be responsible for any damage to existing facilities and shall follow all laws which pertain to use, transfer and storage of explosives.

H. Shaft Construction

The shaft will be lined with reinforced concrete pipe. The annular space between the limestone and the concrete pipe liner will be filled with concrete. The annular space between the liner plate and the concrete pipe liner will be filled with gravel.

The Joints in the liner shall be made water tight so that the shaft is completely dry.

I. Shaft Materials

1. Liner Plate:

Liner plates shall be 12 gauge corrugated steel

2. Reinforced Concrete Pipe:

Precast concrete pipe for shaft construction shall conform to A.S.T.M. C76-59T, Class II, with rubber gasket joints.

3. Cast Iron Soil Pipe:

Cast iron soil pipe used for shaft drains shall conform to ASA A212 latest edition. Joints shall be caulked with pitched oakum and filled with molten lead solidly caulked.

CONCRETE

Formwork:

Forms for the tunnel liner shall be steel and of sufficient strength to insure proper alignment and form.

Materials:

For reinforced concrete structures, concrete shall have a minimum 28 day compressive strength of 4000 PSI, the max size aggregate shall be 1½", maximum slump 4"

Concrete for pumping shall have a minimum 28 day compressive strength of 4000 PSI, and shall have a consistency suitable for pumping

UNIVERSITY
OF
MINNESOTA

HEAT TUNNEL TO ST. MARY'S HOSPITAL

BY	BUILDING	SCALE	SHEET
AUG		1"=20'	ONE
CHECKED	DATE	REVISED	DRAWING
	10/28/77		10/28/77

EXPANSION CHAMBER SECTION

EXPANSION CHAMBER PLAN

HEAT TUNNEL SECTION
(EXPANSION CHAMBER SIMILAR)

TYPICAL TUNNEL AND CHAMBER DETAILS

by	building	scale	sheet
ADG	026	NONE	TWO
checked	date	revised	drawing
	10-28-77		17281

STEAM & CONDENSATE METER CHAMBER AT ST. MARYS HOSPITAL

by	building	scale	sheet
ADG		$\frac{1}{4}" = 1'-0"$	THREE
checked	date	revised	drawing
			17281

UNIVERSITY'S CONCEPT DESIGN

2.2

BUILDING HOT WATER REVISIONS

For this portion of the Phase II project we have costed out the modifications required at each building using heat exchangers. In the second stage of Phase II we will cost project each building using primary hot water with pumps and by-pass controls as an alternate for heat exchangers for the direct radiation and the reheat systems.

In practically every case, it was discovered the present heat exchangers (steam to hot water) will have to be replaced with units designed for lower temperature differentials.

The end design could result in using heat exchangers in some buildings and pump and by-pass systems in others.

**university of minnesota
minneapolis**

**BUILDINGS TO BE CONVERTED
TO HOT WATER**

FOR DISTRIBUTION DESIGN SEE CONSULTANT'S CONCEPT SELECTION DESIGN, SECTION 2.0

HEAT EXCHANGER SYSTEM

PUMP AND BY-PASS SYSTEM

sheet	drawing
scale	revised
building	date
by R.D.S.	checked J.O.
	11-4-77

GRID ICES
HOT WATER BUILDING CONVERSIONS
FLOW AND CONTROL SCHEMATIC

HOT WATER DISTRIBUTION - BUILDING CONVERSION

<u>Equipment</u>	<u>Interior</u>		<u>Exterior</u>		<u>Grand Total</u>
	<u>Material</u>	<u>Labor</u>	<u>Material</u>	<u>Labor</u>	
<u>Building #028 Sanford Hall</u>					
4 - New Converters	\$ 7,000.00	\$ 8,000.00			
3 - New H.W. Heaters	14,000.00				
7 - New Pumps	4,500.00				
Absorber Alterations	-				
Misc. Controls	600.00				
Pipe, Bkts. Ftgs.	250.00		\$ 400.00	\$ 1,800.00	
Insul'n., Exp. Joint	350.00		600.00		
Total	<u>\$26,700.00</u>	<u>\$ 8,000.00</u>	<u>\$ 1,000.00</u>	<u>\$ 1,800.00</u>	\$37,500.00
<u>Building #201 Business Administration Building</u>					
2 - New Converters	\$ 3,600.00	\$ 3,000.00			
0 - New H.W. Heaters	-				
2 - New Pumps	800.00				
Absorber Alterations	-				
Misc. Controls	300.00				
Pipe, Bkts. Ftgs.	200.00		\$ 2,700.00	\$11,400.00	
Insul'n, Exp. Joint	200.00		1,800.00		
Total	<u>\$ 5,100.00</u>	<u>\$ 3,000.00</u>	<u>\$ 4,500.00</u>	<u>\$11,400.00</u>	\$24,000.00
<u>Building #202 Social Science</u>					
4 - New Converters	\$ 7,200.00	\$ 4,000.00			
0 - New N.W. Heaters	-				
4 - New Pumps	1,600.00				
Absorber Alterations	-				
Misc. Controls	350.00				
Pipe, Bkts. Ftgs.	600.00		-	-	
Insul'n., Exp. Joint	500.00		-	-	
Totals	<u>\$10,250.00</u>	<u>\$ 4,000.00</u>	<u>-</u>	<u>-</u>	\$14,250.00
<u>Building #203 Blegen Hall</u>					
2 - New Converters	\$ 1,800.00	\$ 4,000.00			
1 - New H.W. Heaters	5,500.00				
3 - New Pumps	1,200.00				
Absorber Alterations	-				
Misc. Controls	350.00				
Pipe, Bkts. Ftgs.	400.00		-	-	
Insul'n, Exp. Joint	500.00		-	-	
Total	<u>\$ 9,750.00</u>	<u>\$ 4,000.00</u>	<u>-</u>	<u>-</u>	\$13,750.00

<u>Equipment</u>	<u>Internal</u>		<u>External</u>		<u>Grand Total</u>
	<u>Material</u>	<u>Labor</u>	<u>Material</u>	<u>Labor</u>	
<u>Building #204 Wilson Library</u>					
1 - New Converter	\$ 1,800.00	\$ 3,500.00			
1 - New H.W. Heaters	5,500.00				
2 - New Pumps	800.00				
Absorber Alterations	30,000.00	14,000.00			
Misc. Controls	300.00				
Pipe, Bkts. Ftgs	350.00		\$ 1,200.00	\$ 6,600.00	
Insul'n., Exp. Joint	300.00		3,000.00		
Total	<u>\$39,050.00</u>	<u>\$17,500.00</u>	<u>\$ 4,200.00</u>	<u>\$ 6,600.00</u>	\$67,350.00

Building #205 Anderson Hall

4 - New Converters	\$ 7,200.00	\$ 4,500.00			
1 - New H.W. Heater	5,500.00				
5 - New Pumps	2,000.00				
Absorber Alterations	-				
Misc. Controls	400.00				
Pipe, Bkts. Ftgs.	250.00		\$ 200.00	\$ 1,600.00	
Insul'n, Exp. Joint	350.00		700.00		
Total	\$15,700.00	\$ 4,500.00	\$ 900.00	\$ 1,600.00	\$22,700.00

Building #207 Classroom Office Building

0 - New Converters	-	\$ 2,500.00			
1 - New H.W. Heater	\$ 5,500.00				
1 - New Pump	400.00				
Absorber Alterations	10,000.00	3,500.00			
Misc. Controls	550.00				
Pipe, Bkts. Ftgs.	500.00		\$ 2,700.00	\$11,400.00	
Insul'n., Exp. Joint	600.00		1,800.00		
Total	\$17,550.00	\$ 6,000.00	\$ 4,500.00	\$11,400.00	\$39,450.00

Building #208 Middlebrook Hall

1 - New Converter	\$ 1,800.00				
1 - New H.W. Heater	5,500.00	\$ 2,000.00			
2 - New Pumps	800.00				
Absorber Alterations	10,000.00	3,500.00			
Misc. Controls	300.00				
Pipe, Bkts. Ftgs.	350.00		\$ 150.00	\$ 1,500.00	
Insul'n, Exp. Joint	300.00		700.00		
Total	\$19,050.00	\$ 5,500.00	\$ 850.00	\$ 1,500.00	\$26,900.00

Building #209 Rarig Center

2 - New Converters	\$ 3,600.00	\$ 4,000.00			
1 - New H.W. Heater	5,500.00				
3 - Pumps	1,200.00				
Absorber Alterations	10,000.00	3,500.00			
Misc. Controls	500.00				
Pipe, Bkts. Ftgs.	450.00		\$ 200.00	\$ 1,600.00	
Insul'n, Exp. Joint	500.00		700.00		
Total	\$21,750.00	\$ 7,500.00	\$ 900.00	\$ 1,600.00	\$31,750.00

<u>Equipment</u>	<u>Internal</u>		<u>External</u>		<u>Grand Total</u>
	<u>Material</u>	<u>Labor</u>	<u>Material</u>	<u>Labor</u>	
<u>Building #211 Law Building</u>					
1 - New Converter	\$ 1,800.00	\$ 4,500.00			
1 - New H.W. Heater	5,500.00				
2 - New Pumps	800.00				
Absorber Alterations	20,000.00	7,000.00			
Misc. Controls	850.00				
Pipe, Bkts. Ftgs.	950.00		-	-	
Insul'n, Exp. Joint	900.00		-		
Total	<u>\$30,800.00</u>	<u>\$11,500.00</u>	<u>-</u>	<u>-</u>	\$42,300.00

The following letters indicate the intent of St. Mary's and Fairview to enter into agreements for steam tunnels to St. Mary's, Fairview and Augsburg.

Fairview Hospital

2312 South Sixth Street, Minneapolis, Minnesota 55454
Telephone (612) 332-0282

Stephen A. Gregg ■ Administrator

November 7, 1977

Mr. James O'Gara, Principal Plant Engineer
Department of Physical Plant
University of Minnesota
200 Shops Building
319-15 Avenue S.E.
Minneapolis, Minnesota 55455

Re: Temporary Construction Easement Grid-Connected ICES Project

Dear Mr. O'Gara:

This letter is to confirm the willingness of Fairview Hospital to enter into a temporary construction easement for an access shaft site as part of the proposed heat tunnel to the Fairview/St. Mary's complex.

It is our understanding that the temporary easement will involve an area, approximately 10,000 sq. ft., or less, at the southeast corner of 22nd Street and Locust in our employee parking lot for a period of about three months.

In addition to covering such standard items as insurance, site protection, nuisance factors, damages, restoration, etc., the easement will need to make provision for reasonably convenient replacement parking for the parking spaces "lost" during the construction easement.

Please keep us fully advised of the time requirements for this temporary easement.

Sincerely,

Stephen A. Gregg, Administrator

SAG/gs

cc: Marlyn Ervasti
cc: Vern Knutson
cc: Bernt Westernen

Fairview Hospital

2312 South Sixth Street, Minneapolis, Minnesota 55454
Telephone (612) 332-0282

Stephen A. Gregg ■ Administrator

November 14, 1977

Mr. James O'Gara, Principal Plant Engineer
Department of Physical Plant
University of Minnesota
200 Shops Building
319 - 15 Avenue Southeast
Minneapolis, Minnesota 55455

Re: Permanent Easement for Heat Tunnel
Grid-Connected ICES Project

Dear Mr. O'Gara:

This letter is to confirm our intent to enter into a permanent easement, approximately 20 ft. wide, for the Proposed Heat Tunnel to Fairview/St. Mary's Hospitals, as shown in your preliminary Dwg. No. 15451, Sheet 2.

We will require, as part of subject easement, that certain future building capabilities be retained within the easement limits.

Sincerely yours,

Stephen A. Gregg, Administrator

SAG/gs

cc: Marlyn Ervasti
cc: Vern Knutson
cc: Bernt Westernen

A Fairview Community Hospital
Achievement through excellence

ST. MARY'S
HOSPITAL

2414 SOUTH SEVENTH STREET, MINNEAPOLIS, MINNESOTA 55454

EXECUTIVE OFFICES

November 15, 1977

Mr. James O'Gara
Principal Plant Engineer
Department of Physical Plant
University of Minnesota
200 Shops Building
319-15th Avenue S.E.
Minneapolis, Minnesota 55455

Dear Mr. O'Gara:

This letter of intent is to confirm the willingness of St. Mary's Hospital to grant an easement to Augsburg College for construction of an underground steam line to their Campus.

It is our understanding that all costs associated with construction of the steam line to Augsburg will be borne by Augsburg College or the University of Minnesota.

The easement must provide for items such as insurance, permits, site protection and restoration, etc.

Sincerely,

Marlyn K. Ervasti

Marlyn K. Ervasti
Vice President

MKE:se

cc: Sister Mary Madonna
Mr. John Kenefick

The following draft assessment was prepared by the consultant, National Biocentrics, Inc.

Three transmittals of the Phase I Executive Summary were made by the University to various agencies that will impact upon the University's program. Letters attesting to this are included.

GRID CONNECTED INTEGRATED
COMMUNITY ENERGY SYSTEM

PHASE II

STAGE 1 FINAL REPORT
March 8, 1978

CONCEPTUAL DESIGN, DEMAND AND
FUEL PROJECTIONS AND COST ANALYSIS

Prepared By -
National Biocentric, Inc.
2233 Hamline Avenue North
Saint Paul, Minnesota 55113

Prepared For -
Helmick and Lutz Company
Engineers
1315 Glenwood Avenue
Minneapolis, Minnesota 55405

PREPARED FOR
U. S. DEPARTMENT OF ENERGY
UNDER CONTRACT NO. EC-77-C-02-4210.A004

DRAFT

ENVIRONMENTAL ASSESSMENT OUTLINE AND SCOPE

PROJECT SUMMARY

This section will summarize the project and act as an introduction to the volume.

2.4.1 DESCRIPTION OF THE PROPOSED PROJECT

The primary data sources for this section of the Environmental Assessment will be the Final Report for Phase I of the proposed project, and subsequently developed engineering design data.

The purpose of this section will be to describe the location, purpose, construction, and operation characteristics of the proposed GRID ICES project in sufficient detail to permit evaluation of probable environmental impacts.

A. Project Location

1. Within the Twin City Metropolitan Area

The proposed project is located on and adjacent to the Main Campus of the University of Minnesota near the geographic center of the seven-county Twin City Metropolitan Area. The Main Campus of the University and adjacent areas included within the project are situated on both the East and West banks of the

Mississippi River about a mile southeast of the Minneapolis central business district.

2. Within the University of Minnesota Campus Area

The Southeast Generating Station; the focal point of the primary proposed project, is located on the East bank of the Mississippi River about a mile upstream (northwest) of the main (Washington Avenue) bridge between the East and West Bank Campuses of the University.

Option I of the proposed project will be located on the West bank of the Mississippi adjacent to the West Bank Campus of the University.

Option II will be located within the Southeast Generating Station, but will relate to solid waste collection within the Twin City Metropolitan Area.

Option III will occur on both the East and West Campus of the University.

B. Project Description

1. Existing Project

- a. University Main Campus Heating Plant
- b. University Thermal Distribution System
- c. St. Mary's Hospital Heating Plant

- 1) St. Mary's-Fairview Heating System
- d. Augsburg College Heating Plant
 - 1) Augsburg Heating System
- e. Management of Health Care Waste
 - 1) Incineration
 - 2) Landfill

2. Proposed Project

- a. Primary Proposed Project
 - 1) Rehabilitate and reactivate southeast generating station as base load main campus heating plant
 - 2) Convert all boilers at southeast generating station and main campus heating plant to burn western coal
 - 3) Install rail siding and coal unloading and handling systems at southeast generating station and main campus heating plant
 - 4) Install new non-condensing turbine-generator at southeast generating station to generate electrical power from waste heat for use

within the plants and for sale to Northern States Power

- 5) Installation of environmental protection equipment on all fuel handling and air emission equipment at southeast generating station and main campus heating plant
- 6) Estimated primary project costs and construction time schedule

b. Proposed Additional Option I

- 1) Addition of St. Mary's Hospital, Fairview Hospital, and Augsburg College to University of Minnesota thermal distribution system
- 2) Excavate 1,600-foot tunnel between West Bank Campus and St. Mary's Hospital for thermal distribution
- 3) Estimated Option I costs and construction time frame

c. Proposed Additional Option II

- 1) Install and operate a pyrolysis unit at the Southeast Generating Station for the disposal of hospital solid waste from portions of the Twin City Metropolitan Area

- 2) Install and operate a waste heat recovery system and waste heat boiler to utilize pyrolysis exhaust gases
- 3) Install and operate solid waste storage and handling equipment
- 4) Utilize current solid waste incinerators at main heating plant as back-up system
- 5) Install and operate environmental protection equipment on pyrolysis unit
- 6) Estimated Option II costs and construction time frame

d. Proposed Additional Option III

- 1) Phase out main campus steam thermal distribution and replace with hot water thermal distribution
- 2) Install new hot water mains in existing steam main tunnel system
- 3) Immediate hook-up of campus hot water systems near heating plant
- 4) Phased hook-up of remainder of campus heating systems to hot water system
- 5) Installation of thermal (hot water) storage and retrieval capability

- 6) Estimated Option III costs and construction time frame
- e. Additional Specific Factors to be Considered Under a., b., c., and d. Above
 - 1) Fuel handling (coal, oil, waste)
 - a) type and composition
 - b) daily and seasonal requirements
 - c) frequency and volume per delivery
 - d) storage locations and capacities
 - e) method of delivery and on-site handling
 - f) expected coal transport route
 - g) expected coal train handling procedure
 - 2) Ash handling
 - a) type, volume, composition
 - b) method, place, frequency of disposal
 - 3) Air emissions
 - a) SO_2 , NO_x , CO_2 , solids
 - b) bag house characteristics

- c) dust control during coal transport
 - d) dust control during coal handling
- 4) Noise control
 - a) during construction
 - b) during operation
- 5) Traffic control
 - a) during construction
 - b) during operation
- 6) Employment
 - a) during construction by phase
 - b) during operation
 - c) wages as a percentage of costs

2.4.2 ENVIRONMENTAL SETTING

The primary data sources for this section of the Environmental Assessment will be the Final Report for Phase I of the proposed project, and various data assembled at area libraries, agencies, and National Biocentric, Inc.

The purpose of this section will be to describe the characteristics of the environment without the project in

sufficient detail to permit an evaluation of the effects of construction and operation of the proposed project upon those resources.

A. Natural Environment

1. Earth Resources

a. Landscape and Topography

b. Geologic Characteristics

2. Air Resources

a. Weather and Climate

b. Air Quality

3. Water Resources

a. Mississippi River

b. City Water Supply

4. Biological Resources

a. Vegetation

b. Wildlife

B. Cultural Environment

1. Land Use

2. Transportation
3. Community Characteristics
4. Educational Services
5. Health Services
6. Employment
7. Historical Characteristics

2.4.3 RELATIONSHIP OF PROPOSED PROJECT TO FEDERAL, STATE, AND LOCAL PLANS, POLICIES AND CONTROLS

The primary data source for this section of the Environmental Assessment will be the plans, policies, and controls published by the various federal, state, and local agencies having jurisdiction over various aspects of the proposed project.

The purpose of this section will be to document the nature of the various plans, policies, and controls, the nature of their relationship to and with the goals and objectives of the project, and the nature of the various permits required to construct and operate the proposed project.

A. Federal Controls

1. Energy Research and Development Administration (in accordance with the National Environmental Policy Act)

The Environmental Assessment of the Grid ICES will be prepared in accordance with ERDA's guidelines for environmental review

2. Environmental Protection Agency (EPA)

The Grid ICES project does not come under EPA jurisdiction in that the boilers are proposed to function on less than 250 million BTU per hour.

3. Department of the Army, Corps of Engineers

Since barging of coal along the Mississippi River is no longer part of the Grid ICES proposal, no portion of ICES comes under Corps of Engineers jurisdiction.

4. Department of Housing and Urban Development

HUD Circular 1390.2 Exterior and Interior noise levels.

5. Department of Transportation

Title 49, Code of Federal Regulations.

B. State of Minnesota Controls

1. Pollution Control Agency

a. Air Pollution

- 1) APC 1 Ambient Air Quality Standards
 - 2) APC 3 Permits, Emission Source Monitoring,
Measurement of Air Contaminants, Anti-
Degradation
 - a) Installation permit
 - b) Operating permit
 - 3) APC 6 Preventing Particulate Matter from
Becoming Air-Borne - Regulations
 - 4) APC 7 Incinerators - Regulations
 - 5) APC 9 Control of Odors in Ambient Air -
Regulations
 - 6) APC 11 Restriction of Emission of Visible Air
Contaminants
- b. Noise Pollution
- 1) NPC 1 Definitions and Variances - Noise
Standards
 - 2) NPC 2 Noise Standards
- c. Solid Waste
- 1) SW 2 Solid Waste Storage - Regulations

2) SW 3 Collection and Transportation of Solid
Waste - Regulations

3) SW 5 Plan Approval and Permit Issuance,
Denial and Revocation

a) Operating permit

4) SW 7 Incineration - Regulations

2. Environmental Quality Board

The Environmental Assessment will be used to
prepare a voluntary Environmental Assessment Work-
Sheet.

3. Minnesota Department of Health

Guidelines for handling and disposal of infec-
tious waste.

4. Minnesota Department of Occupational Safety and
Health Act (MOSHA)

Regulations and standards protecting the health
and safety of employees.

5. Department of Natural Resources

Since barging of coal along the Mississippi River
is no longer a part of the Grid ICES proposal, no

portion of ICES comes under the jurisdiction of the Department of Natural Resources.

6. Minnesota Energy Agency

The Grid ICES does not come under the preview of the Energy Agency in that 1) the project is a reactivation of an existing facility, 2) the steam plant is under 50 mw in size, 3) the purpose of the project will not include the transshipment of coal, and 4) fuel oil storage will not exceed statutory limits.

C. Local Government and Agency Policies

1. Metropolitan Council

- a. Policies for Resource Recovery Facilities
(Development Guide Chapter - Solid Waste Management)
- b. Permit Applications Submitted to the MPCA
(under SW 5) Must be Approved by the Metropolitan Council (Metropolitan Solid Waste Act)

2. Hennepin County

- a. Solid Waste Management Plan for Hennepin County
- b. Ordinance Number Two: Solid and Hazardous Waste Disposal Ordinance for Hennepin County

- 1) Section IV Incineration - License (\$200 application fee plus yearly fee set by County Board)
 - 2) Section VIII Resource Recovery Facilities - License (\$150 application fee plus yearly fee set by County Board)
3. Riverfront Development Coordination Board
- a. Principal Goals and Objectives for the Development of the Central Riverfront Area
 - b. Development Guide Policies for the Development of the Central Riverfront Area
 - 1) 0.0 Entire Central Riverfront Area
 - 2) 6.0 Dam Flats

4. Minneapolis Zoning Code

The University of Minnesota is exempt from current zoning regulations. However, Grid ICES will take adjacent land uses into consideration to reduce conflicts within the community.

2.4.4 POTENTIAL ENVIRONMENTAL IMPACTS

The primary data sources for this section will be those

sources utilized in Chapters I and II of this Environmental Assessment.

The purpose of this section will be to report the assessment of probable and potential environmental impacts resulting from construction and operation of the proposed facility. The assessment will be based upon an analysis of the technical and engineering characteristics of the project in relation to the project setting and the plans, policies, and controls for the area.

PRIMARY PROPOSED PROJECT

A. Construction-Generated Impacts

1. Earth Resources

a. Landscape and Topography

b. Geologic Characteristics

2. Air Resources

a. Weather and Climate

b. Air Quality

3. Water Resources

a. Mississippi River

b. City Water Supply

4. Biological Resources

a. Vegetation

b. Wildlife

5. Cultural Resources

a. Land Use

b. Transportation

c. Community Characteristics

d. Educational Services

e. Health Services

f. Employment

g. Historical Characteristics

B. Operation-Generated Impacts

1. Earth Resources

a. Landscape and Topography

b. Geologic Characteristics

2. Air Resources

a. Weather and Climate

- b. Air Quality
- 3. Water Resources
 - a. Mississippi River
 - b. City Water Supply
- 4. Biological Resources
 - a. Vegetation
 - b. Wildlife
- 5. Cultural Resources
 - a. Land Use
 - b. Transportation
 - c. Community Characteristics
 - d. Educational Services
 - e. Health Services
 - f. Employment
 - g. Historical Characteristics

PROPOSED ADDITIONAL OPTION I

- A. Construction-Generated Impacts
 - 1. Earth Resources

- a. Landscape and Topography
 - b. Geologic Characteristics
- 2. Air Resources
 - a. Weather and Climate
 - b. Air Quality
- 3. Water Resources
 - a. Mississippi River
 - b. City Water Supply
- 4. Biological Resources
 - a. Vegetation
 - b. Wildlife
- 5. Cultural Resources
 - a. Land Use
 - b. Transportation
 - c. Community Characteristics
 - d. Educational Services
 - e. Health Services
 - f. Employment

g. Historical Characteristics

B. Operation-Generated Impacts

1. Earth Resources

a. Landscape and Topography

b. Geologic Characteristics

2. Air Resources

a. Weather and Climate

b. Air Quality

3. Water Resources

a. Mississippi River

b. City Water Supply

4. Biological Resources

a. Vegetation

b. Wildlife

5. Cultural Resources

a. Land Use

b. Transportation

c. Community Characteristics

- d. Educational Services
- e. Health Services
- f. Employment
- g. Historical Characteristics

PROPOSED ADDITIONAL OPTION II

A. Construction-Generated Impacts

- 1. Earth Resources
 - a. Landscape and Topography
 - b. Geologic Characteristics
- 2. Air Resources
 - a. Weather and Climate
 - b. Air Quality
- 3. Water Resources
 - a. Mississippi River
 - b. City Water Supply
- 4. Biological Resources
 - a. Vegetation
 - b. Wildlife

5. Cultural Resources

- a. Land Use
- b. Transportation
- c. Community Characteristics
- d. Educational Services
- e. Health Services
- f. Employment
- g. Historical Characteristics

B. Operation-Generated Impacts

1. Earth Resources

- a. Landscape and Topography
- b. Geologic Characteristics

2. Air Resources

- a. Weather and Climate
- b. Air Quality

3. Water Resources

- a. Mississippi River
- b. City Water Supply

4. Biological Resources

a. Vegetation

b. Wildlife

5. Cultural Resources

a. Land Use

b. Transportation

c. Community Characteristics

d. Educational Services

e. Health Services

f. Employment

g. Historical Characteristics

PROPOSED ADDITIONAL OPTION III

A. Construction-Generated Impacts

1. Earth Resources

a. Landscape and Topography

b. Geologic Characteristics

2. Air Resources

- a. Weather and Climate
 - b. Air Quality
- 3. Water Resources
 - a. Mississippi River
 - b. City Water Supply
- 4. Biological Resources
 - a. Vegetation
 - b. Wildlife
- 5. Cultural Resources
 - a. Land Use
 - b. Transportation
 - c. Community Characteristics
 - d. Educational Services
 - e. Health Services
 - f. Employment
 - g. Historical Characteristics

B. Operation-Generated Impacts

- 1. Earth Resources

- a. Landscape and Topography
 - b. Geologic Characteristics
- 2. Air Resources
 - a. Weather and Climate
 - b. Air Quality
- 3. Water Resources
 - a. Mississippi River
 - b. City Water Supply
- 4. Biological Resources
 - a. Vegetation
 - b. Wildlife
- 5. Cultural Resources
 - a. Land Use
 - b. Transportation
 - c. Community Characteristics
 - d. Educational Services
 - e. Health Services

f. Employment

g. Historical Characteristics

2.4.5 ALTERNATIVES TO THE PROPOSED PROJECT AND THEIR PRIMARY ENVIRONMENTAL EFFECTS

The purpose of this section will be to briefly describe several functional alternatives to the proposed project along with their probable primary effects.

A. Primary Proposed Project

1. Up-grade Existing Main Heating Plant
2. Up-grade Barge Handling of Coal
3. No Project as Planned

B. Proposed Additional Option I

1. Convert St. Mary's Heating Plant to Coal
2. Convert Augsburg College Heating Plant to Coal
3. No Project as Planned

C. Proposed Additional Option II

1. Install Smaller or Larger Pyrolysis Unit
2. Fire Water-Wall Boiler with Solid Waste
3. No Project as Planned

D. Proposed Additional Option III

1. Continue Entire System on Steam
2. Immediate Conversion of Entire System to Hot Water
3. Eliminate Single Source Thermal Distribution and Operate Scattered Package Boilers
4. No project as Planned

2.4.6 PROJECT COORDINATION

The purpose of this section will be to document all of the various project coordination and information gathering situations involved in the preparation of this report.

The following letters are requests for comments on Grid ICES from the three regulatory agencies that will impact upon Grid ICES. The Phase II, Stage 2 report will require a more complete submittal to these and other agencies.

UNIVERSITY OF MINNESOTA
TWIN CITIES

Physical Plant Maintenance and Operations
200 Shops Building
319 15th Avenue S.E.
Minneapolis, Minnesota 55455

August 29, 1977

Mr. Edward M. Wiik, P.E.
Director, Division of Air Quality
Minnesota Pollution Control Agency
1935 West County Road B-2
Roseville, Minnesota 55113

Re: Review of Grid-ICES.

Dear Mr. Wiik:

This is to inform you of a Phase II contract award given to the University of Minnesota by ERDA (Federal Energy Research and Development Administration) for development of a detailed feasibility analysis and preliminary design of a Grid-Connected ICES (Integrated Community Energy System).

The Phase II contract is for a period of approximately 210 days, with start-up of August 9, 1977.

I am forwarding three copies of the ICES Executive Summary for your review. We would appreciate distribution of the other copies to the Water and Solid Waste Divisions of the MPCA.

ERDA's present Phase II Scope of Work for the University included a preliminary environmental assessment and assessment of Plant equipment to meet regulations for a coal and solid waste burning facility. During our negotiations of the work contract with ERDA on September 6, 1977, we will be insisting on a full environmental assessment, regulatory review and final review by the EQC during Phase II. We will keep you up to date on this matter.

The Grid-Connected ICES, as reflected in the Phase I report, will consist of cogeneration of electricity as a byproduct to steam and high temperature hot water production fueled by solid waste and low sulphur coal. We feel that several factors make hot water the distribution medium of the future. First, it can be transported over greater distances than steam systems and also its more degraded temperatures allow for greater electrical output when generated through a back pressure turbine.

The byproduct electricity will be sold to the Northern States Power Company and/or distributed into the University's electrical system. The system will be closed cycle and will not, therefore, thermally pollute the Mississippi River (unlike a conventional electric utility operation).

A portion of the fuel used for the ICES will be generated by secondary burning of off gases of a solid waste pyrolytic disposal process. The unit will safely handle both general municipal type waste and also "infectious" waste from an optimum area of the seven county Metropolitan

August 29, 1977

To: Edward M. Wiik
Re: Review of Grid-ICES.

area health care institutions.

Baghouses will be installed for all coal-fired and waste heat recovery boilers which should create near particulate free stack emissions. Coal handling facilities will be upgraded and automated to improve coal unloading efficiency and improve them environmentally.

The Southeast Steam Plant, which was recently purchased by the University from NSP, will serve as the base load plant, with the present University Heating Plant being used for peaking and standby capacity. The turbine generator and pyrolysis process will be housed in the Southeast Steam Plant. The existing University incinerator, located at the University Heating Plant, will be environmentally upgraded and used as standby basis for pyrolysis.

Initially, the ICES will serve the thermal heating and cooling requirements of the University of Minnesota and its partners, consisting of St. Mary's and Fairview Hospitals, and Augsburg College.

Any comments the Agency has regarding the concept or envisioned problems would be greatly appreciated.

Yours very truly,

W. E. Soderberg
Director, Physical Plant

WES/JCO:VP
Encs.

cc: George Burke
Marlyn Ervasti
John Pearce
P. E. Kopietz
✓ J. C. O'Gara
R. A. Reid
Joseph Roback

UNIVERSITY OF MINNESOTA
TWIN CITIES

Physical Plant Maintenance and Operations
200 Shops Building
319 15th Avenue S.E.
Minneapolis, Minnesota 55455

August 29, 1977

Mr. Charles R. Kenow, Coordinator
Environmental Impact Statement Program
Environmental Quality Council
550 Cedar Street
St. Paul, Minnesota 55101

Re: Review of Grid-ICES.

Dear Mr. Kenow:

This is to inform you of a Phase II contract award given to the University of Minnesota by ERDA (Federal Energy Research and Development Administration) for development of a detailed feasibility analysis and preliminary design of a Grid-Connected ICES (Integrated Community Energy System).

The Phase II contract is for a period of approximately 210 days, with start-up of August 9, 1977.

I am forwarding three copies of the ICES Executive Summary for your review. We would appreciate distribution of the other copies to Nancy Onkka.

ERDA's present Phase II Scope of Work for the University included a preliminary environmental assessment and assessment of Plant equipment to meet regulations for a coal and solid waste burning facility. During our negotiations of the work contract with ERDA on September 6, 1977, we will be insisting on a full environmental assessment, regulatory review, and final review by the EQC during Phase II. We will keep you up to date on this matter.

The Grid-Connected ICES, as reflected in the Phase I report, will consist of cogeneration of electricity as a byproduct to steam and high temperature hot water production fueled by solid waste and low sulphur coal. We feel that several factors make hot water the distribution medium of the future. First, it can be transported over greater distances than steam systems and also its more degraded temperatures allow for greater electrical output when generated through a back pressure turbine.

The byproduct electricity will be sold to the Northern States Power Company and/or distributed into the University's electrical system. The system will be closed cycle and will not, therefore, thermally pollute the Mississippi River (unlike a conventional electric utility operation).

A portion of the fuel used for the ICES will be generated by secondary burning of off gases of a solid waste pyrolytic disposal process. The unit will safely handle both general municipal type waste and also "infectious" waste from an optimum area of the seven county Metropolitan area health care institutions.

August 29, 1977

To: Charles R. Kenow
Re: Review of Grid-ICES.

Baghouses will be installed for all coal fired and waste heat recovery boilers which should create near particulate free stack emissions. Coal handling facilities will be upgraded and automated to improve coal unloading efficiency and improve them environmentally.

The Southeast Steam Plant, which was recently purchased by the University from NSP, will serve as the base load plant, with the present University Heating Plant being used for peaking and standby capacity. The turbine generator and pyrolysis process will be housed in the Southeast Steam Plant. The existing University incinerator, located at the University Heating Plant, will be environmentally upgraded and used as standby basis for pyrolysis.

Initially, the ICES will serve the thermal heating and cooling requirements of the University of Minnesota and its partners, consisting of St. Mary's and Fairview Hospitals, and Augsburg College.

Any comments you may have regarding the concept or envisioned problems would be greatly appreciated.

Yours very truly,

WES/JCO:VP
Enc.

W. E. Soderberg
Director, Physical Plant

cc: George Burke
Marlyn Ervasti
John Pearce
P. E. Kopietz
✓ J. C. O'Gara
R. A. Reid
Joseph Roback

UNIVERSITY OF MINNESOTA
TWIN CITIES

Physical Plant Maintenance and Operations
200 Shops Building
319 15th Avenue S.E.
Minneapolis, Minnesota 55455

August 26, 1977

Mr. John Boland, Chairman
Metropolitan Council
Room 300 Metro Square Building
7th and Robert Streets
St. Paul, MN. 55101

RE: Review of Grid ICES

Dear Mr. Boland:

This is to inform you of a Phase II contract award given to the University of Minnesota by ERDA (Federal Energy Research and Development Administration) for development of a detailed feasibility analysis and preliminary design of a Grid-Connected ICES (Integrated Community Energy System).

The Phase II contract is for a period of approximately 210 days, with start-up of August 9, 1977.

I am forwarding three copies of the ICES Executive Summary for staff review.

ERDA's present Phase II Scope of Work for the University included a preliminary environmental assessment and assessment of plant equipment to meet regulations for a coal and solid waste burning facility. During our negotiations of the work contract with ERDA on September 6, 1977, we will be insisting on a full environmental assessment, regulatory review, and final review by the EQC and the Metropolitan Council during Phase II. We will keep you up to date on this matter.

Of prime interest to the University will be development of a seven county health care waste disposal district which we understand the Council now has authority to implement. We expect start-up of the Pyrolysis Facility, if significant federal funding is forthcoming, sometime in 1980.

The Grid-Connected ICES, as reflected in the Phase I report, will consist of cogeneration of electricity as a byproduct to steam and high temperature hot water production fueled by solid waste and low sulfur coal. We feel that several factors make hot water the distribution medium of the future. First it can be transported over greater distances than steam systems and also its more degraded temperatures allows for greater electrical output when generated through a back pressure turbine.

The byproduct electricity will be sold to Northern States Power Company and/or distributed into the University's electrical system. The system will be closed cycle and will not, therefore, thermally pollute the Mississippi River

August 26, 1977

To: John Boland

Re: Phase II, Grid-Connected ICES.

(unlike a conventional electric utility operation).

A portion of the fuel used for the ICES will be generated by secondary burning of off gases of solid waste pyrolytic disposal process. The unit will safely handle both general municipal type waste and also "infectious" waste from an optimum area of the seven county Metropolitan area health care institutions.

Baghouses will be installed for all coal fired and waste heat recovery boilers which should create near particulate free stack emissions. Coal handling facilities will be upgraded and automated to improve coal unloading efficiency and improve them environmentally.

The Southeast Steam Plant, which was recently purchased by the University from NSP., will serve as the base load plant, with the present University Heating Plant being used for peaking and standby capacity. The turbine generator and pyrolysis process will be housed in the Southeast Steam Plant. The existing University incinerator, located at the University Heating Plant, will be environmentally upgraded and used as standby basis for pyrolysis.

Initially, the ICES will serve the thermal heating and cooling requirements of the University of Minnesota and its partners consisting of St. Mary's and Fairview Hospitals and Augsburg College.

Any comments the Agency has regarding the concept or envisioned problems would be greatly appreciated.

Yours very truly,

W. E. Soderberg
Director, Physical Plant

WES/JCO:ML
Encs.

cc: George Burke
Marlyn Ervasti
John Pearce
P. E. Kopietz
✓ J. C. O'Gara
R. A. Reid
Joseph Roback

STEAM USE PROJECTIONSBASIC PROGRAM

In projecting steam use for the University of Minnesota, Minneapolis Campus, over the next ten years, three important factors must be taken into account:

Climate

Temperature is the prime climatic factor affecting steam consumption. For these projections steam consumption from September, 1976 through August, 1977 will serve as our "climate normal" year. This we feel is a good choice both because it is our most recent and most accurate data and also it was a good approximation to the true "climate normal" year.

Degree Days (Based on 65° F)

	<u>Heating</u>	<u>Cooling</u>	<u>Heating and Cooling</u>
September '76 - August '77	7,983	857	8,840
True Normal	8,159	585	8,744

Policy

Policy decisions, such as the Energy Conservation Program at this University, significantly affect steam demand.

While building space during the first nine months of 1977 increased by almost 1% over the same period in 1976, steam consumption was actually reduced by nearly 8%. Base load levels were also reduced from 120,000 lbs/hr to 90,000 lbs/hr.

For this study we will assume that University policy concerning day and nighttime thermostat settings remain constant, that little or no major program of reinsulating already existing buildings will be done, that all newly constructed building will approximate the steam demand

density of already existing "newer" buildings of the same type and occupancy and that no significant advances in more efficient production of chilled water will be made.

Space

Addition or subtraction of building space will have the most profound effect upon community steam demand. For this study we will assume that over the next 10 years all buildings which are planned will be constructed on schedule. During the "climate normal" year were some 11 million gross square feet of floor space consuming some 1,744 million lbs of steam annually.

Additional Space

Unit A, constructed in 1974, will be used as the standard for steam demand density for future health science related buildings. Elliot Hall, completely remodelled in the early 70's will be used as the standard for steam demand density for future general classroom buildings. Both buildings are cooled in the summer by steam adsorption machines.

	Steam Demand* Sept '76 - Aug '77 <u>Thousand lbs/yr</u>	Building GSF	Steam Demand Density <u>lbs/GSF/Yr</u>
Unit A	146,941	679,904	216
Elliot Hall	136,704	190,209	193

*Actual metered data

Additional Steam Required by New Buildings Through 1990

<u>Building Name</u>	<u>Occupancy**</u>	<u>GSF</u>	<u>Steam Demand Density (lbs/GSF/Yr)</u>	<u>Annual Steam Requirement (Million Pounds)</u>
Law Building	Dec . '77	244,250	193	47
Unit B-C	Early '78	574,000	216	124
Unit F	79/80	156,837	216	34
Music	80/81	272,000	193	53
Architecture	80/81	25,000	193	5
Electrial Eng. Addition	80/81	151,000	193	29
Civil/Mineral Eng. Addition	80/81	150,000	193	29

**The University has no planned construction beyond 1981.

BASIC PROGRAM - PROJECTED ANNUAL STEAM DEMAND

1975 - 1990

<u>Year</u>	<u>Annual Steam Demand (Million lbs)</u>	<u>Average Demand (Thousands lbs/hr)</u>	<u>Peak Demand (Thousands lbs/hr)</u>	<u>Building Space (Thousands GSF)</u>
1975*	1,833	209	400	9,957
1976*	1,834	209	410	10,068
1977*	1,700	194	460**	10,151
1978	1,750	200	400	10,970
1979	1,750	200	400	10,970
1980	1,785	204	408	11,127
1981	1,901	217	434	11,725
1982	1,901	217	434	11,725
1983	1,901	217	434	11,725
1984	1,901	217	434	11,725
1985	1,901	217	434	11,725
1986	1,901	217	434	11,725
1987	1,901	217	434	11,725
1988	1,901	217	434	11,725
1989	1,901	217	434	11,725

*Actual Metered Steam Data

**High peak demand due to second coldest January of this century. This month will serve as an excellent example of a "worst case" for future projections.

Based upon University Steam Demand September 1976 - August 1977 (See Text)

OPTION I

ST. MARY'S - FAIRVIEW - AUGSBURG ADD-ON

Steam demand projections for St. Mary's and Fairview Hospitals used were provided by the hospitals themselves (see attached letter). Augsburg's future steam demand has been based on projected growth in floor space (193 lbs of steam per gross square foot per year for classroom type buildings as described earlier).

During the "climate normal" year of September 1976 - August 1977 the 1,200,000 GSF of St. Mary's - Fairview Hospital complex required 202 million lbs of steam while Augsburg's 500,000 GSF of floor space required 68 million lbs of steam.

<u>ADD-ONS</u>				
<u>Building</u>	<u>Date of Occupancy</u>	<u>Estimated Annual Steam Consumption (Millions lbs)</u>	<u>Average Demand (lbs/hr)</u>	<u>Building Space (GSF)</u>
Augsburg College - Music-Classroom	78	6	661	30,000
St. Mary's Hospital Addition	80/85*	20	2,283	65,000
Fairview Hospital Addition	80/85*	15	1,712	50,000
St. Mary's-Fairview Medical-Office	80/85*	<u>20</u>	<u>2,283</u>	<u>90,000</u>
Total		61	6,939	235,000

*Since construction completion dates are not known, it will be assumed that this additional load will be brought on in equal segments (i.e. 55 million lbs ÷ 5 years = 11 million lbs/yr for five years).

OPTION I - PROJECTED ANNUAL STEAM DEMAND

ST. MARY'S - FAIRVIEW - AUGSBURG ADD-ON

1975 - 1990

<u>Year</u>	<u>Annual Steam Demand (Million lbs)</u>	<u>Average Demand (Thousand lbs/hr)</u>	<u>Peak Demand (Thousand lbs/hr)</u>	<u>Building Space (Thousands GSF)</u>
1975*	1,833	209	400	9,957
1976*	1,834	209	410	10,068
1977*	1,700	194	460**	10,151
1978	1,750	200	400	10,970
1979	1,750	200	400	10,970
1980	1,785	204	408	11,127
1981	2,199	251	502	13,537
1982	2,210	252	504	13,578
1983	2,222	254	508	13,619
1984	2,233	255	510	13,660
1985	2,233	255	510	13,660
1986	2,233	255	510	13,660
1987	2,233	255	510	13,660
1988	2,233	255	510	13,660
1989	2,233	255	510	13,660

*Actual Metered Data

**High peak demand due to second coldest January of this Century.

Based on University, St. Mary's, Fairview and Augsburg Steam Demand for September 1976 - August 1977.

GRID ICES
PROJECTED COMMUNITY MONTHLY STEAM VARIATIONS
1980 THROUGH 1981

by RDS/ DW	building	scale	sheet
checked J.O.	date 11-4-77	revised	drawing

GRID ICES
PROJECTED TOTAL COMMUNITY STEAM REQUIREMENT
1980 THROUGH 1981

by RDS/ DW	building	scale	sheet
checked J.O.	date 11-4-77	revised	drawing

ST. MARY'S Hospital

2414 SOUTH SEVENTH STREET, MINNEAPOLIS, MINNESOTA 55454

EXECUTIVE OFFICES

October 12, 1977

Mr. Jim O'Gara
Principal Plant Engineer
Department of Physical Plant
University of Minnesota
200 Shops Building
319 15th Avenue
Minneapolis, Minnesota 55455

Dear Mr. O'Gara:

Per your request, this letter is to give you an updated forecast of Fairview/St. Mary's additional steam needs in the next five years.

I talked to Mr. Vern Knutson, Director of Facilities and Planning, Fairview Hospital, and Fairview anticipates construction of an additional 50,000 square feet.

The Fairview-St. Mary's Medical Office Building is nearly fully occupied, so we may build a second Medical Office Building with approximately 90,000 gross square feet. The present Medical Office Building uses 18-19,000,000 pounds of steam annually for heating and cooling.

We don't anticipate the annual steam needs of the St. Mary's Hospital Complex to increase more than 20,000,000 pounds over the next five years.

Sincerely yours,

Marlyn K. Ervasti
Vice President

MKE/se

cc: Mr. Vern Knutson
Mr. Bruce Haskin
Mr. Al Rawlings

After calculation of steam use for each plant it became possible to develop fuel use scenarios for the Basic Plan and Options I and II.

Both the University Heating Plant and the Southeast Steam Plant were assumed to burn 100% western coal (8,600 BTU/lb) for the Basic Plan and Option I, with solid waste being added as a secondary fuel for Option II.

The Minneapolis Plant's fuel use projections were then further developed in order to determine train and truck traffic at the Minneapolis Plants.

In Stage II this data will be refined and given to the prime consultants, Helmick and Lutz for use in their Phase II work.

GRID ICES
PROJECTED COAL USAGE
1980 THROUGH 1981

by RDS/ DW	building	scale	sheet
checked J.O.	date 11-4-77	revised	drawing

Steam production at the University Heating Plant is presently measured by two instruments. The first is a digital integrating type meter which measures feedwater flow. It is read three times daily, and totaled to give daily steam production. The second meter is of a continuous recording graphics type which monitors total boiler steam output. Hourly steam production is then interpreted from the graph.

Much of Stage I work depended upon present and projected community steam demand, and therefore, became necessary to formulate these figures as soon as possible. Since the daily steam production figures were more readily available we used these figures for our early projections.

As Stage I continued, however, we began looking more closely at the hourly steam data. Computer programs were developed to handle the vast amounts of data. We feel that analysis of this data is necessary since it can give us actual hourly peak system demands and a better view of dual plant operations.

However, we soon discovered that the two sets of data did not coincide exactly. On some days they were within 1% of each other, while on others the difference was as much as 7%.

A complete set of computer printouts resulting from the modeling of the hourly steam data follows. Since these figures were derived from hourly steam data and the other figures in this report from the daily data there will be slight discrepancies between them. In Stage II, we will be refining our hourly data and these discrepancies will be corrected.

The printouts cover the years 1976 - 1989. For ALL years it is assumed that all aspects of each option is in full operation. It is further assumed that each option included all lower numbered options.

UNIVERSITY OF MINNESOTA
TWIN CITIES

Physical Plant Maintenance and Operations
200 Shops Building
Minneapolis, Minnesota 55455

August 12, 1977

TO: W. E. Soderberg, Director Physical Plant, Maintenance and Operations
FROM: J. C. O'Gara, Principal Engineer *J. C. O'Gara*
RE: Coal Train Shipments - Meeting with Burlington-Northern and N.S.P. -
August 11, 1977

Present: George Powe - Asst. V. P. Marketing, Burlington-Northern
Allyn Wirkler - Asst. Manager, Unit Train Projects, Burlington-Northern
Richard Sandgren - Director of Pricing, Burlington-Northern
Dave Peterson - Adm., Fuel Procurement, N.S.P.
Jim O'Gara - Principal Engineer, University of Minnesota

Agenda: Mr. O'Gara reviewed the University's concept of unit train shipment to the Southeast Plant. Discussion centered around the method of unloading, number of cars, Burlington-Northern route, tariffs, and engineering.

Results: Mr. O'Gara will have the U of M consultant contact Allyn Wirkler for the engineering design of the trackage and method of drawing presentation. The Burlington-Northern will review these drawings for adequacy and compliance with their construction standards. They will also be sending out, as soon as possible, an engineering team.

Dave Peterson will send Mr. O'Gara coal analysis of the two coals that Northern States Power Company presently buys. The University would be subject to using either one. These are coals of Western Energy Mines at Colstrip, Montana and those of Westmoreland Resources at Sarpy Creek, Montana. Dave will also arrange a meeting between the University and representatives of these mines.

Coal will be shipped (105 car trains) by the Burlington-Northern through Wilmar into the Twin Cities. The present tariff structure imposed upon N.S.P. will be redrawn. The unit train will split so that 35 cars will go to Southeast Steam and 70 cars to Highbridge.

Page Two
TO: W. E. Soderberg
RE: Coal Train Shipments

August 12, 1977

Riverside was not practical. Based upon one car unloader George Powe thought we could off load by bottom dump 35 cars in eight hours. I mentioned we would like to purchase a used switch engine for the University, but did not specifically say from the Burlington-Northern.

Mr. Sandgren will begin estimating tariffs at Mr. O'Gara's request based upon the assumption that all engineering and transport is feasible.

Mr. Allyn Wirkler will handle engineering and train concepts. He will also be the University's prime contact for all matters.

I found both N.S.P. and the railroad to be very cooperative.

cc: J. Roback
D. Wolfson
R. Lewis
R. Reid
G. Burke (Helmick & Lutz)

JCO:skl

GRID ICES PHASE II OPTION II
INTER-CAMPUS COAL SHUTTLE ROUTES

BASIC PLAN
UNIVERSITY COMMUNITY ONLY

YEAR-MONTH	HEATING PLANT (1000 LBS)	S.E. STEAM PLANT (1000 LBS)	TOTAL COMMUNITY REQUIREMENT (1000 LBS)	COMMUN. PEAK DEMAND (LBS/HR)	COMMUN. MINIMUM DEMAND (LBS/HR)	COMMUN. AVERAGE DEMAND (LBS/HR)	TOTAL ELECTRIC GENERATION (KWH)	MINIMUM ELECTRIC GENERATION (KW)	MAXIMUM ELECTRIC GENERATION (KW)	WESTERN COAL USAGE (TONS)	SOLID WASTE USAGE (TONS)	
7601	46430	174940	220470	400	200	296	4825715	5546	6516	17281	1728	0
7602	14675	145065	159740	400	150	237	4022317	4159	6516	12659	1266	0
7603	9565	154445	164010	330	110	220	4281259	3050	6516	13033	1303	0
7604	0	101530	101530	220	90	141	2815091	2495	6100	8112	811	0
7605	0	104320	104320	210	100	140	2892426	2773	5823	8336	834	0
7606	10	124230	124240	240	110	172	3444583	3050	6516	9928	993	0
7607	25	133725	133750	250	130	179	3767866	3604	6516	10087	1069	0
7608	80	133660	133740	250	120	175	3622876	3327	6516	10446	1045	0
7609	0	103820	103820	220	100	144	2878566	2773	6100	8296	830	0
7610	390	132230	132620	270	120	178	3666305	3327	6516	10595	1060	0
7611	131 5	154994	154999	400	138	233	4297649	3026	6516	13337	1334	0
7612	533 4	168777	222081	414	207	298	4679800	5740	6516	17360	1736	0
TOTAL	37544	1627796	1765380	414	90	201	45134555	2495	6516	140079	14008	0
7701	78810	174710	253520	460	220	340	4844291	6100	6516	19688	1969	0
7702	12650	147790	160440	350	140	238	4097849	3882	6516	12728	1273	0
7703	665	129945	130610	300	90	175	3603018	2495	6516	10432	1043	0
7704	45	89885	89930	260	70	124	2492216	1941	6516	7185	719	0
7705	0	92370	92370	210	70	124	2561077	1941	5823	7380	738	0
7706	0	101580	101580	210	100	141	2816461	2773	5823	8117	812	0
7707	0	120480	120480	230	110	161	3340574	3050	6377	9627	963	0
7708	0	94510	94510	220	80	127	2620419	2218	6100	7552	755	0
7709	0	80950	80950	200	80	112	2244456	2218	5546	6467	647	0
7710	390	132230	132620	270	120	178	3666385	3327	6516	10595	1060	0
7711	131 5	154994	154999	400	138	233	4297649	3026	6516	13337	1334	0
7712	533 4	168777	222081	414	207	298	4679800	5740	6516	17360	1736	0
TOTAL	158969	1488221	1647190	460	70	188	41264195	1941	6516	130479	13048	0
7801	101514	174840	276354	471	235	371	4847904	6516	6516	21348	2135	0
7802	22032	153192	175224	372	162	260	4247664	4492	6516	13842	1384	0
7803	1375	136675	138050	310	100	185	3789655	2773	6516	11021	1102	0
7804	115	97115	97230	270	80	134	2689942	2218	6516	7760	776	0
7805	0	105762	105762	228	88	142	2932410	2440	6322	8451	845	0
7806	0	113820	113820	227	117	158	3155889	3244	6294	9094	909	0
7807	322	14246	14568	257	137	188	3888631	3799	6516	11230	1123	0
7808	0	105670	105670	235	95	142	2929840	2634	6516	8443	844	0
7809	14	116146	116160	237	117	161	3217622	3244	6516	9273	927	0
7810	1150	142630	143780	285	135	193	3954734	3743	6516	11480	1148	0
7811	20573	161706	182279	419	157	252	4483660	4353	6516	14380	1438	0
7812	69289	169944	239233	437	23	321	4711019	637	6516	18612	1861	0
TOTAL	215884	1617546	1833430	471	23	209	44848970	637	6516	144947	14495	0
7901	105978	174840	280818	477	235	377	4847904	6516	6516	21673	2167	0
7902	24016	153896	177912	376	166	264	4267160	4603	6516	14042	1404	0
7903	1561	137977	139538	312	102	187	3825725	2828	6516	11138	1114	0
7904	133	98437	98570	272	82	136	2729313	2273	6516	7875	788	0
7905	0	107994	107994	231	91	145	2994311	2523	6405	8629	863	0
7906	0	115980	115980	230	120	161	3215787	3327	6377	9267	927	0
7907	577	143711	144288	262	142	193	3984733	3937	6516	11526	1153	0
7908	2	107156	107158	237	97	144	2971111	2689	6516	8562	856	0
7909	35	118185	118220	240	120	164	3276938	3327	6516	9446	945	0
7910	1471	144541	146012	288	138	196	4007729	3826	6516	11657	1166	0
7911	21881	162778	184659	423	161	256	4513403	4464	6516	14597	1460	0
7912	72834	170079	242913	442	28	326	4715884	776	6516	18884	1888	0
TOTAL	228488	1635574	1864062	477	28	212	45349998	776	6516	147307	14731	0

BASIC PLAN
UNIVERSITY COMMUNITY ONLY

YEAR- MONTH	HEATING PLANT (1000 LBS)	S.E. STEAM PLANT (1000 LBS)	TOTAL COMMUNITY REQUIREMENT (1000 LBS)	COMMUN. PEAK DEMAND (LBS/HR)	COMMUN. MINIMUM DEMAND (LBS/HR)	COMMUN. AVERAGE DEMAND (LBS/HR)	TOTAL ELECTRIC GENERATION (KWH)	MINIMUM ELECTRIC GENERATION (KW)	MAXIMUM ELECTRIC GENERATION (KW)	WESTERN COAL USAGE (TONS)	ASH (TONS)	SOLID WASTE USAGE (TONS)
8001	105978	174840	280818	477	235	377	4847904	6516	6516	21673	2167	0
8002	2116	153896	177912	376	166	264	4267100	4603	6516	14042	1404	0
8003	1561	137977	139538	312	102	187	3825725	2628	6516	11138	1114	0
8004	133	98437	98570	272	82	136	2729313	2273	6516	7874	788	0
8005	0	107994	107994	231	91	145	2994311	2523	6405	8629	863	0
8006	0	115980	115980	230	120	161	3215787	3327	6377	9267	927	0
8007	577	143711	144288	262	142	193	3904733	3437	6516	11526	1153	0
8008	2	107156	107158	237	97	144	2971111	2689	6516	8562	856	0
8009	35	118185	118220	240	120	144	3276938	3327	6516	9446	945	0
8010	1471	144541	144012	288	138	106	4007729	3626	6516	11657	1166	0
8011	21851	162778	184629	423	161	256	4513413	4464	6516	14597	1460	0
8012	72834	170079	242913	442	28	326	4715884	776	6516	18884	1888	0
TOTAL	228498	1635574	1864062	477	28	212	45349998	776	6516	147307	14731	0
8101	118626	174840	293466	494	235	394	4847904	6516	6516	22592	2259	0
8102	30974	155674	186648	389	179	277	4316473	4963	6516	14690	1469	0
8103	2392	142354	144746	319	109	194	3947096	3022	6516	11549	1155	0
8104	182	101268	101450	276	86	140	2807762	2384	6516	8104	810	0
8105	8	116914	116922	243	103	157	3241615	2856	6516	9343	934	0
8106	15	127485	127500	246	136	177	3534814	3771	6516	10187	1019	0
8107	2826	157830	160656	284	164	215	4376223	4547	6516	12817	1282	0
8108	16	117558	117574	251	111	158	3259498	3078	6516	9394	939	0
8109	187	128113	128300	254	134	178	3552266	3715	6516	10251	1025	0
8110	2374	149590	151964	296	146	204	4147703	4048	6516	12125	1213	0
8111	28197	165112	193299	435	173	268	4577900	4797	6516	15242	1524	0
8112	82207	170378	252585	455	41	339	4724164	1136	6516	19589	1959	0
TOTAL	268004	1707106	1975110	494	41	225	47333418	1136	6516	155895	15590	0
8201	118626	174840	293466	494	235	394	4847904	6516	6516	22592	2259	0
8202	30974	155674	186648	389	179	277	4316473	4963	6516	14690	1469	0
8203	2392	142354	144746	319	109	194	3947096	3022	6516	11549	1155	0
8204	182	101268	101450	276	86	140	2807762	2384	6516	8104	810	0
8205	8	116914	116922	243	103	157	3241615	2856	6516	9343	934	0
8206	15	127485	127500	246	136	177	3534814	3771	6516	10187	1019	0
8207	2826	157830	160656	284	164	215	4376223	4547	6516	12817	1282	0
8208	16	117558	117574	251	111	158	3259498	3078	6516	9394	939	0
8209	187	128113	128300	254	134	178	3552266	3715	6516	10251	1025	0
8210	2374	149590	151964	296	146	204	4147703	4048	6516	12125	1213	0
8211	28197	165112	193299	435	173	268	4577900	4797	6516	15242	1524	0
8212	82207	170378	252585	455	41	339	4724164	1136	6516	19589	1959	0
TOTAL	268004	1707106	1975110	494	41	225	47333418	1136	6516	155895	15590	0
8301	118626	174840	293466	494	235	394	4847904	6516	6516	22592	2259	0
8302	30974	155674	186648	389	179	277	4316473	4963	6516	14690	1469	0
8303	2392	142354	144746	319	109	194	3947096	3022	6516	11549	1155	0
8304	182	101268	101450	276	86	140	2807762	2384	6516	8104	810	0
8305	8	116914	116922	243	103	157	3241615	2856	6516	9343	934	0
8306	15	127485	127500	246	136	177	3534814	3771	6516	10187	1019	0
8307	2826	157830	160656	284	164	215	4376223	4547	6516	12817	1282	0
8308	16	117558	117574	251	111	158	3259498	3078	6516	9394	939	0
8309	187	128113	128300	254	134	178	3552266	3715	6516	10251	1025	0
8310	2374	149590	151964	296	146	204	4147703	4048	6516	12125	1213	0
8311	28197	165112	193299	435	173	268	4577900	4797	6516	15242	1524	0
8312	82207	170378	252585	455	41	339	4724164	1136	6516	19589	1959	0
TOTAL	268004	1707106	1975110	494	41	225	47333418	1136	6516	155895	15590	0

BASIC PLAN
UNIVERSITY COMMUNITY ONLY

MONTH	UNIT TRIPS CARLOADS TO S.E. PLANT (10 TON TRUCKS)			COAL TRIPS TO ST. PAUL (10 TON TRUCKS)			SOLID WASTE TRIPS TO S.E. PLANT (10 TON TRUCKS)			TRUCKS OF ASH FROM MPPLS. (10 TON TRUCKS)			TRUCKS OF ASH FROM ST. PAUL (10 TON TRUCKS)			TRUCKS OF FRUIT FROM S.E. PLANT (10 TON TRUCKS)		
	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY
1976																		
JAN	249	62	8	77	193	24	0	0	0	172	43	5	77	19	2	0	0	0
FEB	174	44	6	674	119	17	0	0	0	126	32	4	67	12	1	0	0	0
MAR	17	43	5	6	10	12	0	0	0	13	33	4	46	10	1	0	0	0
APR	17	27	3	252	65	8	0	0	0	81	20	2	25	6	0	0	0	0
MAY	112	28	3	240	74	9	0	0	0	83	21	2	24	7	0	0	0	0
JUN	34	34	4	354	84	11	0	0	0	99	25	3	25	9	1	0	0	0
JUL	146	37	4	342	112	12	0	0	0	106	27	3	24	10	1	0	0	0
AUG	134	35	4	354	66	11	0	0	0	174	20	3	25	9	1	0	0	0
SEP	111	28	3	244	72	9	0	0	0	82	21	2	28	7	0	0	0	0
OCT	144	36	4	342	66	12	0	0	0	105	20	3	26	10	1	0	0	0
NOV	165	46	6	524	132	17	0	0	0	133	33	4	52	13	1	0	0	0
DEC	243	61	7	604	74	22	0	0	0	173	43	5	69	17	2	0	0	0
TOTAL	1914	37	5	5107	100	14	0	0	0	1394	27	4	514	10	1	0	0	0
1977																		
JAN	173	46	8	782	192	24	0	0	0	196	49	6	76	19	2	0	0	0
FEB	174	44	6	674	119	16	0	0	0	127	32	4	67	12	1	0	0	0
MAR	144	36	4	400	100	12	0	0	0	104	26	3	40	10	1	0	0	0
APR	97	24	3	252	65	8	0	0	0	71	18	2	25	6	0	0	0	0
MAY	113	26	3	203	73	9	0	0	0	73	18	2	29	7	0	0	0	0
JUN	116	29	3	355	69	11	0	0	0	61	20	2	25	9	1	0	0	0
JUL	136	34	4	397	69	12	0	0	0	96	24	3	24	10	1	0	0	0
AUG	111	28	3	340	67	11	0	0	0	75	19	2	24	9	1	0	0	0
SEP	92	23	3	245	71	9	0	0	0	64	16	2	28	7	0	0	0	0
OCT	144	36	4	344	66	12	0	0	0	105	20	3	28	10	1	0	0	0
NOV	165	46	6	524	131	17	0	0	0	133	33	4	52	13	1	0	0	0
DEC	243	61	7	604	74	22	0	0	0	173	43	5	69	17	2	0	0	0
TOTAL	1818	35	5	5151	100	14	0	0	0	1296	25	4	512	10	1	0	0	0
1978																		
JAN	290	73	9	740	192	24	0	0	0	213	53	6	76	19	2	0	0	0
FEB	165	46	6	674	119	16	0	0	0	138	35	4	67	12	1	0	0	0
MAR	151	38	4	400	100	12	0	0	0	110	28	3	40	10	1	0	0	0
APR	103	26	3	252	65	8	0	0	0	77	19	2	25	6	0	0	0	0
MAY	113	28	3	203	73	9	0	0	0	84	21	2	29	7	0	0	0	0
JUN	126	32	4	355	69	11	0	0	0	90	23	3	25	9	1	0	0	0
JUL	152	38	4	397	69	12	0	0	0	112	28	3	24	10	1	0	0	0
AUG	119	30	3	340	67	11	0	0	0	64	21	2	24	9	1	0	0	0
SEP	121	30	4	245	71	9	0	0	0	92	23	3	26	7	0	0	0	0
OCT	153	36	4	344	66	12	0	0	0	114	24	3	28	10	1	0	0	0
NOV	196	49	6	524	131	17	0	0	0	143	36	4	52	13	1	0	0	0
DEC	255	64	8	604	74	22	0	0	0	186	47	6	69	17	2	0	0	0
TOTAL	1963	38	5	5181	100	14	0	0	0	1443	28	4	512	10	1	0	0	0

BASIC PLAN
UNIVERSITY COMMUNITY ONLY

MONTH	UNIT TRAILER CHARGES TO S.E. PLANT (100 TON CARS)			COAL TRIPS TO ST. PAUL (10 TON TRUCKS)			SOLID WASTE TRIPS TO S.E. PLANT (6 TON TRUCKS)			TRUCKS OF ASH FROM MPLS. (10 TON TRUCKS)			TRUCKS OF ASH FROM ST. PAUL (10 TON TRUCKS)			TRUCKS OF FRIT FROM S.E. PLANT (10 TON TRUCKS)		
	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY
1979																		
JAN	293	73	9	749	192	24	0	0	0	216	54	6	76	19	2	0	0	0
FEB	187	47	6	474	119	16	0	0	0	140	35	5	47	12	1	0	0	0
MAR	151	38	4	400	100	12	0	0	0	111	28	3	40	10	1	0	0	0
APR	114	28	3	284	65	8	0	0	0	76	20	2	25	6	0	0	0	0
MAY	115	29	3	297	73	9	0	0	0	86	22	2	29	7	0	0	0	0
JUN	128	32	4	355	89	11	0	0	0	92	23	3	35	9	1	0	0	0
JUL	155	39	5	397	99	12	0	0	0	115	29	3	39	10	1	0	0	0
AUG	12	3	3	340	87	11	0	0	0	85	21	2	34	9	1	0	0	0
SEP	122	31	4	285	71	9	0	0	0	94	24	3	28	7	0	0	0	0
OCT	155	39	5	340	90	12	0	0	0	116	29	3	36	10	1	0	0	0
NOV	140	35	5	324	81	17	0	0	0	145	36	4	52	13	1	0	0	0
DEC	255	65	8	604	174	22	0	0	0	166	47	6	69	17	2	0	0	0
TOTAL	944	38	5	5181	100	14	0	0	0	1466	26	4	512	10	1	0	0	0

1980																		
JAN	294	74	9	773	193	24	0	0	0	216	54	6	77	19	2	0	0	0
FEB	188	47	6	475	120	17	0	0	0	140	35	5	47	12	1	0	0	0
MAR	151	38	4	400	101	13	0	0	0	111	28	3	40	10	1	0	0	0
APR	114	28	3	285	65	8	0	0	0	78	20	2	26	7	0	0	0	0
MAY	115	29	3	298	74	9	0	0	0	86	22	2	29	7	0	0	0	0
JUN	128	32	4	358	90	11	0	0	0	92	23	3	35	9	1	0	0	0
JUL	155	39	5	400	100	12	0	0	0	115	29	3	40	10	1	0	0	0
AUG	12	3	3	350	88	11	0	0	0	85	21	2	35	9	1	0	0	0
SEP	123	31	4	297	72	9	0	0	0	94	24	3	28	7	0	0	0	0
OCT	155	39	5	354	97	12	0	0	0	116	29	3	36	10	1	0	0	0
NOV	140	35	5	327	82	17	0	0	0	145	36	4	52	13	1	0	0	0
DEC	255	65	8	600	175	22	0	0	0	168	47	6	69	17	2	0	0	0
TOTAL	944	38	5	5221	100	14	0	0	0	1466	26	4	516	10	1	0	0	0

1981																		
JAN	313	76	9	774	194	25	0	0	0	225	56	7	77	19	2	0	0	0
FEB	195	49	6	481	120	17	0	0	0	146	37	5	48	12	1	0	0	0
MAR	156	39	5	404	102	13	0	0	0	115	29	3	40	10	1	0	0	0
APR	117	27	3	283	66	8	0	0	0	81	20	2	26	7	0	0	0	0
MAY	123	31	3	297	74	9	0	0	0	93	23	3	29	7	0	0	0	0
JUN	137	34	4	350	90	12	0	0	0	101	25	3	36	9	1	0	0	0
JUL	158	42	5	400	101	12	0	0	0	128	32	4	40	10	1	0	0	0
AUG	120	32	4	354	89	11	0	0	0	93	23	3	35	9	1	0	0	0
SEP	131	33	4	288	72	9	0	0	0	102	26	3	28	7	0	0	0	0
OCT	151	40	5	398	97	12	0	0	0	121	30	3	38	10	1	0	0	0
NOV	205	51	6	520	132	17	0	0	0	152	38	5	52	13	1	0	0	0
DEC	266	67	8	700	176	22	0	0	0	195	49	6	70	18	2	0	0	0
TOTAL	2080	40	6	5244	101	14	0	0	0	1552	30	4	519	10	1	0	0	0

OPTION 1
ST. MARYS-FAIRVIEW-AUGSBURG ADD-ON

YEAR-MONTH	U-HEATING PLANT (1000 LBS)	S.E. STEAM PLANT (1000 LBS)	TOTAL COMMUNITY REQUIREMENT (1000 LBS)	COMMUN. PEAK DEMAND (LBS/HR)	COMMUN. MINIMUM DEMAND (LBS/HR)	COMMUN. AVERAGE DEMAND (LBS/HR)	TOTAL ELECTRIC GENERATION (KWH)	MINIMUM ELECTRIC GENERATION (KWH)	MAXIMUM ELECTRIC GENERATION (KWH)	WESTERN COAL USAGE (TONS)	ASH (TONS)	SOLID WASTE USAGE (TONS)
7601	65555	174840	240395	464	235	349	4847904	6516	6516	20189	2419	0
7602	32259	156070	188329	443	191	280	4327458	5296	6516	14815	1482	0
7603	24439	165553	189992	372	144	255	4590300	3493	6516	15005	1501	0
7604	50	12266	12316	252	113	167	3334625	3133	6516	9613	961	0
7605	0	119915	119915	235	119	141	3322117	3299	6516	9574	957	0
7606	267	136665	136932	261	127	190	3789302	3521	6516	10940	1094	0
7607	4.6	146373	146779	269	146	197	4050551	4048	6516	11726	1173	0
7608	517	143310	143827	269	137	193	3973606	3799	6516	11489	1149	0
7609	34	117624	117658	242	114	163	3261360	3101	6516	9401	940	0
7610	3933	159915	164848	308	140	208	4184493	3682	6516	12345	1235	0
7611	32948	165446	197994	453	168	274	4576333	4658	6516	15583	1558	0
7612	88632	169435	258067	478	235	346	4698036	6516	6516	19980	1998	0
TOTAL	269040	1765912	2034952	478	113	232	48964225	3133	6516	160669	16067	0
7701	118605	174840	293445	521	235	394	4847904	6516	6516	22590	2259	0
7702	33742	155287	189029	405	174	281	4305736	4825	6516	14800	1486	0
7703	5947	15635	16229	346	117	210	4178094	3244	6516	12473	1247	0
7704	778	107938	108716	301	94	150	2992767	2606	6516	8681	868	0
7705	0	107865	107865	228	92	144	2990714	2551	6322	8619	862	0
7706	0	114272	114272	229	116	158	3168389	3216	6350	9131	913	0
7707	89	133420	133509	249	127	179	3699351	3521	6516	10667	1067	0
7708	4	107593	107597	239	95	144	2983194	2634	6516	8597	860	0
7709	0	94788	94788	220	98	131	2620124	2717	6100	7574	757	0
7710	3933	159915	164848	308	140	208	4184493	3682	6516	12345	1235	0
7711	32948	165446	197994	453	168	274	4576333	4658	6516	15583	1558	0
7712	88632	169435	258067	478	235	346	4698036	6516	6516	19980	1998	0
TOTAL	284678	1632784	1917462	521	92	218	45253135	2551	6516	151112	15111	0
7801	141439	174840	316279	535	235	425	4847904	6516	6516	24250	2425	0
7802	46621	157192	203813	427	196	303	4358562	5435	6516	15948	1595	0
7803	8413	155659	164072	356	127	220	4316029	3521	6516	13049	1305	0
7804	1297	114619	115916	311	104	160	3178061	2883	6516	9253	925	0
7805	17	121240	121257	246	110	162	3361622	3050	6516	9689	969	0
7806	13	126499	126512	246	133	175	3507474	3688	6516	10109	1011	0
7807	1680	151917	153597	276	154	206	4212245	4270	6516	12261	1226	0
7808	19	118738	118757	254	110	159	3292215	3050	6516	9489	949	0
7809	226	129672	129898	259	131	180	3595457	3632	6516	10378	1038	0
7810	7603	159445	167048	323	155	223	4392167	4298	6516	13210	1321	0
7811	44556	167118	211674	472	187	293	4633795	5185	6516	16592	1659	0
7812	15215	169944	275159	501	23	369	4712687	637	6516	21228	2123	0
TOTAL	357799	1745863	2103662	535	23	240	48408218	637	6516	165467	16547	0
7901	145903	174840	320743	541	235	431	4847904	6516	6516	24574	2457	0
7902	49145	157356	206501	431	200	307	4363113	5546	6516	16145	1615	0
7903	9025	156535	165560	358	129	222	4340317	3577	6516	13104	1316	0
7904	1418	115938	117356	313	106	162	3214592	2939	6516	9367	937	0
7905	26	123463	123489	249	113	165	3423244	3133	6516	9867	987	0
7906	27	128645	128672	249	136	178	3566972	3771	6516	10282	1028	0
7907	2339	154978	157317	281	159	211	4297152	4409	6516	12553	1255	0
7908	23	122222	122245	256	112	161	3333404	3105	6516	9608	961	0
7909	307	131751	132058	262	134	183	3653092	3715	6516	10550	1055	0
7910	8599	159641	168240	326	158	226	4426465	4381	6516	13381	1338	0
7911	47149	167405	214554	476	191	297	4641750	5296	6516	16803	1680	0
7912	108820	170079	278899	506	28	374	4715884	776	6516	21499	2150	0
TOTAL	372781	1760853	2133634	541	28	243	48823889	776	6516	167805	16781	0

OPTION 1
ST. MARYS-FAIRVIEW-AUGSBURG ADD-ON

YEAR-MONTH	HEATING PLANT (1000 LBS)	S.E. STEAM PLANT (1000 LBS)	TOTAL COMMUNITY REQUIREMENT (1000 LBS)	COMMUN. PEAK DEMAND (LBS/HR)	COMMUN. MINIMUM DEMAND (LBS/HR)	COMMUN. AVERAGE DEMAND (LBS/HR)	TOTAL ELECTRIC GENERATION (KWH)	MINIMUM ELECTRIC GENERATION (KWH)	MAXIMUM ELECTRIC GENERATION (KWH)	WESTERN COAL USAGE (TONS)	ASH (TONS)	SOLID WASTE USAGE (TONS)
8001	145923	174840	320763	541	235	431	4847904	6516	6516	24574	2457	0
8002	49145	157356	206501	431	200	307	4303113	5046	6516	16145	1615	0
8003	9125	156535	145560	358	129	222	4340317	3577	6516	13164	1316	0
8004	1418	115938	117356	313	106	162	3214592	2939	6516	9367	937	0
8005	26	123463	123489	249	113	165	3423244	3133	6516	9867	987	0
8006	27	128645	128672	249	136	178	3566972	3771	6516	10282	1028	0
8007	2339	154978	157317	261	159	211	4297152	4439	6516	12553	1255	0
8008	23	12222	12245	256	112	161	3333404	3105	6516	9608	961	0
8009	37	131751	132158	262	134	183	3653092	3715	6516	10550	1055	0
8010	8599	159641	160240	326	158	226	4426405	4381	6516	13381	1338	0
8011	47149	167415	214564	476	191	297	4641750	5296	6516	16863	1686	0
8012	108820	170079	278899	506	26	374	4715864	776	6516	21499	2150	0
TOTAL	372781	176953	2136634	541	28	243	48823869	776	6516	167805	16781	0
8101	161783	174840	336623	561	235	451	4847904	6516	6516	25056	2506	0
8102	58143	157766	215909	445	214	321	4374463	5934	6516	16832	1683	0
8103	11562	159931	171512	366	137	230	4434471	3799	6516	13621	1362	0
8104	1813	119153	120966	318	111	167	3303736	3078	6516	9652	965	0
8105	227	132190	132417	261	125	177	3665280	3466	6516	10579	1058	0
8106	219	139973	142192	265	152	194	3881064	4214	6516	11201	1120	0
8107	7300	166385	173685	303	181	233	4613499	5019	6516	13826	1383	0
8108	82	135579	135661	270	126	175	3620593	3493	6516	10440	1044	0
8109	855	141283	142138	276	148	197	3917423	4104	6516	11351	1135	0
8110	11777	163159	174936	335	167	235	4523997	4630	6516	13893	1389	0
8111	55786	168128	223914	489	204	310	4661794	5656	6516	17488	1749	0
8112	119635	174424	294059	521	43	389	4725452	1192	6516	22312	2231	0
TOTAL	428192	1823810	2252002	561	43	257	50569696	1192	6516	176863	17686	0
8201	163015	174840	337855	564	235	454	4847904	6516	6516	25818	2582	0
8202	58794	157787	216581	446	215	322	4375062	5961	6516	16881	1688	0
8203	11936	160320	172256	367	138	231	4445270	3826	6516	13678	1368	0
8204	1882	119794	121676	319	112	168	3321404	3105	6516	9709	971	0
8205	227	132190	132417	261	125	177	3665280	3466	6516	10579	1058	0
8206	219	139973	142192	265	152	194	3881064	4214	6516	11201	1120	0
8207	7300	166385	173685	303	181	233	4613499	5019	6516	13826	1383	0
8208	82	135579	135661	270	126	175	3620593	3493	6516	10440	1044	0
8209	855	141283	142138	276	148	197	3917423	4104	6516	11351	1135	0
8210	12170	163510	175680	336	168	236	4533732	4658	6516	13950	1395	0
8211	56458	168176	224634	490	205	311	4663125	5684	6516	17542	1754	0
8212	121077	174470	295547	523	45	391	4726717	1247	6516	22421	2242	0
TOTAL	434015	1825307	2259322	564	45	257	50611153	1247	6516	177405	17741	0
8301	165247	174840	340087	567	235	457	4847904	6516	6516	25980	2598	0
8302	59450	157803	217253	447	216	323	4375506	5989	6516	16930	1693	0
8303	12310	160690	173000	368	139	232	4455521	3854	6516	13735	1374	0
8304	1961	120435	122396	320	113	169	3339299	3133	6516	9766	977	0
8305	227	132190	132417	261	125	177	3665280	3466	6516	10579	1058	0
8306	219	139973	142192	265	152	194	3881064	4214	6516	11201	1120	0
8307	7300	166385	173685	303	181	233	4613499	5019	6516	13826	1383	0
8308	82	135579	135661	270	126	175	3620593	3493	6516	10440	1044	0
8309	855	141283	142138	276	148	197	3917423	4104	6516	11351	1135	0
8310	12564	163860	176424	337	169	237	4543447	4686	6516	14007	1401	0
8311	57130	168224	225354	491	206	312	4664462	5712	6516	17594	1759	0
8312	122519	170516	293035	525	47	393	4728005	1303	6516	22530	2253	0
TOTAL	439864	1826778	2266642	567	47	258	50652003	1303	6516	177948	17795	0

OPTION 1
ST. MARYS-FAIRVIEW-AUGSBURG ADD-ON

MONTH	UNIT TR. L. CH-LOADS TO S.E. PLANT (100 TON TRUCKS)			COAL TRIPS TO ST. PAUL (10 TON TRUCKS)			SOLID WASTE TRIPS TO S.E. PLANT (16 TON TRUCKS)			TRUCKS OF ASH FROM MPLS. (10 TON TRUCKS)			TRUCKS OF ASH FROM ST. PAUL (11 TON TRUCKS)			TRUCKS OF FRIT FROM S.E. PLANT (10 TON TRUCKS)		
	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY
1976																		
JAN	278	7	8	77	193	24	0	0	0	201	50	6	77	19	2	0	0	0
FEB	195	49	6	474	119	17	0	0	0	148	37	5	47	12	1	0	0	0
MAR	19	40	6	474	100	12	0	0	0	150	30	4	40	10	1	0	0	0
APR	122	31	4	250	65	8	0	0	0	96	24	3	25	6	0	0	0	0
MAY	125	31	4	244	74	4	0	0	0	95	24	3	24	7	0	0	0	0
JUN	145	36	4	354	89	11	0	0	0	109	27	3	35	9	1	0	0	0
JUL	157	34	5	394	100	12	0	0	0	117	24	3	39	10	1	0	0	0
AUG	149	37	4	354	80	11	0	0	0	114	24	3	35	9	1	0	0	0
SEP	122	31	4	244	72	9	0	0	0	94	24	3	25	7	0	0	0	0
OCT	161	40	5	344	96	12	0	0	0	123	31	3	36	10	1	0	0	0
NOV	208	52	4	524	132	17	0	0	0	155	39	5	52	13	1	0	0	0
DEC	269	67	8	604	174	22	0	0	0	199	50	6	69	17	2	0	0	0
TOTAL	2121	41	6	5197	100	14	0	0	0	1601	31	4	514	10	1	0	0	0

1977																		
JAN	302	76	9	760	192	24	0	0	0	225	50	7	76	19	2	0	0	0
FEB	196	49	7	474	119	16	0	0	0	148	37	5	47	12	1	0	0	0
MAR	164	41	5	400	100	12	0	0	0	124	31	4	40	10	1	0	0	0
APR	112	28	3	250	65	8	0	0	0	86	22	2	25	6	0	0	0	0
MAY	115	28	3	200	73	9	0	0	0	86	22	2	29	7	0	0	0	0
JUN	126	32	4	350	89	11	0	0	0	91	23	3	35	9	1	0	0	0
JUL	146	37	4	397	99	12	0	0	0	106	27	3	39	10	1	0	0	0
AUG	120	30	3	340	67	11	0	0	0	85	21	2	34	9	1	0	0	0
SEP	104	26	3	285	71	9	0	0	0	75	19	2	26	7	0	0	0	0
OCT	161	40	5	344	96	12	0	0	0	123	31	3	38	10	1	0	0	0
NOV	208	52	4	524	131	17	0	0	0	155	39	5	52	13	1	0	0	0
DEC	269	67	8	604	174	22	0	0	0	199	50	6	69	17	2	0	0	0
TOTAL	223	39	6	5100	100	14	0	0	0	1503	29	4	512	10	1	0	0	0

1978																		
JAN	319	61	1	740	192	24	0	0	0	242	61	7	76	19	2	0	0	0
FEB	206	52	7	474	119	16	0	0	0	159	40	5	47	12	1	0	0	0
MAR	170	43	5	400	100	12	0	0	0	130	33	4	40	10	1	0	0	0
APR	118	31	3	250	65	8	0	0	0	92	23	3	25	6	0	0	0	0
MAY	125	32	4	200	73	9	0	0	0	96	24	3	29	7	0	0	0	0
JUN	136	34	4	355	89	11	0	0	0	101	25	3	35	9	1	0	0	0
JUL	162	41	5	397	99	12	0	0	0	122	31	3	39	10	1	0	0	0
AUG	129	32	4	340	67	11	0	0	0	94	24	3	34	9	1	0	0	0
SEP	132	33	4	285	71	9	0	0	0	103	26	3	28	7	0	0	0	0
OCT	170	43	5	344	96	12	0	0	0	132	33	4	38	10	1	0	0	0
NOV	218	55	7	524	131	17	0	0	0	165	41	5	52	13	1	0	0	0
DEC	281	70	9	604	174	22	0	0	0	212	53	6	69	17	2	0	0	0
TOTAL	2167	42	6	5181	100	14	0	0	0	1648	32	5	512	10	1	0	0	0

OPTION 1
ST. MARYS-FAIRVIEW-AUGSBURG ADD-ON

MONTH	UNIT TRAILER CARLOADS TO S.E. PLANT (100 TON TRUCKS)			COAL TRIPS TO ST. PAUL (10 TON TRUCKS)			SOLID WASTE TRIPS TO S.E. PLANT (6 TON TRUCKS)			TRUCKS OF ASH FROM MPLS. (10 TON TRUCKS)			TRUCKS OF ASH FROM ST. PAUL (10 TON TRUCKS)			TRUCKS OF FERT FROM S.E. PLANT (10 TON TRUCKS)		
	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY
1979																		
JAN	322	51	1	742	192	24	0	0	0	245	61	7	76	19	2	0	0	0
FEB	214	52	7	474	119	16	0	0	0	161	40	5	47	12	1	0	0	0
MAR	171	43	5	404	100	12	0	0	0	131	33	4	40	10	1	0	0	0
APR	114	3	3	259	65	8	0	0	0	93	23	3	25	6	0	0	0	0
MAY	126	32	4	223	73	9	0	0	0	96	25	3	29	7	0	0	0	0
JUN	136	35	4	354	80	11	0	0	0	112	28	3	35	9	1	0	0	0
JUL	165	41	5	397	99	12	0	0	0	125	31	4	39	10	1	0	0	0
AUG	131	33	4	345	87	11	0	0	0	94	24	3	34	9	1	0	0	0
SEP	134	34	4	245	71	9	0	0	0	105	26	3	28	7	0	0	0	0
OCT	172	43	5	344	96	12	0	0	0	133	33	4	34	10	1	0	0	0
NOV	22	55	7	524	131	17	0	0	0	166	42	5	52	13	1	0	0	0
DEC	264	71	9	694	174	22	0	0	0	214	54	6	49	17	2	0	0	0
TOTAL	2192	42	6	5191	100	14	0	0	0	1671	32	5	512	10	1	0	0	0

1980																		
JAN	323	51	1	773	193	24	0	0	0	245	61	7	77	19	2	0	0	0
FEB	214	52	7	474	120	17	0	0	0	161	40	5	47	12	1	0	0	0
MAR	172	43	5	404	101	13	0	0	0	131	33	4	40	10	1	0	0	0
APR	114	3	3	241	65	8	0	0	0	93	23	3	26	7	0	0	0	0
MAY	128	32	4	204	74	9	0	0	0	98	25	3	29	7	0	0	0	0
JUN	136	35	4	354	90	11	0	0	0	102	26	3	35	9	1	0	0	0
JUL	165	41	5	400	100	12	0	0	0	125	31	4	40	10	1	0	0	0
AUG	131	33	4	350	88	11	0	0	0	96	24	3	35	9	1	0	0	0
SEP	134	34	4	247	72	9	0	0	0	105	26	3	28	7	0	0	0	0
OCT	172	43	5	344	97	12	0	0	0	133	33	4	34	10	1	0	0	0
NOV	22	55	7	527	132	17	0	0	0	166	42	5	52	13	1	0	0	0
DEC	264	71	9	690	175	22	0	0	0	214	54	6	49	17	2	0	0	0
TOTAL	2195	42	6	5227	100	14	0	0	0	1671	32	5	516	10	1	0	0	0

1981																		
JAN	334	54	1	774	194	25	0	0	0	256	64	8	77	19	2	0	0	0
FEB	216	54	7	481	120	17	0	0	0	168	42	6	48	12	1	0	0	0
MAR	176	44	5	404	102	13	0	0	0	136	34	4	40	10	1	0	0	0
APR	122	31	4	243	66	8	0	0	0	96	24	3	26	7	0	0	0	0
MAY	135	34	4	297	74	9	0	0	0	105	26	3	29	7	0	0	0	0
JUN	148	37	4	340	90	12	0	0	0	112	28	3	36	9	1	0	0	0
JUL	176	45	5	400	101	12	0	0	0	138	35	4	40	10	1	0	0	0
AUG	139	35	4	354	89	11	0	0	0	104	26	3	35	9	1	0	0	0
SEP	142	36	4	288	72	9	0	0	0	113	28	3	28	7	0	0	0	0
OCT	177	44	5	388	97	12	0	0	0	138	35	4	36	10	1	0	0	0
NOV	227	57	7	529	132	17	0	0	0	174	44	5	52	13	1	0	0	0
DEC	293	73	9	700	176	22	0	0	0	223	56	7	70	18	2	0	0	0
TOTAL	2287	44	6	5246	101	14	0	0	0	1763	34	5	519	10	1	0	0	0

OPTION 2A
SOLID WASTE HEAT RECOVERY-86 TONS/DAY

YEAR-MONTH	U-HEATING PLANT (100 LBS)	S.E. STEAM PLANT (1000 LBS)	TOTAL COMMUNITY REQUIREMENT (1000 LBS)	COMMUN. PEAK DEMAND (LBS/HR)	COMMUN. MINIMUM DEMAND (LBS/HR)	COMMUN. AVERAGE DEMAND (LBS/HR)	TOTAL ELECTRIC GENERATION (KW)	MINIMUM ELECTRIC GENERATION (KW)	MAXIMUM ELECTRIC GENERATION (KW)	WESTERN COAL USAGE (TONS)	AS-45 (TONS)	SOLID WASTE USAGE (TONS)
7601	66219	194176	260395	464	254	349	5384106	7000	7237	18981	1898	2378
7602	20668	167661	188329	443	191	240	4648903	5296	7237	13642	1368	2147
7603	13296	176696	189992	372	144	255	4899302	3493	7237	13737	117	2378
7604	0	120316	120316	252	113	167	3336012	3133	6987	8309	431	2301
7605	0	119815	119815	235	119	161	3322117	3299	6516	6226	823	2378
7606	0	136932	136932	261	127	190	3796770	3521	7237	9638	964	2301
7607	8	146771	146779	269	146	197	4069593	4048	7237	10381	1038	2378
7608	28	143799	143827	269	137	193	3987170	3799	7237	10144	1014	2378
7609	0	117658	117658	242	114	163	3262304	3161	6710	8097	811	2301
7610	927	153921	154848	308	140	208	4267855	3882	7237	11019	1102	2378
7611	20062	177912	197974	453	168	274	4933133	4658	7237	14371	1437	2301
7612	70093	187974	258067	478	243	346	5212142	6738	7237	18766	1877	2378
TOTAL	191321	1843631	2034952	476	113	232	51119487	3133	7237	145362	14536	27997
7701	99261	194164	293425	521	261	394	5384328	7000	7237	21382	2138	2378
7702	20527	168502	189029	405	174	281	4672203	4025	7237	13739	1374	2147
7703	1816	154816	156632	346	117	210	4292672	3244	7237	11154	1116	2378
7704	125	108591	108716	301	94	150	3010878	2606	7237	7381	738	2301
7705	0	107865	107865	228	92	144	2990714	2551	6322	7271	727	2378
7706	0	114272	114272	229	116	158	3168389	3216	6350	7627	763	2301
7707	0	133509	133509	249	127	179	3701820	3521	6904	9320	932	2378
7708	0	107597	107597	239	95	144	2983305	2634	6627	7249	725	2378
7709	0	94788	94788	220	98	131	2628124	2717	6100	6270	627	2301
7710	927	153921	154848	308	140	208	4267855	3882	7237	11019	1102	2378
7711	20062	177912	197974	453	168	274	4933133	4658	7237	14371	1437	2301
7712	70093	187974	258067	478	243	346	5212142	6738	7237	18766	1877	2378
TOTAL	212831	1703931	1914762	521	92	218	47240563	2551	7237	135762	13576	27997
7801	122095	194184	314279	535	292	425	5384328	7000	7237	23042	2304	2378
7802	31570	172243	203813	427	196	303	4775948	5435	7237	14840	1484	2147
7803	3096	160976	164072	356	127	220	4463491	3521	7237	11740	1174	2378
7804	267	115649	115916	311	104	160	3206624	2883	7237	7956	796	2301
7805	0	121257	121257	246	110	162	3362093	3050	6821	8341	834	2378
7806	0	126512	126512	246	133	175	3507835	3688	6821	8804	880	2301
7807	110	153487	153597	276	154	206	4255792	4270	7237	10924	1092	2378
7808	0	118757	118757	254	110	159	3292742	3050	7043	8141	814	2378
7809	0	129898	129898	259	131	180	3601726	3632	7162	9075	906	2301
7810	2281	163727	166008	323	155	223	4539771	4298	7237	11901	1190	2378
7811	28967	182707	211674	472	187	293	5066097	5185	7237	15400	1540	2301
7812	86469	183710	270179	501	23	369	5232528	637	7237	20015	2002	2378
TOTAL	274855	1828107	2102962	535	23	240	50688975	637	7237	150193	15019	27997
7901	126559	194184	320743	541	298	431	5384328	7000	7237	23366	2337	2378
7902	33742	172759	206501	431	200	307	4790248	5546	7237	15040	1504	2147
7903	3381	162179	165560	358	129	222	4496850	3577	7237	11656	1166	2378
7904	310	117046	117356	313	106	162	3245321	2939	7237	8071	807	2301
7905	0	123489	123489	249	113	165	3423964	3133	6904	8519	852	2378
7906	0	128672	128672	249	136	178	3567721	3771	6904	8977	898	2301
7907	222	157095	157317	281	159	211	4355858	4409	7237	11221	1122	2378
7908	0	120245	120245	256	112	161	3334042	3105	7098	8260	826	2378
7909	1	132057	132058	262	134	183	3661579	3715	7237	9247	925	2301
7910	2686	165554	168240	326	158	226	4590440	4381	7237	12076	1208	2378
7911	31221	183333	214554	476	191	297	5083450	5296	7237	15615	1562	2301
7912	90074	188825	278899	506	28	374	5235725	776	7237	20286	2029	2378
TOTAL	288196	1845438	2133634	541	28	243	51169526	776	7237	152547	15255	27997

OPTION 2A
SOLID WASTE HEAT RECOVERY-80 TONS/DAY

YEAR-MONTH	HEATING PLANT (1000 LBS)	S.E. STEAM PLANT (1000 LBS)	TOTAL COMMUNITY REQUIREMENT (1000 LBS)	COMMON PEAK DEMAND (LBS/HR)	COMMON MINIMUM DEMAND (LBS/HR)	COMMON AVERAGE DEMAND (LBS/HR)	TOTAL ELECTRIC GENERATION (KW)	MINIMUM ELECTRIC GENERATION (KW)	MAXIMUM ELECTRIC GENERATION (KW)	WESTERN COAL USAGE (TONS)	ASH (TONS)	SOLID WASTE USAGE (TONS)
8001	126559	194184	320743	541	298	431	5384328	7000	7237	23366	2337	2376
8002	33742	172759	206501	431	200	307	4790248	5546	7237	15040	1504	2147
8003	3381	162179	165560	358	129	222	4496850	3577	7237	11856	1186	2378
8004	310	117046	117356	313	106	162	3245321	2939	7237	8071	807	2301
8005	0	123489	123489	249	113	165	3423964	3133	6904	8519	852	2378
8006	0	128672	128672	249	136	178	3567721	3771	6904	8977	898	2301
8007	222	157495	157717	261	159	211	4350856	4409	7237	11221	1122	2378
8008	0	121245	121245	256	112	161	3334042	3105	7098	8260	826	2378
8009	1	132057	132058	262	134	183	3661579	3715	7237	9247	925	2301
8010	2686	165554	168240	326	158	226	4590440	4381	7237	12076	1206	2378
8011	31221	183333	214554	476	191	297	5103450	5246	7237	15615	1562	2301
8012	90074	188825	278899	506	28	374	5235725	776	7237	20266	2029	2378
TOTAL	288196	1845438	2133634	541	28	243	51109526	776	7237	152547	15255	27997
8101	141439	194184	335623	561	318	451	5384328	7000	7237	24448	2445	2378
8102	41747	174162	215909	445	214	321	4829162	5934	7237	15734	1573	2147
8103	4765	166747	171512	366	137	230	4623526	3799	7237	12322	1232	2378
8104	442	121514	121956	318	111	167	3341481	3078	7237	8358	836	2301
8105	0	132417	132417	261	125	177	3671574	3466	7237	9233	923	2378
8106	4	141188	141192	265	152	194	3887030	4214	7237	9898	990	2301
8107	1806	171879	173685	303	181	233	4765843	5019	7237	12518	1252	2378
8108	9	131652	131661	270	126	175	3622618	3493	7237	9092	909	2378
8109	100	142038	142138	276	148	197	3938356	4104	7237	10053	1005	2301
8110	4116	170820	174936	335	167	235	4736465	4630	7237	12601	1260	2378
8111	38915	184999	223914	489	204	310	5129640	5656	7237	16307	1631	2301
8112	100889	189176	290065	521	43	389	5245293	1192	7237	21100	2110	2378
TOTAL	334232	1917770	2252002	561	43	257	53175316	1192	7237	161673	16167	27997
8201	143671	194184	337855	564	321	454	5384328	7000	7237	24610	2461	2378
8202	42344	174237	216581	446	215	322	4831235	5961	7237	15783	1578	2147
8203	4947	167359	172306	367	138	231	4639098	3826	7237	12381	1238	2378
8204	475	121201	121676	319	112	168	3360500	3105	7237	8415	842	2301
8205	0	132417	132417	261	125	177	3671574	3466	7237	9233	923	2378
8206	4	141188	141192	265	152	194	3887030	4214	7237	9898	990	2301
8207	1806	171879	173685	303	181	233	4765843	5019	7237	12518	1252	2378
8208	9	131652	131661	270	126	175	3622618	3493	7237	9092	909	2378
8209	100	142038	142138	276	148	197	3938356	4104	7237	10053	1005	2301
8210	4313	171367	175680	336	168	236	4751619	4658	7237	12659	1266	2378
8211	39533	185191	224724	490	205	311	5132468	5684	7237	16359	1636	2301
8212	112331	189216	291547	523	45	391	5246558	1247	7237	21209	2121	2378
TOTAL	339533	1919789	2259322	564	45	257	53231227	1247	7237	162219	16222	27997
8301	145943	194184	340127	567	324	457	5384328	7000	7237	24772	2477	2378
8302	42941	174312	217253	447	216	323	4833317	5989	7237	15832	1583	2147
8303	5131	167869	173000	368	139	232	4654626	3854	7237	12439	1244	2378
8304	512	121884	122396	320	113	149	3379477	3133	7237	8472	847	2301
8305	0	132417	132417	261	125	177	3671574	3466	7237	9233	923	2378
8306	4	141188	141192	265	152	194	3887030	4214	7237	9898	990	2301
8307	1806	171879	173685	303	181	233	4765843	5019	7237	12518	1252	2378
8308	9	131652	131661	270	126	175	3622618	3493	7237	9092	909	2378
8309	100	142038	142138	276	148	197	3938356	4104	7237	10053	1005	2301
8310	4526	171898	176424	337	169	237	4766349	4686	7237	12717	1272	2378
8311	40153	185201	225354	491	206	312	5135246	5712	7237	16414	1641	2301
8312	103773	189262	293035	525	47	393	5247846	1303	7237	21317	2132	2378
TOTAL	344858	1921784	2266642	567	47	258	53286610	1303	7237	162766	16277	27997

OPTION 2A
SOLID WASTE HEAT RECOVERY-80 TONS/DAY

MONTH	UNIT TR. IN CARLOADS TO S.E. PLANT (10 TON CARS)			COAL TRIPS TO ST. PAUL (10 TON TRUCKS)			SOLID WASTE TRIPS TO S.E. PLANT (10 TON TRUCKS)			TRUCKS OF ASH FROM MPLS. (10 TON TRUCKS)			TRUCKS OF ASH FROM ST. PAUL (10 TON TRUCKS)			TRUCKS OF FRIT FROM S.E. PLANT (10 TON TRUCKS)		
	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY
1976																		
JAN	266	67	8	77	193	24	396	99	12	189	47	6	77	19	2	47	12	1
FEB	266	66	4	474	119	17	357	89	12	134	34	4	47	12	1	42	11	1
MAR	277	64	5	474	100	12	396	99	12	137	34	4	40	10	1	47	12	1
APR	277	27	3	252	65	8	383	96	12	83	21	2	25	6	0	46	12	1
MAY	211	23	3	252	74	9	396	99	12	82	21	2	29	7	0	47	12	1
JUN	232	33	4	355	89	11	383	96	12	94	24	3	29	7	0	47	12	1
JUL	243	36	4	355	88	11	396	99	12	103	25	3	25	9	1	46	12	1
AUG	257	34	4	355	88	11	396	99	12	103	25	3	29	10	1	47	12	1
SEP	257	27	3	252	72	9	396	99	12	101	25	3	25	9	1	47	12	1
OCT	257	37	4	355	96	12	383	96	12	80	20	2	25	7	0	46	12	1
NOV	257	37	4	355	96	12	396	99	12	110	28	3	26	10	1	47	12	1
DEC	257	64	8	644	174	22	396	99	12	143	30	4	52	13	1	46	12	1
TOTAL	968	38	5	5147	100	14	4661	90	13	1447	28	4	514	10	1	555	11	2
1977																		
JAN	29	73	4	744	192	24	396	99	12	213	53	6	76	19	2	47	12	1
FEB	266	66	4	474	119	16	357	89	12	137	34	4	47	12	1	42	11	1
MAR	251	36	4	474	100	12	396	99	12	111	28	3	40	10	1	47	12	1
APR	99	25	3	252	65	8	383	96	12	73	18	2	25	6	0	46	12	1
MAY	12	25	3	252	73	9	396	99	12	72	18	2	29	7	0	47	12	1
JUN	113	26	3	355	89	11	383	96	12	78	20	2	25	9	1	46	12	1
JUL	132	33	4	355	89	11	396	99	12	93	23	3	39	10	1	47	12	1
AUG	127	33	4	355	89	11	396	99	12	93	23	3	39	10	1	47	12	1
SEP	127	27	3	355	87	11	396	99	12	72	18	2	34	9	1	47	12	1
OCT	145	23	3	252	71	9	383	96	12	62	16	2	28	7	0	46	12	1
NOV	145	37	4	355	96	12	396	99	12	110	28	3	28	10	1	47	12	1
DEC	257	64	8	644	174	22	396	99	12	143	30	4	52	13	1	46	12	1
TOTAL	187	36	5	5147	100	14	4661	90	13	1351	26	4	512	10	1	555	11	2
1978																		
JAN	317	77	9	744	192	24	396	99	12	230	58	7	76	19	2	47	12	1
FEB	295	69	6	474	119	16	357	89	12	148	37	5	47	12	1	42	11	1
MAR	257	39	5	474	100	12	396	99	12	117	29	3	40	10	1	47	12	1
APR	145	26	3	252	65	8	383	96	12	79	20	2	25	6	0	46	12	1
MAY	112	28	3	252	73	9	396	99	12	83	21	2	29	7	0	47	12	1
JUN	123	31	4	355	89	11	383	96	12	88	22	2	35	9	1	46	12	1
JUL	146	37	4	355	89	11	396	99	12	109	27	3	39	10	1	47	12	1
AUG	115	29	3	355	87	11	396	99	12	81	20	2	34	9	1	47	12	1
SEP	119	30	3	252	71	9	383	96	12	90	23	3	28	7	0	46	12	1
OCT	157	39	5	355	96	12	396	99	12	119	30	3	28	10	1	47	12	1
NOV	246	52	6	524	131	17	383	96	12	154	39	5	52	13	1	46	12	1
DEC	269	67	8	644	174	22	396	99	12	208	50	6	49	17	2	47	12	1
TOTAL	2114	39	6	5147	100	14	4661	90	13	1498	29	4	512	10	1	555	11	2

OPTION 24
SOLID WASTE HEAT RECOVERY-80 TONS/DAY

065234

MONTH	COAL TRIPS TO S.E. PLANT (110 TON TRUCKS)			COAL TRIPS TO ST. PAUL (110 TON TRUCKS)			SOLID WASTE TRIPS TO S.E. PLANT (15 TON TRUCKS)			TRUCKS OF ASH FROM MPLS. (110 TON TRUCKS)			TRUCKS OF ASH FROM ST. PAUL (110 TON TRUCKS)			TRUCKS OF FRUIT FROM S.E. PLANT (110 TON TRUCKS)		
	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY

1979

JAN	31	75	1	75	192	24	396	99	12	233	58	7	76	19	2	47	12	1
FEB	29	49	7	47	119	16	357	89	12	156	38	5	47	12	1	42	11	1
MAR	31	49	5	47	100	12	396	99	12	118	30	3	40	10	1	47	12	1
APR	30	27	3	25	65	8	383	96	12	83	20	2	25	6	0	46	12	1
MAY	31	29	3	29	73	9	396	99	12	85	21	2	29	7	0	47	12	1
JUN	30	31	4	35	89	11	383	96	12	89	22	2	35	9	1	46	12	1
JUL	31	35	4	37	99	12	396	99	12	112	29	3	39	10	1	47	12	1
AUG	31	29	3	34	87	11	396	99	12	82	21	2	34	9	1	47	12	1
SEP	30	30	4	24	71	9	383	96	12	92	23	3	24	7	0	46	12	1
OCT	31	41	5	34	96	12	396	99	12	120	30	3	38	10	1	47	12	1
NOV	30	52	5	52	131	17	383	96	12	156	39	5	52	13	1	46	12	1
DEC	31	66	8	64	174	22	396	99	12	202	51	6	49	17	2	47	12	1
TOTAL	272	39	5	514	100	14	4661	90	13	1519	29	4	512	10	1	555	11	2

1980

JAN	31	75	1	77	193	24	396	99	12	233	58	7	77	19	2	47	12	1
FEB	29	50	7	47	120	17	357	89	12	156	38	5	47	12	1	42	11	1
MAR	31	49	5	47	101	13	396	99	12	118	30	3	40	10	1	47	12	1
APR	30	27	3	25	65	8	383	96	12	83	20	2	25	6	0	46	12	1
MAY	31	29	3	29	74	9	396	99	12	85	21	2	29	7	0	47	12	1
JUN	30	31	4	35	90	11	383	96	12	89	22	2	35	9	1	46	12	1
JUL	31	35	4	37	100	12	396	99	12	112	29	3	39	10	1	47	12	1
AUG	31	29	3	35	86	11	396	99	12	82	21	2	35	9	1	47	12	1
SEP	30	30	4	24	72	9	383	96	12	92	23	3	24	7	0	46	12	1
OCT	31	41	5	34	97	12	396	99	12	120	30	3	38	10	1	47	12	1
NOV	30	52	5	52	132	17	383	96	12	156	39	5	52	13	1	46	12	1
DEC	31	66	8	64	175	22	396	99	12	202	51	6	49	17	2	47	12	1
TOTAL	242	39	5	522	100	14	4661	90	13	1519	29	4	516	10	1	555	11	2

1981

JAN	32	51	1	77	194	25	396	99	12	244	61	7	77	19	2	47	12	1
FEB	28	51	7	49	120	17	357	89	12	157	39	5	48	12	1	42	11	1
MAR	31	41	5	47	102	13	396	99	12	123	31	3	40	10	1	47	12	1
APR	30	27	3	25	66	8	383	96	12	83	21	2	26	7	0	46	12	1
MAY	31	31	3	29	74	9	396	99	12	92	23	2	29	7	0	47	12	1
JUN	30	34	4	36	90	12	383	96	12	98	25	3	36	9	1	46	12	1
JUL	31	41	5	47	101	12	396	99	12	125	31	4	40	10	1	47	12	1
AUG	31	32	4	35	89	11	396	99	12	90	23	2	35	9	1	47	12	1
SEP	30	32	4	24	72	9	383	96	12	100	25	3	28	7	0	46	12	1
OCT	31	41	5	38	97	12	396	99	12	126	32	4	38	10	1	47	12	1
NOV	30	54	7	52	132	17	383	96	12	163	41	5	52	13	1	46	12	1
DEC	31	70	9	70	176	22	396	99	12	211	53	6	70	18	2	47	12	1
TOTAL	2136	41	6	524	101	14	4661	90	13	1612	31	4	519	10	1	555	11	2

OPTION 2B
SOLID WASTE HEAT RECOVERY-100 TONS/DAY

YEAR-MONTH	HEATING PLANT (1000 LBS)	S.E. STEAM PLANT (1000 LBS)	TOTAL COMMUNITY REQUIREMENT (1000 LBS)	COMMUN. PEAK DEMAND (LBS/HR)	COMMUN. MINIMUM DEMAND (LBS/HR)	COMMUN. AVERAGE DEMAND (LBS/HR)	TOTAL ELECTRIC GENERATION (KWH)	MINIMUM ELECTRIC GENERATION (KW)	MAXIMUM ELECTRIC GENERATION (KW)	WESTERN COAL USAGE (TONS)	454 (TONS)	SOLID WASTE USAGE (TONS)
7601	61798	198597	260395	464	254	349	5506421	7000	7403	18676	1863	2972
7602	18568	169741	188309	443	191	280	4706458	5296	7403	13393	1339	2684
7603	11136	178856	189992	372	144	255	4959146	3493	7403	13416	1342	2972
7604	0	120316	120316	252	113	167	3336012	3133	6967	7983	798	2874
7605	0	119815	119815	235	119	161	3322117	3299	6516	7889	789	2972
7606	0	136932	136932	261	127	190	3746770	3521	7237	9312	931	2876
7607	2	146777	146779	269	146	197	4069759	4046	7403	10044	1004	2972
7608	4	143823	143827	269	137	193	3987834	3799	7403	9808	981	2972
7609	0	117658	117658	242	114	163	3262334	3161	6710	7771	777	2476
7610	606	154242	154848	308	140	208	4276738	3882	7403	10684	1068	2972
7611	17946	180046	197994	453	168	274	4992174	4658	7403	14061	1406	2876
7612	65966	192131	258097	478	243	346	5326323	6738	7403	18460	1846	2972
TOTAL	176748	1858934	2035682	478	113	232	51542058	3133	7403	141507	14151	34992
7701	94803	198642	293445	521	261	394	5507666	7000	7403	21076	2108	2972
7702	17975	171054	189029	405	174	281	4742809	4025	7403	13454	1345	2684
7703	1256	155376	156632	346	117	210	4308166	3244	7403	10822	1082	2972
7704	73	106643	106716	301	94	150	3012317	2606	7403	7056	706	2476
7705	0	107865	107865	228	92	144	2990714	2551	6322	6934	693	2972
7706	0	114272	114272	229	116	158	3168389	3216	6350	7501	750	2876
7707	0	133509	133509	249	127	179	3701820	3521	6904	8983	898	2972
7708	0	107597	107597	239	95	144	2963365	2634	6627	6912	691	2972
7709	0	94788	94788	220	98	131	2628124	2717	6100	5944	594	2876
7710	606	154242	154848	308	140	208	4276738	3882	7403	10684	1068	2972
7711	17948	180046	197994	453	168	274	4992174	4658	7403	14061	1406	2876
7712	65966	192131	258097	478	243	346	5326323	6738	7403	18460	1846	2972
TOTAL	198627	1718135	1916762	521	92	218	47638545	2551	7403	131698	13170	34992
7801	117631	198648	316279	535	292	425	5507832	7000	7403	22737	2274	2972
7802	28404	175449	203853	427	196	303	4863542	5435	7403	14559	1456	2684
7803	2275	161797	164072	356	127	220	4486207	3521	7403	11410	1141	2972
7804	166	115750	115916	311	104	160	3209421	2883	7403	7630	763	2876
7805	0	121257	121257	246	110	162	3362093	3050	6821	6004	600	2972
7806	0	126512	126512	246	133	175	3507835	3688	6821	8478	848	2876
7807	12	153595	153597	276	154	206	4258511	4270	7403	10588	1059	2972
7808	0	118757	118757	254	110	159	3292742	3050	7043	7804	780	2972
7809	0	129898	129898	259	131	180	3601726	3632	7182	8749	875	2876
7810	1622	164386	166008	323	155	223	4558007	4298	7403	11568	1157	2972
7811	25852	185822	211674	472	187	293	5152288	5185	7403	15096	1510	2876
7812	82144	193035	275179	501	23	369	5352187	637	7403	19710	1971	2972
TOTAL	258146	1844856	2102992	535	23	240	51152391	637	7403	146348	14635	34992
7901	122095	198648	320743	541	298	431	5507832	7000	7403	23062	2306	2972
7902	30508	175993	206501	431	200	307	4879729	5546	7403	14758	1476	2684
7903	2544	163016	165560	356	129	222	4520009	3577	7403	11526	1153	2972
7904	192	117164	117356	313	106	162	3248587	2439	7403	7746	775	2876
7905	0	123489	123489	249	113	165	3423964	3133	6904	8182	818	2972
7906	0	128672	128672	249	136	178	3567721	3771	6904	8657	865	2876
7907	89	157228	157317	281	159	211	4359539	4409	7403	10886	1089	2972
7908	0	120245	120245	256	112	161	3334042	3105	7098	7924	792	2972
7909	0	132058	132058	262	134	183	3661607	3715	7265	8921	892	2876
7910	1942	166298	168240	326	158	226	4611026	4381	7403	11745	1175	2972
7911	27877	186677	214554	476	191	297	5175977	5296	7403	15313	1531	2876
7912	85748	193151	278899	506	28	374	5355411	776	7403	19982	1998	2972
TOTAL	270995	1862639	2133634	541	28	243	51645444	776	7403	148706	14871	34992

OPTION 2H
SOLID WASTE HEAT RECOVERY-100 TONS/DAY

YEAR-MONTH	HEATING PLANT (1000 LBS)	S.E. STEAM PLANT (1000 LBS)	TOTAL COMMUNITY REQUIREMENT (1000 LBS)	COMMUN. PEAK DEMAND (LBS/HR)	COMMUN. MINIMUM DEMAND (LBS/HR)	COMMUN. AVERAGE DEMAND (LBS/HR)	TOTAL ELECTRIC GENERATION (KWH)	MINIMUM ELECTRIC GENERATION (KWH)	MAXIMUM ELECTRIC GENERATION (KWH)	WESTERN COAL USAGE (TONS)	ASH (TONS)	SOLID WASTE USAGE (TONS)
8001	122095	198648	320743	541	298	431	5507832	7000	7403	23002	2306	2972
8002	30508	175993	206501	431	200	307	4874729	5546	7403	14758	1476	2684
8003	2544	163016	165560	356	129	222	4520009	3577	7403	11526	1153	2972
8004	192	117164	117356	313	106	162	3248587	2939	7403	7746	775	2876
8005	0	123489	123489	249	113	165	3423964	3133	6904	8182	818	2972
8006	0	128672	128472	249	136	178	3567721	3771	6904	8651	865	2876
8007	89	157228	157317	281	159	211	4359539	4409	7403	10886	1089	2972
8008	0	120245	120245	256	112	161	3334042	3105	7098	7924	792	2972
8009	0	132058	132058	262	134	183	3661667	3715	7265	6921	692	2876
8010	1942	166238	168180	326	158	226	4611026	4381	7403	11745	1175	2972
8011	27877	186677	214554	476	191	297	5175977	5296	7403	15313	1531	2876
8012	85748	193151	278899	506	28	374	5355411	776	7403	19982	1998	2972
TOTAL	270995	1862639	2133634	541	28	243	51645444	776	7403	146706	14871	34992
8101	136975	198648	335623	561	316	451	5507832	7000	7403	24144	2414	2972
8102	38215	177694	215909	445	214	321	4926889	5934	7403	15455	1546	2684
8103	3699	167813	171512	366	137	230	4653021	3799	7403	11994	1199	2972
8104	288	120668	120956	316	111	167	3345741	3078	7403	8033	803	2876
8105	0	132417	132417	261	125	177	3671574	3466	7237	8896	890	2972
8106	0	140192	140192	265	152	194	3887141	4214	7348	9572	957	2876
8107	1213	172472	173685	303	181	233	4782249	5019	7403	12185	1219	2972
8108	3	130658	130661	270	126	175	3622784	3493	7403	8756	876	2972
8109	48	142090	142138	276	148	197	3939794	4104	7403	9727	973	2876
8110	3138	171798	174936	335	167	235	4763529	4630	7403	12271	1227	2972
8111	35292	188624	223914	489	204	310	5229937	5656	7403	16007	1601	2876
8112	96563	193496	290059	521	43	389	5364979	1192	7403	20795	2080	2972
TOTAL	315432	1936570	2250002	561	43	257	53695470	1192	7403	157844	15784	34992
8201	139207	198648	337855	564	321	454	5507832	7000	7403	24305	2431	2972
8202	38787	177794	216581	446	215	322	4929653	5961	7403	15504	1550	2684
8203	3873	168383	172256	367	138	231	4668813	3826	7403	12051	1205	2972
8204	310	121366	121676	319	112	168	3365066	3105	7403	8090	809	2876
8205	0	132417	132417	261	125	177	3671574	3466	7237	8896	890	2972
8206	0	140192	140192	265	152	194	3887141	4214	7348	9572	957	2876
8207	1213	172472	173685	303	181	233	4782249	5019	7403	12185	1219	2972
8208	3	130658	130661	270	126	175	3622784	3493	7403	8756	876	2972
8209	48	142090	142138	276	148	197	3939794	4104	7403	9727	973	2876
8210	3292	172388	175680	336	168	236	4779869	4658	7403	12329	1233	2972
8211	35884	188750	224634	490	205	311	5233429	5684	7403	16000	1600	2876
8212	98005	193542	291547	523	45	391	5366244	1247	7403	20903	2090	2972
TOTAL	320622	1938700	2259322	564	45	257	53754448	1247	7403	158391	15839	34992
8301	141439	198648	340087	567	324	457	5507832	7000	7403	24467	2447	2972
8302	39368	177885	217253	447	216	323	4932176	5989	7403	15554	1555	2684
8303	4050	168950	173000	368	139	232	4684534	3854	7403	12109	1211	2972
8304	333	122063	122396	320	113	169	3384432	3133	7403	8147	815	2876
8305	0	132417	132417	261	125	177	3671574	3466	7237	8896	890	2972
8306	0	140192	140192	265	152	194	3887141	4214	7348	9572	957	2876
8307	1213	172472	173685	303	181	233	4782249	5019	7403	12185	1219	2972
8308	3	130658	130661	270	126	175	3622784	3493	7403	8756	876	2972
8309	48	142090	142138	276	148	197	3939794	4104	7403	9727	973	2876
8310	3447	172977	176424	337	169	237	4796207	4686	7403	12388	1239	2972
8311	36482	188872	225354	491	206	312	5236812	5712	7403	16114	1611	2876
8312	99447	193588	293035	525	47	393	5367532	1303	7403	21012	2101	2972
TOTAL	325830	1940812	2264642	567	47	258	53813067	1303	7403	158938	15894	34992

OPTION 2A
SOLID WASTE HEAT RECOVERY-100 TONS/DAY

UNIT TRAIN CAPLOADS TO S.E. PLANT (10 TON CARS)				COAL TRIPS TO ST. PAUL (10 TON TRUCKS)			SOLID WASTE TRIPS TO S.E. PLANT (6 TON TRUCKS)			TRUCKS OF ASH FROM MPLS. (10 TON TRUCKS)			TRUCKS OF ASH FROM ST. PAUL (10 TON TRUCKS)			TRUCKS OF FRIT FROM S.E. PLANT (10 TON TRUCKS)		
MONTH	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY
1976																		
JAN	263	66	8	77	193	2	495	124	15	186	47	6	77	19	2	59	15	1
FEB	181	45	6	474	119	17	447	112	15	133	33	4	47	12	1	53	13	1
MAR	174	44	5	441	100	12	495	124	15	134	34	4	40	10	1	59	15	1
APR	15	26	3	259	65	8	479	120	15	79	20	2	25	6	0	57	14	1
MAY	18	27	3	234	74	9	495	124	15	78	20	2	29	7	0	59	15	1
JUN	126	32	4	354	89	11	479	120	15	93	23	3	15	9	1	57	14	1
JUL	14	35	4	392	100	12	495	124	15	100	25	3	19	10	1	59	15	1
AUG	133	33	4	354	89	11	495	124	15	98	25	3	15	9	1	59	15	1
SEP	16	27	3	244	72	9	479	120	15	77	19	2	28	7	0	57	14	1
OCT	145	36	4	344	96	12	495	124	15	106	27	3	18	10	1	59	15	1
NOV	193	48	6	524	132	17	479	120	15	140	35	4	52	13	1	57	14	1
DEC	254	64	8	694	174	22	495	124	15	184	46	5	69	17	2	59	15	1
TOTAL	1931	37	5	5197	100	14	5828	112	16	1408	27	4	514	10	1	694	13	2
1977																		
JAN	287	72	9	744	192	24	495	124	15	210	53	6	76	19	2	59	15	1
FEB	181	45	6	474	119	16	447	112	15	134	34	4	47	12	1	53	13	1
MAR	145	37	4	441	100	12	495	124	15	108	27	3	40	10	1	59	15	1
APR	96	24	3	259	65	8	479	120	15	70	18	2	25	6	0	57	14	1
MAY	98	25	3	293	73	9	495	124	15	69	17	2	29	7	0	59	15	1
JUN	11	28	3	355	89	11	479	120	15	75	19	2	15	9	1	57	14	1
JUL	129	32	4	397	99	12	495	124	15	89	22	2	39	10	1	59	15	1
AUG	14	26	3	349	87	11	495	124	15	69	17	2	34	9	1	59	15	1
SEP	87	22	2	244	71	9	479	120	15	59	15	1	28	7	0	57	14	1
OCT	145	36	4	344	96	12	495	124	15	104	27	3	38	10	1	59	15	1
NOV	193	48	6	524	131	17	479	120	15	140	35	4	52	13	1	57	14	1
DEC	254	64	8	694	174	22	495	124	15	184	46	5	69	17	2	59	15	1
TOTAL	632	35	5	5141	100	14	5828	112	16	1313	25	4	512	10	1	694	13	2
1978																		
JAN	314	76	9	744	192	24	495	124	15	227	57	7	76	19	2	59	15	1
FEB	193	48	6	474	119	16	447	112	15	145	36	5	47	12	1	53	13	1
MAR	154	39	4	441	100	12	495	124	15	114	29	3	40	10	1	59	15	1
APR	112	26	3	259	65	8	479	120	15	76	19	2	25	6	0	57	14	1
MAY	119	27	3	293	73	9	495	124	15	80	20	2	29	7	0	59	15	1
JUN	121	30	4	355	89	11	479	120	15	84	21	2	15	9	1	57	14	1
JUL	145	36	4	397	99	12	495	124	15	105	26	3	19	10	1	59	15	1
AUG	112	26	3	349	87	11	495	124	15	78	20	2	14	9	1	59	15	1
SEP	116	29	3	244	71	9	479	120	15	87	22	2	28	7	0	57	14	1
OCT	154	39	4	344	96	12	495	124	15	115	29	3	18	10	1	59	15	1
NOV	203	51	6	524	131	17	479	120	15	150	38	5	52	13	1	57	14	1
DEC	266	67	8	694	174	22	495	124	15	197	49	6	69	17	2	59	15	1
TOTAL	1978	38	5	5181	100	14	5828	112	16	1458	28	4	512	10	1	694	13	2

OPTION 2B
SOLID WASTE HEAT RECOVERY-100 TONS/DAY

MONTH	UNIT TRAIN CARLOADS TO S.E. PLANT (100 TON CARS)			COAL TRIPS TO ST. PAUL (10 TON TRUCKS)			SOLID WASTE TRIPS TO S.E. PLANT (6 TON TRUCKS)			TRUCKS OF ASH FROM MPLS. (10 TON TRUCKS)			TRUCKS OF ASH FROM ST. PAUL (10 TON TRUCKS)			TRUCKS OF FERT FROM S.E. PLANT (10 TON TRUCKS)		
	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY
1979																		
JAN	3.7	77	9	769	192	24	495	124	15	230	58	7	76	19	2	59	15	1
FEB	195	49	6	474	119	16	447	112	15	147	37	5	47	12	1	53	13	1
MAR	155	39	5	470	100	12	445	124	15	115	29	3	40	10	1	59	15	1
APR	1.3	26	3	259	65	8	479	120	15	77	19	2	25	6	0	57	14	1
MAY	111	29	1	299	73	9	495	124	15	81	20	2	29	7	0	59	15	1
JUN	122	31	4	355	89	11	479	120	15	66	22	2	35	9	1	57	14	1
JUL	146	37	4	397	99	12	495	124	15	108	27	3	39	10	1	59	15	1
AUG	114	29	3	340	87	11	495	124	15	79	20	2	34	9	1	59	15	1
SEP	117	29	3	245	71	9	479	120	15	89	22	2	28	7	0	57	14	1
OCT	156	39	5	354	96	12	495	124	15	117	29	3	38	10	1	59	15	1
NOV	2.5	51	6	524	131	17	479	120	15	153	38	5	52	13	1	57	14	1
DEC	269	67	8	694	174	22	495	124	15	199	50	6	69	17	2	59	15	1
TOTAL	2001	38	5	5141	100	14	5828	112	16	1481	28	4	512	10	1	694	13	2

1980																		
JAN	3.7	77	9	773	93	24	495	124	15	230	58	7	77	19	2	59	15	1
FEB	195	49	6	475	120	17	447	112	15	147	37	5	47	12	1	53	13	1
MAR	155	39	5	470	101	13	445	124	15	115	29	3	40	10	1	59	15	1
APR	1.3	26	3	251	65	8	479	120	15	77	19	2	26	7	0	57	14	1
MAY	111	28	3	245	74	9	495	124	15	81	20	2	29	7	0	59	15	1
JUN	122	31	4	355	90	11	479	120	15	66	22	2	35	9	1	57	14	1
JUL	146	37	4	400	100	12	495	124	15	108	27	3	40	10	1	59	15	1
AUG	114	29	3	350	88	11	495	124	15	79	20	2	35	9	1	59	15	1
SEP	117	29	3	287	72	9	479	120	15	89	22	2	28	7	0	57	14	1
OCT	156	39	5	384	97	12	495	124	15	117	29	3	38	10	1	59	15	1
NOV	2.5	51	6	527	132	17	479	120	15	153	38	5	52	13	1	57	14	1
DEC	269	67	8	640	175	22	495	124	15	199	50	6	69	17	2	59	15	1
TOTAL	2002	39	5	5221	100	14	5828	112	16	1481	28	4	516	10	1	694	13	2

1981																		
JAN	319	80	10	774	194	25	495	124	15	241	60	7	77	19	2	59	15	1
FEB	232	51	7	491	120	17	447	112	15	154	39	5	48	12	1	53	13	1
MAR	160	40	5	404	102	13	445	124	15	119	30	3	40	10	1	59	15	1
APR	116	27	3	263	66	8	479	120	15	80	20	2	26	7	0	57	14	1
MAY	110	30	3	297	74	9	495	124	15	88	22	2	29	7	0	59	15	1
JUN	131	33	4	360	90	12	479	120	15	95	24	3	36	9	1	57	14	1
JUL	162	41	5	407	101	12	495	124	15	121	30	3	40	10	1	59	15	1
AUG	122	31	3	354	89	11	495	124	15	87	22	2	35	9	1	59	15	1
SEP	126	32	4	299	72	9	479	120	15	97	24	3	28	7	0	57	14	1
OCT	161	40	5	388	97	12	495	124	15	122	31	3	38	10	1	59	15	1
NOV	213	53	7	529	132	17	479	120	15	160	40	5	52	13	1	57	14	1
DEC	278	70	8	709	176	22	495	124	15	207	52	6	70	18	2	59	15	1
TOTAL	2098	40	6	5244	101	14	5828	112	16	1571	30	4	519	10	1	694	13	2

OPTION 2C
SOLID WASTE HEAT RECOVERY-132 TONS/DAY

YEAR-MONTH	HEATING PLANT (1000 LBS)	S.E. STEAM PLANT (1000 LBS)	TOTAL COMMUNITY REQUIREMENT (1000 LBS)	COMMUN. PEAK DEMAND (LBS/HR)	COMMUN. MINIMUM DEMAND (LBS/HR)	COMMUN. AVERAGE DEMAND (LBS/HR)	TOTAL ELECTRIC GENERATION (KWH)	MINIMUM ELECTRIC GENERATION (KWH)	MAXIMUM ELECTRIC GENERATION (KWH)	WESTERN COAL USAGE (TONS)	ASH (TONS)	SOLID WASTE USAGE (TONS)
7601	54578	205817	260395	464	254	349	5577619	7000	7500	18156	1816	3923
7602	15676	172653	188329	443	191	280	4737305	5296	7500	12917	1291	3544
7603	8007	181985	189992	372	144	255	4991317	3993	7500	12885	1289	3923
7604	0	120316	120316	252	113	167	3336012	3133	6907	7461	746	3797
7605	0	119815	119815	235	119	141	3322117	3299	6516	7350	735	3923
7606	0	136932	136932	261	127	190	3796770	3521	7237	8790	879	3797
7607	0	146779	146779	269	146	197	4069615	4048	7459	9505	951	3923
7608	0	143827	143827	269	137	193	3987946	3799	7459	9269	927	3923
7609	0	117658	117658	242	114	163	3262364	3161	6710	7249	725	3797
7610	266	154532	154848	308	140	208	4280512	3882	7500	10146	1015	3923
7611	14674	183320	197994	453	168	274	5025270	4658	7500	13547	1355	3797
7612	59173	198894	258067	478	243	346	5392865	6738	7500	17938	1794	3923
TOTAL	52374	1882578	2034952	478	113	232	51779852	3133	7500	135219	13522	46193
7701	87438	206017	293445	521	261	394	5579737	7000	7500	20558	2056	3923
7702	14193	174836	189029	405	174	281	4783096	4025	7500	12976	1298	3544
7703	635	155997	156632	346	117	210	4315834	3244	7500	10285	1029	3923
7704	24	108692	108716	301	94	150	3012886	2606	7500	6534	653	3797
7705	0	107865	107865	228	92	144	2990714	2551	6322	6395	640	3923
7706	0	114272	114272	229	116	158	3168389	3216	6350	6979	698	3797
7707	0	133539	133509	249	127	179	3701620	3521	6904	8444	844	3923
7708	0	107597	107597	239	95	144	2983305	2634	6627	6373	637	3923
7709	0	94788	94788	220	98	131	2628124	2717	6100	5422	542	3797
7710	266	154532	154848	308	140	208	4280512	3882	7500	10146	1015	3923
7711	14674	183320	197994	453	168	274	5025270	4658	7500	13547	1355	3797
7712	59173	198894	258067	478	243	346	5392865	6738	7500	17938	1794	3923
TOTAL	176413	1741359	1914762	521	92	218	47862552	2551	7500	125608	12561	46193
7801	110191	206088	316279	535	292	425	5580000	7000	7500	22217	2222	3923
7802	23366	180447	203813	427	196	303	4914156	5435	7500	14085	1409	3544
7803	1256	162816	164072	356	127	220	4497604	3521	7500	10874	1087	3923
7804	73	115843	115916	311	104	140	3210434	2883	7500	7109	711	3797
7805	0	121257	121257	246	110	162	3362093	3050	6821	7466	747	3923
7806	0	126512	126512	246	133	175	3507835	3688	6821	7956	796	3797
7807	0	153597	153597	276	154	206	4258692	4270	7500	10049	1005	3923
7808	0	118757	118757	254	110	159	3292742	3050	7043	7264	727	3923
7809	0	129898	129898	259	131	180	3601726	3632	7182	8227	823	3797
7810	872	165136	166008	323	155	223	4567499	4298	7500	11032	1103	3923
7811	21324	191350	211674	472	187	293	5197444	5185	7500	14586	1459	3797
7812	75036	200143	275179	501	23	369	5421434	637	7500	19189	1919	3923
TOTAL	232118	1871844	2103962	535	23	240	51411659	637	7500	140066	14007	46193
7901	114655	206088	320743	541	298	431	5580000	7000	7500	22542	2254	3923
7902	25321	181180	206501	431	200	307	4930751	5546	7500	14285	1429	3544
7903	1442	164118	165560	358	129	222	4532916	3577	7500	10991	1099	3923
7904	89	117267	117356	313	106	162	3249766	2939	7500	7224	722	3797
7905	0	123489	123489	249	113	165	3423964	3133	6904	7643	764	3923
7906	0	128672	128672	249	136	178	3567721	3771	6904	8129	813	3797
7907	4	157313	157317	281	159	211	4361388	4408	7500	10347	1035	3923
7908	0	120245	120245	256	112	161	3334042	3105	7098	7384	738	3923
7909	0	132058	132058	262	134	183	3661607	3715	7265	8399	840	3797
7910	1042	167198	168240	326	158	226	4621325	4381	7500	11208	1121	3923
7911	23094	191460	214554	476	191	297	5225327	5296	7500	14804	1480	3797
7912	78581	200318	278899	506	28	374	5425348	776	7500	19461	1946	3923
TOTAL	244228	1889406	2133634	541	28	243	51914155	776	7500	142427	14243	46193

OPTION 2C
SOLID WASTE HEAT RECOVERY-132 TONS/DAY

YEAR-MONTH	HEATING PLANT (1000 LBS)	S.E. STEAM PLANT (1000 LBS)	TOTAL COMMUNITY REQUIREMENT (1000 LBS)	COMMUN. PEAK DEMAND (LBS/HR)	COMMUN. MINIMUM DEMAND (LBS/HR)	COMMUN. AVERAGE DEMAND* (LBS/HR)	TOTAL ELECTRIC GENERATION (KWH)	MINIMUM ELECTRIC GENERATION (KWH)	MAXIMUM ELECTRIC GENERATION (KWH)	WESTERN COAL USAGE (TONS)	ASH (TONS)	SOLID WASTE USAGE (TONS)
8001	114655	206088	320743	541	298	471	5580000	7000	7500	22542	2254	3923
8002	25321	181191	206501	431	200	307	4930751	5540	7500	14265	1429	3544
8003	1442	164118	165560	356	129	222	4532916	3577	7500	10991	1099	3923
8004	89	117267	117356	313	106	162	3249766	2439	7500	7224	722	3797
8005	0	123489	123489	249	113	145	3423964	3133	6904	7643	764	3923
8006	0	128672	128672	249	136	178	3567721	3771	6904	8129	813	3797
8007	4	157313	157317	281	159	211	4361368	4409	7500	10347	1035	3923
8008	0	120245	120245	256	112	141	3334042	3105	7098	7384	738	3923
8009	0	132058	132058	262	134	183	3601607	3715	7265	8399	840	3797
8010	1042	167198	168240	326	158	226	4621325	4381	7500	11208	1121	3923
8011	23094	191460	214554	476	191	297	5225327	5240	7500	14804	1480	3797
8012	78581	200318	278899	506	28	374	5425348	776	7500	19401	1940	3923
TOTAL	244226	18894.6	2137434	541	28	243	51914155	776	7500	142427	14243	46193
8101	129535	206088	335623	561	318	451	5580000	7000	7500	23623	2362	3923
8102	32650	183259	215909	445	214	321	4981519	5434	7500	14982	1498	3544
8103	2275	169237	171512	366	137	230	4467805	3799	7500	11458	1146	3923
8104	134	120822	120956	318	111	167	3347668	3078	7500	7511	751	3797
8105	0	132417	132417	261	125	177	3671574	3466	7237	8357	836	3923
8106	0	140192	140192	265	152	194	3887141	4214	7348	9050	905	3797
8107	510	173175	173685	303	181	233	4790817	5019	7500	11648	1165	3923
8108	0	130661	130661	270	126	175	3622868	3493	7487	8214	822	3923
8109	0	142138	142138	276	148	197	3940473	4104	7500	9205	921	3797
8110	1834	173172	174936	335	167	235	4778044	4630	7500	11736	1174	3923
8111	29526	194388	223914	489	204	310	5286813	5656	7500	15500	1550	3797
8112	89353	200756	290059	521	43	349	5434916	1192	7500	20274	2027	3923
TOTAL	285817	1966185	2252002	561	43	257	53989638	1192	7500	151570	15157	46193
8201	131767	206088	337855	564	321	454	5580000	7000	7500	23785	2379	3923
8202	33193	183388	216581	446	215	322	4984630	5461	7500	15031	1503	3544
8203	2409	169847	172256	367	138	231	4684474	3826	7500	11510	1152	3923
8204	144	121532	121676	319	112	168	3367077	3105	7500	7568	757	3797
8205	0	132417	132417	261	125	177	3671574	3466	7237	8357	836	3923
8206	0	140192	140192	265	152	194	3887141	4214	7348	9050	905	3797
8207	510	173175	173685	303	181	233	4790817	5019	7500	11648	1165	3923
8208	0	130661	130661	270	126	175	3622868	3493	7487	8214	822	3923
8209	0	142138	142138	276	148	197	3940473	4104	7500	9205	921	3797
8210	1942	173738	175680	336	168	236	4794632	4658	7500	11794	1179	3923
8211	30088	194546	224634	490	205	311	5290637	5684	7500	15553	1555	3797
8212	90795	200752	291547	523	45	391	5436181	1247	7500	20383	2038	3923
TOTAL	290848	1968474	2259322	564	45	257	54050504	1247	7500	152118	15212	46193
8301	133999	206088	340087	567	324	457	5580000	7000	7500	23947	2395	3923
8302	33742	183511	217253	447	216	323	4987668	5489	7500	15081	1508	3544
8303	2544	170456	173000	368	139	232	4700941	3854	7500	11575	1158	3923
8304	155	122241	122396	320	113	169	3386540	3133	7500	7626	763	3797
8305	0	132417	132417	261	125	177	3671574	3466	7237	8357	836	3923
8306	0	140192	140192	265	152	194	3887141	4214	7348	9050	905	3797
8307	510	173175	173685	303	181	233	4790817	5019	7500	11648	1165	3923
8308	0	130661	130661	270	126	175	3622868	3493	7487	8214	822	3923
8309	0	142138	142138	276	148	197	3940473	4104	7500	9205	921	3797
8310	2051	174373	176424	337	169	237	4811134	4686	7500	11852	1185	3923
8311	30654	194700	225354	491	206	312	5294352	5712	7500	15607	1561	3797
8312	92237	200798	293035	525	47	393	5437469	1303	7500	20491	2049	3923
TOTAL	295892	1970750	2266642	567	47	258	54110977	1303	7500	152666	15267	46193

OPTION 2C
SOLID WASTE HEAT RECOVERY-132 TONS/DAY

UNIT TRAIN CARLOADS TO S.E. PLANT (110 TON CARS)				COAL TRIPS TO ST. PAUL (110 TON TRUCKS)			SOLID WASTE TRIPS TO S.E. PLANT (16 TON TRUCKS)			TRUCKS OF ASH FROM MPLS. (110 TON TRUCKS)			TRUCKS OF ASH FROM ST. PAUL (110 TON TRUCKS)			TRUCKS OF FRIT FROM S.E. PLANT (10 TON TRUCKS)		
MONTH	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY
1976																		
JAN	258	65	8	77	193	24	653	163	21	181	45	5	77	19	2	78	20	2
FEB	176	44	6	474	119	17	590	148	21	129	32	4	47	12	1	70	18	2
MAR	149	42	5	401	100	12	653	163	21	128	32	4	40	10	1	78	20	2
APR	100	25	3	259	65	8	632	158	21	74	14	2	25	6	0	75	19	2
MAY	112	26	3	294	74	9	653	163	21	73	18	2	29	7	0	78	20	2
JUN	123	31	4	354	89	11	632	158	21	87	22	2	25	9	1	75	19	2
JUL	134	34	4	349	100	12	653	163	21	95	24	3	39	10	1	78	20	2
AUG	127	32	4	351	88	11	653	163	21	92	23	2	25	9	1	78	20	2
SEP	111	25	3	244	72	9	632	158	21	72	18	2	28	7	0	75	19	2
OCT	130	35	4	344	96	12	653	163	21	101	25	3	28	10	1	78	20	2
NOV	166	47	6	524	132	17	632	158	21	135	34	4	52	13	1	75	19	2
DEC	249	62	8	634	174	22	653	163	21	179	45	5	49	17	2	76	20	2
TOTAL	866	36	5	5197	100	14	7689	148	21	1346	26	4	514	10	1	916	18	3

1977																		
JAN	282	71	9	769	192	24	653	163	21	205	51	6	76	19	2	78	20	2
FEB	177	44	6	474	119	16	590	148	21	129	32	4	47	12	1	70	18	2
MAR	142	36	4	400	100	12	653	163	21	102	26	3	40	10	1	78	20	2
APR	91	23	3	255	65	8	632	158	21	65	16	2	25	6	0	75	19	2
MAY	93	23	3	233	73	9	653	163	21	63	16	2	29	7	0	78	20	2
JUN	115	26	3	355	89	11	632	158	21	69	17	2	25	9	1	75	19	2
JUL	124	31	4	397	99	12	653	163	21	84	21	2	29	10	1	78	20	2
AUG	98	25	3	340	87	11	653	163	21	63	16	2	34	9	1	78	20	2
SEP	82	21	2	285	71	9	632	158	21	54	14	1	28	7	0	75	19	2
OCT	139	35	4	384	96	12	653	163	21	101	25	3	38	10	1	78	20	2
NOV	187	47	6	524	131	17	632	158	21	135	34	4	52	13	1	75	19	2
DEC	248	62	8	634	174	22	653	163	21	179	45	5	49	17	2	78	20	2
TOTAL	1768	34	5	5181	100	14	7689	148	21	1249	24	3	512	10	1	916	18	3

1978																		
JAN	299	75	9	769	192	24	653	163	21	222	56	7	76	19	2	78	20	2
FEB	188	47	6	474	119	16	590	148	21	140	35	5	47	12	1	70	18	2
MAR	148	37	4	400	100	12	653	163	21	108	27	3	40	10	1	78	20	2
APR	96	24	3	259	65	8	632	158	21	71	18	2	25	6	0	75	19	2
MAY	104	26	3	233	73	9	653	163	21	74	19	2	29	7	0	78	20	2
JUN	115	29	3	355	89	11	632	158	21	79	20	2	25	9	1	75	19	2
JUL	146	35	4	397	99	12	653	163	21	100	25	3	39	10	1	78	20	2
AUG	107	27	3	340	87	11	653	163	21	72	18	2	34	9	1	78	20	2
SEP	110	28	3	285	71	9	632	158	21	82	21	2	28	7	0	75	19	2
OCT	148	37	4	384	96	12	653	163	21	110	28	3	38	10	1	78	20	2
NOV	198	50	6	524	131	17	632	158	21	145	36	4	52	13	1	75	19	2
DEC	261	65	8	634	174	22	653	163	21	191	48	6	49	17	2	78	20	2
TOTAL	1914	37	5	5181	100	14	7689	148	21	1394	27	4	512	10	1	916	18	3

OPTION 2C
SOLID WASTE HEAT RECOVERY-132 TONS/DAY

MONTH	UNIT TRAIN CARLOADS TO S.E. PLANT (100 TON CARS)			COAL TRIPS TO ST. PAUL (10 TON TRUCKS)			SOLID WASTE TRIPS TO S.E. PLANT (16 TON TRUCKS)			TRUCKS OF ASH FROM MPLS. (10 TON TRUCKS)			TRUCKS OF ASH FROM ST. PAUL (10 TON TRUCKS)			TRUCKS OF FRIT FROM S.E. PLANT (10 TON TRUCKS)		
	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY
1979																		
JAN	302	76	9	769	192	24	653	163	21	225	56	7	76	19	2	78	20	2
FEB	191	48	6	474	119	16	590	148	21	142	36	5	47	12	1	70	18	2
MAR	149	37	4	400	100	12	653	163	21	109	27	3	40	10	1	78	20	2
APR	95	25	3	250	65	8	632	158	21	72	18	2	25	6	0	75	19	2
MAY	115	26	3	290	73	9	653	163	21	76	19	2	29	7	0	78	20	2
JUN	116	29	3	350	89	11	632	158	21	81	20	2	35	9	1	75	19	2
JUL	143	36	4	367	99	12	653	163	21	103	26	3	39	10	1	78	20	2
AUG	118	27	3	340	87	11	653	163	21	73	18	2	34	9	1	78	20	2
SEP	112	28	3	280	71	9	632	158	21	83	21	2	28	7	0	75	19	2
OCT	151	38	4	344	86	12	653	163	21	112	28	3	36	10	1	78	20	2
NOV	200	50	6	524	131	17	632	158	21	148	37	4	52	13	1	75	19	2
DEC	264	66	8	690	174	22	653	163	21	194	49	6	69	17	2	78	20	2
TOTAL	937	37	5	5141	100	14	7689	148	21	1418	27	4	512	10	1	916	18	3

1980																		
JAN	302	76	9	770	193	24	653	163	21	225	56	7	77	19	2	78	20	2
FEB	191	48	6	470	120	17	590	148	21	142	36	5	47	12	1	70	18	2
MAR	151	38	4	400	101	13	653	163	21	109	27	3	40	10	1	78	20	2
APR	96	25	3	261	65	8	632	158	21	72	18	2	26	7	0	75	19	2
MAY	116	27	3	290	74	9	653	163	21	76	19	2	29	7	0	78	20	2
JUN	117	29	3	350	90	11	632	158	21	81	20	2	35	9	1	75	19	2
JUL	143	36	4	400	100	12	653	163	21	103	26	3	40	10	1	78	20	2
AUG	119	27	3	352	88	11	653	163	21	73	18	2	35	9	1	78	20	2
SEP	112	28	3	287	72	9	632	158	21	83	21	2	28	7	0	75	19	2
OCT	151	38	4	380	97	12	653	163	21	112	28	3	38	10	1	76	20	2
NOV	200	50	6	527	132	17	632	158	21	148	37	4	52	13	1	75	19	2
DEC	264	66	8	690	175	22	653	163	21	194	49	6	69	17	2	78	20	2
TOTAL	1941	37	5	5221	100	14	7689	148	21	1418	27	4	516	10	1	916	18	3

1981																		
JAN	313	78	1	774	194	25	653	163	21	236	59	7	77	19	2	78	20	2
FEB	197	49	7	481	120	17	590	148	21	149	37	5	48	12	1	70	18	2
MAR	155	39	5	400	102	13	653	163	21	114	29	3	40	10	1	78	20	2
APR	111	25	3	263	66	8	632	158	21	75	19	2	26	7	0	75	19	2
MAY	113	28	3	297	74	9	653	163	21	83	21	2	29	7	0	78	20	2
JUN	126	32	4	340	90	12	632	158	21	90	23	3	36	9	1	75	19	2
JUL	156	39	5	400	101	12	653	163	21	116	29	3	40	10	1	78	20	2
AUG	117	29	3	354	89	11	653	163	21	82	21	2	35	9	1	78	20	2
SEP	120	30	4	280	72	9	632	158	21	92	23	3	28	7	0	75	19	2
OCT	156	39	5	380	97	12	653	163	21	117	29	3	38	10	1	78	20	2
NOV	208	52	6	520	132	17	632	158	21	155	39	5	52	13	1	75	19	2
DEC	272	68	8	700	176	22	653	163	21	202	51	6	70	18	2	78	20	2
TOTAL	2034	39	6	5244	101	14	7689	148	21	1511	29	4	519	10	1	916	18	3

OPTION 20
SOLID WASTE HEAT RECOVERY-250 TONS/DAY

YEAR-MONTH	HEATING PLANT (1000 LBS)	S.E. STEAM PLANT (1000 LBS)	TOTAL COMMUNITY REQUIREMENT (1000 LBS)	COMMON. PEAK DEMAND (LBS/HR)	COMMON. MINIMUM DEMAND (LBS/HR)	COMMON. AVERAGE DEMAND (LBS/HR)	TOTAL ELECTRIC GENERATION (KWH)	MINIMUM ELECTRIC GENERATION (KWH)	MAXIMUM ELECTRIC GENERATION (KWH)	WESTERN COAL USAGE (TONS)	ASH (TONS)	SOLID WASTE USAGE (TONS)
7601	29523	231872	240395	464	254	349	5577619	7000	7500	16167	1617	7431
7602	8227	180112	188329	443	191	280	4737305	5296	7500	11117	1112	6712
7603	1530	185462	186992	372	144	255	4991317	3493	7500	10897	1090	7431
7604	0	120316	120316	252	113	167	3336012	3133	6967	5537	554	7191
7605	0	119815	119815	235	119	161	3322117	3299	6516	5362	536	7431
7606	0	136932	136932	261	127	190	3796770	3521	7237	6866	687	7191
7607	0	146779	146779	269	146	197	4069815	4048	7459	7516	752	7431
7608	0	143827	143827	269	137	193	3987946	3799	7459	7281	728	7431
7609	0	117656	117656	242	114	163	3202304	3101	6710	5325	533	7191
7610	0	154848	154848	306	140	208	4280512	3682	7500	6158	616	7431
7611	6323	191671	197994	453	168	274	5025270	4656	7500	11623	1162	7191
7612	35771	222296	258067	476	243	346	5392805	6736	7500	15449	1595	7431
TOTAL	81374	1953578	2034952	478	113	232	51779852	3133	7500	111604	11181	87493
7701	5779	232666	238445	521	261	394	5579737	7000	7500	16569	1657	7431
7702	4649	184330	188979	405	174	281	4783096	4825	7500	11180	1118	6712
7703	73	156559	156632	346	117	210	4315834	3244	7500	8296	830	7431
7704	0	103716	103716	301	94	150	3012806	2606	7500	4610	461	7191
7705	0	107865	107865	228	92	144	2990714	2551	6322	4406	441	7431
7706	0	114272	114272	229	110	158	3168309	3210	6350	5055	506	7191
7707	0	133509	133509	249	127	179	3701820	3521	6904	6456	646	7431
7708	0	107597	107597	239	95	144	2903305	2634	6627	4385	439	7431
7709	0	94788	94788	220	98	131	2628124	2717	6100	3498	350	7191
7710	0	154848	154848	306	140	208	4280512	3682	7500	6158	616	7431
7711	6323	191671	197994	453	168	274	5025270	4656	7500	11623	1162	7191
7712	35771	222296	258067	476	243	346	5392805	6736	7500	15449	1595	7431
TOTAL	17595	1809167	1914762	521	92	218	47802552	2551	7500	102197	10220	87493
7801	81452	234827	316279	535	292	425	5580000	7000	7500	20229	2023	7431
7802	9172	194641	203813	427	196	303	4914156	5435	7500	12289	1229	6712
7803	119	163953	164072	356	127	220	4497604	3521	7500	8865	887	7431
7804	0	115916	115916	311	104	160	3210434	2883	7500	5185	519	7191
7805	0	121257	121257	246	110	162	3302093	3050	6821	5476	548	7431
7806	0	126512	126512	246	133	175	3507835	3688	6821	6032	603	7191
7807	0	153597	153597	276	154	206	4258692	4270	7500	8661	866	7431
7808	0	118757	118757	254	110	159	3292742	3050	7043	5277	528	7431
7809	0	129898	129898	259	131	180	3601726	3632	7182	6303	630	7191
7810	7	166001	166008	323	155	223	4567499	4298	7500	9044	904	7431
7811	9686	211988	211674	472	187	293	5197444	5185	7500	12662	1266	7191
7812	48990	226189	275179	501	23	369	5421434	637	7500	17201	1720	7431
TOTAL	49426	1953536	2102962	535	23	240	51411659	637	7500	116655	11666	87493
7901	85756	234987	320743	541	298	431	5580000	7000	7500	20553	2055	7431
7902	10226	196275	206501	431	200	307	4930751	5546	7500	12489	1249	6712
7903	130	165430	165560	358	129	222	4532916	3577	7500	9002	900	7431
7904	0	117356	117356	313	106	162	3249766	2939	7500	5300	530	7191
7905	0	123489	123489	249	113	165	3423964	3133	6904	5655	566	7431
7906	0	128672	128672	249	136	178	3567721	3771	6904	6205	621	7191
7907	0	157317	157317	281	159	211	4361388	4409	7500	6358	636	7431
7908	0	120245	120245	256	112	161	3334042	3105	7098	5396	540	7431
7909	0	132058	132058	262	134	183	3661607	3715	7265	6475	648	7191
7910	16	168224	168240	326	158	226	4621325	4381	7500	9220	922	7431
7911	10541	204013	214554	476	191	297	5225327	5296	7500	12880	1288	7191
7912	52098	226801	278899	506	28	374	5425348	776	7500	17472	1747	7431
TOTAL	158767	1974867	2133634	541	28	243	51914155	776	7500	119016	11902	87493

OPTION 20
SOLID WASTE HEAT RECOVERY-250 TONS/DAY

YEAR-MONTH	HEATING PLANT (1000 LBS)	S.E. STEAM PLANT (1000 LBS)	TOTAL COMMUNITY REQUIREMENT (1000 LBS)	COMMUN. PEAK DEMAND (LBS/HR)	COMMUN. MINIMUM DEMAND (LBS/HR)	COMMUN. AVERAGE DEMAND (LBS/HR)	TOTAL ELECTRIC GENERATION (KWH)	MINIMUM ELECTRIC GENERATION (KWH)	MAXIMUM ELECTRIC GENERATION (KWH)	WESTERN COAL USAGE (TONS)	SOLID WASTE ASH (TONS)	SOLID WASTE USAGE (TONS)
8001	85756	234987	320743	541	290	431	5580000	7000	7500	20553	2055	7431
8002	12226	196275	208501	431	200	307	4930751	5546	7500	12489	1249	6712
8003	130	165431	165560	358	129	222	4532916	3577	7500	9002	900	7431
8004	0	117356	117356	313	106	162	3249766	2439	7500	5300	530	7191
8005	0	123489	123489	249	113	165	3423964	3133	6904	5655	560	7431
8006	0	128072	128072	249	136	176	3567721	3771	6904	6205	621	7191
8007	0	157317	157317	281	159	211	4361366	4409	7500	8358	835	7431
8008	0	122245	122245	256	112	161	3334642	3105	7098	5394	540	7431
8009	0	132258	132258	262	134	183	366167	3715	7265	6475	646	7191
8010	16	168224	168240	326	158	226	4621325	4381	7500	9220	922	7431
8011	1541	204013	214554	476	191	297	5225327	5246	7500	12800	1280	7191
8012	52296	22651	274849	506	20	374	5425346	776	7500	17472	1747	7431
TOTAL	58767	1974667	2133434	541	28	243	51914155	776	7500	119016	11902	67493
8101	100519	235104	335623	561	318	451	5500000	7000	7500	21634	2163	7431
8102	14543	201366	215909	445	214	321	4981519	5734	7500	13186	1319	6712
8103	195	171317	171512	366	137	230	4467605	3749	7500	9470	947	7431
8104	2	122954	122956	318	111	167	3347668	3074	7500	5587	559	7191
8105	0	132417	132417	261	125	177	3671574	3466	7237	6368	637	7431
8106	0	140192	140192	265	152	194	3887141	4214	7348	7126	713	7191
8107	0	173685	173685	303	181	233	4790817	5319	7500	9660	966	7431
8108	0	130661	130661	270	126	175	3622868	3493	7487	6228	623	7431
8109	0	142138	142138	276	146	197	3940473	4104	7500	7281	728	7191
8110	71	174865	174936	335	167	235	4778044	4630	7500	9748	975	7431
8111	13844	210070	223914	469	204	310	5286813	5656	7500	13574	1357	7191
8112	61850	228209	290059	521	43	389	5434916	1192	7500	18285	1829	7431
TOTAL	191324	2061978	2253302	561	43	257	53969638	1192	7500	128159	12816	87493
8201	102751	235104	337855	564	321	454	5580000	7000	7500	21797	2180	7431
8202	14893	201638	216531	446	215	322	4984630	5961	7500	13234	1324	6712
8203	205	172251	172456	367	136	231	4684474	3826	7500	9528	953	7431
8204	3	121673	121676	319	112	168	3367077	3105	7500	5644	564	7191
8205	0	132417	132417	261	125	177	3671574	3466	7237	6368	637	7431
8206	0	140192	140192	265	152	194	3887141	4214	7348	7126	713	7191
8207	0	173685	173685	303	181	233	4790817	5319	7500	9660	966	7431
8208	0	130661	130661	270	126	175	3622868	3493	7487	6228	623	7431
8209	0	142138	142138	276	146	197	3940473	4104	7500	7281	728	7191
8210	83	175597	175680	336	168	236	4794632	4658	7500	9806	981	7431
8211	14118	210516	224634	490	205	311	5290637	5684	7500	13629	1363	7191
8212	63222	228325	291547	523	45	391	5436181	1247	7500	18394	1839	7431
TOTAL	195275	2064047	2259322	564	45	257	54050504	1247	7500	128707	12871	87493
8301	104983	235104	340087	567	324	457	5580000	7000	7500	21959	2196	7431
8302	15245	202008	217253	447	216	323	4987668	5989	7500	13282	1329	6712
8303	215	172785	173000	368	139	232	4700941	3854	7500	9587	959	7431
8304	4	122392	122396	320	113	169	3386540	3133	7500	5705	570	7191
8305	0	132417	132417	261	125	177	3671574	3466	7237	6368	637	7431
8306	0	140192	140192	265	152	194	3887141	4214	7348	7126	713	7191
8307	0	173685	173685	303	181	233	4790817	5319	7500	9660	966	7431
8308	0	130661	130661	270	126	175	3622868	3493	7487	6228	623	7431
8309	0	142138	142138	276	148	197	3940473	4104	7500	7281	728	7191
8310	96	176328	176424	337	169	237	4811134	4686	7500	9864	986	7431
8311	14394	210960	225354	491	206	312	5294352	5712	7500	13683	1368	7191
8312	64594	228441	293035	525	47	393	5437469	1303	7500	18502	1850	7431
TOTAL	199531	2067111	2266642	567	47	258	54110977	1303	7500	129255	12926	87493

OPTION 20
SOLID WASTE HEAT RECOVERY=250 TONS/DAY

MONTH	UNIT TR. IN CARLOADS TO S.E. PLANT (100 TON CAR)			COAL TRIPS TO ST. PAUL (10 TON TRUCKS)			SOLID WASTE TRIPS TO S.E. PLANT (10 TON TRUCKS)			TRUCKS OF ASH FROM MPLS. (10 TON TRUCKS)			TRUCKS OF ASH FROM ST. PAUL (10 TON TRUCKS)			TRUCKS OF FRIT FROM S.E. PLANT (10 TON TRUCKS)		
	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY
1976																		
JAN	238	60	7	77	193	24	1236	310	39	161	40	5	77	19	2	148	37	4
FEB	158	40	5	474	119	17	1118	280	39	111	28	3	47	12	1	134	34	4
MAR	149	37	4	471	100	12	1238	310	39	108	27	3	40	10	1	148	37	4
APR	81	20	2	250	65	8	1198	300	39	55	14	1	25	6	0	143	36	4
MAY	83	21	2	294	74	9	1238	310	39	53	13	1	29	7	0	148	37	4
JUN	14	26	3	344	89	11	1198	300	39	66	17	2	35	9	1	143	36	4
JUL	115	29	3	334	100	12	1236	310	39	75	19	2	39	10	1	148	37	4
AUG	107	27	3	354	68	11	1238	310	39	72	18	2	35	9	1	148	37	4
SEP	61	20	2	284	72	9	1198	300	39	53	13	1	28	7	0	143	36	4
OCT	12	30	3	344	96	12	1238	310	39	81	20	2	38	10	1	148	37	4
NOV	166	42	5	524	132	17	1198	300	39	116	29	3	52	13	1	143	36	4
DEC	229	57	7	694	174	22	1238	310	39	159	40	5	49	17	2	148	37	4
TOTAL	1633	31	4	5197	100	14	14576	280	40	1112	21	3	514	10	1	1742	34	5

1977																		
JAN	262	66	8	744	192	24	1238	310	39	185	46	5	76	19	2	148	37	4
FEB	159	41	5	474	119	16	1118	280	39	111	28	3	47	12	1	134	34	4
MAR	122	31	3	471	100	12	1238	310	39	82	21	2	40	10	1	148	37	4
APR	71	18	2	250	65	8	1198	300	39	46	12	1	25	6	0	143	36	4
MAY	73	18	2	294	73	9	1238	310	39	44	11	1	29	7	0	148	37	4
JUN	86	22	2	354	89	11	1198	300	39	50	13	1	35	9	1	143	36	4
JUL	14	26	3	397	99	12	1238	310	39	64	16	2	39	10	1	148	37	4
AUG	78	20	2	344	87	11	1238	310	39	64	16	2	39	10	1	148	37	4
SEP	63	16	2	284	71	9	1198	300	39	43	11	1	34	9	1	148	37	4
OCT	12	30	3	344	96	12	1236	310	39	34	9	1	28	7	0	143	36	4
NOV	168	42	5	524	131	17	1198	300	39	81	20	2	38	10	1	148	37	4
DEC	228	57	7	694	174	22	1238	310	39	116	29	3	52	13	1	143	36	4
TOTAL	1534	31	4	5197	100	14	14576	280	40	1015	20	3	512	10	1	1742	34	5

1978																		
JAN	279	70	9	744	192	24	1238	310	39	202	51	6	76	19	2	148	37	4
FEB	17	43	6	474	119	16	1118	280	39	122	31	4	47	12	1	134	34	4
MAR	126	32	4	471	100	12	1238	310	39	88	22	2	40	10	1	148	37	4
APR	77	19	2	250	65	8	1198	300	39	51	13	1	25	6	0	143	36	4
MAY	84	21	2	294	73	9	1238	310	39	54	14	1	29	7	0	148	37	4
JUN	95	24	3	354	89	11	1198	300	39	64	15	2	35	9	1	143	36	4
JUL	12	30	3	397	99	12	1238	310	39	80	20	2	39	10	1	148	37	4
AUG	87	22	2	344	87	11	1238	310	39	80	20	2	39	10	1	148	37	4
SEP	91	23	3	284	71	9	1198	300	39	52	13	1	34	9	1	148	37	4
OCT	128	32	4	344	96	12	1238	310	39	63	16	2	28	7	0	143	36	4
NOV	179	45	5	524	131	17	1198	300	39	90	23	2	38	10	1	148	37	4
DEC	241	60	7	694	174	22	1238	310	39	126	32	4	52	13	1	143	36	4
TOTAL	1679	32	5	5181	100	14	14576	280	40	1160	22	3	512	10	1	1742	34	5

OPTION 20
SOLID WASTE HEAT RECOVERY-250 TONS/DAY

MONTH	UNIT TRIPS CARLOWAY TO S.E. PLANT (11 TON TRUCKS)			COAL TRIPS TO ST. PAUL (110 TON TRUCKS)			SOLID WASTE TRIPS TO S.E. PLANT (16 TON TRUCKS)			TRUCKS OF ASH FROM MPLS. (110 TON TRUCKS)			TRUCKS OF ASH FROM ST. PAUL (11 TON TRUCKS)			TRUCKS OF FRIT FROM S.E. PLANT (110 TON TRUCKS)		
	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY	MONTH	WEEK	DAY
1979																		
JAN	282	71	9	740	92	24	1238	310	39	205	51	6	76	19	2	146	37	4
FEB	172	43	6	474	119	16	1118	280	39	124	31	4	27	12	1	134	34	4
MAR	13	33	4	400	100	12	1238	310	39	90	23	2	40	10	1	146	37	4
APR	76	20	2	250	65	8	1198	300	39	53	13	1	25	6	0	143	36	4
MAY	65	21	2	240	73	9	1238	310	39	56	14	1	29	7	0	146	37	4
JUN	97	24	3	350	84	11	1198	300	39	62	16	2	25	9	1	143	36	4
JUL	123	31	3	300	99	12	1238	310	39	83	21	2	29	10	1	148	37	4
AUG	69	22	2	340	87	11	1238	310	39	53	13	1	24	9	1	146	37	4
SEP	43	23	3	240	71	9	1198	300	39	64	16	2	26	7	0	143	36	4
OCT	13	33	4	344	86	12	1238	310	39	92	23	2	26	10	1	148	37	4
NOV	161	45	6	524	131	17	1198	300	39	128	32	4	52	13	1	143	36	4
DEC	244	61	7	600	174	22	1238	310	39	174	44	5	69	17	2	148	37	4
TOTAL	1713	33	5	5100	100	14	14576	280	40	1184	23	3	512	10	1	1742	34	5

1980																		
JAN	282	71	9	772	93	24	1238	310	39	205	51	6	77	19	2	148	37	4
FEB	172	43	6	474	120	17	1118	280	39	124	31	4	27	12	1	134	34	4
MAR	13	33	4	400	101	13	1238	310	39	90	23	2	40	10	1	148	37	4
APR	76	21	2	250	65	8	1198	300	39	53	13	1	26	7	0	143	36	4
MAY	66	22	2	240	74	9	1238	310	39	56	14	1	29	7	0	148	37	4
JUN	97	24	3	350	90	11	1198	300	39	62	16	2	25	9	1	143	36	4
JUL	123	31	3	300	100	12	1238	310	39	83	21	2	29	10	1	148	37	4
AUG	69	22	2	350	88	11	1238	310	39	53	13	1	25	9	1	148	37	4
SEP	43	23	3	240	72	9	1198	300	39	64	16	2	28	7	0	143	36	4
OCT	13	33	4	344	97	12	1238	310	39	92	23	2	28	10	1	148	37	4
NOV	161	45	6	524	132	17	1198	300	39	128	32	4	52	13	1	143	36	4
DEC	244	61	7	600	175	22	1238	310	39	174	44	5	69	17	2	148	37	4
TOTAL	1716	33	5	5220	100	14	14576	280	40	1184	23	3	516	10	1	1742	34	5

1981																		
JAN	293	73	9	774	194	25	1238	310	39	216	54	6	77	19	2	148	37	4
FEB	181	45	6	481	120	17	1118	280	39	131	33	4	28	12	1	134	34	4
MAR	135	34	4	404	102	13	1238	310	39	94	24	3	40	10	1	148	37	4
APR	82	21	2	243	66	8	1198	300	39	55	14	1	26	7	0	143	36	4
MAY	93	23	3	297	74	9	1238	310	39	63	16	2	29	7	0	148	37	4
JUN	107	27	3	340	90	12	1198	300	39	71	18	2	26	9	1	143	36	4
JUL	136	34	4	402	101	12	1238	310	39	96	24	3	40	10	1	148	37	4
AUG	97	24	3	354	89	11	1238	310	39	62	16	2	25	9	1	148	37	4
SEP	111	25	3	268	72	9	1198	300	39	72	18	2	28	7	0	143	36	4
OCT	136	34	4	388	97	12	1238	310	39	97	24	3	28	10	1	148	37	4
NOV	188	47	6	520	132	17	1198	300	39	135	34	4	52	13	1	143	36	4
DEC	253	63	8	700	176	22	1238	310	39	182	46	5	70	18	2	148	37	4
TOTAL	1661	35	5	5244	101	14	14576	280	40	1274	25	3	519	10	1	1742	34	5

BASIC PLAN
UNIVERSITY COMMUNITY ONLY

YEAR	U-HEATING PLANT (1000 LBS)	S.E. STEAM PLANT (1000 LBS)	TOTAL COMMUNITY REQUIREMENT (1000 LBS)	COMMUN. PEAK DEMAND (LBS/HR)	COMMUN. MINIMUM DEMAND (LBS/HR)	COMMUN. AVERAGE DEMAND (LBS/HR)	TOTAL ELECTRIC GENERATION (KWH)	MINIMUM ELECTRIC GENERATION (KW)	MAXIMUM ELECTRIC GENERATION (KW)	WESTERN COAL USAGE (TONS)	ASH USAGE (TONS)	SOLID WASTE USAGE (TONS)
1976	137584	1627796	1765380	414	90	201	45134555	2495	6516	140079	14008	0
1977	158969	1488221	1647190	460	70	188	41264195	1941	6516	130479	13048	0
1978	215884	1617506	1833390	471	23	209	44848970	637	6516	144947	14495	0
1979	228488	1635574	1864062	477	28	212	45349998	776	6516	147307	14731	0
1980	228488	1635574	1864062	477	28	212	45349998	776	6516	147307	14731	0
1981	268004	1707106	1975110	494	41	225	47333418	1136	6516	155895	15590	0
1982	268004	1707106	1975110	494	41	225	47333418	1136	6516	155895	15590	0
1983	268004	1707106	1975110	494	41	225	47333418	1136	6516	155895	15590	0
1984	268004	1707106	1975110	494	41	225	47333418	1136	6516	155895	15590	0
1985	268004	1707106	1975110	494	41	225	47333418	1136	6516	155895	15590	0
1986	268004	1707106	1975110	494	41	225	47333418	1136	6516	155895	15590	0
1987	268004	1707106	1975110	494	41	225	47333418	1136	6516	155895	15590	0
1988	268004	1707106	1975110	494	41	225	47333418	1136	6516	155895	15590	0
1989	268004	1707106	1975110	494	41	225	47333418	1136	6516	155895	15590	0

OPTION 1
ST. MARYS-FAIRVIEW-AUGSBURG ADD-ON

YEAR	U-HEATING PLANT (1000 LBS)	S.E. STEAM PLANT (1000 LBS)	TOTAL COMMUNITY REQUIREMENT (1000 LBS)	COMMUN. PEAK DEMAND (LBS/HR)	COMMUN. MINIMUM DEMAND (LBS/HR)	COMMUN. AVERAGE DEMAND (LBS/HR)	TOTAL ELECTRIC GENERATION (KWH)	MINIMUM ELECTRIC GENERATION (KW)	MAXIMUM ELECTRIC GENERATION (KW)	WESTERN COAL USAGE (TONS)	ASH USAGE (TONS)	SOLID WASTE USAGE (TONS)
1976	269040	1765912	2034952	478	113	232	48964225	3133	6516	160669	16067	0
1977	284678	1632084	1916762	521	92	218	45253135	2551	6516	151112	15111	0
1978	357099	1745863	2102962	535	23	240	48408218	637	6516	165467	16547	0
1979	372781	1760853	2133634	541	28	243	48823889	776	6516	167805	16781	0
1980	372781	1760853	2133634	541	28	243	48823889	776	6516	167805	16781	0
1981	428192	1823810	2252002	561	43	257	50569696	1192	6516	176863	17686	0
1982	434015	1825307	2259322	564	45	257	50611153	1247	6516	177405	17741	0
1983	439864	1826778	2266642	567	47	258	50652003	1303	6516	177948	17795	0
1984	445721	1828241	2273962	570	49	259	50692592	1358	6516	178491	17849	0
1985	451580	1829702	2281282	573	51	260	50733136	1414	6516	179033	17903	0
1986	451580	1829702	2281282	573	51	260	50733136	1414	6516	179033	17903	0
1987	451580	1829702	2281282	573	51	260	50733136	1414	6516	179033	17903	0
1988	451580	1829702	2281282	573	51	260	50733136	1414	6516	179033	17903	0
1989	451580	1829702	2281282	573	51	260	50733136	1414	6516	179033	17903	0

OPTION 2A
SOLID WASTE HEAT RECOVERY-80 TONS/DAY

YEAR	U-HEATING PLANT (1000_LBS)	S.E. STEAM PLANT (1000 LBS)	TOTAL COMMUNITY REQUIREMENT (1000_LBS)	COMMUN. PEAK DEMAND (LBS/HR)	COMMUN. MINIMUM DEMAND (LBS/HR)	COMMUN. AVERAGE DEMAND (LBS/HR)	TOTAL ELECTRIC GENERATION (KWH)	MINIMUM ELECTRIC GENERATION (KW)	MAXIMUM ELECTRIC GENERATION (KW)	WESTERN COAL USAGE (TONS)	ASH (TONS)	SOLID WASTE USAGE (TONS)
1976	191321	1843631	2034952	478	113	232	51119487	3133	7237	145362	14536	27997
1977	212831	1703931	1916762	521	92	218	47245563	2551	7237	135762	13576	27997
1978	274855	1828107	2102962	535	23	240	50688975	637	7237	150193	15019	27997
1979	288196	1845438	2133634	541	28	243	51169526	776	7237	152547	15255	27997
1980	288196	1845438	2133634	541	28	243	51169526	776	7237	152547	15255	27997
1981	334232	1917770	2252002	561	43	257	53175316	1192	7237	161673	16167	27997
1982	339533	1919789	2259322	564	45	257	53231227	1247	7237	162219	16222	27997
1983	344858	1921784	2266642	567	47	258	53286610	1303	7237	162766	16277	27997
1984	350212	1923750	2273962	570	49	259	53341149	1358	7237	163312	16331	27997
1985	355583	1925699	2281282	573	51	260	53395215	1414	7237	163858	16386	27997
1986	355583	1925699	2281282	573	51	260	53395215	1414	7237	163858	16386	27997
1987	355583	1925699	2281282	573	51	260	53395215	1414	7237	163858	16386	27997
1988	355583	1925699	2281282	573	51	260	53395215	1414	7237	163858	16386	27997
1989	355583	1925699	2281282	573	51	260	53395215	1414	7237	163858	16386	27997

OPTION 2B
SOLID WASTE HEAT RECOVERY-100 TONS/DAY

YEAR	U-HEATING PLANT (1000_LBS)	S.E. STEAM PLANT (1000 LBS)	TOTAL COMMUNITY REQUIREMENT (1000_LBS)	COMMUN. PEAK DEMAND (LBS/HR)	COMMUN. MINIMUM DEMAND (LBS/HR)	COMMUN. AVERAGE DEMAND (LBS/HR)	TOTAL ELECTRIC GENERATION (KWH)	MINIMUM ELECTRIC GENERATION (KW)	MAXIMUM ELECTRIC GENERATION (KW)	WESTERN COAL USAGE (TONS)	ASH (TONS)	SOLID WASTE USAGE (TONS)
1976	176048	1858904	2034952	478	113	232	51542058	3133	7403	141507	14151	34992
1977	198627	1718135	1916762	521	92	218	47638545	2551	7403	131898	13190	34992
1978	258106	1844856	2102962	535	23	240	51152391	637	7403	146348	14635	34992
1979	270995	1862639	2133634	541	28	243	51645444	776	7403	148706	14871	34992
1980	270995	1862639	2133634	541	28	243	51645444	776	7403	148706	14871	34992
1981	315432	1936570	2252002	561	43	257	53695470	1192	7403	157844	15784	34992
1982	320622	1938700	2259322	564	45	257	53754448	1247	7403	158391	15839	34992
1983	325830	1940812	2266642	567	47	258	53813067	1303	7403	158938	15894	34992
1984	331055	1942907	2273962	570	49	259	53871176	1358	7403	159485	15949	34992
1985	336298	1944984	2281282	573	51	260	53928785	1414	7403	160032	16003	34992
1986	336298	1944984	2281282	573	51	260	53928785	1414	7403	160032	16003	34992
1987	336298	1944984	2281282	573	51	260	53928785	1414	7403	160032	16003	34992
1988	336298	1944984	2281282	573	51	260	53928785	1414	7403	160032	16003	34992
1989	336298	1944984	2281282	573	51	260	53928785	1414	7403	160032	16003	34992

OPTION 2C
SOLID WASTE HEAT RECOVERY-132 TONS/DAY

YEAR	U-HEATING PLANT (1000 LBS)	S.E. STEAM PLANT (1000 LBS)	TOTAL COMMUNITY REQUIREMENT (1000 LBS)	COMMUN. PEAK DEMAND (LBS/HR)	COMMUN. MINIMUM DEMAND (LBS/HR)	COMMUN. AVERAGE DEMAND (LBS/HR)	TOTAL ELECTRIC GENERATION (KWH)	MINIMUM ELECTRIC GENERATION (KW)	MAXIMUM ELECTRIC GENERATION (KW)	WESTERN COAL USAGE (TONS)	ASH (TONS)	SOLID WASTE USAGE (TONS)
1976	152374	1882578	2034952	478	113	232	51779852	3133	7500	135219	13522	46193
1977	176403	1740359	1916762	521	92	218	47862552	2551	7500	125608	12561	46193
1978	232118	1870844	2102962	535	23	240	51411659	637	7500	140066	14007	46193
1979	244228	1889406	2133634	541	28	243	51914155	776	7500	142427	14243	46193
1980	244228	1889406	2133634	541	28	243	51914155	776	7500	142427	14243	46193
1981	285817	1966185	2252002	561	43	257	53989638	1192	7500	151570	15157	46193
1982	290848	1968474	2259322	564	45	257	54050504	1247	7500	152118	15212	46193
1983	295892	1970750	2266642	567	47	258	54110977	1303	7500	152666	15267	46193
1984	300945	1973017	2273962	570	49	259	54170875	1358	7500	153214	15321	46193
1985	306020	1975262	2281282	573	51	260	54230241	1414	7500	153761	15376	46193
1986	306020	1975262	2281282	573	51	260	54230241	1414	7500	153761	15376	46193
1987	306020	1975262	2281282	573	51	260	54230241	1414	7500	153761	15376	46193
1988	306020	1975262	2281282	573	51	260	54230241	1414	7500	153761	15376	46193
1989	306020	1975262	2281282	573	51	260	54230241	1414	7500	153761	15376	46193

OPTION 2D
SOLID WASTE HEAT RECOVERY-250 TONS/DAY

YEAR	U-HEATING PLANT (1000 LBS)	S.E. STEAM PLANT (1000 LBS)	TOTAL COMMUNITY REQUIREMENT (1000 LBS)	COMMUN. PEAK DEMAND (LBS/HR)	COMMUN. MINIMUM DEMAND (LBS/HR)	COMMUN. AVERAGE DEMAND (LBS/HR)	TOTAL ELECTRIC GENERATION (KWH)	MINIMUM ELECTRIC GENERATION (KW)	MAXIMUM ELECTRIC GENERATION (KW)	WESTERN COAL USAGE (TONS)	ASH (TONS)	SOLID WASTE USAGE (TONS)
1976	81374	1953578	2034952	478	113	232	51779852	3133	7500	111808	11181	87493
1977	107595	1809167	1916762	521	92	218	47862552	2551	7500	102197	10220	87493
1978	149426	1953536	2102962	535	23	240	51411659	637	7500	116655	11666	87493
1979	158767	1974867	2133634	541	28	243	51914155	776	7500	119016	11902	87493
1980	158767	1974867	2133634	541	28	243	51914155	776	7500	119016	11902	87493
1981	191024	2060978	2252002	561	43	257	53989638	1192	7500	128159	12816	87493
1982	195275	2064047	2259322	564	45	257	54050504	1247	7500	128707	12871	87493
1983	199531	2067111	2266642	567	47	258	54110977	1303	7500	129255	12926	87493
1984	203796	2070166	2273962	570	49	259	54170875	1358	7500	129803	12980	87493
1985	208082	2073200	2281282	573	51	260	54230241	1414	7500	130350	13035	87493
1986	208082	2073200	2281282	573	51	260	54230241	1414	7500	130350	13035	87493
1987	208082	2073200	2281282	573	51	260	54230241	1414	7500	130350	13035	87493
1988	208082	2073200	2281282	573	51	260	54230241	1414	7500	130350	13035	87493
1989	208082	2073200	2281282	573	51	260	54230241	1414	7500	130350	13035	87493

BASIC PLAN
UNIVERSITY COMMUNITY ONLY

UNIT TRAIN CARLOADS TO S.E. PLANT (100 TON CARS)				COAL TRIPS TO ST. PAUL (10 TON TRUCKS)			SOLID WASTE TRIPS TO S.E. PLANT (6 TON TRUCKS)			TRUCKS OF ASH FROM MPLS. (10 TON TRUCKS)			TRUCKS OF ASH FROM ST. PAUL (10 TON TRUCKS)			TRUCKS OF FRIT FROM S.E. PLANT (10 TON TRUCKS)		
YEAR	YEAR	WEEK	DAY	YEAR	WEEK	DAY	YEAR	WEEK	DAY	YEAR	WEEK	DAY	YEAR	WEEK	DAY	YEAR	WEEK	DAY
1976	1914	37	5	5197	100	14	0	0	0	1394	27	4	514	10	1	0	0	0
1977	1818	35	5	5181	100	14	0	0	0	1298	25	4	512	10	1	0	0	0
1978	1963	38	5	5181	100	14	0	0	0	1443	28	4	512	10	1	0	0	0
1979	1986	38	5	5181	100	14	0	0	0	1466	28	4	512	10	1	0	0	0
1980	1989	38	5	5220	100	14	0	0	0	1466	28	4	516	10	1	0	0	0
1981	2080	40	6	5246	101	14	0	0	0	1552	30	4	519	10	1	0	0	0
1982	2080	40	6	5246	101	14	0	0	0	1552	30	4	519	10	1	0	0	0
1983	2080	40	6	5246	101	14	0	0	0	1552	30	4	519	10	1	0	0	0
1984	2080	40	6	5246	101	14	0	0	0	1552	30	4	519	10	1	0	0	0
1985	2080	40	6	5246	101	14	0	0	0	1552	30	4	519	10	1	0	0	0
1986	2080	40	6	5246	101	14	0	0	0	1552	30	4	519	10	1	0	0	0
1987	2080	40	6	5246	101	14	0	0	0	1552	30	4	519	10	1	0	0	0
1988	2080	40	6	5246	101	14	0	0	0	1552	30	4	519	10	1	0	0	0
1989	2080	40	6	5246	101	14	0	0	0	1552	30	4	519	10	1	0	0	0

OPTION 1
ST. MARYS-FAIRVIEW-AUGSBURG ADD-ON

UNIT TRAIN CARLOADS TO S.E. PLANT (100 TON CARS)				COAL TRIPS TO ST. PAUL (10 TON TRUCKS)			SOLID WASTE TRIPS TO S.E. PLANT (6 TON TRUCKS)			TRUCKS OF ASH FROM MPLS. (10 TON TRUCKS)			TRUCKS OF ASH FROM ST. PAUL (10 TON TRUCKS)			TRUCKS OF FRIT FROM S.E. PLANT (10 TON TRUCKS)		
YEAR	YEAR	WEEK	DAY	YEAR	WEEK	DAY	YEAR	WEEK	DAY	YEAR	WEEK	DAY	YEAR	WEEK	DAY	YEAR	WEEK	DAY
1976	2121	41	6	5197	100	14	0	0	0	1601	31	4	514	10	1	0	0	0
1977	2023	39	6	5181	100	14	0	0	0	1503	29	4	512	10	1	0	0	0
1978	2167	42	6	5181	100	14	0	0	0	1648	32	5	512	10	1	0	0	0
1979	2192	42	6	5181	100	14	0	0	0	1671	32	5	512	10	1	0	0	0
1980	2195	42	6	5220	100	14	0	0	0	1671	32	5	516	10	1	0	0	0
1981	2287	44	6	5246	101	14	0	0	0	1763	34	5	519	10	1	0	0	0
1982	2293	44	6	5246	101	14	0	0	0	1769	34	5	519	10	1	0	0	0
1983	2298	44	6	5246	101	14	0	0	0	1774	34	5	519	10	1	0	0	0
1984	2304	44	6	5246	101	14	0	0	0	1779	34	5	519	10	1	0	0	0
1985	2310	44	6	5246	101	14	0	0	0	1786	34	5	519	10	1	0	0	0
1986	2310	44	6	5246	101	14	0	0	0	1786	34	5	519	10	1	0	0	0
1987	2310	44	6	5246	101	14	0	0	0	1786	34	5	519	10	1	0	0	0
1988	2310	44	6	5246	101	14	0	0	0	1786	34	5	519	10	1	0	0	0
1989	2310	44	6	5246	101	14	0	0	0	1786	34	5	519	10	1	0	0	0

OPTION 2A
SOLID WASTE HEAT RECOVERY-80 TONS/DAY

UNIT TRAIN CARLOADS TO S.E. PLANT (100 TON CARS)				COAL TRIPS TO ST. PAUL (10 TON TRUCKS)			SOLID WASTE TRIPS TO S.E. PLANT (6 TON TRUCKS)			TRUCKS OF ASH FROM MPLS. (10 TON TRUCKS)			TRUCKS OF ASH FROM ST. PAUL (10 TON TRUCKS)			TRUCKS OF FRIT FROM S.E. PLANT (10 TON TRUCKS)		
YEAR	YEAR	WEEK	DAY	YEAR	WEEK	DAY	YEAR	WEEK	DAY	YEAR	WEEK	DAY	YEAR	WEEK	DAY	YEAR	WEEK	DAY
1976	1968	38	5	5197	100	14	4661	90	13	1447	28	4	514	10	1	555	11	2
1977	1870	36	5	5181	100	14	4661	90	13	1351	26	4	512	10	1	555	11	2
1978	2014	39	6	5181	100	14	4661	90	13	1498	29	4	512	10	1	555	11	2
1979	2037	39	6	5181	100	14	4661	90	13	1519	29	4	512	10	1	555	11	2
1980	2042	39	6	5220	100	14	4661	90	13	1519	29	4	516	10	1	555	11	2
1981	2136	41	6	5246	101	14	4661	90	13	1612	31	4	519	10	1	555	11	2
1982	2141	41	6	5246	101	14	4661	90	13	1616	31	4	519	10	1	555	11	2
1983	2148	41	6	5246	101	14	4661	90	13	1622	31	4	519	10	1	555	11	2
1984	2151	41	6	5246	101	14	4661	90	13	1626	31	4	519	10	1	555	11	2
1985	2159	42	6	5246	101	14	4661	90	13	1632	31	4	519	10	1	555	11	2
1986	2159	42	6	5246	101	14	4661	90	13	1632	31	4	519	10	1	555	11	2
1987	2159	42	6	5246	101	14	4661	90	13	1632	31	4	519	10	1	555	11	2
1988	2159	42	6	5246	101	14	4661	90	13	1632	31	4	519	10	1	555	11	2
1989	2159	42	6	5246	101	14	4661	90	13	1632	31	4	519	10	1	555	11	2

OPTION 2B
SOLID WASTE HEAT RECOVERY-100 TONS/DAY

UNIT TRAIN CARLOADS TO S.E. PLANT (100 TON CARS)				COAL TRIPS TO ST. PAUL (10 TON TRUCKS)			SOLID WASTE TRIPS TO S.E. PLANT (6 TON TRUCKS)			TRUCKS OF ASH FROM MPLS. (10 TON TRUCKS)			TRUCKS OF ASH FROM ST. PAUL (10 TON TRUCKS)			TRUCKS OF FRIT FROM S.E. PLANT (10 TON TRUCKS)		
YEAR	YEAR	WEEK	DAY	YEAR	WEEK	DAY	YEAR	WEEK	DAY	YEAR	WEEK	DAY	YEAR	WEEK	DAY	YEAR	WEEK	DAY
1976	1930	37	5	5197	100	14	5828	112	16	1408	27	4	514	10	1	694	13	2
1977	1832	35	5	5181	100	14	5828	112	16	1313	25	4	512	10	1	694	13	2
1978	1978	38	5	5181	100	14	5828	112	16	1458	28	4	512	10	1	694	13	2
1979	2001	38	5	5181	100	14	5828	112	16	1481	28	4	512	10	1	694	13	2
1980	2002	39	5	5220	100	14	5828	112	16	1481	28	4	516	10	1	694	13	2
1981	2098	40	6	5246	101	14	5828	112	16	1571	30	4	519	10	1	694	13	2
1982	2104	40	6	5246	101	14	5828	112	16	1578	30	4	519	10	1	694	13	2
1983	2108	41	6	5246	101	14	5828	112	16	1583	30	4	519	10	1	694	13	2
1984	2114	41	6	5246	101	14	5828	112	16	1589	31	4	519	10	1	694	13	2
1985	2118	41	6	5246	101	14	5828	112	16	1594	31	4	519	10	1	694	13	2
1986	2118	41	6	5246	101	14	5828	112	16	1594	31	4	519	10	1	694	13	2
1987	2118	41	6	5246	101	14	5828	112	16	1594	31	4	519	10	1	694	13	2
1988	2118	41	6	5246	101	14	5828	112	16	1594	31	4	519	10	1	694	13	2
1989	2118	41	6	5246	101	14	5828	112	16	1594	31	4	519	10	1	694	13	2

OPTION 2C
SOLID WASTE HEAT RECOVERY-132 TONS/DAY

UNIT TRAIN CARLOADS TO S.E. PLANT (100 TON CARS)				COAL TRIPS TO ST. PAUL (10 TON TRUCKS)			SOLID WASTE TRIPS TO S.E. PLANT (6 TON TRUCKS)			TRUCKS OF ASH FROM MPLS. (10 TON TRUCKS)			TRUCKS OF ASH FROM ST. PAUL (10 TON TRUCKS)			TRUCKS OF FRIT FROM S.E. PLANT (10 TON TRUCKS)		
YEAR	YEAR	WEEK	DAY	YEAR	WEEK	DAY	YEAR	WEEK	DAY	YEAR	WEEK	DAY	YEAR	WEEK	DAY	YEAR	WEEK	DAY
1976	1866	36	5	5197	100	14	7689	148	21	1346	26	4	514	10	1	916	18	3
1977	1768	34	5	5181	100	14	7689	148	21	1249	24	3	512	10	1	916	18	3
1978	1914	37	5	5181	100	14	7689	148	21	1394	27	4	512	10	1	916	18	3
1979	1937	37	5	5181	100	14	7689	148	21	1418	27	4	512	10	1	916	18	3
1980	1941	37	5	5220	100	14	7689	148	21	1418	27	4	516	10	1	916	18	3
1981	2034	39	6	5246	101	14	7689	148	21	1511	29	4	519	10	1	916	18	3
1982	2040	39	6	5246	101	14	7689	148	21	1515	29	4	519	10	1	916	18	3
1983	2046	39	6	5246	101	14	7689	148	21	1521	29	4	519	10	1	916	18	3
1984	2051	39	6	5246	101	14	7689	148	21	1527	29	4	519	10	1	916	18	3
1985	2056	40	6	5246	101	14	7689	148	21	1532	29	4	519	10	1	916	18	3
1986	2056	40	6	5246	101	14	7689	148	21	1532	29	4	519	10	1	916	18	3
1987	2056	40	6	5246	101	14	7689	148	21	1532	29	4	519	10	1	916	18	3
1988	2056	40	6	5246	101	14	7689	148	21	1532	29	4	519	10	1	916	18	3
1989	2056	40	6	5246	101	14	7689	148	21	1532	29	4	519	10	1	916	18	3

OPTION 2D
SOLID WASTE HEAT RECOVERY-250 TONS/DAY

UNIT TRAIN CARLOADS TO S.E. PLANT (100 TON CARS)				COAL TRIPS TO ST. PAUL (10 TON TRUCKS)			SOLID WASTE TRIPS TO S.E. PLANT (6 TON TRUCKS)			TRUCKS OF ASH FROM MPLS. (10 TON TRUCKS)			TRUCKS OF ASH FROM ST. PAUL (10 TON TRUCKS)			TRUCKS OF FRIT FROM S.E. PLANT (10 TON TRUCKS)		
YEAR	YEAR	WEEK	DAY	YEAR	WEEK	DAY	YEAR	WEEK	DAY	YEAR	WEEK	DAY	YEAR	WEEK	DAY	YEAR	WEEK	DAY
1976	1633	31	4	5197	100	14	14576	280	40	1112	21	3	514	10	1	1742	34	5
1977	1534	30	4	5181	100	14	14576	280	40	1015	20	3	512	10	1	1742	34	5
1978	1679	32	5	5181	100	14	14576	280	40	1160	22	3	512	10	1	1742	34	5
1979	1703	33	5	5181	100	14	14576	280	40	1184	23	3	512	10	1	1742	34	5
1980	1706	33	5	5220	100	14	14576	280	40	1184	23	3	516	10	1	1742	34	5
1981	1801	35	5	5246	101	14	14576	280	40	1274	25	3	519	10	1	1742	34	5
1982	1805	35	5	5246	101	14	14576	280	40	1281	25	4	519	10	1	1742	34	5
1983	1811	35	5	5246	101	14	14576	280	40	1286	25	4	519	10	1	1742	34	5
1984	1817	35	5	5246	101	14	14576	280	40	1293	25	4	519	10	1	1742	34	5
1985	1821	35	5	5246	101	14	14576	280	40	1297	25	4	519	10	1	1742	34	5
1986	1821	35	5	5246	101	14	14576	280	40	1297	25	4	519	10	1	1742	34	5
1987	1821	35	5	5246	101	14	14576	280	40	1297	25	4	519	10	1	1742	34	5
1988	1821	35	5	5246	101	14	14576	280	40	1297	25	4	519	10	1	1742	34	5
1989	1821	35	5	5246	101	14	14576	280	40	1297	25	4	519	10	1	1742	34	5

TOTAL SYSTEM LOAD DURATION CURVE FOR JULY 1976 THROUGH JUNE 1977

*+*****+*****+*****+*****+*****+*****+*****+*****+*****+*****+*****+*

	550000.+	:	:	:	:	:
	540000.+	:	:	:	:	:
	530000.+	:	:	:	:	:
	520000.+*	:	:	:	:	:
	510000.+*	:	:	:	:	:
	500000.+*	:	:	:	:	:
	490000.+*	:	:	:	:	:
	480000.+*	:	:	:	:	:
	470000.+*	:	:	:	:	:
	460000.+**	:	:	:	:	:
	450000.+**	:	:	:	:	:
	440000.+**	:	:	:	:	:
	430000.+***	:	:	:	:	:
	420000.+***	:	:	:	:	:
	410000.+****	:	:	:	:	:
	400000.+*****	:	:	:	:	:
L	390000.+*****	:	:	:	:	:
B	380000.+*****	:	:	:	:	:
S	370000.+*****	:	:	:	:	:
	360000.+*****	:	:	:	:	:
S	350000.+*****	:	:	:	:	:
T	340000.+*****	:	:	:	:	:
E	330000.+*****	:	:	:	:	:
A	320000.+*****	:	:	:	:	:
M	310000.+*****	:	:	:	:	:
	300000.+*****	:	:	:	:	:
F	290000.+*****	:	:	:	:	:
E	280000.+*****	:	:	:	:	:
R	270000.+*****	:	:	:	:	:
	260000.+*****	:	:	:	:	:
H	250000.+*****	:	:	:	:	:
D	240000.+*****	:	:	:	:	:
U	230000.+*****	:	:	:	:	:
R	220000.+*****	:	:	:	:	:
	210000.+*****	:	:	:	:	:
	200000.+*****	:	:	:	:	:
	190000.+*****	:	:	:	:	:
	180000.+*****	:	:	:	:	:
	170000.+*****	:	:	:	:	:
	160000.+*****	:	:	:	:	:
Steam Load	150000.+*****	:	:	:	:	:
Data	140000.+*****	:	:	:	:	:
Date of	130000.+*****	:	:	:	:	:
Run	120000.+*****	:	:	:	:	:
77/11/02	110000.+*****	:	:	:	:	:
	100000.+*****	:	:	:	:	:
	90000.+*****	:	:	:	:	:
	80000.+*****	:	:	:	:	:
	70000.+*****	:	:	:	:	:
	60000.+*****	:	:	:	:	:
	50000.+*****	:	:	:	:	:

*+*****+*****+*****+*****+*****+*****+*****+*****+*****+*****+*****+*

+ + + + + +
0. 20. 40. 60. 80. 100.

PERCENT OCCURRENCE

*+*****+*****+*****+*****+*****+*****+*****+*****+*****+*****+*****+*

+ + + + + +
0. 1752. 3504. 5256. 7008. 8760.

178 HOURS OF OPERATION

STEAM LOAD DATA

DATE OF RUN-- 77/11/02.

MINNEAPOLIS CAMPUS STEAM LOAD DURATION CURVE
FOR JULY 1976 THROUGH JUNE 1977

STEAM LOAD DATA

DATE OF RUN- 77/11/02.

MINNEAPOLIS CAMPUS STEAM LOAD DURATION CURVE
FOR JULY 1975 THROUGH JUNE 1976

[illegible]

Steam Load
Data
Date of Run
77/11/02

0. 20. 40. 60. 80. 100.

PERCENT OCCURRENCE

+	+	+	+	+	+
0,	1752,	3504,	5256,	7008,	8760,

181 HOURS OF OPERATION

STEAM LOAD DATA

DATE OF RUN- 77/11/04.

TOTAL SYSTEM STEAM LOAD DURATION CURVE
FOR APR. - SEPT. 1976-1977

DATE OF RUN- 77/11/04.

MINNEAPOLIS CAMPUS STEAM LOAD DURATION CURVE
 FOR APR. - SEPT. 1975-1976

ST. MARYS-FAIRVIEW STEAM LOAD DURATION CURVE FOR APR. - SEPT. 1976-1977

*+*****+*****+*****+*****+*****+*****+*****+*****+*****+*****+*****+*

Steam Load
Data
Date of
Run
77/11/04

PERCENT OCCURRENCE
*+*****+*****+*****+*****+*****+*****+*****+*****+*****+*****+*****+*
+ + + + +
0. 878. 185 1757. 2635. 3514. 4392.
HOURS OF OPERATION

TOTAL SYSTEM LOAD DURATION CURVE
FOR MONTHS OCT. - MAR. 1976-1977

	550000.+	:	:	:	:	+
	540000.+	:	:	:	:	+
	530000.+	:	:	:	:	+
	520000.+*	:	:	:	:	+
	510000.+*	:	:	:	:	+
	500000.+*	:	:	:	:	+
	490000.+*	:	:	:	:	+
	480000.+*	:	:	:	:	+
	470000.+**	:	:	:	:	+
	460000.+**	:	:	:	:	+
	450000.+***	:	:	:	:	+
	440000.+****	:	:	:	:	+
	430000.+*****	:	:	:	:	+
	420000.+*****	:	:	:	:	+
	410000.+*****	:	:	:	:	+
	400000.+*****	:	:	:	:	+
L	390000.+*****	:	:	:	:	+
B	380000.+*****	:	:	:	:	+
S	370000.+*****	:	:	:	:	+
	360000.+*****	:	:	:	:	+
S	350000.+*****	:	:	:	:	+
T	340000.+*****	:	:	:	:	+
E	330000.+*****	:	:	:	:	+
A	320000.+*****	:	:	:	:	+
M	310000.+*****	:	:	:	:	+
	300000.+*****	:	:	:	:	+
F	290000.+*****	:	:	:	:	+
E	280000.+*****	:	:	:	:	+
R	270000.+*****	:	:	:	:	+
	260000.+*****	:	:	:	:	+
H	250000.+*****	:	:	:	:	+
O	240000.+*****	:	:	:	:	+
U	230000.+*****	:	:	:	:	+
R	220000.+*****	:	:	:	:	+
	210000.+*****	:	:	:	:	+
	200000.+*****	:	:	:	:	+
	190000.+*****	:	:	:	:	+
	180000.+*****	:	:	:	:	+
	170000.+*****	:	:	:	:	+
	160000.+*****	:	:	:	:	+
	150000.+*****	:	:	:	:	+
	140000.+*****	:	:	:	:	+
	130000.+*****	:	:	:	:	+
	120000.+*****	:	:	:	:	+
	110000.+*****	:	:	:	:	+
	100000.+*****	:	:	:	:	+
	90000.+*****	:	:	:	:	+
	80000.+*****	:	:	:	:	+
	70000.+*****	:	:	:	:	+
	60000.+*****	:	:	:	:	+
	50000.+*****	:	:	:	:	+

+	+	+	+	+	+
0.	20.	40.	60.	80.	100.

PERCENT OCCURRENCE

+	+	+	+	+	+
0.	874.	1747.	2621.	3494.	4368.

186 HOURS OF OPERATION

Steam Load
Data
ate of Run
7/11/03

STEAM LOAD DATA

DATE OF RUN- 77/11/03.

MINNEAPOLIS CAMPUS STEAM LOAD DURATION CURVE
FOR MONTHS OCT. - MAR. 1975-1976

MINNEAPOLIS CAMPUS STEAM LOAD DURATION CURVE
FOR MONTHS OCT. - MAR. 1976-1977

ST. MARYS-FAIRVIEW STEAM LOAD DURATION CURVE FOR MONTHS OCT. - MAR. 1976-1977

Steam Load
Data
Date of Run
77/11/03

Included in this section are profiles of:

Steam demand versus Dry Bulb Temperature, Monthly Steam Plant

Load Factors, Daily Low, Peak, Average Steam Rate.

COMBINED MINNEAPOLIS CAMPUS, ST. MARYS-FAIRVIEW AND AUGSBURG STEAM LOAD
BASED ON HOURLY DATA FROM JULY 1976 THROUGH JUNE 1977

550.+	:	:	:	:	:	:	:	+
540.+	:	:	:	:	:	:	:	+
530.+	X	:	:	:	:	:	:	+
520.+	XXX	:	:	:	:	:	:	+
510.+	X XXX	:	:	:	:	:	:	+
500.+	X X:	:	:	:	:	:	:	+
490.+	X X X	:	:	:	:	:	:	+
480.+	XXXXXXXXXXXX	:	:	:	:	:	:	+
470.+	XXXXXXXXXXXX X	:	:	:	:	:	:	+
H 460.+	XXXXXXXXXXXX X	:	:	:	:	:	:	+
450.+	XXXXXXXXXXXX	:	:	:	:	:	:	+
440.+	XXXXXXXXXXXX	:	:	:	:	:	:	+
S 430.+	X XXXXXXXXXX X:XX	:	:	:	:	:	:	+
A 420.+	XXXXXXXXXXXX	:	:	:	:	:	:	+
410.+	XX XXXXXXXXXX	:	:	:	:	:	:	+
L 400.+	X XXXXXXXXXX	:	:	:	:	:	:	+
S 390.+	XXXXXXXXXXXX	:	:	:	:	:	:	+
380.+	XXXXXXXXXXXX	:	:	:	:	:	:	+
370.+	XXX XXXXXXXXXX	:	:	:	:	:	:	+
F 360.+	:XXXXXXXXXXXX	:	:	:	:	:	:	+
350.+	XXXXXXXXXXXX	:	:	:	:	:	:	+
340.+	:XXXXXXXXXXXX	:	:	:	:	:	:	+
B 330.+	:XXXXXXXXXXXX	:	:	:	:	:	:	+
S 320.+	:XXXXXXXXXXXX X	:	:	:	:	:	:	+
310.+	X:XXXXXXXXXXXX:XX	:	:	:	:	:	:	+
J 300.+	:X XXXXXXXXXX X	:	:	:	:	:	:	+
F 290.+	:XXXXXXXXXXXX	:	:	:	:	:	:	+
280.+	:XXXXXXXXXXXX	:	:	:	:	:	:	+
270.+	:XXXXXXXXXXXX X	:	:	:	:	:	:	+
T 260.+	:XXXXXXXXXXXX	:	:	:	:	:	:	+
250.+	XXXXXXXXXXXX-X-XXXX-XXXX-XX	:	:	:	:	:	:	+
M 240.+	:XXXXXXXXXXXX:XXXXXXXXXXXX	:	:	:	:	:	:	+
230.+	:XXXXXXXXXXXX:X XXXXXXXXXX	:	:	:	:	:	:	+
220.+	:XXXXXXXXXXXX:XXXXXXXXXXXX XX	:	:	:	:	:	:	+
210.+	:XXXXXXXXXXXX XXXXXXXXXX	:	:	:	:	:	:	+
L 200.+	:XXXXXXXXXXXX	:	:	:	:	:	:	+
R 190.+	:XXXXXXXXXXXX	:	:	:	:	:	:	+
180.+	:XXXXXXXXXXXX	:	:	:	:	:	:	+
170.+	:XXXXXXXXXXXX	:	:	:	:	:	:	+
D 160.+	:XXXXXXXXXXXX	:	:	:	:	:	:	+
150.+	X-XXXXXXXXXXXX	:	:	:	:	:	:	+
140.+	:XXXXXXXXXXXX	:	:	:	:	:	:	+
130.+	:XXXXXXXXXXXX	:	:	:	:	:	:	+
120.+	:XXXXXXXXXXXX X	:	:	:	:	:	:	+
110.+	:XXXXXXXXXXXX	:	:	:	:	:	:	+
100.+	:XXXXXXXXXXXX XXXX	:	:	:	:	:	:	+
90.+	:XXX XX	:	:	:	:	:	:	+
80.+	:	:	:	:	:	:	:	+
70.+	:	:	:	:	:	:	:	+
60.+	:	:	:	:	:	:	:	+
50.+	:	:	:	:	:	:	:	+

-30. -10. 10. 30. 50. 70. 90. 110.

DRY BULB TEMPERATURE DEGREES F

95. 75. 55. 35. 15. -5. -25. -45.

DEGREE HOURS (BASE = 65 F, - = COOLING)

MINNEAPOLIS CAMPUS STEAM LOAD
BASED ON HOURLY DATA FROM JULY 1975 THROUGH JUNE 1976

+++++

DEGREE HOURS (BASE = 65 F, - = COOLING)

ST. MARYS - FAIRVIEW STEAM LOAD
 BASED ON HOURLY DATA FROM JULY 1976 THROUGH JUNE 1977

STEAM LOAD - DRY BULB TEMPERATURE DATA

RUN DATE- 77/11/04.

TOTAL SYSTEM STEAM LOAD
FOR APR. - SEPT. 1976 - 1977

	500.+	:	:	:	:	:	:	:	+
	490.+	:	:	:	:	:	:	:	+
	480.+	:	:	:	:	:	:	:	+
	470.+	:	:	:	:	:	:	:	+
	460.+	:	:	:	:	:	:	:	+
	450.+	-----							+
T	440.+	:	:	:	:	:	:	:	+
H	430.+	:	:	:	:	:	:	:	+
O	420.+	:	:	:	:	:	:	:	+
U	410.+	:	:	:	:	:	:	:	+
S	400.+	:	:	:	:	:	:	:	+
A	390.+	:	:	:	:	:	:	:	+
N	380.+	:	:	:	:	:	:	:	+
D	370.+	:	:	:	:	:	:	:	+
S	360.+	:	:	:	:	:	:	:	+
	350.+	-----							+
O	340.+	:	:	:	:	:	:	:	+
F	330.+	:	:	:	:	:	:	:	+
	320.+	:	:	:	:	:	:	:	+
L	310.+	:	X	:	:	:	:	:	+
B	300.+	:	:	:	:	:	:	:	+
S	290.+	:	:	:	:	:	:	:	+
	280.+	:	X	XX	X	:	:	:	+
O	270.+	:	:	XX	:	:	X	XXX	+
F	260.+	:	XXX	XXX	:	:	XX	X X X	+
	250.+	-----	XXXX	XXX-X	-----	X-XXX	XXXX	XX	+
S	240.+	:	XXXXXXXX	X	:	XXXXXXXXXXXXXXXXXXXX			+
T	230.+	:	XXXXXX	XX	:	XXXXXXXXXXXXXXXXXXXX			+
E	220.+	:	XXXXXX	X	:	XXXXXXXXXXXXXXXXXXXX	XX		+
A	210.+	:	XXXXXX	XX	:	X XXXXXXXXXXXXXXXXXXXX			+
M	200.+	:	XXXXXXXXXX	X	:	XXXXXXXXXXXXXXXXXXXX			+
	190.+	:	XXXXXXXXXX	XXX	:	XXXXXXXXXXXXXXXXXXXX			+
P	180.+	:	:	XXXXXXXXXXXXXXXXXXXX	:	XXXXXXXXXXXXXXXXXXXX	:		+
E	170.+	:	:	XXXXXXXXXXXXXXXXXXXX	:	XXXXXXXXXXXXXXXXXXXX	:		+
R	160.+	:	:	XXXXXXXXXXXXXXXXXXXX	:	XXXXXXXXXXXXXXXXXXXX	:		+
	150.+	-----	X-XXXXXXXXXXXXXXXXXXXX	-----					+
H	140.+	:	:	XXXXXXXXXXXXXXXXXXXX	:	XXXXXXXXXXXXXXXXXXXX	:		+
O	130.+	:	:	XXXXXXXXXXXXXXXXXXXX	:	XXXXXXXXXXXXXXXXXXXX	:		+
U	120.+	:	:	XXXXXXXXXXXXXXXXXXXX	:	XXXXXXXXXXXXXXXXXXXX	:		+
R	110.+	:	:	XXXXXXXXXXXXXXXXXXXX	:	XXXXXXXXXXXXXXXXXXXX	:		+
	100.+	:	:	XXXXXXXXXXXXXXXXXXXX	:	XXXXXXXXXXXXXXXXXXXX	:		+
	90.+	:	:	XXXX XX	:	:	:		+
	80.+	:	:	:	:	:	:		+
	70.+	:	:	:	:	:	:		+
	60.+	:	:	:	:	:	:		+
	50.+	:	:	:	:	:	:		+

	+	+	+	+	+	+	+	+	+
	-10.	10.	30.	50.	70.	90.	110.		

	+	+	+	+	+	+	+	+	+
	75.	55.	35.	15.	-5.	-25.	-45.		

DREGREE HOURS (BASE = 65 F, - = COOLING)									

RUN DATE- 77/11/04.

MINNEAPOLIS CAMPUS STEAM LOAD
FOR APR. - SEPT. 1975 - 1976

[illegible]

STEAM LOAD - DRY BULB TEMPERATURE DATA

RUN DATE- 77/11/04.

MINNEAPOLIS CAMPUS STEAM LOAD
FOR APR. - SEPT. 1976- 1977

	500.+	:	:	:	:	:	:	:	:
	490.+	:	:	:	:	:	:	:	:
	480.+	:	:	:	:	:	:	:	:
	470.+	:	:	:	:	:	:	:	:
	460.+	:	:	:	:	:	:	:	:
	450.+	-----							
T	440.+	:	:	:	:	:	:	:	:
H	430.+	:	:	:	:	:	:	:	:
O	420.+	:	:	:	:	:	:	:	:
U	410.+	:	:	:	:	:	:	:	:
S	400.+	:	:	:	:	:	:	:	:
A	390.+	:	:	:	:	:	:	:	:
N	380.+	:	:	:	:	:	:	:	:
D	370.+	:	:	:	:	:	:	:	:
S	360.+	:	:	:	:	:	:	:	:
	350.+	-----							
O	340.+	:	:	:	:	:	:	:	:
F	330.+	:	:	:	:	:	:	:	:
	320.+	:	:	:	:	:	:	:	:
L	310.+	:	:	:	:	:	:	:	:
B	300.+	:	:	:	:	:	:	:	:
S	290.+	:	:	:	:	:	:	:	:
	280.+	:	:	:	:	:	:	:	:
O	270.+	:	:	:	:	:	:	:	:
F	260.+	:	:	X	:	:	:	:	:
	250.+	-----					X	---	XXX
S	240.+	:	:	X	X	X	:	XX	X X X
T	230.+	:	:	X	XX	:	:	X XXX	XXXX XX
E	220.+	:	:	XXX	XXXX	:	:	XXXXXXXXXXXXXXXXXX	
A	210.+	:	:	XXXX	XXX X	:	:	XXXXXXXXXXXXXXXXXXXX	
M	200.+	:	:	XXXXXXX	X	:	:	XXXXXXXXXXXXXXXXXXXX	XX
	190.+	:	:	XXX	XXX XX	:	:	X XXXXXXXXXXXXXXXXXXXX	
P	180.+	:	:	XXXXXX	X	:	:	XXXXXXXXXXXXXXXXXXXX	
E	170.+	:	:	XXXXXXXXXX	X:X	:	:	XXXXXXXXXXXXXXXXXXXX	
R	160.+	:	:	XXXXXXXXXX	XXX	:	:	XXXXXXXXXXXXXXXXXXXX	
	150.+	-----						XXXXXXXXXXXXXXXXXXXX	
H	140.+	:	:	:	:	:	:	XXXXXXXXXXXXXXXXXXXX	
O	130.+	:	:	:	:	:	:	XXXXXXXXXXXXXXXXXXXX	XX:
U	120.+	:	:	:	:	:	:	XXXXXXXXXXXXXXXXXXXX	
R	110.+	:	:	:	:	:	:	XXXXXXXXXXXXXXXXXXXX	
	100.+	:	:	:	:	:	:	XXXXXXXXXXXXXXXXXXXX	X
	90.+	:	:	:	:	:	:	XXXXXXXXXXXXXXXXXXXX	
	80.+	:	:	:	:	:	:	XXXXXXXXXXXXXXXXXXXX	XXXX
	70.+	:	:	:	:	:	:	XXX XX	:
	60.+	:	:	:	:	:	:	:	:
	50.+	:	:	:	:	:	:	:	:

	+	+	+	+	+	+	+	+	+
	-30.	-10.	10.	30.	50.	70.	90.	110.	

	+	+	+	+	+	+	+	+	+
	95.	75.	55.	35.	15.	-5.	-25.	-45.	

DRY BULB TEMPERATURE DEGREES F

DREGREE HOURS (BASE = 65 F, - = COOLING)

RUN DATE- 77/11/04.

+**+**

DEGREE HOURS (BASE = 65 F, - = COOLING)

TOTAL SYSTEM STEAM LOAD
FOR OCT. - MAR. 1976-1977

	550.+	:	:	:	:	:	:	+
	540.+	:	:	:	:	:	:	+
	530.+	X	:	:	:	:	:	+
	520.+	XXX	:	:	:	:	:	+
	510.+	X XXX	:	:	:	:	:	+
	500.+	X X	:	:	:	:	:	+
	490.+	X X X	:	:	:	:	:	+
	480.+	XXXXXXXXXXXXX	:	:	:	:	:	+
T	470.+	XXXXXXXXXXXXX X	:	:	:	:	:	+
H	460.+	XXXXXXXXXXXXXXX X	:	:	:	:	:	+
D	450.+	-----XXXXXXXXXXXXX-----	:	:	:	:	:	+
U	440.+	XXXXXXXXXXXXXXXXXXXXX	:	:	:	:	:	+
S	430.+	X XXXXXXXXXXXXXXXX X:XX	:	:	:	:	:	+
A	420.+	XXXXXXXXXXXXXXXXXXXXX	:	:	:	:	:	+
N	410.+	XX XXXXXXXXXXXXXXXX	:	:	:	:	:	+
D	400.+	X XXXXXXXXXXXXXXXX	:	:	:	:	:	+
S	390.+	XXXXXXXXXXXXXXXXXXXXX	:	:	:	:	:	+
	380.+	XXXXXXXXXXXXXXXXXXXXX	:	:	:	:	:	+
J	370.+	XXX XXXXXXXXXXXXXXXX	:	:	:	:	:	+
F	360.+	:XXXXXXXXXXXXXXXXXXXXX	:	:	:	:	:	+
	350.+	-----XXXXXXXXXXXXX-----	:	:	:	:	:	+
	340.+	:XXXXXXXXXXXXXXXXXXXXX	:	:	:	:	:	+
B	330.+	:XXXXXXXXXXXXXXXXXXXXX	:	:	:	:	:	+
S	320.+	:XXXXXXXXXXXXXXXXXXXXX X	:	:	:	:	:	+
	310.+	X:XXXXXXXXXXXXXXXXXXXXX:XX	:	:	:	:	:	+
J	300.+	:X XXXXXXXXXXXXXXXX X	:	:	:	:	:	+
F	290.+	:XXXXXXXXXXXXXXXXXXXXX	:	:	:	:	:	+
	280.+	:XXXXXXXXXXXXXXXXXXXXX	:	:	:	:	:	+
S	270.+	:XXXXXXXXXXXXXXXXXXXXX X	:	:	:	:	:	+
T	260.+	:XXXXXXXXXXXXXXXXXXXXX	:	:	:	:	:	+
	250.+	-----XXXXXXXXXXXXX-----X-----	:	:	:	:	:	+
A	240.+	:XXXXXXXXXXXXXXXXXXXXX	:	:	:	:	:	+
M	230.+	:XXXXXXXXXXXXXXXXXXXXX:X	:	:	:	:	:	+
	220.+	:XXXXXXXXXXXXXXXXXXXXX	:	:	:	:	:	+
	210.+	:XXXXXXXXXXXXXXXXXXXXX X X: XX	:	:	:	:	:	+
E	200.+	:XXXXXXXXXXXXXXXXXXXXX X: X	:	:	:	:	:	+
R	190.+	:XXXXXXXXXXXXXXXXXXXXX XXXXX X	:	:	:	:	:	+
	180.+	:XXXXXXXXXXXXXXXXXXXXX XXX	:	:	:	:	:	+
	170.+	:XXXXXXXXXXXXXXXXXXXXX XX	:	:	:	:	:	+
O	160.+	:XXXXXXXXXXXXXXXXXXXXX XXXXX	:	:	:	:	:	+
	150.+	-----X-----XXXXXXXXXXXXX-----XXXX-----	:	:	:	:	:	+
	140.+	:XXXXXXXXXXXXXXXXXXXXX	:	:	:	:	:	+
	130.+	:XXXX	:	:	:	:	:	+
	120.+	:XXXXXXX	:	:	:	:	:	+
	110.+	:X XX XXX	:	:	:	:	:	+
	100.+	:	:	:	:	:	:	+
	90.+	:	:	:	:	:	:	+
	80.+	:	:	:	:	:	:	+
	70.+	:	:	:	:	:	:	+
	60.+	:	:	:	:	:	:	+
	50.+	:	:	:	:	:	:	+

+ + + + + + + +

-30. -10. 10. 30. 50. 70. 90. 110.

DRY BULB TEMPERATURE DEGREES F

+ + + + + + +

95. 75. 55. 35. 199 15. -5. -25. -45.

DEGREE HOURS (BASE = 65 F, - = COOLING)

STEAM LOAD - DRY BULB TEMPERATURE DATA.

RUN DATE- 77/11/03.

MINNEAPOLIS CAMPUS STEAM LOAD
BASED ON HOURLY DATA FOR OCT. - MAR. 1975-1976

	500.+	:	:	:	:	:	:	:	+
	490.+	:	:	:	:	:	:	:	+
	480.+	:	:	:	:	:	:	:	+
	470.+	:	:	:	:	:	:	:	+
	460.+	:	:	:	:	:	:	:	+
	450.+	-----	-----	-----	-----	-----	-----	-----	+
I	440.+	:	:	:	:	:	:	:	+
H	430.+	:	:	:	:	:	:	:	+
	420.+	:	:	:	:	:	:	:	+
J	410.+	:	:	:	:	:	:	:	+
S	400.+	XXXXXXXXXX	X	:	:	:	:	:	+
	390.+	X : XX	:	:	:	:	:	:	+
	380.+	XX X XXX X	:	:	:	:	:	:	+
D	370.+	XXXXXXXXXX X	:	:	:	:	:	:	+
S	360.+	XXX XXXXXXXX	:	:	:	:	:	:	+
	350.+	-----	-----	-----	-----	-----	-----	-----	+
J	340.+	XXXXXXXXXXXXXX	:	:	:	:	:	:	+
F	330.+	XXXXXXXXXXXXXX X X	:	:	:	:	:	:	+
	320.+	: XXXXXXXXXXXXXXX	:	:	:	:	:	:	+
	310.+	: XXXXXXXXXXXXXXX	:	:	:	:	:	:	+
B	300.+	:X XXXXXXXXXXXXXXX	:	:	:	:	:	:	+
	290.+	: XXXXXXXXXXXXXXX	:	:	:	:	:	:	+
	280.+	:X XXXXXXXXXXXXXXX	:	:	:	:	:	:	+
O	270.+	: X XXXXXXXXXXXXXXX	:	:	:	:	:	:	+
E	260.+	: XX XXXXXXXXXXXXXXX	:	:	:	:	:	:	+
	250.+	-----	-----	-----	-----	-----	-----	-----	+
S	240.+	: XXXXXXXXXXXXXXX	:	:	:	:	:	:	+
T	230.+	: XXXXXXXXXXXXXXX	:	:	:	:	:	:	+
	220.+	:X XXXXXXXXXXXXXXX	:	:	:	:	:	:	+
	210.+	: XXXXXXXXXXXXXXX	:	:	:	:	:	:	+
M	200.+	: XXXXXXXXXXXXXXX	:	:	:	:	:	:	+
	190.+	: XXXXXXXXXXXXXXX X	:	:	:	:	:	:	+
	180.+	: XXXXXXXXXXXXXXX	:	:	:	:	:	:	+
E	170.+	: XXXXX XXXXXXXX XX X	:	:	:	:	:	:	+
R	160.+	: XXXXXXXXXXXXXXX XX XX XXX	:	:	:	:	:	:	+
	150.+	-----	-----	-----	-----	-----	-----	-----	+
H	140.+	: XXXXXXXXXXXXXXX:XXX XX	:	:	:	:	:	:	+
O	130.+	: XXXXXXXXXXXXXXX:XX X X	:	:	:	:	:	:	+
J	120.+	: X XXXXXXXXXXXXXXX XXX	:	:	:	:	:	:	+
	110.+	: X XXXXXXXXXXXXXXX X	:	:	:	:	:	:	+
	100.+	: XXXXXX	:	:	:	:	:	:	+
	90.+	:	:	:	:	:	:	:	+
	80.+	:	:	:	:	:	:	:	+
	70.+	:	:	:	:	:	:	:	+
	60.+	:	:	:	:	:	:	:	+
	50.+	:	:	:	:	:	:	:	+

+	+	+	+	+	+	+	+	+	+
-30.	-10.	10.	30.	50.	70.	90.	110.		

DRY BULB TEMPERATURE DEGREES F

+	+	+	+	+	+	+	+	+	+
95.	75.	55.	35.	15.	-5.	-25.	-45.		

DEGREE HOURS (BASE = 65 F, - = COOLING)

STEAM LOAD - DRY BULB TEMPERATURE DATA

RUN DATE- 77/11/03.

MINNEAPOLIS CAMPUS STEAM LOAD
BASED ON HOURLY DATA FOR OCT. - MAR. 1976-1977

	500.+	:	:	:	:	:	:	:
	490.+	:	:	:	:	:	:	:
	480.+	:	:	:	:	:	:	:
	470.+	:	:	:	:	:	:	:
	460.+	:	:	:	:	:	:	:
	450.+	X	:	:	:	:	:	:
	440.+	XXX-X	:	:	:	:	:	:
T	440.+	X XXX:	:	:	:	:	:	:
H	430.+	X X : X	:	:	:	:	:	:
O	420.+	XXXXX XXXX	:	:	:	:	:	:
U	410.+	XXXXXXXXXXXX X	:	:	:	:	:	:
S	400.+	XXXXXXXXXXXXXXXX X	:	:	:	:	:	:
A	390.+	XXXXXXXXXXXXXXXX	:	:	:	:	:	:
N	380.+	XXXXXXXXXX XX XXXX	:	:	:	:	:	:
D	370.+	X XXXXXXXXXXXXXXX X:XX	:	:	:	:	:	:
S	360.+	XXXXXXXXXXXXXXXXXXXX	:	:	:	:	:	:
	350.+	XX-XXXXXXXXXXXXXXXX	:	:	:	:	:	:
O	340.+	X XXXXXXXXXXXXXXX	:	:	:	:	:	:
F	330.+	XX XXXXXXXXXXXXXXX	:	:	:	:	:	:
	320.+	XXXXXXXXXXXXXXXX X	:	:	:	:	:	:
L	310.+	XXX XXXXXXXXXXXXXX	:	:	:	:	:	:
B	300.+	:XXXXXXXXXXXXXXXX	:	:	:	:	:	:
S	290.+	:XXXXXXXXXXXXXXXX	:	:	:	:	:	:
	280.+	:XXXXXXXXXXXXXXXX X	:	:	:	:	:	:
O	270.+	:XXXXXXXXXXXX X:	:	:	:	:	:	:
F	260.+	:XXXXXXXXXXXXXXXXXXXX	:	:	:	:	:	:
	250.+	X-XXXXXXXXXXXXXXXXXXXX	:	:	:	:	:	:
S	240.+	:XXXXXXXXXXXXXXXXXXXX	:	:	:	:	:	:
T	230.+	:XXXXXXXXXXXX	:	:	:	:	:	:
E	220.+	:XXXXXXXXXXXXXXXXXXXX	:	:	:	:	:	:
A	210.+	:XXXXXXXXXXXXXXXXXXXX	:	:	:	:	:	:
M	200.+	:XXXXXXXXXXXXXXXXXXXX	:	:	:	:	:	:
	190.+	:XXXXXXXXXXXXXXXXXXXX X	:	:	:	:	:	:
P	180.+	:XXXXXXXXXXXXXXXXXXXX	:	:	:	:	:	:
E	170.+	:XXXXXXXXXXXXXXXXXXXX XXX:	:	:	:	:	:	:
R	160.+	:XXXXXXXXXXXXXXXXXXXX XXXX	:	:	:	:	:	:
	150.+	XXXXXXXXXXXXXXXXXXXX-XX	:	:	:	:	:	:
H	140.+	:XXXXXXXXXXXXXXXXXXXX XXXX	:	:	:	:	:	:
O	130.+	:XXXXXXXXXXXXXXXXXXXX XXXX	:	:	:	:	:	:
U	120.+	:X XXXXXXXXXX	:	:	:	:	:	:
R	110.+	:XXX XX X X	:	:	:	:	:	:
	100.+	:XXXXXXXXXX	:	:	:	:	:	:
	90.+	:X XX XXX	:	:	:	:	:	:
	80.+	:	:	:	:	:	:	:
	70.+	:	:	:	:	:	:	:
	60.+	:	:	:	:	:	:	:
	50.+	:	:	:	:	:	:	:

	+ -30.	+ -10.	+ 10.	+ 30.	+ 50.	+ 70.	+ 90.	+ 110.
DRY BULB TEMPERATURE DEGREES F								

	+ 95.	+ 75.	+ 55.	+ 35.	+ 15.	+ -5.	+ -25.	+ -45.
DREGREE HOURS (BASE = 65 F, - = COOLING)								

ST. MARYS-FAIRVIEW STEAM LOAD
FOR OCT. - MAR. 1976-1977

58.+	:	:	:	:	:	:	:	:	:
57.+	:	:	X:	:	:	:	:	:	:
56.+	X	:	X	:	:	:	:	:	:
55.+	:	:	:	:	:	:	:	:	:
54.+	X	:	X	:	:	:	:	:	:
53.+	:	X	X XX	:	:	:	:	:	:
52.+	X XX	XXXXXX	XXX X	:	:	:	:	:	:
51.+	XXXXXXXX	X	XXX:	:	:	:	:	:	:
50.+	X X X	:	X X: X	:	:	:	:	:	:
I 49.+	XXXXXXXXXXXXXXXXXXXX	X	:	:	:	:	:	:	:
O 48.+	XX-X--	XXXXXXXXXXXXX-X	:	:	:	:	:	:	:
U 47.+	X	XXXXXXXXXXXXXXXXXXXX	XXX X	:	:	:	:	:	:
S 46.+	X	XXXXXXXXXXXXXXXXXXXX	X XXXX	:	:	:	:	:	:
A 45.+	XXXXXXXXXXXXXXXXXXXX	XX XXX	:	:	:	:	:	:	:
N 44.+	XXXXXXXXXXXXXXXXXXXX	X XXX	:	:	:	:	:	:	:
I 43.+	XXXXXXXXXXXXXXXXXXXX	X	:	:	:	:	:	:	:
S 42.+	XX	XXXXXXXXXXXXXXXXXXXX	XXX XXX	:	:	:	:	:	:
41.+	XXXXXXXXXXXXXXXXXXXX	:	:	:	:	:	:	:	:
G 40.+	X	XXXXXXXXXXXXXXXXXXXX	:	X	:	:	:	:	:
F 39.+	X	X XXXXXXXXXXXXXXX	X X	:	:	:	:	:	:
38.+	XXXXXXXXXXXXXXXXXXXX	:	:	:	:	:	:	:	:
L 37.+	:	XXXXXXXXXXXXXXXXXXXX	:	:	:	:	:	:	:
B 36.+	X X	XXXXXXXXXXXXXXXXXXXX	:	:	:	:	:	:	:
S 35.+	X	XX X XXXXXXXXXXXXXXX	:	:	:	:	:	:	:
34.+	X	XX XXXXXXXXXXXXXXX	X	:	:	:	:	:	:
O 33.+	:	XXXXXXXXXXXXXXXXXXXX	X	:	:	:	:	:	:
F 32.+	X	XX XXXX XXXXXXXXXXXXXXX	X	:	:	:	:	:	:
31.+	:	XX X XXXXXXXXXXXXXXX	X	:	:	:	:	:	:
S 30.+	:	XX XXXX X:XXXXXXXXXXXXXXXXXXXX	:	:	:	:	:	:	:
T 29.+	:	X	X XXXXXXXXXXXXXXX	:	:	:	:	:	:
E 28.+	X	XXX-XXXXXXXXXXXXX-X	:	:	:	:	:	:	:
A 27.+	:	XX XXXXXXXXXXXXXXX	:	:	:	:	:	:	:
M 26.+	:	XXXXXXXXXXXXXXXXXXXX	:	:	:	:	:	:	:
25.+	:	XXX XX XXXXXXXXXXXXXXX	:	:	:	:	:	:	:
P 24.+	:	XX XXXXXXXXXXXXXXX	:	:	:	:	:	:	:
E 23.+	:	XX XXXXXXXXXXXXXXX	:	:	:	:	:	:	:
R 22.+	:	XX X XXXXXXXXXXXXXXX	X	:	:	:	:	:	:
21.+	:	X XX XX XXXXXXXXXXXXXXX	:	:	:	:	:	:	:
H 20.+	:	X X XX:XXXXXXXXXXXXXXXXXXXX	XX	:	:	:	:	:	:
D 19.+	:	X XX:XX XXXXXXXXXXXXXXX	X XXX	:	:	:	:	:	:
J 18.+	XX-X-XXXX-XXXXXXXXXXXX-XXXXX	:	:	:	:	:	:	:	:
R 17.+	:	XX X X XX X:XXX XXX XX	X	:	:	:	:	:	:
16.+	:	X X X: X XXXX XXXXXX XXXX X	:	:	:	:	:	:	:
15.+	:	X:XXX XXXXXXXXXXXXXXX XXX	:	:	:	:	:	:	:
14.+	:	X XXXXXXXXXXXXXXX XX	:	:	:	:	:	:	:
13.+	:	XXXXX XX X	:	:	:	:	:	:	:
12.+	:	:	:	:	:	:	:	:	:
11.+	:	:	:	:	:	:	:	:	:
10.+	:	:	:	:	:	:	:	:	:
9.+	:	:	:	:	:	:	:	:	:
8.+	:	:	:	:	:	:	:	:	:

-30. -10. 10. 30. 50. 70. 90. 110.

DRY BULB TEMPERATURE DEGREES F

95. 75. 55. 35. 15. -5. -25. -45.

DEGREE HOURS 202 (BASE = 65 F, - = COOLING)

TOTAL SYSTEM MONTHLY STEAM LOAD FACTOR
FOR JULY 1976 THROUGH JUNE 1977

[illegible]

MINNEAPOLIS CAMPUS MONTHLY STEAM LOAD FACTOR
FOR JULY 1976 THROUGH JUNE 1977

[illegible]

MINNEAPOLIS CAMPUS MONTHLY STEAM LOAD FACTOR
FOR JULY 1975 THROUGH JUNE 1976

```

*****
1.00+
*
*
*
*
.90+
*
*
*
.80+
*
*
* X
* X X
* X X
.70+ X X
* X X X
* X X X X
* X X X X
* X X X X
.60+ X X X X X
* X X X X X
* X X X X X
* X X X X X
* X X X X X
.50+ X X X X X
* X X X X X
* X X X X X
* X X X X X
* X X X X X
.40+ X X X X X
* X X X X X
* X X X X X
* X X X X X
* X X X X X
.30+ X X X X X
* X X X X X
* X X X X X
* X X X X X
* X X X X X
.20+ X X X X X
* X X X X X
* X X X X X
* X X X X X
* X X X X X
.10+ X X X X X
* X X X X X
* X X X X X
* X X X X X
* X X X X X
0+ X X X X X
*****
+ + + + + + + + + + + + + + + + +
77/11/03 JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN

```

ST. MARYS-FAIRVIEW MONTHLY STEAM LOAD FACTORS
FOR JULY 1976 THROUGH JUNE 1977

*****+*****+*****+*****+*****+*****+*****+*****+*****+*****+*****+*****											
1.00+	*										+
	*										*
	*										*
	*										*
	*										*
.90+	*										+
	*										*
	*										*
	*										*
.80+	*										+
	*										*
	*	X									*
	*	X					X				*
	*	X					X				*
.70+	X						X				+
	X						X				*
	X						X				*
	X						X				*
	X						X				*
	X						X				*
	X						X				*
.60+	X	X					X				+
	X	X					X				*
	X	X					X				*
	X	X					X				*
	X	X					X				*
	X	X					X				*
	X	X					X				*
.50+	X	X	X				X				+
	X	X	X				X				*
	X	X	X				X				*
	X	X	X				X				*
	X	X	X				X				*
	X	X	X				X				*
	X	X	X				X				*
.40+	X	X	X				X				+
	X	X	X				X				*
	X	X	X				X				*
	X	X	X				X				*
	X	X	X				X				*
	X	X	X				X				*
	X	X	X				X				*
.30+	X	X	X				X				+
	X	X	X				X				*
	X	X	X				X				*
	X	X	X				X				*
	X	X	X				X				*
	X	X	X				X				*
	X	X	X				X				*
.20+	X	X	X				X				+
	X	X	X				X				*
	X	X	X				X				*
	X	X	X				X				*
	X	X	X				X				*
	X	X	X				X				*
	X	X	X				X				*
.10+	X	X	X				X				+
	X	X	X				X				*
	X	X	X				X				*
	X	X	X				X				*
	X	X	X				X				*
	X	X	X				X				*
0+	X	X	X				X				+
*****+*****+*****+*****+*****+*****+*****+*****+*****+*****+*****+*****											
	+	+	+	+	+	+	+	+	+	+	+
	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY JUN

TOTAL SYSTEM STEAM LOAD

1000'S OF LBS STEAM PER HOUR (L=LOW, A=AVERAGE, H=HIGH)		TEMPERATURE (F) (L=LOW, A=AVERAGE, H=HIGH)	
50. 150. 250. 350. 450. 550.		-25. 0 25. 50. 75. 100.	
DATE	+ + + + +	+ + + + +	+ + + + +
YY-MM-DD	*+*****+*****+*****+*****+*****+*	*+*****+*****+*****+*****+*****+*	*+*****+*****+*****+*****+*****+*
76- 7- 1 *	L AH :	:	: L A :H *
76- 7- 2 *	L A H:	:	: L A:H *
76- 7- 3 *	LA :	:	: L A H *
76- 7- 4 *	LA :	:	: L A H *
76- 7- 5 *	L AH :	:	: L A H *
76- 7- 6 *	:LA H:	:	: L A H *
76- 7- 7 *	:L AH:	:	: L A H *
76- 7- 8 *	:L AH:	:	: L A H *
76- 7- 9 *	:L A H	:	: L A H *
76- 7-10 *	: LA :	:	: L A H *
76- 7-11 *	:LAH :	:	: L A H *
76- 7-12 *	:L AH:	:	: L A:H *
76- 7-13 *	:L A H	:	: L A H *
76- 7-14 *	: LA H	:	: L A H *
76- 7-15 *	:L A :H	:	: L A:H *
76- 7-16 *	LAH :	:	: L A H:
76- 7-17 *	LAH :	:	: L A:H *
76- 7-18 *	LA H:	:	: L A H *
76- 7-19 *	:L A :H	:	: L A H *
76- 7-20 *	:L A H	:	: LA H *
76- 7-21 *	L A H:	:	: L A:H *
76- 7-22 *	:L A H	:	: L A H *
76- 7-23 *	:L A H	:	: LA H *
76- 7-24 *	:LAH :	:	: L A H *
76- 7-25 *	:LAH :	:	: L A:H *
76- 7-26 *	:L A H	:	: LA H *
76- 7-27 *	: LA H	:	: LA H *
76- 7-28 *	: LA H	:	: LA H *
76- 7-29 *	:L A H	:	: L A:H *
76- 7-30 *	: LA H	:	: LA H *
76- 7-31 *	LA H :	:	: L A H *
76- 8- 1 *	LAH :	:	: L A:H *
76- 8- 2 *	L A H:	:	: L A:H *
76- 8- 3 *	:LA H:	:	: L A:H *
76- 8- 4 *	:L A H	:	: L A: H *
76- 8- 5 *	:LA H:	:	: LAH: *
76- 8- 6 *	LA H :	:	: L A H *
76- 8- 7 *	L:AH :	:	: L A H *
76- 8- 8 *	LA :	:	: L A:H *
76- 8- 9 *	L A H:	:	: L A:H *
76- 8-10 *	:L A H	:	: L A H *
76- 8-11 *	:L A H	:	: L A: H *
76- 8-12 *	:L AH:	:	: L A H *
76- 8-13 *	:LA H:	:	: LA H *
76- 8-14 *	LA :	:	: L A H *
76- 8-15 *	AH :	:	: L A H *
76- 8-16 *	LA H :	:	: LA H *
76- 8-17 *	:L AH:	:	: LA:H *
76- 8-18 *	:L A:H	:	: L A H *
76- 8-19 *	: L A:H	:	: L A H *

TOTAL SYSTEM STEAM LOAD

DATE	1000'S OF LBS STEAM PER HOUR						TEMPERATURE (F)					
	(L=LOW, A=AVERAGE, H=HIGH)						(L=LOW, A=AVERAGE, H=HIGH)					
	50.	150.	250.	350.	450.	550.	-25.	0	25.	50.	75.	100.
YY-MM-DD	+	+	+	+	+	+	+	+	+	+	+	+
76- 8-20 *	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
76- 8-21 *	: LAH:	:	:	:	:	:	: LAH:	:	:	:	:	:
76- 8-22 *	: LA:	:	:	:	:	:	: LA:	:	:	:	:	:
76- 8-23 *	: LAH:	:	:	:	:	:	: LAH:	:	:	:	:	:
76- 8-24 *	: LAH:	:	:	:	:	:	: LAH:	:	:	:	:	:
76- 8-25 *	: LAH:	:	:	:	:	:	: LAH:	:	:	:	:	:
76- 8-26 *	: LAH:	:	:	:	:	:	: LAH:	:	:	:	:	:
76- 8-27 *	: LAH:	:	:	:	:	:	: LAH:	:	:	:	:	:
76- 8-28 *	: AH:	:	:	:	:	:	: AH:	:	:	:	:	:
76- 8-29 *	: AH:	:	:	:	:	:	: AH:	:	:	:	:	:
76- 8-30 *	: LAH:	:	:	:	:	:	: LAH:	:	:	:	:	:
76- 8-31 *	: LAH:	:	:	:	:	:	: LAH:	:	:	:	:	:
76- 9- 1 *	: LAH:	:	:	:	:	:	: LAH:	:	:	:	:	:
76- 9- 2 *	: LAH:	:	:	:	:	:	: LAH:	:	:	:	:	:
76- 9- 3 *	: LAH:	:	:	:	:	:	: LAH:	:	:	:	:	:
76- 9- 4 *	: AH:	:	:	:	:	:	: AH:	:	:	:	:	:
76- 9- 5 *	: LAH:	:	:	:	:	:	: LAH:	:	:	:	:	:
76- 9- 6 *	: LAH:	:	:	:	:	:	: LAH:	:	:	:	:	:
76- 9- 7 *	: LAH:	:	:	:	:	:	: LAH:	:	:	:	:	:
76- 9- 8 *	: LAH:	:	:	:	:	:	: LAH:	:	:	:	:	:
76- 9- 9 *	: LAH:	:	:	:	:	:	: LAH:	:	:	:	:	:
76- 9-10 *	: LAH:	:	:	:	:	:	: LAH:	:	:	:	:	:
76- 9-11 *	: LAH:	:	:	:	:	:	: LAH:	:	:	:	:	:
76- 9-12 *	: A:	:	:	:	:	:	: A:	:	:	:	:	:
76- 9-13 *	: LAH:	:	:	:	:	:	: LAH:	:	:	:	:	:
76- 9-14 *	: LAH:	:	:	:	:	:	: LAH:	:	:	:	:	:
76- 9-15 *	: LAH:	:	:	:	:	:	: LAH:	:	:	:	:	:
76- 9-16 *	: LAH:	:	:	:	:	:	: LAH:	:	:	:	:	:
76- 9-17 *	: LAH:	:	:	:	:	:	: LAH:	:	:	:	:	:
76- 9-18 *	: LAH:	:	:	:	:	:	: LAH:	:	:	:	:	:
76- 9-19 *	: LA:	:	:	:	:	:	: LA:	:	:	:	:	:
76- 9-20 *	: LAH:	:	:	:	:	:	: LAH:	:	:	:	:	:
76- 9-21 *	: LAH:	:	:	:	:	:	: LAH:	:	:	:	:	:
76- 9-22 *	: LAH:	:	:	:	:	:	: LAH:	:	:	:	:	:
76- 9-23 *	: LAH:	:	:	:	:	:	: LAH:	:	:	:	:	:
76- 9-24 *	: LAH:	:	:	:	:	:	: LAH:	:	:	:	:	:
76- 9-25 *	: LAH:	:	:	:	:	:	: LAH:	:	:	:	:	:
76- 9-26 *	: LA:	:	:	:	:	:	: LA:	:	:	:	:	:
76- 9-27 *	: LAH:	:	:	:	:	:	: LAH:	:	:	:	:	:
76- 9-28 *	: LAH:	:	:	:	:	:	: LAH:	:	:	:	:	:
76- 9-29 *	: LAH:	:	:	:	:	:	: LAH:	:	:	:	:	:
76- 9-30 *	: LAH:	:	:	:	:	:	: LAH:	:	:	:	:	:
76-10- 1 *	: LAH:	:	:	:	:	:	: LAH:	:	:	:	:	:
76-10- 2 *	: AH:	:	:	:	:	:	: AH:	:	:	:	:	:
76-10- 3 *	: LAH:	:	:	:	:	:	: LAH:	:	:	:	:	:
76-10- 4 *	: LAH:	:	:	:	:	:	: LAH:	:	:	:	:	:
76-10- 5 *	: LAH:	:	:	:	:	:	: LAH:	:	:	:	:	:
76-10- 6 *	: LAH:	:	:	:	:	:	: LAH:	:	:	:	:	:
76-10- 7 *	: LAH:	:	:	:	:	:	: LAH:	:	:	:	:	:
76-10- 8 *	: LAH:	:	:	:	:	:	: LAH:	:	:	:	:	:
	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****

TOTAL SYSTEM STEAM LOAD

1000'S OF LBS STEAM PER HOUR (L=LOW, A=AVERAGE, H=HIGH)							TEMPERATURE (F) (L=LOW, A=AVERAGE, H=HIGH)					
50. 150. 250. 350. 450. 550.							-25. 0 25. 50. 75. 100.					
DATE	+	+	+	+	+	+	+	+	+	+	+	+
YY-MM-DD	+	+	+	+	+	+	+	+	+	+	+	+
76-10- 9	*	:	LAH	:	:	:	*	:	:	LA	:	H
76-10-10	*	:	LA H	:	:	:	*	:	:	L A	:	H
76-10-11	*	:	LAH	:	:	:	*	:	:	L:A	:	H
76-10-12	*	:	L:AH	:	:	:	*	:	:	L:A	:	H
76-10-13	*	:	L:AH	:	:	:	*	:	:	LAH	:	:
76-10-14	*	:	LAH	:	:	:	*	:	:	L:A	:	H
76-10-15	*	:	L AH:	:	:	:	*	:	:	A H:	:	:
76-10-16	*	:	LA:	:	:	:	*	:	:	AH	:	:
76-10-17	*	:	LAH	:	:	:	*	:	:	L A H:	:	:
76-10-18	*	:	LAH	:	:	:	*	:	:	AH	:	:
76-10-19	*	:	LA H	:	:	:	*	:	:	A	:	:
76-10-20	*	:	LA H	:	:	:	*	:	:	LA H	:	:
76-10-21	*	:	LA H	:	:	:	*	:	:	LAH	:	:
76-10-22	*	:	LA H	:	:	:	*	:	:	L:A H	:	:
76-10-23	*	:	LA:H	:	:	:	*	:	:	LAH	:	:
76-10-24	*	:	LAH	:	:	:	*	:	:	LA H	:	:
76-10-25	*	:	L:AH	:	:	:	*	:	:	LA	:	:
76-10-26	*	:	LAH	:	:	:	*	:	:	L:AH	:	:
76-10-27	*	:	L:A H	:	:	:	*	:	:	L:AH	:	:
76-10-28	*	:	L A: H	:	:	:	*	:	:	LA H	:	:
76-10-29	*	:	L A :H	:	:	:	*	:	:	L A H	:	:
76-10-30	*	:	LA H:	:	:	:	*	:	:	LA :H	:	:
76-10-31	*	:	LAH:	:	:	:	*	:	:	L A H	:	:
76-11- 1	*	:	LA H	:	:	:	*	:	:	L A H	:	:
76-11- 2	*	:	LA H:	:	:	:	*	:	:	LAH	:	:
76-11- 3	*	:	L A H	:	:	:	*	:	:	LAH	:	:
76-11- 4	*	:	LA H	:	:	:	*	:	:	LAH	:	:
76-11- 5	*	:	L A : H	:	:	:	*	:	:	LA H	:	:
76-11- 6	*	:	A H :	:	:	:	*	:	:	LAH	:	:
76-11- 7	*	:	LAH	:	:	:	*	:	:	LAH	:	:
76-11- 8	*	:	LAH	:	:	:	*	:	:	L A H	:	:
76-11- 9	*	:	LA H	:	:	:	*	:	:	LA H	:	:
76-11-10	*	:	L AH	:	:	:	*	:	:	LAH	:	:
76-11-11	*	:	: LA :H	:	:	:	*	:	:	LA H	:	:
76-11-12	*	:	:L A H	:	:	:	*	:	:	LAH	:	:
76-11-13	*	:	:LAH	:	:	:	*	:	:	LA:H	:	:
76-11-14	*	:	LA H	:	:	:	*	:	:	L A H	:	:
76-11-15	*	:	LA H:	:	:	:	*	:	:	LA H	:	:
76-11-16	*	:	LA H:	:	:	:	*	:	:	L:A H	:	:
76-11-17	*	:	LA H	:	:	:	*	:	:	L A H:	:	:
76-11-18	*	:	LA: H	:	:	:	*	:	:	L A :H	:	:
76-11-19	*	:	LA H	:	:	:	*	:	:	:LAH	:	:
76-11-20	*	:	A H	:	:	:	*	:	:	LAH	:	:
76-11-21	*	:	LAH	:	:	:	*	:	:	AH	:	:
76-11-22	*	:	:L AH:	:	:	:	*	:	:	LA:	:	:
76-11-23	*	:	: LA:H	:	:	:	*	:	:	LA	:	:
76-11-24	*	:	L A H:	:	:	:	*	:	:	L A H	:	:
76-11-25	*	:	AH	:	:	:	*	:	:	LAH	:	:
76-11-26	*	:	L AH	:	:	:	*	:	:	L AH	:	:
76-11-27	*	:	: L AH	:	:	:	*	:	:	LAH	:	:

TOTAL SYSTEM STEAM LOAD

		1000'S OF LBS STEAM PER HOUR						TEMPERATURE (F)					
		(L=LOW, A=AVERAGE, H=HIGH)						(L=LOW, A=AVERAGE, H=HIGH)					
		50.	150.	250.	350.	450.	550.	-25.	0	25.	50.	75.	100.
DATE		+	+	+	+	+	+	+	+	+	+	+	+
YY-MM-DD		*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
76-11-28	*	:	:	:	LAH	:	*	*	LA	:	:	:	*
76-11-29	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
76-11-30	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
76-12- 1	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
76-12- 2	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
76-12- 3	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
76-12- 4	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
76-12- 5	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
76-12- 6	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
76-12- 7	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
76-12- 8	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
76-12- 9	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
76-12-10	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
76-12-11	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
76-12-12	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
76-12-13	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
76-12-14	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
76-12-15	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
76-12-16	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
76-12-17	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
76-12-18	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
76-12-19	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
76-12-20	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
76-12-21	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
76-12-22	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
76-12-23	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
76-12-24	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
76-12-25	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
76-12-26	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
76-12-27	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
76-12-28	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
76-12-29	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
76-12-30	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
76-12-31	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
77- 1- 1	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
77- 1- 2	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
77- 1- 3	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
77- 1- 4	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
77- 1- 5	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
77- 1- 6	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
77- 1- 7	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
77- 1- 8	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
77- 1- 9	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
77- 1-10	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
77- 1-11	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
77- 1-12	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
77- 1-13	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
77- 1-14	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
77- 1-15	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
77- 1-16	*	:	:	:	LAH	:	*	*	LAH	:	:	:	*
		*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****

TOTAL SYSTEM STEAM LOAD

1000'S OF LBS STEAM PER HOUR (L=LOW, A=AVERAGE, H=HIGH) 50. 150. 250. 350. 450. 550.							TEMPERATURE (F) (L=LOW, A=AVERAGE, H=HIGH) -25. 0 25. 50. 75. 100.						
DATE	+	+	+	+	+	+	+	+	+	+	+	+	+
YY-MM-DD	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 1-17 *	:	:	:	:	L:A H	*	*	LAH:	:	:	:	:	*
77- 1-18 *	:	:	:	:	L A:H	*	*	LA H	:	:	:	:	*
77- 1-19 *	:	:	:	:	L A H	*	*	L:AH	:	:	:	:	*
77- 1-20 *	:	:	:	:	LA:H	*	*	: LAH:	:	:	:	:	*
77- 1-21 *	:	:	:	:	LA:H	*	*	: LAH:	:	:	:	:	*
77- 1-22 *	:	:	:	:	LA H	*	*	:LA H:	:	:	:	:	*
77- 1-23 *	:	:	:	:	AH :	*	*	: LAH	:	:	:	:	*
77- 1-24 *	:	:	:	:	L A H:	*	*	: LAH	:	:	:	:	*
77- 1-25 *	:	:	:	:	A H:	*	*	: LA:	:	:	:	:	*
77- 1-26 *	:	:	:	:	L A H :	*	*	L :A H:	:	:	:	:	*
77- 1-27 *	:	:	:	:	L : A H	*	*	L A : H	:	:	:	:	*
77- 1-28 *	:	:	:	:	LA: H	*	*	LAH :	:	:	:	:	*
77- 1-29 *	:	:	:	:	L A :	*	*	LAH	:	:	:	:	*
77- 1-30 *	:	:	:	:	AH :	*	*	LAH	:	:	:	:	*
77- 1-31 *	:	:	:	:	LA H:	*	*	LA H	:	:	:	:	*
77- 2- 1 *	:	:	:	:	L A H :	*	*	L A H:	:	:	:	:	*
77- 2- 2 *	:	:	:	:	LA H	*	*	:L AH	:	:	:	:	*
77- 2- 3 *	:	:	:	:	L A H	*	*	: L AH	:	:	:	:	*
77- 2- 4 *	:	:	:	:	L A H	*	*	L A H	:	:	:	:	*
77- 2- 5 *	:	:	:	:	LAH	*	*	LAH	:	:	:	:	*
77- 2- 6 *	:	:	:	:	LAH	*	*	L A H	:	:	:	:	*
77- 2- 7 *	:	:	:	:	L A H :	*	*	LA H:	:	:	:	:	*
77- 2- 8 *	:	:	:	:	L A : H	*	*	: L A:H	:	:	:	:	*
77- 2- 9 *	:	:	:	:	LA: H	*	*	: L:A H:	:	:	:	:	*
77- 2-10 *	:	:	:	:	L A :H	*	*	: L: A H:	:	:	:	:	*
77- 2-11 *	:	:	:	:	L A :H	*	*	: L A H	:	:	:	:	*
77- 2-12 *	:	:	:	:	LA H	*	*	: :AH	:	:	:	:	*
77- 2-13 *	:	:	:	:	LA:H	*	*	: LAH	:	:	:	:	*
77- 2-14 *	:	:	:	:	L: A H	*	*	: LAH:	:	:	:	:	*
77- 2-15 *	:	:	:	:	L A: H	*	*	L A H:	:	:	:	:	*
77- 2-16 *	:	:	:	:	:L A :H	*	*	:L A H	:	:	:	:	*
77- 2-17 *	:	:	:	:	L:A H	*	*	: L:A H	:	:	:	:	*
77- 2-18 *	:	:	:	:	LA H	*	*	: LA:H	:	:	:	:	*
77- 2-19 *	:	:	:	:	:LA H:	*	*	:L AH:	:	:	:	:	*
77- 2-20 *	:	:	:	:	LAH	*	*	: LAH	:	:	:	:	*
77- 2-21 *	:	:	:	:	L A H	*	*	: L :A H	:	:	:	:	*
77- 2-22 *	:	:	:	:	LA:H	*	*	: LA H	:	:	:	:	*
77- 2-23 *	:	:	:	:	L A H	*	*	: LA	:	:	:	:	*
77- 2-24 *	:	:	:	:	L A H	*	*	: LAH	:	:	:	:	*
77- 2-25 *	:	:	:	:	LA H	*	*	: A:	:	:	:	:	*
77- 2-26 *	:	:	:	:	LAH	*	*	: LA:H	:	:	:	:	*
77- 2-27 *	:	:	:	:	LAH	*	*	: LAH	:	:	:	:	*
77- 2-28 *	:	:	:	:	:LA H:	*	*	: L A:H	:	:	:	:	*
77- 3- 1 *	:	:	:	:	:LA H	*	*	:L A:H	:	:	:	:	*
77- 3- 2 *	:	:	:	:	LA H	*	*	: AH	:	:	:	:	*
77- 3- 3 *	:	:	:	:	L:AH	*	*	: AH	:	:	:	:	*
77- 3- 4 *	:	:	:	:	LA H	*	*	: LA	:	:	:	:	*
77- 3- 5 *	:	:	:	:	LA H	*	*	: LA:H	:	:	:	:	*
77- 3- 6 *	:	:	:	:	LA H	*	*	: LA: H	:	:	:	:	*
77- 3- 7 *	:	:	:	:	L A H	*	*	: L :A H	:	:	:	:	*

TOTAL SYSTEM STEAM LOAD

1000'S OF LBS STEAM PER HOUR (L=LOW, A=AVERAGE, H=HIGH) 50. 150. 250. 350. 450. 550.							TEMPERATURE (F) (L=LOW, A=AVERAGE, H=HIGH) -25. 0 25. 50. 75. 100.						
DATE	+	+	+	+	+	+	+	+	+	+	+	+	+
YY-MM-DD	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 3- 8 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 3- 9 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-10 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-11 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-12 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-13 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-14 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-15 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-16 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-17 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-18 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-19 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-20 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-21 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-22 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-23 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-24 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-25 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-26 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-27 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-28 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-29 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-30 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-31 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 4- 1 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 4- 2 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 4- 3 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 4- 4 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 4- 5 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 4- 6 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 4- 7 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 4- 8 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 4- 9 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 4-10 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 4-11 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 4-12 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 4-13 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 4-14 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 4-15 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 4-16 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 4-17 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 4-18 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 4-19 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 4-20 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 4-21 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 4-22 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 4-23 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 4-24 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 4-25 *	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 4-26 *	+	+	+	+	+	+	+	+	+	+	+	+	+

TOTAL SYSTEM STEAM LOAD

1000'S OF LBS STEAM PER HOUR (L=LOW, A=AVERAGE, H=HIGH) 50. 150. 250. 350. 450. 550.							TEMPERATURE (F) (L=LOW, A=AVERAGE, H=HIGH) -25. 0 25. 50. 75. 100.						
DATE	+	+	+	+	+	+	+	+	+	+	+	+	+
YY-MM-DD	+	+	+	+	+	+	+	+	+	+	+	+	+
77- 4-27	*	LA: H	:	:	:	*	*	:	:	L: A	:	H	*
77- 4-28	*	LA: H	:	:	:	*	*	:	:	L A: H	:	:	*
77- 4-29	*	LAH	:	:	:	*	*	:	:	L: A	H:	:	*
77- 4-30	*	LAH:	:	:	:	*	*	:	:	L A H:	:	:	*
77- 5- 1	*	LAH:	:	:	:	*	*	:	:	L A H:	:	:	*
77- 5- 2	*	A H	:	:	:	*	*	:	:	L: A	H:	:	*
77- 5- 3	*	LA: H	:	:	:	*	*	:	:	L A H:	:	:	*
77- 5- 4	*	LA: H	:	:	:	*	*	:	:	A H:	:	:	*
77- 5- 5	*	LAH	:	:	:	*	*	:	:	L A H:	:	:	*
77- 5- 6	*	L A H	:	:	:	*	*	:	:	L A H	:	:	*
77- 5- 7	*	LAH:	:	:	:	*	*	:	:	L: A	H:	:	*
77- 5- 8	*	LAH:	:	:	:	*	*	:	:	L: A	H:	:	*
77- 5- 9	*	AH:	:	:	:	*	*	:	:	L: A	H:	:	*
77- 5-10	*	LA H	:	:	:	*	*	:	:	L: A	H	:	*
77- 5-11	*	L A H	:	:	:	*	*	:	:	L A H	:	:	*
77- 5-12	*	L A: H	:	:	:	*	*	:	:	L A: H	:	:	*
77- 5-13	*	L A H	:	:	:	*	*	:	:	L A: H	:	:	*
77- 5-14	*	LAH	:	:	:	*	*	:	:	L A H	:	:	*
77- 5-15	*	LAH	:	:	:	*	*	:	:	L A: H	:	:	*
77- 5-16	*	LA H	:	:	:	*	*	:	:	L A: H	:	:	*
77- 5-17	*	L: AH	:	:	:	*	*	:	:	L A: H	:	:	*
77- 5-18	*	LA H	:	:	:	*	*	:	:	L A H	:	:	*
77- 5-19	*	L: A H	:	:	:	*	*	:	:	L A H	:	:	*
77- 5-20	*	L: A H	:	:	:	*	*	:	:	L A H	:	:	*
77- 5-21	*	L A H	:	:	:	*	*	:	:	L A H:	:	:	*
77- 5-22	*	LA: H	:	:	:	*	*	:	:	AH:	:	:	*
77- 5-23	*	L: A H	:	:	:	*	*	:	:	L A: H	:	:	*
77- 5-24	*	L: A H:	:	:	:	*	*	:	:	L A H	:	:	*
77- 5-25	*	L A H:	:	:	:	*	*	:	:	L A H	:	:	*
77- 5-26	*	L A H:	:	:	:	*	*	:	:	L A H	:	:	*
77- 5-27	*	LA H	:	:	:	*	*	:	:	L A H	:	:	*
77- 5-28	*	LAH	:	:	:	*	*	:	:	L A H	:	:	*
77- 5-29	*	LA H	:	:	:	*	*	:	:	L A: H	:	:	*
77- 5-30	*	LA H	:	:	:	*	*	:	:	L A: H	:	:	*
77- 5-31	*	L A H	:	:	:	*	*	:	:	LAH:	:	:	*
77- 6- 1	*	L A H	:	:	:	*	*	:	:	L AH:	:	:	*
77- 6- 2	*	L A H	:	:	:	*	*	:	:	L A H:	:	:	*
77- 6- 3	*	L: A H	:	:	:	*	*	:	:	L A: H	:	:	*
77- 6- 4	*	L: AH	:	:	:	*	*	:	:	L A: H	:	:	*
77- 6- 5	*	L A H	:	:	:	*	*	:	:	L A: H	:	:	*
77- 6- 6	*	L A H	:	:	:	*	*	:	:	L AH:	:	:	*
77- 6- 7	*	L A H	:	:	:	*	*	:	:	L A: H	:	:	*
77- 6- 8	*	LA H	:	:	:	*	*	:	:	LA H:	:	:	*
77- 6- 9	*	L A H	:	:	:	*	*	:	:	L AH:	:	:	*
77- 6-10	*	LA H	:	:	:	*	*	:	:	L A: H	:	:	*
77- 6-11	*	LAH	:	:	:	*	*	:	:	L AH	:	:	*
77- 6-12	*	L AH	:	:	:	*	*	:	:	LA H:	:	:	*
77- 6-13	*	L A H	:	:	:	*	*	:	:	L A H	:	:	*
77- 6-14	*	L A H	:	:	:	*	*	:	:	L A: H	:	:	*
77- 6-15	*	L: A H	:	:	:	*	*	:	:	LAH:	:	:	*

TOTAL SYSTEM STEAM LOAD

DATE	1000'S OF LBS STEAM PER HOUR (L=LOW, A=AVERAGE, H=HIGH)						TEMPERATURE (F) (L=LOW, A=AVERAGE, H=HIGH)						
	50.	150.	250.	350.	450.	550.	-25.	0	25.	50.	75.	100.	
77- 6-16 *	L	A	H	:	:	:	*	:	:	:	L	A	H
77- 6-17 *	L	A	H	:	:	:	*	:	:	:	L	A	H
77- 6-18 *	L	A	H	:	:	:	*	:	:	:	L	A	H
77- 6-19 *	A	H	:	:	:	:	*	:	:	:	L	A	H
77- 6-20 *	L	A	H	:	:	:	*	:	:	:	L	A	H
77- 6-21 *	L	A	H	:	:	:	*	:	:	:	L	A	H
77- 6-22 *	L	A	H	:	:	:	*	:	:	:	L	A	H
77- 6-23 *	L	A	H	:	:	:	*	:	:	:	L	A	H
77- 6-24 *	L	A	H	:	:	:	*	:	:	:	L	A	H
77- 6-25 *	L	A	H	:	:	:	*	:	:	:	L	A	H
77- 6-26 *	L	A	H	:	:	:	*	:	:	:	L	A	H
77- 6-27 *	L	A	H	:	:	:	*	:	:	:	L	A	H
77- 6-28 *	L	A	H	:	:	:	*	:	:	:	L	A	H
77- 6-29 *	L	A	H	:	:	:	*	:	:	:	L	A	H
77- 6-30 *	L	A	H	:	:	:	*	:	:	:	L	A	H

MINNEAPOLIS CAMPUS STEAM LOAD

1000'S OF LBS STEAM PER HOUR: (L=LOW, A=AVERAGE, H=HIGH) 50. 150. 250. 350. 450. 550.							TEMPERATURE (F) (L=LOW, A=AVERAGE, H=HIGH) -25. 0 25. 50. 75. 100.						
DATE	+	+	+	+	+	+	+	+	+	+	+	+	+
YY-MM-DD	+	+	+	+	+	+	+	+	+	+	+	+	+
75- 7- 1 *	*	:	LA H	:	:	*	*	:	:	:	L A H	*	*
75- 7- 2 *	*	:	L H	:	:	*	*	:	:	:	L A H	*	*
75- 7- 3 *	*	:	LAH	:	:	*	*	:	:	:	LA H	*	*
75- 7- 4 *	*	:	LH :	:	:	*	*	:	:	:	L A H	*	*
75- 7- 5 *	*	:	LAH:	:	:	*	*	:	:	:	L A H	*	*
75- 7- 6 *	*	:	LH :	:	:	*	*	:	:	:	L A H	*	*
75- 7- 7 *	*	:	LAH:	:	:	*	*	:	:	:	L A H	*	*
75- 7- 8 *	*	:	LAH :	:	:	*	*	:	:	:	LAH	*	*
75- 7- 9 *	*	:	LA H:	:	:	*	*	:	:	:	LA :H	*	*
75- 7-10 *	*	:	LA H :	:	:	*	*	:	:	:	LA H:	*	*
75- 7-11 *	*	:	L A H:	:	:	*	*	:	:	:	LA H:	*	*
75- 7-12 *	*	:	LA H :	:	:	*	*	:	:	:	L A H:	*	*
75- 7-13 *	*	:	LAH :	:	:	*	*	:	:	:	LAH :	*	*
75- 7-14 *	*	:	L A H:	:	:	*	*	:	:	:	L A: H	*	*
75- 7-15 *	*	:	L A H	:	:	*	*	:	:	:	L A H	*	*
75- 7-16 *	*	:	LA H	:	:	*	*	:	:	:	L A H	*	*
75- 7-17 *	*	:	LAH	:	:	*	*	:	:	:	L A H	*	*
75- 7-18 *	*	:	LA:H	:	:	*	*	:	:	:	LA H	*	*
75- 7-19 *	*	:	LAH:	:	:	*	*	:	:	:	L A H	*	*
75- 7-20 *	*	:	LAH :	:	:	*	*	:	:	:	LA:H	*	*
75- 7-21 *	*	:	L A H	:	:	*	*	:	:	:	L A H	*	*
75- 7-22 *	*	:	LH:	:	:	*	*	:	:	:	L A H	*	*
75- 7-23 *	*	:	LAH:	:	:	*	*	:	:	:	LA H	*	*
75- 7-24 *	*	:	LAH :	:	:	*	*	:	:	:	L AH	*	*
75- 7-25 *	*	:	LAH :	:	:	*	*	:	:	:	L A: H	*	*
75- 7-26 *	*	:	LAH :	:	:	*	*	:	:	:	L A H	*	*
75- 7-27 *	*	:	LAH :	:	:	*	*	:	:	:	L A H	*	*
75- 7-28 *	*	:	LAH:	:	:	*	*	:	:	:	L A H	*	*
75- 7-29 *	*	:	LAH	:	:	*	*	:	:	:	L A H	*	*
75- 7-30 *	*	:	LAH	:	:	*	*	:	:	:	L A H	*	*
75- 7-31 *	*	:	LAH	:	:	*	*	:	:	:	LA H	*	*
75- 8- 1 *	*	:	LAH	:	:	*	*	:	:	:	L A H	*	*
75- 8- 2 *	*	:	LAH :	:	:	*	*	:	:	:	LA:H	*	*
75- 8- 3 *	*	:	L A H:	:	:	*	*	:	:	:	L A H	*	*
75- 8- 4 *	*	:	L A H:	:	:	*	*	:	:	:	L A H	*	*
75- 8- 5 *	*	:	LA H:	:	:	*	*	:	:	:	LA H	*	*
75- 8- 6 *	*	:	LAH :	:	:	*	*	:	:	:	L A H	*	*
75- 8- 7 *	*	:	LA H :	:	:	*	*	:	:	:	L A: H	*	*
75- 8- 8 *	*	:	L A H:	:	:	*	*	:	:	:	L A H	*	*
75- 8- 9 *	*	:	LAH :	:	:	*	*	:	:	:	L A H	*	*
75- 8-10 *	*	:	LAH :	:	:	*	*	:	:	:	L A H	*	*
75- 8-11 *	*	:	L AH :	:	:	*	*	:	:	:	L A H	*	*
75- 8-12 *	*	:	LAH:	:	:	*	*	:	:	:	LA H	*	*
75- 8-13 *	*	:	LAH :	:	:	*	*	:	:	:	L A: H	*	*
75- 8-14 *	*	:	LA H :	:	:	*	*	:	:	:	L A: H	*	*
75- 8-15 *	*	:	L AH :	:	:	*	*	:	:	:	L AH	*	*
75- 8-16 *	*	:	LH :	:	:	*	*	:	:	:	LA :H	*	*
75- 8-17 *	*	:	LA H :	:	:	*	*	:	:	:	LA H:	*	*
75- 8-18 *	*	:	LAH :	:	:	*	*	:	:	:	L A H:	*	*
75- 8-19 *	*	:	LAH :	:	:	*	*	:	:	:	LA H	*	*

MINNEAPOLIS CAMPUS STEAM LOAD

		1000'S OF LBS STEAM PER HOUR (L=LOW, A=AVERAGE, H=HIGH) 50. 150. 250. 350. 450. 550.						TEMPERATURE (F) (L=LOW, A=AVERAGE, H=HIGH) -25. 0 25. 50. 75. 100.					
DATE		+	+	+	+	+	+	+	+	+	+	+	+
YY-MM-DD		+	+	+	+	+	+	+	+	+	+	+	+
75- 8-20	*	L	A	H	:	:	:	:	:	:	L	A	H
75- 8-21	*	:	L	A	H	:	:	:	:	:	:	L	A
75- 8-22	*	:	L	A	H	:	:	:	:	:	:	L	A
75- 8-23	*	:	L	A	H	:	:	:	:	:	:	L	A
75- 8-24	*	:	L	A	H	:	:	:	:	:	:	L	A
75- 8-25	*	L	A	H	:	:	:	:	:	:	:	L	A
75- 8-26	*	L	H	:	:	:	:	:	:	:	:	L	A
75- 8-27	*	L	A	H	:	:	:	:	:	:	:	L	A
75- 8-28	*	:	L	A	H	:	:	:	:	:	:	L	A
75- 8-29	*	:	L	A	H	:	:	:	:	:	:	L	A
75- 8-30	*	:	L	:	:	:	:	:	:	:	:	L	A
75- 8-31	*	L	H	:	:	:	:	:	:	:	:	L	A
75- 9- 1	*	L	A	H	:	:	:	:	:	:	:	L	A
75- 9- 2	*	L	A	H	:	:	:	:	:	:	:	L	A
75- 9- 3	*	L	A	H	:	:	:	:	:	:	:	L	A
75- 9- 4	*	L	A	H	:	:	:	:	:	:	:	L	A
75- 9- 5	*	L	H	:	:	:	:	:	:	:	:	L	A
75- 9- 6	*	L	A	H	:	:	:	:	:	:	:	L	A
75- 9- 7	*	L	A	H	:	:	:	:	:	:	:	L	A
75- 9- 8	*	L	H	:	:	:	:	:	:	:	:	L	A
75- 9- 9	*	L	A	H	:	:	:	:	:	:	:	L	A
75- 9-10	*	L	A	H	:	:	:	:	:	:	:	L	A
75- 9-11	*	L	A	H	:	:	:	:	:	:	:	L	A
75- 9-12	*	L	H	:	:	:	:	:	:	:	:	L	A
75- 9-13	*	L	H	:	:	:	:	:	:	:	:	L	A
75- 9-14	*	L	H	:	:	:	:	:	:	:	:	L	A
75- 9-15	*	L	H	:	:	:	:	:	:	:	:	L	A
75- 9-16	*	L	A	H	:	:	:	:	:	:	:	L	A
75- 9-17	*	L	A	H	:	:	:	:	:	:	:	L	A
75- 9-18	*	L	A	H	:	:	:	:	:	:	:	L	A
75- 9-19	*	L	A	H	:	:	:	:	:	:	:	L	A
75- 9-20	*	L	H	:	:	:	:	:	:	:	:	L	A
75- 9-21	*	L	H	:	:	:	:	:	:	:	:	L	A
75- 9-22	*	L	A	H	:	:	:	:	:	:	:	L	A
75- 9-23	*	L	A	H	:	:	:	:	:	:	:	L	A
75- 9-24	*	L	A	H	:	:	:	:	:	:	:	L	A
75- 9-25	*	L	A	H	:	:	:	:	:	:	:	L	A
75- 9-26	*	L	A	H	:	:	:	:	:	:	:	L	A
75- 9-27	*	L	H	:	:	:	:	:	:	:	:	L	A
75- 9-28	*	L	A	H	:	:	:	:	:	:	:	L	A
75- 9-29	*	L	A	H	:	:	:	:	:	:	:	L	A
75- 9-30	*	L	A	H	:	:	:	:	:	:	:	L	A
75-10- 1	*	L	A	H	:	:	:	:	:	:	:	L	A
75-10- 2	*	L	A	H	:	:	:	:	:	:	:	L	A
75-10- 3	*	L	A	H	:	:	:	:	:	:	:	L	A
75-10- 4	*	L	H	:	:	:	:	:	:	:	:	L	A
75-10- 5	*	L	H	:	:	:	:	:	:	:	:	L	A
75-10- 6	*	L	A	H	:	:	:	:	:	:	:	L	A
75-10- 7	*	L	A	H	:	:	:	:	:	:	:	L	A
75-10- 8	*	L	A	H	:	:	:	:	:	:	:	L	A

MINNEAPOLIS CAMPUS STEAM LOAD

1000'S OF LBS STEAM PER HOUR (L=LOW, A=AVERAGE, H=HIGH)							TEMPERATURE (F) (L=LOW, A=AVERAGE, H=HIGH)						
DATE	+	+	+	+	+	+	+	+	+	+	+	+	+
YY-MM-DD	+	+	+	+	+	+	+	+	+	+	+	+	+
75-10- 9 *	L	A	H	:	:	:	*	:	:	L	A	H	:
75-10-10 *	L	H	:	:	:	:	*	:	:	L	H	:	:
75-10-11 *	L	A	H	:	:	:	*	:	:	L	A	H	:
75-10-12 *	L	H	:	:	:	:	*	:	:	L	A	H	:
75-10-13 *	L	A	H	:	:	:	*	:	:	L	A	H	:
75-10-14 *	L	H	:	:	:	:	*	:	:	L	A	H	:
75-10-15 *	L	A	H	:	:	:	*	:	:	L	A	H	:
75-10-16 *	L	A	H	:	:	:	*	:	:	L	A	H	:
75-10-17 *	L	A	H	:	:	:	*	:	:	L	A	H	:
75-10-18 *	L	A	H	:	:	:	*	:	:	L	A	H	:
75-10-19 *	L	:	H	:	:	:	*	:	:	L	A	H	:
75-10-20 *	L	A	H	:	:	:	*	:	:	L	A	H	:
75-10-21 *	L	H	:	:	:	:	*	:	:	L	H	:	:
75-10-22 *	L	:	H	:	:	:	*	:	:	L	A	H	:
75-10-23 *	L	A	H	:	:	:	*	:	:	L	A	H	:
75-10-24 *	L	H	:	:	:	:	*	:	:	L	A	H	:
75-10-25 *	L	A	H	:	:	:	*	:	:	L	A	H	:
75-10-26 *	L	H	:	:	:	:	*	:	:	L	A	H	:
75-10-27 *	L	H	:	:	:	:	*	:	:	L	A	H	:
75-10-28 *	:	L	H	:	:	:	*	:	:	L	A	H	:
75-10-29 *	L	:	A	H	:	:	*	:	:	L	A	H	:
75-10-30 *	L	:	A	H	:	:	*	:	:	L	A	H	:
75-10-31 *	L	A	H	:	:	:	*	:	:	L	A	H	:
75-11- 1 *	L	A	H	:	:	:	*	:	:	L	A	H	:
75-11- 2 *	L	A	H	:	:	:	*	:	:	L	A	H	:
75-11- 3 *	L	A	H	:	:	:	*	:	:	L	A	H	:
75-11- 4 *	L	A	H	:	:	:	*	:	:	L	A	H	:
75-11- 5 *	L	H	:	:	:	:	*	:	:	L	A	H	:
75-11- 6 *	L	H	:	:	:	:	*	:	:	L	A	H	:
75-11- 7 *	L	A	H	:	:	:	*	:	:	L	A	H	:
75-11- 8 *	L	:	H	:	:	:	*	:	:	L	A	H	:
75-11- 9 *	L	A	H	:	:	:	*	:	:	L	A	H	:
75-11-10 *	:	L	H	:	:	:	*	:	:	L	A	H	:
75-11-11 *	:	L	H	:	:	:	*	:	:	L	A	H	:
75-11-12 *	:	L	A	H	:	:	*	:	:	L	A	H	:
75-11-13 *	:	L	A	H	:	:	*	:	:	L	A	H	:
75-11-14 *	:	L	A	H	:	:	*	:	:	L	A	H	:
75-11-15 *	L	:	A	H	:	:	*	:	:	L	A	H	:
75-11-16 *	L	A	H	:	:	:	*	:	:	L	A	H	:
75-11-17 *	L	A	H	:	:	:	*	:	:	L	A	H	:
75-11-18 *	L	A	H	:	:	:	*	:	:	L	A	H	:
75-11-19 *	L	A	H	:	:	:	*	:	:	L	A	H	:
75-11-20 *	:	L	A	H	:	:	*	:	:	L	A	H	:
75-11-21 *	:	L	A	H	:	:	*	:	:	L	A	H	:
75-11-22 *	:	L	A	H	:	:	*	:	:	L	A	H	:
75-11-23 *	:	L	A	H	:	:	*	:	:	L	A	H	:
75-11-24 *	:	:	L	A	H	:	*	:	:	L	A	H	:
75-11-25 *	:	:	L	A	H	:	*	:	:	L	A	H	:
75-11-26 *	:	:	L	A	H	:	*	:	:	L	A	H	:
75-11-27 *	:	:	L	A	H	:	*	:	:	L	A	H	:

MINNEAPOLIS CAMPUS STEAM LOAD

1000'S OF LBS STEAM PER HOUR (L=LOW, A=AVERAGE, H=HIGH)		TEMPERATURE (F) (L=LOW, A=AVERAGE, H=HIGH)	
50. 150. 250. 350. 450. 550.		-25. 0 25. 50. 75. 100.	
DATE	+ + + + +	+ + + + +	+ + + + +
YY-MM-DD	*+*****+*****+*****+*****+*****+*	*+*****+*****+*****+*****+*****+*	*+*****+*****+*****+*****+*****+*
75-11-28	* : LA H : : *	* : L AH : : *	* : L AH : : *
75-11-29	* : L H : : *	* : LAH : : *	* : LAH : : *
75-11-30	* : L:AH : : *	* : LA H: : : *	* : LA H: : : *
75-12- 1	* : :L A H : : *	* : L A H: : : *	* : L A H: : : *
75-12- 2	* : :LA H : : *	* : :LA H: : : *	* : :LA H: : : *
75-12- 3	* : LA H : : *	* : LA:H : : : *	* : LA:H : : : *
75-12- 4	* : L A: H : : *	* : : LA H : : : *	* : : LA H : : : *
75-12- 5	* : LA :H : : *	* : : L : AH : : *	* : : L : AH : : *
75-12- 6	* : :L H : : *	* : :LA H: : : *	* : :LA H: : : *
75-12- 7	* : LAH : : *	* : : LAH : : : *	* : : LAH : : : *
75-12- 8	* : LA H : : *	* : : LAH : : : *	* : : LAH : : : *
75-12- 9	* : LA H : : *	* : : LAH : : : *	* : : LAH : : : *
75-12-10	* : LAH : : *	* : : LH : : : *	* : : LH : : : *
75-12-11	* : L: A H : : *	* : : LAH : : : *	* : : LAH : : : *
75-12-12	* : LA H : : *	* : : L AH : : : *	* : : L AH : : : *
75-12-13	* : LAH: : : *	* : : :LH : : : *	* : : :LH : : : *
75-12-14	* L A H : : *	* : L A :H : : *	* : L A :H : : *
75-12-15	* : L A :H : : *	* : L A H : : : *	* : L A H : : : *
75-12-16	* : :L A:H : : *	* : L:A H : : : *	* : L:A H : : : *
75-12-17	* : : :L:A H : : *	* : LAH : : : *	* : LAH : : : *
75-12-18	* : : L A H : : *	* : L A H : : : *	* : L A H : : : *
75-12-19	* : L:A H : : *	* : : LA:H : : : *	* : : LA:H : : : *
75-12-20	* : LAH : : *	* : : LAH: : : *	* : : LAH: : : *
75-12-21	* : L:A H : : *	* : :L AH: : : *	* : :L AH: : : *
75-12-22	* : LA H : : *	* : : LH: : : *	* : : LH: : : *
75-12-23	* : LA H : : *	* : : LH: : : *	* : : LH: : : *
75-12-24	* : LA H : : *	* : : LH: : : *	* : : LH: : : *
75-12-25	* : LH : : *	* : : L : : : *	* : : L : : : *
75-12-26	* : LH : : *	* : : LH: : : *	* : : LH: : : *
75-12-27	* : LH : : *	* : : LH: : : *	* : : LH: : : *
75-12-28	* : LAH : : *	* : : LH : : : *	* : : LH : : : *
75-12-29	* : L:H : : *	* : : LH : : : *	* : : LH : : : *
75-12-30	* : LH. : : *	* : : LH : : : *	* : : LH : : : *
75-12-31	* : LH : : *	* : : LAH : : : *	* : : LAH : : : *
76- 1- 1	* : LH: : : *	* : : LAH : : : *	* : : LAH : : : *
76- 1- 2	* : L A H : : *	* : L A:H : : : *	* : L A:H : : : *
76- 1- 3	* : : LAH: : : *	* : L H : : : *	* : L H : : : *
76- 1- 4	* : : LH : : *	* : L AH : : : *	* : L AH : : : *
76- 1- 5	* : L A H : : *	* : L A H : : : *	* : L A H : : : *
76- 1- 6	* : L A H : : *	* : L : A H : : *	* : L : A H : : *
76- 1- 7	* : : L AH : : *	* : LAH : : : *	* : LAH : : : *
76- 1- 8	* : : L AH : : *	* : LAH: : : *	* : LAH: : : *
76- 1- 9	* : : LA H : : *	* : L A H : : : *	* : L A H : : : *
76- 1-10	* : : LAH: : : *	* : :LH : : : *	* : :LH : : : *
76- 1-11	* : : LH : : *	* : :LA H: : : *	* : :LA H: : : *
76- 1-12	* : LA H : : *	* : : L A H : : *	* : : L A H : : *
76- 1-13	* : L AH : : *	* : : LAH: : : *	* : : LAH: : : *
76- 1-14	* : : LA H : : *	* : L AH : : : *	* : L AH : : : *
76- 1-15	* : :LA H: : : *	* : L : AH : : : *	* : L : AH : : : *
76- 1-16	* : : L A:H : : *	* : L:AH : : : *	* : L:AH : : : *

MINNEAPOLIS CAMPUS STEAM LOAD

1000'S OF LBS STEAM PER HOUR (L=LOW, A=AVERAGE, H=HIGH)							TEMPERATURE (F) (L=LOW, A=AVERAGE, H=HIGH)						
DATE	+	+	+	+	+	+	+	+	+	+	+	+	+
YY-MM-DD	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
76- 1-17 *	:	:	:	LA	H	:	:	:	:	:	:	:	:
76- 1-18 *	:	:	:	L	A	H	:	:	:	:	:	:	:
76- 1-19 *	:	:	:	L	A	H	:	:	:	:	:	:	:
76- 1-20 *	:	:	:	L	A	H	:	:	:	:	:	:	:
76- 1-21 *	:	:	:	LA	H	:	:	:	:	:	:	:	:
76- 1-22 *	:	:	:	:LA	H	:	:	:	:	:	:	:	:
76- 1-23 *	:	:	:	:LA	H	:	:	:	:	:	:	:	:
76- 1-24 *	:	:	:	LAH	:	:	:	:	:	:	:	:	:
76- 1-25 *	:	:	:	LH	:	:	:	:	:	:	:	:	:
76- 1-26 *	:	:	:	:L	A	H	:	:	:	:	:	:	:
76- 1-27 *	:	:	:	:L	A	H	:	:	:	:	:	:	:
76- 1-28 *	:	:	:	LA	H	:	:	:	:	:	:	:	:
76- 1-29 *	:	:	:	L	A	H	:	:	:	:	:	:	:
76- 1-30 *	:	:	:	L	A	H	:	:	:	:	:	:	:
76- 1-31 *	:	:	:	L	A	H	:	:	:	:	:	:	:
76- 2- 1 *	:	:	:	L	A	H	:	:	:	:	:	:	:
76- 2- 2 *	:	:	:	:L	A	H	:	:	:	:	:	:	:
76- 2- 3 *	:	:	:	:LA	H	:	:	:	:	:	:	:	:
76- 2- 4 *	:	:	:	:L	A	H	:	:	:	:	:	:	:
76- 2- 5 *	:	:	:	:LA	H	:	:	:	:	:	:	:	:
76- 2- 6 *	:	:	:	:LA	H	:	:	:	:	:	:	:	:
76- 2- 7 *	:	:	:	L	A	H	:	:	:	:	:	:	:
76- 2- 8 *	:	:	:	LAH	:	:	:	:	:	:	:	:	:
76- 2- 9 *	:	:	:	LA	H	:	:	:	:	:	:	:	:
76- 2-10 *	:	:	:	LA	H	:	:	:	:	:	:	:	:
76- 2-11 *	:	:	:	L	A	H	:	:	:	:	:	:	:
76- 2-12 *	:	:	:	LA	H	:	:	:	:	:	:	:	:
76- 2-13 *	:	:	:	:L	A	H	:	:	:	:	:	:	:
76- 2-14 *	:	:	:	LA	H	:	:	:	:	:	:	:	:
76- 2-15 *	:	:	:	LH	:	:	:	:	:	:	:	:	:
76- 2-16 *	:	:	:	L	A	H	:	:	:	:	:	:	:
76- 2-17 *	:	:	:	LA	H	:	:	:	:	:	:	:	:
76- 2-18 *	:	:	:	LAH	:	:	:	:	:	:	:	:	:
76- 2-19 *	:	:	:	LA	H	:	:	:	:	:	:	:	:
76- 2-20 *	:	:	:	LAH	:	:	:	:	:	:	:	:	:
76- 2-21 *	:	:	:	L	A	H	:	:	:	:	:	:	:
76- 2-22 *	:	:	:	LH	:	:	:	:	:	:	:	:	:
76- 2-23 *	:	:	:	:L	A	H	:	:	:	:	:	:	:
76- 2-24 *	:	:	:	:LA	H	:	:	:	:	:	:	:	:
76- 2-25 *	:	:	:	:LA	H	:	:	:	:	:	:	:	:
76- 2-26 *	:	:	:	:LA	H	:	:	:	:	:	:	:	:
76- 2-27 *	:	:	:	:LAH	:	:	:	:	:	:	:	:	:
76- 2-28 *	:	:	:	:LAH	:	:	:	:	:	:	:	:	:
76- 2-29 *	:	:	:	:L	A	H	:	:	:	:	:	:	:
76- 3- 1 *	:	:	:	:LA	H	:	:	:	:	:	:	:	:
76- 3- 2 *	:	:	:	:L	A	H	:	:	:	:	:	:	:
76- 3- 3 *	:	:	:	:L	A	H	:	:	:	:	:	:	:
76- 3- 4 *	:	:	:	:L	A	H	:	:	:	:	:	:	:
76- 3- 5 *	:	:	:	:LA	H	:	:	:	:	:	:	:	:
76- 3- 6 *	:	:	:	:L	A	H	:	:	:	:	:	:	:

MINNEAPOLIS CAMPUS STEAM LOAD

		1000'S OF LBS STEAM PER HOUR						TEMPERATURE (F)					
		(L=LOW, A=AVERAGE, H=HIGH)						(L=LOW, A=AVERAGE, H=HIGH)					
		50.	150.	250.	350.	450.	550.	-25.	0	25.	50.	75.	100.
DATE		+	+	+	+	+	+	+	+	+	+	+	+
YY-MM-DD		+	+	+	+	+	+	+	+	+	+	+	+
76- 3- 7 *		*	:	LH	:	:	*	*	:	LAH	:	:	*
76- 3- 8 *		*	:	L:AH	:	:	*	*	:	L AH	:	:	*
76- 3- 9 *		*	:	LA:H	:	:	*	*	:	LAH	:	:	*
76- 3-10 *		*	:	L A H	:	:	*	*	:	LA:H	:	:	*
76- 3-11 *		*	:	L A: H	:	:	*	*	:	L :A H	:	:	*
76- 3-12 *		*	:	L AH	:	:	*	*	:	L A H	:	:	*
76- 3-13 *		*	:	L A H	:	:	*	*	:	L A:H	:	:	*
76- 3-14 *		*	:	LAH	:	:	*	*	:	LAH	:	:	*
76- 3-15 *		*	:	LAH	:	:	*	*	:	L A H	:	:	*
76- 3-16 *		*	:	LA H	:	:	*	*	:	LAH:	:	:	*
76- 3-17 *		*	:	L A: H	:	:	*	*	:	LA H	:	:	*
76- 3-18 *		*	:	LA H:	:	:	*	*	:	:L A : H	:	:	*
76- 3-19 *		*	:	L A H	:	:	*	*	:	:L A H	:	:	*
76- 3-20 *		*	:	L:AH	:	:	*	*	:	L :A H	:	:	*
76- 3-21 *		*	:	LH	:	:	*	*	:	LAH	:	:	*
76- 3-22 *		*	:	LA :H	:	:	*	*	:	L :A H	:	:	*
76- 3-23 *		*	:	L:AH	:	:	*	*	:	:L A: H	:	:	*
76- 3-24 *		*	:	LA H	:	:	*	*	:	:L AH:	:	:	*
76- 3-25 *		*	:	L:AH	:	:	*	*	:	:L A :H	:	:	*
76- 3-26 *		*	:	L:AH	:	:	*	*	:	:L A H	:	:	*
76- 3-27 *		*	:	LAH	:	:	*	*	:	:LA H:	:	:	*
76- 3-28 *		*	:	LA H	:	:	*	*	:	:L A:H	:	:	*
76- 3-29 *		*	:	LAH	:	:	*	*	:	:LAH:	:	:	*
76- 3-30 *		*	:	:LA H	:	:	*	*	:	:LAH:	:	:	*
76- 3-31 *		*	:	:LA H:	:	:	*	*	:	:L A H	:	:	*
76- 4- 1 *		*	:	LA H:	:	:	*	*	:	L A :H	:	:	*
76- 4- 2 *		*	:	LA H	:	:	*	*	:	:L A H	:	:	*
76- 4- 3 *		*	:	L:AH	:	:	*	*	:	:L A H	:	:	*
76- 4- 4 *		*	:	LA H	:	:	*	*	:	L :A H	:	:	*
76- 4- 5 *		*	:	LA H	:	:	*	*	:	:L A H	:	:	*
76- 4- 6 *		*	:	LA H	:	:	*	*	:	:L A H	:	:	*
76- 4- 7 *		*	:	LAH	:	:	*	*	:	:L A H	:	:	*
76- 4- 8 *		*	:	LA H	:	:	*	*	:	:L A H	:	:	*
76- 4- 9 *		*	:	L:H	:	:	*	*	:	:L A H	:	:	*
76- 4-10 *		*	:	LAH	:	:	*	*	:	:L A H	:	:	*
76- 4-11 *		*	:	LAH	:	:	*	*	:	L A H	:	:	*
76- 4-12 *		*	:	L:AH	:	:	*	*	:	:L A:H	:	:	*
76- 4-13 *		*	:	LA: H	:	:	*	*	:	:L A H:	:	:	*
76- 4-14 *		*	:	L A:H	:	:	*	*	:	:LA H	:	:	*
76- 4-15 *		*	:	L AH	:	:	*	*	:	:L A H	:	:	*
76- 4-16 *		*	:	L AH	:	:	*	*	:	:L A H	:	:	*
76- 4-17 *		*	:	LH:	:	:	*	*	:	:LA H:	:	:	*
76- 4-18 *		*	:	LH:	:	:	*	*	:	:L AH	:	:	*
76- 4-19 *		*	:	LA:H	:	:	*	*	:	:L A H	:	:	*
76- 4-20 *		*	:	LAH	:	:	*	*	:	:L A H	:	:	*
76- 4-21 *		*	:	LA:H	:	:	*	*	:	:LA H	:	:	*
76- 4-22 *		*	:	L:H	:	:	*	*	:	:LA:H	:	:	*
76- 4-23 *		*	:	LAH	:	:	*	*	:	:LAH	:	:	*
76- 4-24 *		*	:	LAH	:	:	*	*	:	:LH	:	:	*
76- 4-25 *		*	:	LAH	:	:	*	*	:	:LA :H	:	:	*
		*+*****+*****+*****+*****+*****+*						*+*****+*****+*****+*****+*****+*					

MINNEAPOLIS CAMPUS STEAM LOAD

		1000'S OF LBS STEAM PER HOUR						TEMPERATURE (F)					
		(L=LOW, A=AVERAGE, H=HIGH)						(L=LOW, A=AVERAGE, H=HIGH)					
		50.	150.	250.	350.	450.	550.	-25.	0	25.	50.	75.	100.
DATE		+	+	+	+	+	+	+	+	+	+	+	+
YY-MM-DD		*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
76- 4-26	*	LA	H	:	:	:	*	*	:	L	A	H	:
76- 4-27	*	L	H	:	:	:	*	*	:	L	A	H	:
76- 4-28	*	LA	H	:	:	:	*	*	:	L	A	H	:
76- 4-29	*	LAH	:	:	:	:	*	*	:	L	A	H	:
76- 4-30	*	LAH	:	:	:	:	*	*	:	LAH	:	:	*
76- 5- 1	*	LH:	:	:	:	:	*	*	:	LAH	:	:	*
76- 5- 2	*	LAH	:	:	:	:	*	*	:	LAH	:	:	*
76- 5- 3	*	LA	H	:	:	:	*	*	:	L	A	H	:
76- 5- 4	*	LA	H	:	:	:	*	*	:	L	A	H	:
76- 5- 5	*	LAH	:	:	:	:	*	*	:	L	A	H	:
76- 5- 6	*	LA	H	:	:	:	*	*	:	L	A	H	:
76- 5- 7	*	LA	H	:	:	:	*	*	:	L	A	H	:
76- 5- 8	*	LAH	:	:	:	:	*	*	:	L	A	H	:
76- 5- 9	*	LH:	:	:	:	:	*	*	:	L	A	H	:
76- 5-10	*	LA:H	:	:	:	:	*	*	:	L	A	H	:
76- 5-11	*	LH:	:	:	:	:	*	*	:	L	A	H	:
76- 5-12	*	LA:H	:	:	:	:	*	*	:	L	A	H	:
76- 5-13	*	L	H	:	:	:	*	*	:	LAH	:	:	*
76- 5-14	*	LA:H	:	:	:	:	*	*	:	L	A	H	:
76- 5-15	*	LAH	:	:	:	:	*	*	:	L	A	H	:
76- 5-16	*	LH:	:	:	:	:	*	*	:	L	A	H	:
76- 5-17	*	LA:H	:	:	:	:	*	*	:	L	A	H	:
76- 5-18	*	LA:H	:	:	:	:	*	*	:	L	A	H	:
76- 5-19	*	LA	H	:	:	:	*	*	:	L	A	H	:
76- 5-20	*	L:A	H	:	:	:	*	*	:	L	A	H	:
76- 5-21	*	LA	H	:	:	:	*	*	:	L	A	H	:
76- 5-22	*	LAH	:	:	:	:	*	*	:	L	A	H	:
76- 5-23	*	LH	:	:	:	:	*	*	:	L	A	H	:
76- 5-24	*	LA	H	:	:	:	*	*	:	L	A	H	:
76- 5-25	*	LA	H	:	:	:	*	*	:	L	A	H	:
76- 5-26	*	L:AH	:	:	:	:	*	*	:	L	A	H	:
76- 5-27	*	LA	H	:	:	:	*	*	:	L	A	H	:
76- 5-28	*	LA	H	:	:	:	*	*	:	LH	:	:	*
76- 5-29	*	L:	:	:	:	:	*	*	:	LAH	:	:	*
76- 5-30	*	LH	:	:	:	:	*	*	:	LAH	:	:	*
76- 5-31	*	LAH	:	:	:	:	*	*	:	LAH	:	:	*
76- 6- 1	*	L:A	H	:	:	:	*	*	:	L	A	H	:
76- 6- 2	*	LA	H	:	:	:	*	*	:	L	A	H	:
76- 6- 3	*	LA	H	:	:	:	*	*	:	L	A	H	:
76- 6- 4	*	LA	H	:	:	:	*	*	:	L	A	H	:
76- 6- 5	*	LAH	:	:	:	:	*	*	:	L	A	H	:
76- 6- 6	*	LAH	:	:	:	:	*	*	:	L	A	H	:
76- 6- 7	*	L	A	H	:	:	*	*	:	L	A	H	:
76- 6- 8	*	:LA	H	:	:	:	*	*	:	L	A	H	:
76- 6- 9	*	:LA	H	:	:	:	*	*	:	L	A	H	:
76- 6-10	*	:LAH	:	:	:	:	*	*	:	L	A	H	:
76- 6-11	*	:L	A	H	:	:	*	*	:	L	A	H	:
76- 6-12	*	:LAH	:	:	:	:	*	*	:	L	A	H	:
76- 6-13	*	:LH	:	:	:	:	*	*	:	L	A	H	:
76- 6-14	*	:LA	H	:	:	:	*	*	:	L	A	H	:
		*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****

MINNEAPOLIS CAMPUS STEAM LOAD

DATE	1000'S OF LBS STEAM PER HOUR (L=LOW, A=AVERAGE, H=HIGH)						TEMPERATURE (F) (L=LOW, A=AVERAGE, H=HIGH)						
	50.	150.	250.	350.	450.	550.	-25.	0	25.	50.	75.	100.	
	+	+	+	+	+	+	+	+	+	+	+	+	
YY-MM-DD	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	
76- 6-15 *	L	A	H	:	:	:	*	:	:	:	L	A	H
76- 6-16 *	L	A	H	:	:	:	*	:	:	:	L	A	H
76- 6-17 *	L	A	H	:	:	:	*	:	:	:	L	A	H
76- 6-18 *	L	A	H	:	:	:	*	:	:	:	L	A	H
76- 6-19 *	L	A	H	:	:	:	*	:	:	:	L	A	H
76- 6-20 *	L	A	H	:	:	:	*	:	:	:	L	A	H
76- 6-21 *	L	A	H	:	:	:	*	:	:	:	L	A	H
76- 6-22 *	L	A	H	:	:	:	*	:	:	:	L	A	H
76- 6-23 *	L	A	H	:	:	:	*	:	:	:	L	A	H
76- 6-24 *	L	A	H	:	:	:	*	:	:	:	L	A	H
76- 6-25 *	L	A	H	:	:	:	*	:	:	:	L	A	H
76- 6-26 *	L	A	H	:	:	:	*	:	:	:	L	A	H
76- 6-27 *	L	A	H	:	:	:	*	:	:	:	L	A	H
76- 6-28 *	L	A	H	:	:	:	*	:	:	:	L	A	H
76- 6-29 *	L	A	H	:	:	:	*	:	:	:	L	A	H
76- 6-30 *	L	A	H	:	:	:	*	:	:	:	L	A	H
	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	

MINNEAPOLIS CAMPUS STEAM LOAD

1000'S OF LBS STEAM PER HOUR								TEMPERATURE (F)							
(L=LOW, A=AVERAGE, H=HIGH)								(L=LOW, A=AVERAGE, H=HIGH)							
50. 150. 250. 350. 450. 550.								-25. 0 25. 50. 75. 100.							
DATE	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
YY-MM-DD	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 7- 1	*	LA	H	:	:	:	*	*	:	:	:	:	LA	:	H
76- 7- 2	*	LA	H	:	:	:	*	*	:	:	:	:	LA	:	H
76- 7- 3	*	LH	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 7- 4	*	LH	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 7- 5	*	LAH	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 7- 6	*	L AH	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 7- 7	*	:LAH	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 7- 8	*	:LAH	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 7- 9	*	:LA H:	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 7-10	*	:LH	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 7-11	*	LAH	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 7-12	*	:LAH	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 7-13	*	:LA H:	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 7-14	*	:LA H:	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 7-15	*	L A H	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 7-16	*	L H	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 7-17	*	LAH	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 7-18	*	LA H	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 7-19	*	L A H	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 7-20	*	L A H:	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 7-21	*	L: A H	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 7-22	*	:LA H:	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 7-23	*	:LA H:	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 7-24	*	LAH	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 7-25	*	:L H	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 7-26	*	:LA H:	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 7-27	*	:LA H:	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 7-28	*	:LA H:	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 7-29	*	:LA H:	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 7-30	*	:LA H:	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 7-31	*	LA H	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 8- 1	*	LH	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 8- 2	*	LA H	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 8- 3	*	LA H	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 8- 4	*	:LA H:	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 8- 5	*	LA H	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 8- 6	*	L:AH	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 8- 7	*	LAH	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 8- 8	*	L	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 8- 9	*	LA H	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 8-10	*	L A H:	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 8-11	*	L A H:	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 8-12	*	:LAH	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 8-13	*	LA H	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 8-14	*	LAH	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 8-15	*	LH	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 8-16	*	L:AH	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 8-17	*	L A H:	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 8-18	*	:L A H	:	:	:	:	*	*	:	:	:	:	L	:	AH
76- 8-19	*	:L A H	:	:	:	:	*	*	:	:	:	:	L	:	AH
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MINNEAPOLIS CAMPUS STEAM LOAD

		1000'S OF LBS STEAM PER HOUR						TEMPERATURE (F)					
		(L=LOW, A=AVERAGE, H=HIGH)						(L=LOW, A=AVERAGE, H=HIGH)					
		50.	150.	250.	350.	450.	550.	-25.	0	25.	50.	75.	100.
DATE		+	+	+	+	+	+	+	+	+	+	+	+
YY-MM-DD		+	+	+	+	+	+	+	+	+	+	+	+
76- 8-20	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76- 8-21	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76- 8-22	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76- 8-23	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76- 8-24	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76- 8-25	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76- 8-26	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76- 8-27	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76- 8-28	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76- 8-29	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76- 8-30	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76- 8-31	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76- 9- 1	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76- 9- 2	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76- 9- 3	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76- 9- 4	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76- 9- 5	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76- 9- 6	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76- 9- 7	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76- 9- 8	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76- 9- 9	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76- 9-10	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76- 9-11	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76- 9-12	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76- 9-13	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76- 9-14	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76- 9-15	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76- 9-16	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76- 9-17	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76- 9-18	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76- 9-19	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76- 9-20	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76- 9-21	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76- 9-22	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76- 9-23	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76- 9-24	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76- 9-25	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76- 9-26	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76- 9-27	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76- 9-28	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76- 9-29	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76- 9-30	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76-10- 1	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76-10- 2	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76-10- 3	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76-10- 4	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76-10- 5	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76-10- 6	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76-10- 7	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*
76-10- 8	*	:	LAH	:	:	:	*	*	:	:	:	LAH	*

MINNEAPOLIS CAMPUS STEAM LOAD

		1000'S OF LBS STEAM PER HOUR						TEMPERATURE (F)					
		(L=LOW, A=AVERAGE, H=HIGH)						(L=LOW, A=AVERAGE, H=HIGH)					
		50.	150.	250.	350.	450.	550.	-25.	0	25.	50.	75.	100.
DATE		+	+	+	+	+	+	+	+	+	+	+	+
YY-MM-DD		*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
76-10- 9	*	L	H	:	:	:	*	*	:	L	A	H	*
76-10-10	*	LAH	:	:	:	:	*	*	:	L	A	H	*
76-10-11	*	LAH	:	:	:	:	*	*	:	L	A	H	*
76-10-12	*	LAH	:	:	:	:	*	*	:	L	A	H	*
76-10-13	*	LAH	:	:	:	:	*	*	:	LAH	:	:	*
76-10-14	*	LAH	:	:	:	:	*	*	:	L	A	H	*
76-10-15	*	LA H	:	:	:	:	*	*	:	L H	:	:	*
76-10-16	*	: LH	:	:	:	:	*	*	:	: LH	:	:	*
76-10-17	*	: LH	:	:	:	:	*	*	:	L A H	:	:	*
76-10-18	*	: LA H	:	:	:	:	*	*	:	: LH	:	:	*
76-10-19	*	: LA H	:	:	:	:	*	*	:	: L	:	:	*
76-10-20	*	: LA H	:	:	:	:	*	*	:	LA H	:	:	*
76-10-21	*	: LA :H	:	:	:	:	*	*	:	LAH	:	:	*
76-10-22	*	: LA :H	:	:	:	:	*	*	:	L A H	:	:	*
76-10-23	*	: L H:	:	:	:	:	*	*	:	: LAH	:	:	*
76-10-24	*	: LH	:	:	:	:	*	*	:	LA H	:	:	*
76-10-25	*	: L AH	:	:	:	:	*	*	:	LH	:	:	*
76-10-26	*	: LAH	:	:	:	:	*	*	:	L AH	:	:	*
76-10-27	*	: LA:H	:	:	:	:	*	*	:	L AH	:	:	*
76-10-28	*	:LA H	:	:	:	:	*	*	:	:LA H	:	:	*
76-10-29	*	L A H:	:	:	:	:	*	*	:	:L A H	:	:	*
76-10-30	*	LAH	:	:	:	:	*	*	:	: LA :H	:	:	*
76-10-31	*	LA H	:	:	:	:	*	*	:	L A H	:	:	*
76-11- 1	*	LA H	:	:	:	:	*	*	:	: L AH	:	:	*
76-11- 2	*	LAH	:	:	:	:	*	*	:	: LAH	:	:	*
76-11- 3	*	:L A H	:	:	:	:	*	*	:	LAH	:	:	*
76-11- 4	*	: L H	:	:	:	:	*	*	:	LAH	:	:	*
76-11- 5	*	L : A :H	:	:	:	:	*	*	:	LA H	:	:	*
76-11- 6	*	L:H	:	:	:	:	*	*	:	LAH	:	:	*
76-11- 7	*	:LAH	:	:	:	:	*	*	:	LAH	:	:	*
76-11- 8	*	: LAH	:	:	:	:	*	*	:	L A H	:	:	*
76-11- 9	*	: LAH:	:	:	:	:	*	*	:	: LA H	:	:	*
76-11-10	*	: L AH	:	:	:	:	*	*	:	LAH	:	:	*
76-11-11	*	: LA H	:	:	:	:	*	*	:	LA H	:	:	*
76-11-12	*	: L AH	:	:	:	:	*	*	:	LAH	:	:	*
76-11-13	*	: LAH	:	:	:	:	*	*	:	LA:H	:	:	*
76-11-14	*	: L:H	:	:	:	:	*	*	:	L A H	:	:	*
76-11-15	*	: LA:H	:	:	:	:	*	*	:	LA H	:	:	*
76-11-16	*	: LA:H	:	:	:	:	*	*	:	L A H	:	:	*
76-11-17	*	: LA H	:	:	:	:	*	*	:	L A H:	:	:	*
76-11-18	*	:LA H	:	:	:	:	*	*	:	: L A :H	:	:	*
76-11-19	*	: LA H	:	:	:	:	*	*	:	: LAH	:	:	*
76-11-20	*	: LH:	:	:	:	:	*	*	:	LAH	:	:	*
76-11-21	*	: LH:	:	:	:	:	*	*	:	LH	:	:	*
76-11-22	*	: LAH	:	:	:	:	*	*	:	LH:	:	:	*
76-11-23	*	: :LAH	:	:	:	:	*	*	:	LH	:	:	*
76-11-24	*	: L A H	:	:	:	:	*	*	:	L A H	:	:	*
76-11-25	*	: LH:	:	:	:	:	*	*	:	LAH	:	:	*
76-11-26	*	: LA:H	:	:	:	:	*	*	:	L AH	:	:	*
76-11-27	*	: :LAH	:	:	:	:	*	*	:	LAH	:	:	*
		*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****

MINNEAPOLIS CAMPUS STEAM LOAD

1000'S OF LBS STEAM PER HOUR (L=LOW, A=AVERAGE, H=HIGH) 50. 150. 250. 350. 450. 550.							TEMPERATURE (F) (L=LOW, A=AVERAGE, H=HIGH) -25. 0 25. 50. 75. 100.						
DATE	+	+	+	+	+	+	+	+	+	+	+	+	+
YY-MM-DD	+	+	+	+	+	+	+	+	+	+	+	+	+
76-11-28 *	:	:	:	:	:	:	:	:	:	:	:	:	:
76-11-29 *	:	:	:	:	:	:	:	:	:	:	:	:	:
76-11-30 *	:	:	:	:	:	:	:	:	:	:	:	:	:
76-12- 1 *	:	:	:	:	:	:	:	:	:	:	:	:	:
76-12- 2 *	:	:	:	:	:	:	:	:	:	:	:	:	:
76-12- 3 *	:	:	:	:	:	:	:	:	:	:	:	:	:
76-12- 4 *	:	:	:	:	:	:	:	:	:	:	:	:	:
76-12- 5 *	:	:	:	:	:	:	:	:	:	:	:	:	:
76-12- 6 *	:	:	:	:	:	:	:	:	:	:	:	:	:
76-12- 7 *	:	:	:	:	:	:	:	:	:	:	:	:	:
76-12- 8 *	:	:	:	:	:	:	:	:	:	:	:	:	:
76-12- 9 *	:	:	:	:	:	:	:	:	:	:	:	:	:
76-12-10 *	:	:	:	:	:	:	:	:	:	:	:	:	:
76-12-11 *	:	:	:	:	:	:	:	:	:	:	:	:	:
76-12-12 *	:	:	:	:	:	:	:	:	:	:	:	:	:
76-12-13 *	:	:	:	:	:	:	:	:	:	:	:	:	:
76-12-14 *	:	:	:	:	:	:	:	:	:	:	:	:	:
76-12-15 *	:	:	:	:	:	:	:	:	:	:	:	:	:
76-12-16 *	:	:	:	:	:	:	:	:	:	:	:	:	:
76-12-17 *	:	:	:	:	:	:	:	:	:	:	:	:	:
76-12-18 *	:	:	:	:	:	:	:	:	:	:	:	:	:
76-12-19 *	:	:	:	:	:	:	:	:	:	:	:	:	:
76-12-20 *	:	:	:	:	:	:	:	:	:	:	:	:	:
76-12-21 *	:	:	:	:	:	:	:	:	:	:	:	:	:
76-12-22 *	:	:	:	:	:	:	:	:	:	:	:	:	:
76-12-23 *	:	:	:	:	:	:	:	:	:	:	:	:	:
76-12-24 *	:	:	:	:	:	:	:	:	:	:	:	:	:
76-12-25 *	:	:	:	:	:	:	:	:	:	:	:	:	:
76-12-26 *	:	:	:	:	:	:	:	:	:	:	:	:	:
76-12-27 *	:	:	:	:	:	:	:	:	:	:	:	:	:
76-12-28 *	:	:	:	:	:	:	:	:	:	:	:	:	:
76-12-29 *	:	:	:	:	:	:	:	:	:	:	:	:	:
76-12-30 *	:	:	:	:	:	:	:	:	:	:	:	:	:
76-12-31 *	:	:	:	:	:	:	:	:	:	:	:	:	:
77- 1- 1 *	:	:	:	:	:	:	:	:	:	:	:	:	:
77- 1- 2 *	:	:	:	:	:	:	:	:	:	:	:	:	:
77- 1- 3 *	:	:	:	:	:	:	:	:	:	:	:	:	:
77- 1- 4 *	:	:	:	:	:	:	:	:	:	:	:	:	:
77- 1- 5 *	:	:	:	:	:	:	:	:	:	:	:	:	:
77- 1- 6 *	:	:	:	:	:	:	:	:	:	:	:	:	:
77- 1- 7 *	:	:	:	:	:	:	:	:	:	:	:	:	:
77- 1- 8 *	:	:	:	:	:	:	:	:	:	:	:	:	:
77- 1- 9 *	:	:	:	:	:	:	:	:	:	:	:	:	:
77- 1-10 *	:	:	:	:	:	:	:	:	:	:	:	:	:
77- 1-11 *	:	:	:	:	:	:	:	:	:	:	:	:	:
77- 1-12 *	:	:	:	:	:	:	:	:	:	:	:	:	:
77- 1-13 *	:	:	:	:	:	:	:	:	:	:	:	:	:
77- 1-14 *	:	:	:	:	:	:	:	:	:	:	:	:	:
77- 1-15 *	:	:	:	:	:	:	:	:	:	:	:	:	:
77- 1-16 *	:	:	:	:	:	:	:	:	:	:	:	:	:

MINNEAPOLIS CAMPUS STEAM LOAD

		1000'S OF LBS STEAM PER HOUR						TEMPERATURE (F)					
		(L=LOW, A=AVERAGE, H=HIGH)						(L=LOW, A=AVERAGE, H=HIGH)					
		50.	150.	250.	350.	450.	550.	-25.	0	25.	50.	75.	100.
DATE		+	+	+	+	+	+	+	+	+	+	+	+
YY-MM-DD		*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
77- 1-17	*	:	:	:	L A H	:	*	*	LAH:	:	:	:	*
77- 1-18	*	:	:	:	LA H	:	*	*	LA H	:	:	:	*
77- 1-19	*	:	:	:	LA: H	:	*	*	L:AH	:	:	:	*
77- 1-20	*	:	:	:	LAH :	:	*	*	: LAH:	:	:	:	*
77- 1-21	*	:	:	:	L H :	:	*	*	: LAH:	:	:	:	*
77- 1-22	*	:	:	:	LA H :	:	*	*	:LA H:	:	:	:	*
77- 1-23	*	:	:	:	LH :	:	*	*	: LAH	:	:	:	*
77- 1-24	*	:	:	:	LA H :	:	*	*	: LAH	:	:	:	*
77- 1-25	*	:	:	:	LA H :	:	*	*	: LH:	:	:	:	*
77- 1-26	*	:	:	:	L: A H	:	*	*	L: A H:	:	:	:	*
77- 1-27	*	:	:	:	L A: H	:	*	*	L A: H	:	:	:	*
77- 1-28	*	:	:	:	LA H :	:	*	*	LAH :	:	:	:	*
77- 1-29	*	:	:	:	LH :	:	*	*	LAH :	:	:	:	*
77- 1-30	*	:	:	:	LH:	:	*	*	LAH :	:	:	:	*
77- 1-31	*	:	:	:	LA:H	:	*	*	LA H :	:	:	:	*
77- 2- 1	*	:	:	:	L A H	:	*	*	L A H:	:	:	:	*
77- 2- 2	*	:	:	:	LAH :	:	*	*	:L AH	:	:	:	*
77- 2- 3	*	:	:	:	LA H :	:	*	*	: L AH	:	:	:	*
77- 2- 4	*	:	:	:	L:AH :	:	*	*	L A H	:	:	:	*
77- 2- 5	*	:	:	:	: LH :	:	*	*	LAH :	:	:	:	*
77- 2- 6	*	:	:	:	: L H:	:	*	*	L A H :	:	:	:	*
77- 2- 7	*	:	:	:	:LA H	:	*	*	LA H:	:	:	:	*
77- 2- 8	*	:	:	:	LA H:	:	*	*	: L A:H	:	:	:	*
77- 2- 9	*	:	:	:	L A H	:	*	*	: L:A H:	:	:	:	*
77- 2-10	*	:	:	:	LA H:	:	*	*	: L: A H:	:	:	:	*
77- 2-11	*	:	:	:	LA H:	:	*	*	: L A H	:	:	:	*
77- 2-12	*	:	:	:	L H :	:	*	*	: :LH :	:	:	:	*
77- 2-13	*	:	:	:	LAH:	:	*	*	: LAH	:	:	:	*
77- 2-14	*	:	:	:	L A H :	:	*	*	: LAH:	:	:	:	*
77- 2-15	*	:	:	:	L A H	:	*	*	L A H:	:	:	:	*
77- 2-16	*	:	:	:	L:A H:	:	*	*	:L A H	:	:	:	*
77- 2-17	*	:	:	:	LA:H	:	*	*	: L:A H	:	:	:	*
77- 2-18	*	:	:	:	L:H	:	*	*	: LA:H	:	:	:	*
77- 2-19	*	:	:	:	LA H	:	*	*	:L AH:	:	:	:	*
77- 2-20	*	:	:	:	LH	:	*	*	: LAH	:	:	:	*
77- 2-21	*	:	:	:	L A :H	:	*	*	: L :A H	:	:	:	*
77- 2-22	*	:	:	:	LA H:	:	*	*	: LA H	:	:	:	*
77- 2-23	*	:	:	:	LA H	:	*	*	: LH	:	:	:	*
77- 2-24	*	:	:	:	LA H	:	*	*	: LAH	:	:	:	*
77- 2-25	*	:	:	:	LA:H	:	*	*	: L:	:	:	:	*
77- 2-26	*	:	:	:	LAH	:	*	*	: LA:H	:	:	:	*
77- 2-27	*	:	:	:	LAH	:	*	*	: LAH	:	:	:	*
77- 2-28	*	:	:	:	LA H	:	*	*	: L A:H	:	:	:	*
77- 3- 1	*	:	:	:	LA H	:	*	*	:L A:H	:	:	:	*
77- 3- 2	*	:	:	:	L:H	:	*	*	: LH	:	:	:	*
77- 3- 3	*	:	:	:	LAH	:	*	*	: LH	:	:	:	*
77- 3- 4	*	:	:	:	L H	:	*	*	: LH	:	:	:	*
77- 3- 5	*	:	:	:	L H	:	*	*	: LA:H	:	:	:	*
77- 3- 6	*	:	:	:	LA H	:	*	*	: LA: H	:	:	:	*
77- 3- 7	*	:	:	:	LA H	:	*	*	: L :A H	:	:	:	*
		*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****

MINNEAPOLIS CAMPUS STEAM LOAD

1000'S OF LBS STEAM PER HOUR (L=LOW, A=AVERAGE, H=HIGH)							TEMPERATURE (F) (L=LOW, A=AVERAGE, H=HIGH)					
DATE	+	+	+	+	+	+	-25.	0	25.	50.	75.	100.
YY-MM-DD	+	+	+	+	+	+	+	+	+	+	+	+
77- 3- 8 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 3- 9 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-10 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-11 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-12 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-13 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-14 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-15 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-16 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-17 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-18 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-19 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-20 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-21 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-22 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-23 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-24 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-25 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-26 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-27 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-28 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-29 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-30 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 3-31 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 4- 1 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 4- 2 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 4- 3 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 4- 4 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 4- 5 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 4- 6 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 4- 7 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 4- 8 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 4- 9 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 4-10 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 4-11 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 4-12 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 4-13 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 4-14 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 4-15 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 4-16 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 4-17 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 4-18 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 4-19 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 4-20 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 4-21 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 4-22 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 4-23 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 4-24 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 4-25 *	+	+	+	+	+	+	+	+	+	+	+	+
77- 4-26 *	+	+	+	+	+	+	+	+	+	+	+	+

MINNEAPOLIS CAMPUS STEAM LOAD

1000'S OF LBS STEAM PER HOUR							TEMPERATURE (F)								
(L=LOW, A=AVERAGE, H=HIGH)							(L=LOW, A=AVERAGE, H=HIGH)								
50. 150. 250. 350. 450. 550.							-25. 0 25. 50. 75. 100.								
DATE	+	+	+	+	+	+	+	+	+	+	+	+	+		
YY-MM-DD	+	+	+	+	+	+	+	+	+	+	+	+	+		
77- 4-27	*	LA	:	H	:	:	*	:	:	L	:	A	:	H	*
77- 4-28	*	LA	:	H	:	:	*	:	:	L	:	A	:	H	*
77- 4-29	*	L	:	H	:	:	*	:	:	L	:	A	:	H	*
77- 4-30	*	LA	:	H	:	:	*	:	:	L	:	A	:	H	*
77- 5- 1	*	LA	:	H	:	:	*	:	:	L	:	A	:	H	*
77- 5- 2	*	L	:	H	:	:	*	:	:	L	:	A	:	H	*
77- 5- 3	*	LA	:	H	:	:	*	:	:	L	:	A	:	H	*
77- 5- 4	*	LA	:	H	:	:	*	:	:	L	:	A	:	H	*
77- 5- 5	*	LA	:	H	:	:	*	:	:	L	:	A	:	H	*
77- 5- 6	*	LA	:	H	:	:	*	:	:	L	:	A	:	H	*
77- 5- 7	*	L	:	H	:	:	*	:	:	L	:	A	:	H	*
77- 5- 8	*	L	:	H	:	:	*	:	:	L	:	A	:	H	*
77- 5- 9	*	L	:	H	:	:	*	:	:	L	:	A	:	H	*
77- 5-10	*	LA	:	H	:	:	*	:	:	L	:	A	:	H	*
77- 5-11	*	L	:	A	:	H	*	:	:	L	:	A	:	H	*
77- 5-12	*	L	:	A	:	H	*	:	:	L	:	A	:	H	*
77- 5-13	*	L	:	A	:	H	*	:	:	L	:	A	:	H	*
77- 5-14	*	LA	:	H	:	:	*	:	:	L	:	A	:	H	*
77- 5-15	*	LA	:	H	:	:	*	:	:	L	:	A	:	H	*
77- 5-16	*	LA	:	H	:	:	*	:	:	L	:	A	:	H	*
77- 5-17	*	L	:	A	:	H	*	:	:	L	:	A	:	H	*
77- 5-18	*	LA	:	H	:	:	*	:	:	L	:	A	:	H	*
77- 5-19	*	L	:	A	:	H	*	:	:	L	:	A	:	H	*
77- 5-20	*	L	:	A	:	H	*	:	:	L	:	A	:	H	*
77- 5-21	*	LA	:	H	:	:	*	:	:	L	:	A	:	H	*
77- 5-22	*	L	:	H	:	:	*	:	:	L	:	A	:	H	*
77- 5-23	*	L	:	A	:	H	*	:	:	L	:	A	:	H	*
77- 5-24	*	LA	:	H	:	:	*	:	:	L	:	A	:	H	*
77- 5-25	*	L	:	A	:	H	*	:	:	L	:	A	:	H	*
77- 5-26	*	L	:	A	:	H	*	:	:	L	:	A	:	H	*
77- 5-27	*	L	:	A	:	H	*	:	:	L	:	A	:	H	*
77- 5-28	*	LA	:	H	:	:	*	:	:	L	:	A	:	H	*
77- 5-29	*	LA	:	H	:	:	*	:	:	L	:	A	:	H	*
77- 5-30	*	L	:	A	:	H	*	:	:	L	:	A	:	H	*
77- 5-31	*	LA	:	H	:	:	*	:	:	L	:	A	:	H	*
77- 6- 1	*	LA	:	H	:	:	*	:	:	L	:	A	:	H	*
77- 6- 2	*	LA	:	H	:	:	*	:	:	L	:	A	:	H	*
77- 6- 3	*	L	:	A	:	H	*	:	:	L	:	A	:	H	*
77- 6- 4	*	LA	:	H	:	:	*	:	:	L	:	A	:	H	*
77- 6- 5	*	LA	:	H	:	:	*	:	:	L	:	A	:	H	*
77- 6- 6	*	LA	:	H	:	:	*	:	:	L	:	A	:	H	*
77- 6- 7	*	LA	:	H	:	:	*	:	:	L	:	A	:	H	*
77- 6- 8	*	LA	:	H	:	:	*	:	:	L	:	A	:	H	*
77- 6- 9	*	LA	:	H	:	:	*	:	:	L	:	A	:	H	*
77- 6-10	*	L	:	A	:	H	*	:	:	L	:	A	:	H	*
77- 6-11	*	LA	:	H	:	:	*	:	:	L	:	A	:	H	*
77- 6-12	*	LA	:	H	:	:	*	:	:	L	:	A	:	H	*
77- 6-13	*	LA	:	H	:	:	*	:	:	L	:	A	:	H	*
77- 6-14	*	L	:	A	:	H	*	:	:	L	:	A	:	H	*
77- 6-15	*	L	:	A	:	H	*	:	:	L	:	A	:	H	*
*+*****+*****+*****+*****+*****+*							*+*****+*****+*****+*****+*****+*								

MINNEAPOLIS CAMPUS STEAM LOAD

DATE	1000'S OF LBS STEAM PER HOUR (L=LOW, A=AVERAGE, H=HIGH)						TEMPERATURE (F) (L=LOW, A=AVERAGE, H=HIGH)						
	50.	150.	250.	350.	450.	550.	-25.	0	25.	50.	75.	100.	
77- 6-16 *	LA	H	:	:	:	*	*	:	:	:	L	A:H	*
77- 6-17 *	LAH	:	:	:	:	*	*	:	:	:	L	A:H	*
77- 6-18 *	LAH	:	:	:	:	*	*	:	:	:	L	A H	*
77- 6-19 *	LH:	:	:	:	:	*	*	:	:	:	L	A H	*
77- 6-20 *	LA:H	:	:	:	:	*	*	:	:	:	L	A H	*
77- 6-21 *	L AH	:	:	:	:	*	*	:	:	:	L	A H	*
77- 6-22 *	L:H	:	:	:	:	*	*	:	:	:	LAH:	:	*
77- 6-23 *	L A H	:	:	:	:	*	*	:	:	:	L	A H	*
77- 6-24 *	LA H	:	:	:	:	*	*	:	:	:	L	A H	*
77- 6-25 *	LH	:	:	:	:	*	*	:	:	:	L	A H	*
77- 6-26 *	LH	:	:	:	:	*	*	:	:	:	L	A H	*
77- 6-27 *	L:A H	:	:	:	:	*	*	:	:	:	L	A H	*
77- 6-28 *	LA H	:	:	:	:	*	*	:	:	:	LAH:	:	*
77- 6-29 *	LAH	:	:	:	:	*	*	:	:	:	L	A: H	*
77- 6-30 *	LAH	:	:	:	:	*	*	:	:	:	L	A:H	*

ST. MARYS-FAIRVIEW STEAM LOAD

1000'S OF LBS STEAM PER HOUR (L=LOW, A=AVERAGE, H=HIGH)							TEMPERATURE (F) (L=LOW, A=AVERAGE, H=HIGH)						
0 12. 24. 36. 48. 60.							-25. 0 25. 50. 75. 100.						
DATE	+	+	+	+	+	+	+	+	+	+	+	+	+
YY-MM-DD	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 7- 1 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 7- 2 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 7- 3 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 7- 4 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 7- 5 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 7- 6 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 7- 7 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 7- 8 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 7- 9 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 7-10 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 7-11 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 7-12 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 7-13 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 7-14 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 7-15 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 7-16 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 7-17 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 7-18 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 7-19 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 7-20 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 7-21 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 7-22 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 7-23 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 7-24 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 7-25 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 7-26 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 7-27 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 7-28 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 7-29 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 7-30 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 7-31 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 8- 1 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 8- 2 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 8- 3 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 8- 4 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 8- 5 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 8- 6 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 8- 7 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 8- 8 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 8- 9 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 8-10 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 8-11 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 8-12 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 8-13 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 8-14 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 8-15 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 8-16 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 8-17 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 8-18 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76- 8-19 *	+	+	+	+	+	+	+	+	+	+	+	+	+

ST. MARYS-FAIRVIEW STEAM LOAD

1000'S OF LBS STEAM PER HOUR

(L=LOW, A=AVERAGE, H=HIGH)

0 12. 24. 36. 48. 60.

TEMPERATURE / (F)

(L=LOW, A=AVERAGE, H=HIGH)

-25. 0 25. 50. 75. 100.

DATE	+	+	+	+	+	+	+	+	+
YY-MM-DD	*	*	*	*	*	*	*	*	*
76- 8-20 *	:	LA H :	:	:	*	*	:	:	: LA H *
76- 8-21 *	:	AH :	:	:	*	*	:	:	: LA H *
76- 8-22 *	:	A H :	:	:	*	*	:	:	: L:A H *
76- 8-23 *	:	LAH :	:	:	*	*	:	:	: LA H *
76- 8-24 *	:	LAH :	:	:	*	*	:	:	: LA H *
76- 8-25 *	:	LAH :	:	:	*	*	:	:	: L AH *
76- 8-26 *	:	LA H :	:	:	*	*	:	:	: LA H *
76- 8-27 *	:	LAH :	:	:	*	*	:	:	: LAH *
76- 8-28 *	:	LA H:	:	:	*	*	:	:	:LAH :
76- 8-29 *	:	AH :	:	:	*	*	:	:	L : A H:
76- 8-30 *	:	LAH :	:	:	*	*	:	:	:L A: H *
76- 8-31 *	:	LAH :	:	:	*	*	:	:	: LA H *
76- 9- 1 *	:	LAH :	:	:	*	*	:	:	LAH :
76- 9- 2 *	:	LAH :	:	:	*	*	:	:	L A H *
76- 9- 3 *	:	LA H :	:	:	*	*	:	:	: L AH *
76- 9- 4 *	:	LAH :	:	:	*	*	:	:	: L A H *
76- 9- 5 *	:	LAH :	:	:	*	*	:	:	: L A:H *
76- 9- 6 *	:	LAH :	:	:	*	*	:	:	: L A: H *
76- 9- 7 *	:	LA H :	:	:	*	*	:	:	: L:A H *
76- 9- 8 *	:	LAH :	:	:	*	*	:	:	:LA H *
76- 9- 9 *	:	LA H :	:	:	*	*	:	:	LA H :
76- 9-10 *	:	LA H :	:	:	*	*	:	:	L : A H *
76- 9-11 *	:	LAH :	:	:	*	*	:	:	: L A:H *
76- 9-12 *	:	LAH :	:	:	*	*	:	:	: L A: H *
76- 9-13 *	:	L:A H :	:	:	*	*	:	:	: LAH: *
76- 9-14 *	:	L AH :	:	:	*	*	:	:	: LA :
76- 9-15 *	:	L:A H :	:	:	*	*	:	:	: LA H :
76- 9-16 *	:	L:A H :	:	:	*	*	:	:	:L:A H *
76- 9-17 *	:	LA H :	:	:	*	*	:	:	:L: A H *
76- 9-18 *	:	LA H :	:	:	*	*	:	:	:L: A :H *
76- 9-19 *	:	:A H :	:	:	*	*	:	:	: L AH :
76- 9-20 *	:	LA H :	:	:	*	*	:	:	: L :A H :
76- 9-21 *	:	:LAH :	:	:	*	*	:	:	: L A H :
76- 9-22 *	:	:LA H:	:	:	*	*	:	:	: L A H:
76- 9-23 *	:	: LA H	:	:	*	*	:	:	: L A:H :
76- 9-24 *	:	:L A H	:	:	*	*	:	:	: L A H :
76- 9-25 *	:	L A H	:	:	*	*	:	:	: L A H :
76- 9-26 *	:	:LA H:	:	:	*	*	:	:	: LAH :
76- 9-27 *	:	:L A H	:	:	*	*	:	:	: LAH :
76- 9-28 *	:	:L A H	:	:	*	*	:	:	: L A: H :
76- 9-29 *	:	:L A H	:	:	*	*	:	:	: L A H:
76- 9-30 *	:	:LA H	:	:	*	*	:	:	: L : A :H *
76-10- 1 *	:	:LA H	:	:	*	*	:	:	: L: A :H *
76-10- 2 *	:	:LAH :	:	:	*	*	:	:	: L: A H *
76-10- 3 *	:	LA H :	:	:	*	*	:	:	:L A:H *
76-10- 4 *	:	:LA H	:	:	*	*	:	:	:L:A H :
76-10- 5 *	:	:L A H	:	:	*	*	:	:	: L A:
76-10- 6 *	:	: L A H	:	:	*	*	:	:	:LA H:
76-10- 7 *	:	: LA H	:	:	*	*	:	:	: LAH :
76-10- 8 *	:	: LA: H	:	:	*	*	:	:	:L A H :

ST. MARYS-FAIRVIEW STEAM LOAD

1000'S OF LBS STEAM PER HOUR (L=LOW, A=AVERAGE, H=HIGH)							TEMPERATURE (F) (L=LOW, A=AVERAGE, H=HIGH)						
DATE	+	+	+	+	+	+	+	+	+	+	+	+	+
YY-MM-DD	0	12.	24.	36.	48.	60.	-25.	0	25.	50.	75.	100.	
76-10- 9 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-10-10 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-10-11 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-10-12 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-10-13 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-10-14 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-10-15 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-10-16 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-10-17 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-10-18 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-10-19 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-10-20 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-10-21 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-10-22 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-10-23 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-10-24 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-10-25 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-10-26 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-10-27 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-10-28 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-10-29 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-10-30 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-10-31 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-11- 1 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-11- 2 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-11- 3 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-11- 4 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-11- 5 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-11- 6 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-11- 7 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-11- 8 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-11- 9 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-11-10 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-11-11 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-11-12 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-11-13 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-11-14 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-11-15 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-11-16 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-11-17 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-11-18 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-11-19 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-11-20 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-11-21 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-11-22 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-11-23 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-11-24 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-11-25 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-11-26 *	+	+	+	+	+	+	+	+	+	+	+	+	+
76-11-27 *	+	+	+	+	+	+	+	+	+	+	+	+	+

ST. MARYS-FAIRVIEW STEAM LOAD

1000'S OF LBS STEAM PER HOUR							TEMPERATURE (F)						
(L=LOW, A=AVERAGE, H=HIGH)							(L=LOW, A=AVERAGE, H=HIGH)						
DATE	+	+	+	+	+	+	+	+	+	+	+	+	+
0 12. 24. 36. 48. 60.							-25. 0 25. 50. 75. 100.						
YY-MM-DD	+	+	+	+	+	+	+	+	+	+	+	+	+
76-11-28 *	*	:	:	:	LA H	*	*	LA	:	:	:	:	*
76-11-29 *	*	:	:	:	L A : H	*	*	LA H	:	:	:	:	*
76-11-30 *	*	:	:	:	L : A H:	*	*	L:AH	:	:	:	:	*
76-12- 1 *	*	:	:	:	L: A H	*	*	LAH	:	:	:	:	*
76-12- 2 *	*	:	:	:	: L A: H	*	*	L A:H	:	:	:	:	*
76-12- 3 *	*	:	:	:	:LA H:	*	*	LAH	:	:	:	:	*
76-12- 4 *	*	:	:	:	: L A H	*	*	:LAH	:	:	:	:	*
76-12- 5 *	*	:	:	:	L : A: H	*	*	:L AH:	:	:	:	:	*
76-12- 6 *	*	:	:	:	: L A H	*	*	L :A H:	:	:	:	:	*
76-12- 7 *	*	:	:	:	LA H :	*	*	LA:H :	:	:	:	:	*
76-12- 8 *	*	:	:	:	LA:H :	*	*	LAH :	:	:	:	:	*
76-12- 9 *	*	:	:	:	: L A H :	*	*	:L A H	:	:	:	:	*
76-12-10 *	*	:	:	:	: L: A H	*	*	L A H:	:	:	:	:	*
76-12-11 *	*	:	:	:	: L A H :	*	*	L: A H:	:	:	:	:	*
76-12-12 *	*	:	:	:	: L A H :	*	*	L A H	:	:	:	:	*
76-12-13 *	*	:	:	:	: L:A H	*	*	LA H :	:	:	:	:	*
76-12-14 *	*	:	:	:	:LA H:	*	*	: L:A H	:	:	:	:	*
76-12-15 *	*	:	:	:	:L A H	*	*	: LA H	:	:	:	:	*
76-12-16 *	*	:	:	:	L A H:	*	*	: L:AH	:	:	:	:	*
76-12-17 *	*	:	:	:	:LA H	*	*	: LAH	:	:	:	:	*
76-12-18 *	*	:	:	:	L A H:	*	*	: LA H	:	:	:	:	*
76-12-19 *	*	:	:	:	:L A H	*	*	: L A:H	:	:	:	:	*
76-12-20 *	*	:	:	:	: L A H	*	*	LA H :	:	:	:	:	*
76-12-21 *	*	:	:	:	: L:A H :	*	*	L :A H :	:	:	:	:	*
76-12-22 *	*	:	:	:	: L:A H :	*	*	L A H	:	:	:	:	*
76-12-23 *	*	:	:	:	: L:A H:	*	*	LA H :	:	:	:	:	*
76-12-24 *	*	:	:	:	: LAH	*	*	: L AH	:	:	:	:	*
76-12-25 *	*	:	:	:	: LAH	*	*	: AH	:	:	:	:	*
76-12-26 *	*	:	:	:	: L:A H :	*	*	:LA H:	:	:	:	:	*
76-12-27 *	*	:	:	:	: LAH	*	*	:LA H:	:	:	:	:	*
76-12-28 *	*	:	:	:	: L A H	*	*	LA:H	:	:	:	:	*
76-12-29 *	*	:	:	:	: LA H	*	*	AH:	:	:	:	:	*
76-12-30 *	*	:	:	:	: LAH	*	*	LAH :	:	:	:	:	*
76-12-31 *	*	:	:	:	: L A:H	*	*	L A H	:	:	:	:	*
77- 1- 1 *	*	:	:	:	:L A : H	*	*	LAH	:	:	:	:	*
77- 1- 2 *	*	:	:	:	: L A : H	*	*	L:AH	:	:	:	:	*
77- 1- 3 *	*	:	:	:	: L A H :	*	*	L AH	:	:	:	:	*
77- 1- 4 *	*	:	:	:	: L A H:	*	*	LA H	:	:	:	:	*
77- 1- 5 *	*	:	:	:	: L A H:	*	*	LAH	:	:	:	:	*
77- 1- 6 *	*	:	:	:	:LA H:	*	*	L:AH	:	:	:	:	*
77- 1- 7 *	*	:	:	:	: L A H	*	*	LAH	:	:	:	:	*
77- 1- 8 *	*	:	:	:	:L A H	*	*	L A H	:	:	:	:	*
77- 1- 9 *	*	:	:	:	: LA: H	*	*	LAH :	:	:	:	:	*
77- 1-10 *	*	:	:	:	: LA: H	*	*	LA H:	:	:	:	:	*
77- 1-11 *	*	:	:	:	: LAH	*	*	LA H	:	:	:	:	*
77- 1-12 *	*	:	:	:	: L A H :	*	*	LA H:	:	:	:	:	*
77- 1-13 *	*	:	:	:	:LA H:	*	*	LA H	:	:	:	:	*
77- 1-14 *	*	:	:	:	: LAH:	*	*	L AH	:	:	:	:	*
77- 1-15 *	*	:	:	:	: L A: H	*	*	LAH :	:	:	:	:	*
77- 1-16 *	*	:	:	:	: LA:H	*	*	LA H :	:	:	:	:	*
	*	+	+	+	+	+	*	+	+	+	+	+	*

ST. MARYS-FAIRVIEW STEAM LOAD

1000'S OF LBS STEAM PER HOUR

(L=LOW, A=AVERAGE, H=HIGH)

0 12. 24. 36. 48. 60.

TEMPERATURE (F)

(L=LOW, A=AVERAGE, H=HIGH)

-25. 0 25. 50. 75. 100.

[illegible]

ST. MARYS-FAIRVIEW STEAM LOAD

1000'S OF LBS STEAM PER HOUR

(L=LOW, A=AVERAGE, H=HIGH)

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[illegible]

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TEMPERATURE (F)

(L=LOW, A=AVERAGE, H=HIGH)

-25. 0 25. 50. 75. 100.

DATE	+	+	+	+	+	+	+	+	+
YY-MM-DD	*+*	*+*	*+*	*+*	*+*	*+*	*+*	*+*	*+*
77- 4-27 *	:	A H:	:	:	*	*	:	:	L A :H *
77- 4-28 *	:	LAH:	:	:	*	*	:	:	L A : H *
77- 4-29 *	:	A H	:	:	*	*	:	:	L A H: *
77- 4-30 *	:	A :	:	:	*	*	:	:	L A H: *
77- 5- 1 *	:	A :	:	:	*	*	:	:	L A H: *
77- 5- 2 *	:	A H	:	:	*	*	:	:	L A H: *
77- 5- 3 *	:	LA :	:	:	*	*	:	:	LA H: *
77- 5- 4 *	:	A :	:	:	*	*	:	:	A H: *
77- 5- 5 *	:	A H	:	:	*	*	:	:	L AH: *
77- 5- 6 *	:	AH :	:	:	*	*	:	:	:L A H *
77- 5- 7 *	:	LAH :	:	:	*	*	:	:	L A H: *
77- 5- 8 *	:	LA H	:	:	*	*	:	:	L A :H *
77- 5- 9 *	:	LAH:	:	:	*	*	:	:	L A H: *
77- 5-10 *	:	LA :	:	:	*	*	:	:	L A H *
77- 5-11 *	:	A H:	:	:	*	*	:	:	:L A H *
77- 5-12 *	:	AH :	:	:	*	*	:	:	:L A:H *
77- 5-13 *	:	LAH :	:	:	*	*	:	:	:L A: H *
77- 5-14 *	:	LAH :	:	:	*	*	:	:	:L A H *
77- 5-15 *	:	LAH :	:	:	*	*	:	:	:L A:H *
77- 5-16 *	:	LA H	:	:	*	*	:	:	:L A: H *
77- 5-17 *	:	LAH :	:	:	*	*	:	:	:L A:H *
77- 5-18 *	:	LAH :	:	:	*	*	:	:	:L A H *
77- 5-19 *	:	LAH :	:	:	*	*	:	:	:L A H *
77- 5-20 *	:	LAH :	:	:	*	*	:	:	:L A H *
77- 5-21 *	:	AH :	:	:	*	*	:	:	:LA H: *
77- 5-22 *	:	LA H :	:	:	*	*	:	:	:AH :
77- 5-23 *	:	LAH :	:	:	*	*	:	:	:L A :H *
77- 5-24 *	:	LA :	:	:	*	*	:	:	:L A H *
77- 5-25 *	:	LA :	:	:	*	*	:	:	:L A H *
77- 5-26 *	:	AH :	:	:	*	*	:	:	:L A H *
77- 5-27 *	:	A H :	:	:	*	*	:	:	:L A H *
77- 5-28 *	:	AH :	:	:	*	*	:	:	:L A H *
77- 5-29 *	:	A H :	:	:	*	*	:	:	:L A:H *
77- 5-30 *	:	A H :	:	:	*	*	:	:	:L A:H *
77- 5-31 *	:	LA H :	:	:	*	*	:	:	:LAH :
77- 6- 1 *	:	LAH :	:	:	*	*	:	:	L AH: *
77- 6- 2 *	:	LAH :	:	:	*	*	:	:	L A H: *
77- 6- 3 *	:	LAH :	:	:	*	*	:	:	:L A:H *
77- 6- 4 *	:	A H :	:	:	*	*	:	:	:L A:H *
77- 6- 5 *	:	A H :	:	:	*	*	:	:	:L A: H *
77- 6- 6 *	:	LA H :	:	:	*	*	:	:	:L AH: *
77- 6- 7 *	:	LAH :	:	:	*	*	:	:	:L A :H *
77- 6- 8 *	:	LA :H	:	:	*	*	:	:	:LA H: *
77- 6- 9 *	:	LA H :	:	:	*	*	:	:	L AH: *
77- 6-10 *	:	LAH :	:	:	*	*	:	:	:L A :H *
77- 6-11 *	:	LAH :	:	:	*	*	:	:	:L AH *
77- 6-12 *	:	LA H :	:	:	*	*	:	:	:LA H: *
77- 6-13 *	:	LAH :	:	:	*	*	:	:	L A H *
77- 6-14 *	:	LAH :	:	:	*	*	:	:	:L A :H *
77- 6-15 *	:	LAH :	:	:	*	*	:	:	:LAH: *

ST. MARYS-FAIRVIEW STEAM LOAD

1000'S OF LBS STEAM PER HOUR							TEMPERATURE (F)						
(L=LOW, A=AVERAGE, H=HIGH)							(L=LOW, A=AVERAGE, H=HIGH)						
DATE	+	+	+	+	+	+	-25.	0	25.	50.	75.	100.	
YY-MM-DD	+	+	+	+	+	+	+	+	+	+	+	+	
77- 6-16 *	LAH	:	:	:	:	*	:	:	:	:	L A:H	*	
77- 6-17 *	LA H	:	:	:	:	*	:	:	:	:	L A:H	*	
77- 6-18 *	LAH	:	:	:	:	*	:	:	:	:	L A H	*	
77- 6-19 *	LAH	:	:	:	:	*	:	:	:	:	L A H	*	
77- 6-20 *	LAH	:	:	:	:	*	:	:	:	:	L A H	*	
77- 6-21 *	LAH	:	:	:	:	*	:	:	:	:	L A H	*	
77- 6-22 *	LAH	:	:	:	:	*	:	:	:	:	LAH:	*	
77- 6-23 *	LA H	:	:	:	:	*	:	:	:	:	L A H	*	
77- 6-24 *	A H	:	:	:	:	*	:	:	:	:	L A H	*	
77- 6-25 *	AH	:	:	:	:	*	:	:	:	:	L A H	*	
77- 6-26 *	AH	:	:	:	:	*	:	:	:	:	L :A H	*	
77- 6-27 *	A H	:	:	:	:	*	:	:	:	:	L A H	*	
77- 6-28 *	LA H	:	:	:	:	*	:	:	:	:	LAH:	*	
77- 6-29 *	LAH	:	:	:	:	*	:	:	:	:	L A: H	*	
77- 6-30 *	LA H	:	:	:	:	*	:	:	:	:	L A:H	*	

The following sections present the development of cost benefits and preliminary life cycles for several plans. For the comparisons of different studies, the University's Basic Plan was used at varying interest rates and amortization periods. Also included is the total program cost for escalation of plant investment to the end of 1979 and one year of operation through 1981. Straight steam plants versus co-generation plants were compared.

The first comparisons were made on one year of experience, namely the updated Phase I costs. The results of that study indicated the following:

Direct Comparison of Benefits in 1977

Basic Plan "A" - No In-Plant Cash Flow

Loan Basis: Straight tax free 10 year @ $6\frac{1}{4}\%$
 Loan Amount: Full 1977 Investment
 Escalation: None
 Life Cycle: End of 1977
 Costs: No cost sharing
 Year (1977): Cost Benefit of steam side of Co-generation Plant = -\$7,667
 Year (1977): Cost Benefit of total Co-generation Plant = \$654,733
 Year (1977): Cost Benefit of Turbine-Generator (Non-Support) = \$144,975
 Year (2012): Benefit-to-Cost Ratio = 1.31
 : T-G Payoff Period = 19.09 Years

Basic Plan "B" - With In-Plant Cash Flow

Loan Basis: Straight tax free 10 year @ $6\frac{1}{4}\%$
 Loan Amount: Full 1977 Investment
 Escalation: None
 Life Cycles: End of 1977
 Year 1977: Cost Benefit of Steam Side of Co-Generation Plant = \$324,828
 Year 1977: Cost Benefit of Total Co-Generation Plant = \$136,953
 Year 1977: Cost Benefit for Turbine-Generator (Self Support) = -\$187,875
 Year (2012): Benefit-to-Cost Ratio = 1.31
 : Turbine Generator Payoff Period = 19 years

Basic Plan "C" - With In-Plant Cash Flow

Loan Basis: Steam - 15 year loan, 10 year balloon @ 9.96256%
Electric - 10 year loan, 5 year balloon @ 13.5866%
Loan Amount: Full 1977 Investments
Escalation: None
Life Cycle: End of 1977
Costs: No cost sharing
Year (1977): Cost Benefit of Steam Side of Co-Generation Plant = \$287,342
Year (1977): Cost Benefit of total Co-Generation Plant = \$141,848
Year (1977): Cost Benefit of Turbine-Generator (Self Supporting) = -\$145,494
Year (2012): Benefit-to-Cost Ratio = 1.35
: Turbine-Generator Payoff Period = 18.48 Years

*Basic Plan "D" - With In-Plant Cash Flow

Loan Basis: Steam - 15 year loan, 10 year balloon @ 9.96256%
Electric - 10 year loan, 5 year balloon @ 13.5866%
Loan Amount: University's cost sharing plan
Escalation: None
Life Cycle: End of 1977
Costs: Cost sharing per Executive Funding
Year (1977): Cost Benefit of Steam Side of Co-Generation Plant = \$223,104
Year (1977): Cost Benefit of Total Co-Generation Plant = \$235,267
Year (1977): Cost Benefit of Turbine-Generator = \$15,163
Year (2012): Benefit-to-Cost Ratio = 2.27
: Turbine-Generator Payoff Period = 10.99 Years

Life Cycle Cost Benefits to 1981 or 1982 and 2012

**Basic Plan "B" - Case 1 - With In-Plant Cash Flow

Loan Basis: Straight tax free 10 year @ 6 $\frac{1}{4}$ %
Loan Amount: Full 1977 Investment
Escalation: 1977 Construction Costs escalated to end of 1979
Life Cycle: End of 1982
Costs: No Cost Sharing
Year (1982): Cost Benefit for Steam Side of Co-Generation Plant = \$1,994,252
Year (1982): Cost Benefit for Total Co-Generation Plant = \$1,011,020
Year (1982): Cost Benefit for Turbine-Generator = -\$983,232
Year (2012): Benefit-to-Cost Ratio = 3.215
: Turbine-Generator Payoff Period = 6.09 Years

Basic Plan "B" - Case 2 - No In-Plant Cash Flow

Same as Case 1 above for 25 Years (2012), Construction Not Escalated

Year (2012): Cost Benefit for Steam Side of Co-Generation Plant = \$0
Year (2012): Cost Benefit for Total Co-Generation Plant = \$20,194,570
Year (2012): Cost Benefit for Turbine-Generator = \$0
Year (2012): Benefit-to-Cost Ratio = 7.706
: Turbine-Generator Payoff Period = 2.83 Years

*Option I Not Studied

**"A" Not Studied

Basic Plan "C" - Case 1 - With In-Plant Cash Flow

Loan Basis: Steam - 15 year, 10 year balloon @ 9.96256%
Electric - 10 year, 5 year balloon @ 13.5866%
Loan Amount: Full 1979 Investment
Escalation: Construction from 1977 to 1979
Life Cycle: End of 1981
Costs: No Cost Sharing
Year (1981): Cost Benefit for Steam Side of Co-Generation Plant = \$947,393
Year (1981): Cost Benefit for Total Co-Generation Plant = \$1,384,190
Year (1981): Cost Benefit for Turbine-Generator = \$436,797
Year (2012): Benefit-to-Cost Ratio = .660
: Turbine-Generator Payoff Period = 3.25 Years

Basic Plan "C" - Case 2 = With In-Plant Cash Flow

Loan Basis: Same as Basic Plan "C", Case 1
Loan Amount: Full 1977 Plant Investment
Escalation: Life Cycle 25 Years
Costs: No Cost Sharing
Life Cycle: 1977 to 2012
Year (2012): Cost Benefit for Steam Side Co-Generation Plant = \$10,342,514
Year (2012): Cost Benefit for Total Co-Generation Plant = \$10,941,102
Year (2012): Cost Benefit for Turbine-Generator = \$598,588
Year (2012): Benefit-to-Cost Ratio = 4.175
: Turbine-Generator Payoff Period = 4.85 Years

Basic Plan "D" - Case 1 - With In-Plant Cash Flow

Loan Basis: Same as Basic Plan "C", Case 1
Loan Amount: University's cost shared
Escalation: 1977 Plant Investment to 1979
Life Cycle: 1979 to 1981
Costs: No Cost Sharing
Year (1981): Cost Benefit for Steam Side of Co-Generation Plant = \$977,413
Year (1981): Cost Benefit for Total Co-Generation Plant = \$1,750,478
Year (1981): Cost Benefit for Turbine Generator = \$773,065
Year (1981): Benefit-to-Cost Ratio = 8.35
: Turbine-Generator Payoff Period = 2.63

Basic Plan "D" - Case 2 - With In-Plant Cash Flow

Same as Basic Plan "D" - Case 1 above for 25 Years 1977 to 2012 -
Construction Not Escalated
Year (2012): Cost Benefit for Steam Side of Co-Generation Plant = \$7,400,460
Year (2012): Cost Benefit for Total Co-Generation Plant = \$9,683,872
Year (2012): Cost Benefit for Turbine-Generator = \$2,463,412
Year (2012): Benefit-to-Cost Ratio = 3.70
: Turbine-Generator Payoff Period = 5.37 Years

2.9.1 PLANT AND DISTRIBUTION INVESTMENT, MAINTENANCE AND OPERATIONS

COSTS AND LIFE CYCLE ANALYSIS

The following sections will describe the major components of the ICES, the component costs, investment requirements to construction, and life cycle energy and financial analysis for definition of present worth, benefit-to-cost and payback period of the ICES investment. The following sections will also analyze the cost sharing concept in terms of cost benefit. Cost Projections of the program are included.

Many economic parameters are used to rank the relative worth of energy and capital alternatives of a project being evaluated. They range from the relatively simple gross payout methods initially used here to the complex parameters established using discounting techniques which will be discussed in Section 2.10. When capital dollars are required, life cycle financial analysis becomes an energy management tool. The final report of Phase II will go into detail on these aspects. Some of the parameters will be discussed throughout this section.

In many applications, short payout periods are considered necessary because advances in the art may require updating process equipment to the latest technology after short periods of time, often 5 years or less. Also many industrial equipment applications into the public sector requires that debt financing for capital be provided by a local or state government, the legislators of which are responsive to the voter. Legislators by nature are not responsive to risk ventures of lengthy durations because of their responsiveness to the voter and taxes.

Industrial steam generation equipment and turbine-generators are not as susceptible to technological obsolescence and usually provide satisfactory service up to 40 years. The University is dependent upon the state legislature for its funds to operate its steam plants. For this reason various comparisons will be analyzed by simple payback and later, by life cycle methods to indicate relative risks, benefits, and based upon 1977 dollars the necessity for a cost shared concept to construct ICES.

As will be shown, the cost shared concept will change significantly as the ICES program approaches the actual letting date for construction.

When evaluating investments, it is relatively simple to estimate annual savings of alternative projects wherein these methods are more readily understood. However, these savings by themselves tell us nothing about the effects of depreciation, interest on money, escalation of energy costs, fuel costs and maintenance costs, and additional funds generated by the depreciation fund and annual savings and sales. To analyze this, life cycles will be developed which will take into account the aforementioned variables for the purpose of deciding upon the magnitude of continued investigation into the concepts of ICES wherein the aforementioned variables affect today's dollars at some future time.

BASIC PLANUPDATED PHASE I PROJECT COSTSFOR CONCEPTUAL DESIGN

I. PLANT INVESTMENT REQUIREMENTS

A. Heating Plants

1. Pollution Control Equipment	\$ 2,600,000
2. Southeast Plant Acquisition	500,000
3. Plant Interconnect and Coal Unloadings	4,843,800
4. Southeast Steam Utilities	246,400
5. Southeast Fuel System	1,736,000
6. Southeast Plant Systems	4,580,800
7. Southeast Exterior Repair	980,000
8. Southeast Instrumentation	<u>257,600</u>

Sub-Total Heating Plant Investment \$15,744,600
Includes Equipment and Construction,
Engineering, and Contingency @ 12%

B. Turbine-Generator Investment Requirement \$ 2,620,800

Total ICES Investment on the Basic Plan* \$18,365,400

*Stage II of Phase II will detail all elected options of the ICES.

A. STEAM GENERATION SIDE OF CENTRAL PLANTS

Annual Equipment Replacement Cost

*University Heating Plant Replacement Cost (Depreciation)	\$20,000,000
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*Southeast Steam Plant Replacement Cost (15,744,600 - 2,600,000)	<u>\$13,144,600</u>
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Total Replacement	\$33,144,600
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Depreciation Expenses

For replacement accumulation we will assume a flat annual payment is deposited to a sinking fund to accumulate the replacement value of the equipment at the end of the equipment life. For these purposes we will assume a 0.667% monthly return on investment rate (8% annual) and a 25 year lifetime of the equipment.

University Heating Plant

Thirty annual payments of \$273,575 each at 8% per year will accumulate to \$20,000,000 after 25 years, neglecting inflationary rates.

Annual Depreciation, University Heating Plant	\$ 273,575
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Southeast Steam Plant

Thirty annual payments of \$179,802 each at 8% per year will accumulate to \$13,144,600 after 25 years, neglecting inflationary costs

Annual Depreciation, Southeast Steam Plant	<u>\$ 179,802</u>
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Total Annual Depreciation Expense	\$ 453,377
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Central Plants M & O

Administration	\$ 100,000
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Ash Hauling and Landfill (8% Ash) (144,430T x \$5.75/T x .08)	66,438
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Steam Distribution Maintenance	100,000
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Central Plants Maintenance, Supplies and Operation	122,840
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Custodial	10,000
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Utilities	
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Water and Sewer	60,000
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Electricity	
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Non-integrated - U of M	50,755
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Non-integrated - S.E. Steam	203,020
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Insurance	28,000
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*Stage II Will Define Actual Depreciation Amounts. Total investments
Used for Simplification. 245

Annual Salaries and Fringe Benefits (2,080 hours)

Southeast Steam Plant

1 - Sr. Chief Operating Engineer @ \$11.74/Hr	\$	24,420
5 - Principal Operating Engineer @ \$ 7.89/Hr		82,055
5 - Jr. Operating Engineers @ \$ 6.93/Hr		72,070

University Heating Plant

1 - Chief Operating Engineer @ \$ 9.67/Hr	\$	20,115
6 - Principal Operating Engineers @ \$ 7.89/Hr		98,466
5 - Jr. Operating Engineers @ \$ 6.93/Hr		72,070

Floating Labor Requirements Between Plants

3 - Jr. Operating Engineers @ \$ 6.93/Hr	\$	43,245
1½- Crane Operators @ \$ 7.62/Hr		23,775
1 - Truck Driver		12,750
*1 - Journeyman Electrician @ \$13.20/Hr		27,456

Gross Salaries \$ 476,422

Fringe Benefits - Civil Service

Gross Salary Base = \$432,555		
Vacation - 80 hours/man/year	\$	17,266
Holidays - 72 hours/man/year		15,543
Sick Pay - 104 hours/man/year		22,401
Insurance - .1972% of Gross Salary		880
Retirement - 6.000% of Gross Salary		26,940
Social Security - 5.9727% of Gross Sal.		26,815
Unemployment & Workmens Compensation - 1.16% of Gross Salary		5,205
Health Plan - 6.5001% of Gross Salary		29,182

Fringe Benefits - Union

Gross Salary Base = \$13,730		
Social Security - 5.9727% of Gross Sal.		1,640
Unemployment & Workmens Compensation - 1.16% of Gross Salary		320

Gross Fringe Benefits \$ 146,192 \$ 146,192

Annual Fuel Costs

144,430 Tons @ \$17.00 per ton \$ 2,455,310 \$ 2,455,310

*Electrician is Trade Union. All other personnel are civil service Union.

B. ELECTRIC GENERATION SIDE OF CENTRAL PLANTS

Annual Turbine-Generator Replacement Value \$ 1,890,000

For replacement accumulation we will assume a flat annual payment is deposited to a sinking fund to accumulate the replacement value of the equipment life. For this purpose we will assume a .667% monthly return on investment rate (8% annual) and a 25 year life of the equipment. The analysis will neglect inflationary trends over the lifetime.

25 annual payments of \$25,853 each at 8% per year will accumulate to \$1,890,000 after 30 years, neglecting inflationary trends over the lifetime.

Annual Depreciation Expense	\$ 25,853	\$ 25,853
Administration Expense	\$ 20,000	
Ash Hauling and Landfill		
(12,070T x .08 x \$5.75/T)	5,550	
Maintenance, Supplies, and Operation	30,000	
Custodial	2,000	
Utilities	5,000	
Insurance	3,000	
	<u>\$ 65,550</u>	\$ 65,550

Annual Salaries and Fringe Benefits (2,080 hours)

Southeast Steam Plant		
2 - Principal Operating Engineers		
@ \$ 7.89/Hr	\$ 32,823	
1 - Journeyman Electrician @ \$13.20/Hr	<u>27,460</u>	
Gross Salaries	\$ 60,283	\$ 60,283
Fringe Benefits - Civil Service		
Base Gross Salary - \$94,475		
Vacation - 80 hours/man/year	\$ 1,262	
Holidays - 72 hours/man/year	1,135	
Sick Pay - 104 hours/man/year	1,643	
Insurance - .1972% of Gross Salary	63	
Retirement - 6.000% of Gross Salary	1,970	
Social Security - 5.9727% of Gross Sal.	1,958	
Unemployment & Workmens Compensation -		
1.16% of Gross Salary	379	
Health Plan - 6.5001% of Gross Salary	2,132	

Fringe Benefits - Union

Base Gross Salary = \$27,460

Social Security - 5.9727% of Gross Sal. \$ 1,640

Unemployment & Workemens Compensation -
1.16% of Gross Salary 320

Total Annual Fringe Benefits \$ 12,502 \$ 12,502

Turbine-Generator Annual Fuel Consumption = 12,070T

Steam Required for 46,231,000 KWH = $\frac{12,070 \times 8,600 \times 2,000 \times .8}{1,000}$

Annual Steam = 166.0832 (10^6) lbs

Annual Generation Credits

The consultants design calls for a high voltage interconnect between the central plants to provide generator power at the U of M plant. For this analysis that high voltage line was removed from the conceptual plan. The generator output is then realized to be the following:

Total Central Plant Electric Requirements = 9,330,000/yr

Southeast Steam Annual KWh = 7,464,000 KWh/yr

U of M Plant Annual KWh = 1,866,000 KWh/yr

Net KWh delivered to Pool = 35,076,000

Pool Credit = \$662,460

U of M plant charge for electricity is at the standard industrial rate.

U of M charge = 1,866,000 x \$.0272

= \$50,755

*Southeast Charge = Generator Cost per KWh

Net Annual Generation = 42,540,000 KWh

Annual Generator and Line Loss = 3,691,000 Kwh

*In the Basic Plan Analysis A through D to follow, Southeast Steam Plant purchased power is at \$.0272/KWh in a non-integrated plant.

For this analysis the life cycle of a basic steam generation plant will be compared to the same steam generation plant with by-product electric power generation. We investigated to determine if cost savings are available in the co-generation plant over the basic steam plant that will offset the owning and operating cost of the turbine-generator plus additional savings.

All plant investments will be made with tax free standard bank loans. There will be no cost sharing by the state legislature or D.O.E. for this analysis.

As indicated in the following calculations the co-generation plant will have a net cost benefit over a basic steam plant amounting to \$662,450 annually. Annual owning and operating costs for the turbine-generator exclusive of fuel costs which are recovered on the steam side was calculated at \$517,425 annually leaving a net plant gain in co-generation of \$145,025 annually over the basic steam generating plant. The payoff period on the turbine-generator was 18 years. It had a Benefit-to-Cost ratio of 1.38.

BASIC PLAN "A" ANNUAL COSTS

10 Year Amortization, 7½% prime rate tax free Loan

*Actual Interest Rate = $(7\frac{1}{2}\% \times \frac{1}{2}) + 2.5\% = 6.25\%$

	Year (0) Annual Costs		
	Steam Side Non-Integrated Plant	Turbine- Generator Side	Steam Side Co-Generation Plant
Year (0) Total Plant Invest. (No Cost Sharing)	\$15,744,600	\$ 2,620,800	\$15,744,600
Annual Principal & Interest	2,164,596	360,312	2,164,596
Annual Labor	630,400	73,260	630,400
Utilities			
Annual Water and Sewer	60,000	0	60,000
Annual Elect. - U of M	50,755	0	50,755
- S.E.	203,020	5,000	NO CHARGE**
Supplies	122,840	30,000	122,840
Tunnel & Steam Dist. Maint.	100,000	0	100,000
Ash Removal	66,438	0	71,990
Insurance	28,000	3,000	28,000
Depreciation	453,377	25,853	453,377
Administration	100,000	20,000	100,000
Annual Fuel Cost	2,455,310	NO CHARGE**	2,660,500
Annual Owning and Operating	\$ 6,434,736	\$ 517,425	\$ 6,442,453
Annual Energy Production			
Total Steam = (156,500T x 2,000 x 8,600 x .8) ÷ 1,000 = 2,153.44 (10 ⁶			
Steam to Generation = (12,070T x 2,000 x 8,600 x .8) ÷ 1,000			
= 166.0832 (10 ⁶) lbs.			
Steam to Community = 1,875 (10 ⁶) lbs			
Steam Losses = 112.3568 (10 ⁶) lbs			
Total Elec. Production = 46,231,000 KWh			
Electric to Pool = 35,076,000			
Electric to S.E. = 7,464,000			
Electric Losses = 3,691,000			
Average Annual Production Cost			
Steam, \$ per 1,000 lbs.	\$2.988	-	\$2.988
Electric, Mills per KWh	-	11.192	-

*Actual present Bank Formula for University of Minnesota

**No cash flow within plant for steam to turbine or electricity to steam side of plant.

	Year (0) Annual Costs - Continued		
	Steam Side Non-Integrated Plant	Turbine- Generator Side	Steam Side Co-Generation Plant
Annual Pool Credits		\$ 662,400	
Annual Steam Credits 1,875 (10 ⁶) lbs @ \$2.988/1,000	\$ 5,602,500		\$ 5,602,500

	Cost Summary	
	Non-Integrated	Integrated
Annual Credits		
Steam	\$ 5,602,500	\$ 5,602,500
Electricity	0	662,400
Annual Debits		
Owning and Operating	\$ 6,434,786	\$ 6,442,453
Net Annual Gains	-\$ 832,286	-\$ 177,553
Cost Benefit for Co-Generation =	\$ 832,286	
	- 177,553	
	<u>\$ 654,733</u>	\$ 654,733
Turbine Generator Annual O & M =	\$ 517,425	<u>-\$ 517,425</u>
Net Annual Co-Generation Gain, Year (1)		\$ 137,308
Payoff Period Turbine-Generator =	$\frac{\text{First Cost}}{\text{Annual Saving}}$	
	$= \frac{\$2,620,800}{137,308}$	

Payoff Period Turbine-Generator = 19.09 Years

Benefit-to-Cost Ratio = $\frac{\text{Total 25 Year Savings}}{\text{Year (0) Cost}}$

Life = 25 Years

Benefit-to-Cost Ratio = $\frac{25 \times \$137,308}{\$2,620,800}$

= 1.31

In the foregoing analysis of Basic Plan "A" in Section 2.7.4 the fuel cost for turbine-generation of electricity was paid on the steam side, and the electricity used in the Southeast Steam Plant was chargeable to the generator. Steam and electric losses in the plant were covered in the fuel costs. There was no in-plant cash flow.

The intent of this analysis will be to have turbine-generation and steam generation recover their individual costs. In so doing the turbine-generator will pay for its heat to produce electricity and the steam side will pay for its electricity from the generator. Cash flow within the plant between steam and electricity and the revenues gained by either from the thermal grid through steam sales or from the generator through plant and pool credits will be required to support their respective annual owning and operating costs.

The analysis will show that the steam side of a co-generation plant has an annual cost benefit over the basic steam plant of \$324,828. The generator which was required to recover its own costs through revenues suffered an annual loss of \$187,875. However, as a total integrated plant the net annual cost benefit was determined at \$136,953 compared to the basic steam plant. The payoff period on the turbine-generator was 19 years compared to 18.00 years of the total integrated plant of Basic Plan "A". The Benefit-to-cost ratio was 1.31.

BASIC PLAN "B" ANNUAL COSTS

10 Year Amortization @ 6.25% Principal & Interest

	Year (0) Annual Costs		
	Steam Side Non-Integrated Plant	Turbine Generator Side	Steam Side Integrated Plant
Year (0) Total Plant Invest. (No Cost Sharing)	\$15,744,600	\$ 2,620,800	\$15,744,600
Annual Principal & Investment PV = 7.445715466	2,164,596	360,312	2,164,596
Annual Labor	630,400	73,260	630,400
Utilities			
Annual Water & Sewer	60,000	0	60,000
Annual Elect. - U of M	50,755	0	50,755
- S.E.	203,020	5,000	163,707
Supplies	122,840	30,000	122,840
Tunnel & Steam Dist. Main.	100,000	0	100,000
Ash Removal	66,438	0	71,990
Insurance	28,000	3,000	28,000
Depreciation	453,377	25,853	453,377
Administration	100,000	20,000	100,000
Annual Fuel Cost	2,455,310	496,257	2,660,500
Annual Owning and Operating	\$ 6,434,736	\$ 1,013,982	\$ 6,606,165
Annual Production Cost			
Steam, \$ per 1,000 lbs	2.988		2.988
Elect., mills per KWh		21.93	
Annual Steam Credits			
Steam Sales to Community	\$ 5,602,500	-	\$ 5,602,500
Steam Sales to Turbine	0	-	496,257
Gross Steam Sales	\$ 5,602,500	-	\$ 6,098,757
Annual Electric Credits			
Electric Sales to Plant	0	\$ 163,707	0
Electric Sales to Pool	0	662,400	0
Gross Elect. Sales	0	\$ 826,107	0

A. Cost Summary - Steam Side

	<u>Non-Integrated</u>	<u>Integrated</u>
Annual Sales Steam	\$ 5,602,500	\$ 6,098,757
Annual O & M	<u>6,434,736</u>	<u>6,606,165</u>
Annual Deficit	-\$ 832,236	-\$ 507,408
Cost Benefit for Steam	\$ 832,236	
Side of a Co-Generation Plant	<u>- 507,408</u>	
Annual Cost Benefit	\$ <u>324,828</u>	

B. Cost Summary - Electric Side

Annual Sales	\$ 826,107
Annual O & M (T-G)	<u>1,013,982</u>
Annual Deficit	-\$ <u>187,875</u>

C. Net Plant Cost Benefit

	\$ 324,828
	<u>- 187,875</u>
Cost Benefit	\$ <u>136,953</u>

D. Payoff of Turbine-Generator

$$\text{Payoff of Turbine-Generator} = \frac{\$2,620,800}{136,953}$$

$$\text{Payoff Period} = 19.13 \text{ Years}$$

$$\text{E. Benefit-to-Cost Ratio} = \frac{136,953 \times 25}{2,620,800}$$

$$= 1.31$$

Since this is a demonstration program over a five year period, the University cannot risk tax money to the full extent of the total plant investment cost. In this plan we will assume no cost sharing and use these results to compare with the analysis of Basic Plan "D" which will represent the University's Cost Shared program.

For this plan and Basic Plan "D" to follow we will assume that two loans are taken by the University to finance the plant investment costs. The loans are as follows:

Steam Side of Plant

15 Year Loan, 10 Year Balloon
Level Annual Principal and Interest = 9.96256%* P & I

Turbine-Generator Side of Plant

10 Year Loan, 5 Year Balloon
Level Annual Principal and Interest Rate = 13.5866% P & I

We will also require that the analysis of Basic Plan "B" be used. That is the steam side and turbine-generator side are not integrated in the accounting procedure. They must each support themselves.

The analysis indicates that the steam side of a co-generation plant offers an annual cost benefit of \$287,342. However, the turbine-generator side of the co-generation plant when required to recover its own costs operates at an annual deficit of \$145,494. If the net cost benefit of the steam side is used for generation, the turbine-generator payoff period becomes 18.48 years. The Benefit-to-Cost ratio was 1.35.

*Level annual P & I changed to 10.51%, November 4, 1977.

BASIC PLAN "C" ANNUAL COSTS

STEAM

15 Year Amortization, 10 Year Balloon
Level Annual Principal and Interest Rate @ 10.51%

GENERATION

10 Year Amortization, 5 Year Balloon
Level Annual Principal and Interest Rate @ 13.5866%

	Year (0) Annual Costs		
	Steam Side Non-Integrated Plant	Turbine- Generator Side	Steam Side Co-Generation Plant
Year (0) Total Plant Invest. (No Cost Sharing)	\$15,744,600 9.96256%	\$ 2,620,800 13.5866%	\$15,744,600 9.96256%
Annual Principal & Interest	\$ 1,568,565	\$ 356,077	\$ 1,568,565
Annual Labor	630,400	73,260	630,400
Utilities			
Annual Water & Sewer	60,000	0	60,000
Annual Elect. - U of M	50,755	0	50,755
- S.E.	203,020	5,000	155,548
Supplies	122,840	30,000	122,480
Tunnel and Steam Dist. Maint.	100,000	0	100,000
Ash Removal	66,438	0	71,990
Insurance	28,000	3,000	28,000
Depreciation	453,377	25,853	453,377
Administration	100,000	20,000	100,000
Annual Fuel Cost	2,455,310	450,252	2,660,500
Annual Owning & Operating	\$ 5,838,705	\$ 963,442	\$ 6,001,615
Annual Production Cost			
Steam, \$ per 1,000 lbs	\$2.711	-	\$2.711
Elect., mills per Kwh	-	20.84	-
Annual Steam Credits			
Steam Sales to Community	\$ 5,083,125	0	\$ 5,083,125
Steam Sales to Turbine	0	0	450,252
Gross Annual Sales	\$ 5,083,125	0	\$ 5,533,377
Annual Electric Credit			
Electric Sales to Plant	0	\$ 155,548	0
Electric Sales to Pool	0	662,400	0
Gross Annual Sales	0	\$ 817,948	0

A. Cost Summary - Steam Side

	<u>Non-Integrated</u>	<u>Integrated</u>
Annual Sales Steam	\$ 5,083,125	\$ 5,533,377
Annual O & M	<u>5,838,705</u>	<u>6,001,615</u>
Annual Deficit	-\$ 755,580	-\$ 468,238
Cost Benefit for Steam Side of a Co-Generation Plant	\$ 755,580	
	<u>- 468,238</u>	
Annual Cost Benefit =	\$ 287,342	

B. Cost Summary - Turbine-Generator Side

Annual Electric Sales =	\$817,948
Annual O & M - T-G	<u>963,442</u>
Annual Deficit	-\$145,494

C. Net Plant Cost Benefit

$$\begin{array}{r} \$287,342 \\ - 145,494 \\ \hline \end{array}$$

Plant Annual Benefit = \$141,848

$$\begin{aligned} \text{D. } \underline{\text{Payoff of Turbine-Generator}} &= \frac{\$2,620,800}{141,848} \text{ (Plant Basis)} \\ &= 18.48 \text{ Years} \end{aligned}$$

$$\text{E. Benefit-to-Cost Ratio} = \frac{141,848 \times 25}{2,620,800} = 1.35$$

The University with this report is submitting a cost shared approach to ICES. Assuming that state legislature and D.O.E. funds are forgiven the following analysis will determine the cost benefit based upon the established loans that the U of M must take out. These loans are established at:

Steam: \$3,349,781 @ 9.96256%* Principal and Interest

Electric: \$1,911,136 @ 13.5866 Principal and Interest

We will determine the cost benefits of this plan and require the accounting of the Basic Plan "C" be used for Plan "D". That is the steam side and generator side of the plant must recover their annual owning costs from steam and electric sales to the Community and Plant.

The cost shared approach and the University's share by loans allows the turbine-generator side of the plant to have a net profit at the end of the first year of \$15,163. The co-generation plant has an annual cost benefit of \$223,104 compared to a basic steam plant without co-generation. Total annual cost benefit was \$238,267.

The profit of \$15,163 annually, if put back to principal and interest would reduce the 10 year period of the balloon payment to 9.4667 Years, a reduction of 6.40 months. T-G payoff was 11 years. Benefit-to-Cost was 2.27

Therefore, based upon the analysis the turbine-generator is reasonably close to break-even to warrant continued optimization in Phase II.

*November 4, 1977 was changed to 10.51%

BASIC PLAN "D" ANNUAL COSTS

STEAM: 15 Year Amortization, 10 Year Balloon @ 9.96256%

ELECTRIC: 10 Year Amortization, 5 Year Balloon @ 13.5866%

COST SHARING BY INVESTMENT PLAN

	Year (0) Annual Costs		
	Steam Side Non-Integrated Plant	Turbine- Generator Side	Steam Side Co-Generation Plant
Year (0) U of M Loan	\$ 3,349,781	\$ 1,911,136	\$ 3,349,781
(With Cost Sharing)	9.96256%	13.5866%	9.96256%
Annual Prin. & Interest (U of M)	333,724	259,658	333,724
Annual Labor	630,400	73,260	630,400
Utilities			
Annual Water and Sewer	60,000	0	60,000
Annual Elect. - U of M	50,755	0	50,755
- S.E.	203,020	5,000	124,619
Supplies	122,840	30,000	122,480
Tunnel & Steam Dist.	100,000	0	100,000
Ash Removal	66,438	0	71,990
Insurance	28,000	3,000	28,000
Depreciation	453,377	25,853	453,377
Administration	100,000	20,000	100,000
Annual Fuel Cost	2,455,310	355,085	2,660,500
Annual Owning and Operating	\$ 4,603,864	\$ 771,856	\$ 4,735,845
Annual Production Costs			
Steam, \$ per 1,000 lbs	\$2.138	-	\$2.138
Elect., Mills per KWh	-	16.696	-
Annual Steam Credits			
Steam Sales to Community	\$ 4,008,750	0	\$ 4,008,750
Steam Sale to Turbine	0	0	355,085
Gross Annual Sales	\$ 4,008,750	0	\$ 4,363,835
Annual Electric Credits			
Electric Sales to Plant	0	\$ 124,619	0
Electric Sales to Pool	0	662,400	0
Gross Electric Sales	0	\$ 787,019	0

A. Cost Summary - Steam Side

	<u>Non-Integrated</u>	<u>Integrated</u>
Annual Sales Steam	\$ 4,008,750	\$ 4,363,835
Annual O & M Steam	<u>4,603,864</u>	<u>4,735,845</u>
Annual Deficit	-\$ 595,114	-\$ 372,010
Cost Benefit for Steam Side for Co-Generation	\$ 595,114 <u>- 372,010</u>	
Cost Benefit (Year (1))	\$ 223,104	

B. Cost Summary Electric Side

Annual Electric Sales =	\$787,019
Annual O & M - Turbine-Generator =	<u>- 771,856</u>
Annual Cost Benefit for Turbine-Generator =	\$ 15,163

C. Payoff Period for Turbine-Generator

Annual Profit = \$15,163
 10 Year PV of Compound Amount = 6.0147271
 9 Year PV of Compound Amount = 5.6463238

PV 10 Year: $\frac{\$2,620,800}{6.0147271} = \$435,730$

PV 9 Year: $\frac{\$2,620,800}{5.6463238} = \$464,160$

$\begin{array}{r} \$464,160 \\ - 435,730 \\ \hline \end{array}$
 Diff. = \$ 28,430 Annual Payment

$\frac{15,163}{28,430} \times 12 \text{ Months} = 6.40 \text{ Months}$

Therefore payoff on turbine-generator has been reduced from 10 years
 to the Balloon to:

$\begin{array}{r} 10.0000 \text{ Years} \\ - .5333 \\ \hline 9.4667 \text{ Years} \end{array}$

or

9 Years - 6.40 Months

D. Turbine-Generator Payoff

$$\begin{aligned}\text{Payoff} &= \frac{\$2,620,800}{\$223,104 + 15,163} \\ &= 10.99 \text{ Years}\end{aligned}$$

E. Benefit-to-Cost Ratio

$$\text{Benefit-to-Cost Ratio} = \frac{238,267 \times 25}{2,620,800} = 2.27$$

COST BENEFIT ANALYSIS OF BASIC PLAN "D"WITH OPTION I ADD-ON

The following analysis will use the results of Basic Plan "D"--the University's Cash Flow Program--and determine the additional cost benefits by adding on St. Mary's, Fairview and Augsburg to the steam distribution system.

Adding on the partners to the Basic Plan increased the Steam ICES (plant plus customers) annual cost benefit by \$24,391.

The annual cost benefit for the turbine generator was increased \$31,269 over the Basic Plan without the add-on customers. The total cost benefit for the turbine-generator of the plan was \$46,432 annually. Payoff period was decreased an additional 1.6 years. Turbine-Generator payoff was 8.92 years.

BASIC PLAN "D" ANALYSIS WITH OPTION I ADD-ON

Basic Plan "D" Base Costs

Electric Generation = 16.696 mills per KWh

Steam Production Cost = \$2.318 per 1,000 lbs.

<u>Annual Increments</u>	<u>Annual Incremental Year (0) Costs</u>		
	<u>Steam Side Non-Integrated Plant</u>	<u>Turbine- Generator Side</u>	<u>Steam Side Co-Generation Plant</u>
Incremental Fuel	24,400T	1,100T	25,500T
Total Incremental Steam Production 1,000 BTU = 1 lbs St.	419.680(10 ⁶)	18.9(10 ⁶)	-
Incremental Steam Use @ 80% Efficiency	335.744(10 ⁶)	15.12(10 ⁶)	
Incremental Total Electric Generation, KWh 50,440,000 - 46,231,000	-	4,209,000	-
Incremental Central Plant Electric Consumption 9,800,000 - 9,330,000 = 470,000 KWh			
S.E. = 423,000 KWh	423,000		423,000
U of M = 47,000 KWh	47,000		47,000
Incremental Utilities @ 10%	6,000		6,000
Incremental Ash (8%)	1,952T	88T	2,040T
Incremental Fuel Cost	\$ 414,800	\$ 32,326	\$ 433,500
Incremental Utilities			
Water and Sewer	6,000	0	6,000
Elect. - U of M	1,278	0	1,278
- S.E.	11,506	0	235
Incremental Ash	11,224	0	11,730
Incremental Maint. Dist.	500	0	500
Incremental Administration	3,000	0	3,000
Incremental Water Treatment	500	0	500
Incremental Owning & Operating	\$ 448,808	\$ 32,326	\$ 456,743

<u>Annual Increments</u>	<u>Annual Incremental Year (0) Costs</u>		
	<u>Steam Side Non-Integrated Plant</u>	<u>Turbine- Generator Side</u>	<u>Steam Side Co-Generation Plant</u>
Incremental Production Cost			
Steam, \$ per 1,000 lbs	\$.1070	-	\$.1070
Elect., Mills per KWh		\$.00768	
Base Steam Cost	2.138	-	2.138
Base Elect. Gen. Cost	-	16.696	-
Base St. Mary's-Fairview Augsburg Steam Cost			
\$ per 1,000 lbs	\$ 2.245	-	\$ 2.245
Total Elct. Gen. Cost	-	\$ 16.70	-
Add-On Investment	\$922,880		\$922,880
Principal & Int. @ 13.5866%	\$125,388		\$125,388
St. Mary's-Fairview-Augsburg Surcharge @ 335.744(10 ⁶) lbs			
\$ per 1,000 lbs	.373		.373
Total St. Mary's-Fairview- Augsburg Steam Cost, \$ /1,000	*2.618		*2.618

	<u>Non-Integrated</u>	<u>Co-Generation</u>
Incremental Annual Steam Credits		
St. Mary's-Fairview-Augsburg	\$878,978	\$ 878,978
Turbine-Gnerator	0	32,326
Total Incremental Steam Sales	\$878,978	\$ 911,304
Incremental Annual Electric Credits		
From Steam Side	0	\$ 235
From Pool	0	63,360
Total Incremental Electric Sales	\$ 0	\$ 63,595

*Line Loss and balloon costs not included.

A. Cost Summary - Steam Side of System

	<u>Non-Integrated Plant</u>	<u>Co-Generation Plant</u>
Annual Steam Credits		
Basic Plan "D"	\$ 4,008,750	\$ 4,363,835
St. Mary's-Fairview-Augsburg	878,978	878,978
Turbine-Generator Add-On	0	32,326
Total Annual Sales	<u>\$ 4,887,728</u>	<u>5,275,139</u>
Annual Operation and Maintenance		
Basic Plan "D"	\$ 4,603,864	\$ 4,735,845
St. Mary's-Fairview-Augsburg	125,388	125,388
Add-On Plant	448,808	456,743
Total Annual Operation and Maintenance	<u>\$ 5,178,060</u>	<u>\$ 5,317,976</u>
Annual Operating Gain	-\$ 290,332	-\$ 42,837
Year (1) Cost Benefit for Co-Generation on Steam Side of Basic Plan "D" with Add-Ons of St. Mary's-Fairview-Augsburg	<u>\$ 290,332</u> <u>- 42,837</u> <u>\$ 247,495</u>	

Year (1) Cost Benefit of Add-Ons for Steam Side

Incremental Annual Steam Credits	\$ 878,978	\$ 911,304
Incremental Annual O & M	<u>- 448,808</u>	<u>- 456,743</u>
Incremental Annual Gain	\$ 430,170	454,561
Incremental Year (1) Cost Benefit of Co-Generation on Steam Side	<u>\$ 454,561</u> <u>430,170</u>	
Year (1) Cost Benefit	\$ 24,391	
Net Year (1) Benefit of Co-Generation on Steam Side of Basic Plan "D"	\$ 223,104	
Incremental Add-On Benefit	<u>24,391</u>	
Total Year (1) Cost Benefit of Co-Generation on Steam Side for Basic Plan with St. Mary's- Fairview-Augsburg	<u>\$ 247,495</u>	

B. Cost Summary for Turbine-Generator

Annual Incremental Electric Sales	\$ 63,595	
Annual Incremental O & M	<u>- 32,326</u>	
Annual Incremental Cost Benefit for T-G	<u>\$ 31,269</u>	\$ 31,269
Basic Plan "D" Annual Cost Benefit for T-G		<u>\$ 15,163</u>
Total Annual Basic Plan "D" Cost Benefit for Turbine-Generator with Add-On of St. Mary's-Fairview-Augsburg		<u>\$ 46,432</u>

C. Turbine-Generator Payoff Period Reduction

PV 10 year to 9 year = 28,430

$$\frac{\$46,430}{28,430} = 1.633 \text{ years}$$

D. Total Turbine-Generator Payoff Period

$$\begin{aligned} \text{Payoff Period} &= \frac{2,620,800}{293,927} \\ &= \underline{8.92 \text{ Years}} \end{aligned}$$

The concept of life-cycle costing embraces the total cost of owning an investment throughout its entire life. It differs from the traditional concept of focusing exclusively on first cost as the sole economic criterion as presented in Section 2.9.

For accurate comparisons of alternatives, the costs must be analyzed on a common basis. Normally, this is the total annual cost comprising amortization for the capital investment, O & M costs, etc. Another basis is total life time cost reduced to a present worth basis.

We will use the direct comparison, benefit-to-cost and payback period methods to analyze the Basic Plans for comparative benefits over various life cycles.

During Stage II of this Phase of work all options will be analyzed for different financing plans to determine the most favorable. This requires a great amount of work especially if construction cost is allowed to escalate from the Basic Plan costs of 1977.

COST ESCALATION DATA FOR LIFE CYCLESUNIVERSITY OF MINNESOTASUMMARY OF EXPENDITURES

	<u>1975-76</u>	<u>1976-77</u>	<u>% Escalation</u>
Labor	\$14,963,361	\$16,666,992	10.22
Water and Sewer	804,318	914,924	12.09
Administration	505,625	572,393	12.54

<u>Electricity</u>	<u>Annual Cost</u>	<u>Annual Escalation, %</u>
1972/73	\$ 1,642,868	Base
1973/74	1,948,932	15.7
1974/75	2,798,243	30.3
1975/76	3,301,396	15.2
1976/77	4,006,955	<u>17.61</u>
	Total Escalation	78.81%
	Average Annual	19.70%

Total Construction Costs - 7% Annually

Energy Cost Annual Escalation per R.W.R. LeGrassie, ERDA = 7%
 Annual Inflation on 10 year doubling = 7%
 Average energy price increase = $1.071 \times 1.07 = 1.146$
 Average Annual increase = 14.6%

Ash Handling and Landfill Escalation

Cost/ton - 1976 = \$4.00
 Cost/ton - 1977 = \$5.75
 Annual Escalation = 30.43%

NORTHERN STATES POWER

November, 1977 Projection on Pool Credits Per J. Pearce, of N.S.P.

<u>Rate Structure</u>	<u>1977</u>	<u>1981</u>	<u>Total Escalation</u>	<u>Annual Escalation</u>
Capacity	\$64.00/MW	\$83.00/MW	22.89%	5.72%
Base Load				
Energy Rates	\$11.00/MWH	\$14.00/MWH	21.43%	<u>5.36%</u>
			Average Annual Escalation	5.54%

Economy Rates

		1977		1981	
		<u>On Peak</u>	<u>Off Peak</u>	<u>On Peak</u>	<u>Off Peak</u>
<u>Summer</u>					
	Per (MW-Hrs)	\$11.20	\$ 7.20	\$13.66	\$ 8.48
<u>Winter</u>					
	Per (NW-Hrs)	\$16.00	\$ 8.00	\$21.20	\$10.17

UNIVERSITY FUEL COST

See attached graph of actual costs

Annual Average Escalation

Coal	8.26%
Oil - No. 2	13.00%
Gas	28.00%

NOTE: The letter received from John Pearce, N.S.P. (following) would significantly increase the turbine-generator payoffs. These were not factored into the report because of the November 4, 1977 receipt. An escalation factor of 5.5% was used.

△ EASTERN COAL
○ WESTERN COAL

◇ GAS
◇ OIL

COST/10⁶ BTU PER YEAR

UNIVERSITY OF MINNESOTA - PHYSICAL PLANT MAINTENANCE & OPERATIONS

BY	BUILDING	SCALE	SHEET
88R			
CHECKED	DATE	REVISED	DRAWING

UNIVERSITY OF MINNESOTA MINNEAPOLIS CAMPUS FUEL COSTS

SYMBOL DEFINITION
 A EASTERN COAL
 B WESTERN COAL
 C GAS
 D OIL

DATE OF COMPLETION MAY 1, 1984

NSP

NORTHERN STATES POWER COMPANY
414 Nicollet Mall
MINNEAPOLIS, MINNESOTA 55401

RECEIVED
NOV 7 11 48 AM '77
UNIV. OF MINN.
PHYSICAL PLANT

November 3, 1977

Mr. Warren Soderberg
UNIVERSITY OF MINNESOTA
University Physical Plant
Room 200, Shops Bldg.
Minneapolis, MN 55455

Subject: 1981 Electricity Values

Dear Warren:

In my memo dated 5/17/77, I listed the 1977 electric energy values. We have projected these to 1981 as you have requested.

<u>Capacity Rate</u>	1977 \$64,000/MW		1981 \$83,000/MW	
	On Peak		Off Peak	
<u>Energy Rates</u>	1977	1981	1977	1981
Base Load	\$11.00/MWhrs	\$14.00/MWhrs	\$11.00/MWhrs	\$14.00/MWhrs
Economy Energy				
Summer	11.20 "	13.56 "	7.20 "	8.45 "
Winter	16.00 "	21.20 "	8.00 "	10.17 "

These figures are based on estimates and projections and will be altered to conform with actual costs when your plants goes into operation.

Sincerely,

John C. Pearce
Assistant to Director of
Planning & Research

jo

cc: Gerry Marx

UNIVERSITY OF MINNESOTA
GRID ICES

COGENERATION CREDIT

	<u>Basic Plan</u>	<u>Option I</u>	<u>Option II</u>	<u>Option III</u>
Available MWH	34,910	38,300	36,190	39,485
Pool Credit - MW	5.31	5.83	5.51	6.0
<u>1977</u>				
Capacity @ \$64/KW	\$339,840	\$373,120	\$352,640	\$384,000
Energy @ \$11/MWH	<u>384,010</u>	<u>421,300</u>	<u>398,090</u>	<u>434,335</u>
Total Annual	\$723,850	\$794,420	\$750,730	\$818,335
Ave/KWH	\$.0207	\$.0207	\$.0207	\$.0207
<u>1981</u>				
Capacity @ \$83/KW	\$440,730	\$483,890	\$457,330	\$498,000
Energy @ \$14/MWH	<u>488,740</u>	<u>536,200</u>	<u>506,660</u>	<u>552,790</u>
Total Annual	\$929,470	\$1,020,090	\$963,990	\$1,050,790
Ave/KWH	\$.0266	\$.0266	\$.0266	\$.0266

HELMICK & LUTZ COMPANY
 ENGINEERS
 1315 GLENWOOD AVENUE
 MINNEAPOLIS, MINNESOTA 55405

By

 George W. Burke

November 4, 1977

PROJECT COST - ESCALATION

Project costs at the end of 1979 using the escalation factors of Section 2.10.1 and 2.10.4 is presented here with an overall cost summary for a 1 year construction period and 1 year operation period. This will be changed in Stage II to signify the actual periods. However, the bid letting of 1979 is reasonable. Phase IV, V and VI costs are not included.

Phase II Updated Costs

I. Basic Plan

A. Basic Plan - *1977 Costs In Plant Investment

1. Construction and material - Plant - 1977	\$11,290,000
2. Construction and material - T-G - 1977	2,340,000
3. Under Construction - Pollution - 1977	2,600,000
4. October, 1977 - Acquisition, S.E. Plant	500,000
5. Engineering: Phase I, completed 1977	58,651
Phase II, completed 1977	199,284
Phase III, completed 1978	1,221,152
6. Contingencies @ 12.358% of A.1, A.2	1,684,400
End of 1977 Total Plant Investment	<u>\$19,893,487</u>

Annual Escalation

Construction and Material @ 7%

Engineering @ 10.22%

B. Basic Plan - End of 1979 Costs

1. Construction and material - Plant - 1980	\$12,870,600
2. Construction and material - T-G - 1980	2,667,600
3. Constructed - Pollution	2,600,000
4. October, 1977 - Acquisition	500,000
5. Engineering: Phase I, completed 1977	58,651
Phase II, completed 1977	199,284
Phase III, completed 1978	1,345,955
6. Contingencies @ 12.35% of B.1 and B.2	1,920,210
End of 1979 Total Plant Investments	<u>\$22,162,300</u>

II. Option I - Add-on Steam Customers

A. Option I - 1977 Costs in Distribution Investment

1. Construction and materials	\$ 1,648,000
2. Engineering: Phase I - In Basic Plan	0
Phase II - Complete in 1977	22,860
Phase III - Complete in 1978	257,935
3. Contingencies @ 12.358%	<u>207,318</u>
End of 1977 Costs - Total Distribution Investment	<u>\$ 2,136,113</u>

*Does not Include Risk Assistance

B.	Option I - End of 1979 Costs	
1.	Construction and materials	\$ 1,878,720
2.	Engineering: Phase I - In Basic Plan	0
	Phase II - Completed 1978	23,860
	Phase III - Completed 1978	284,296
3.	Contingencies @ 12.358% of B.1	232,172
	End of 1979 Total Distribution Investment	<u>\$ 2,418,048</u>
III.	Option II - Pyrolysis - 130 Ton per Day	
A.	Option II - 1977 Costs in Pyrolysis	
1.	Andco-Torrax Cost (Including Eng. & Const.)	\$ 6,707,000
2.	Upgrade Incinerators	250,000
3.	Engineering: Phase I - In Basic Plan	0
	Phase II - Completed 1977	130,171
	Phase III - Completed 1978	616,222
4.	Contingencies @ 12.358% of A.1, A.2	859,745
	End of 1977 Total Pyrolysis Investment	<u>\$ 8,563,138</u>
B.	Option II - End of 1979 Costs	
1.	Andco-Torrax Cost (Including Eng. & Const.)	\$ 7,645,980
2.	Upgrade Incinerators	285,000
3.	Engineering - Phase I - In Basic Plan	0
	Phase II - Completed 1977	130,170
	Phase III - Completed 1978	679,200
4.	Contingencies @ 12.358% of B.1, B.2	980,110
	End of 1979 Total Pyrolysis Investment	<u>\$ 9,720,460</u>
IV.	Option II - Pyrolysis - 250 Ton per Day	
A.	Option II - 1977 Costs in Pyrolysis	
1.	Andco-Torrax Cost (Including Eng. & Const.)	\$ 8,582,780
2.	Upgrade Incinerators	250,000
3.	Engineering: Phase I - In Basic Plan	0
	Phase II - Completed 1977	130,171
	Phase III - Completed 1978	745,629
4.	Contingencies @ 12.358% of A.1, A.2	1,091,555
	End of 1977 Pyrolysis Investment	<u>\$10,800,135</u>
B.	Option II - End of 1979 Costs	
1.	Andco-Torrax Cost (Including Eng. & Const.)	\$ 9,784,370
2.	Upgrade Incinerators	285,000
3.	Engineering: Phase I - In Basic Plan	0
	Phase II - Completed 1977	130,171
	Phase III - Completed 1978	821,832
4.	Contingencies @ 12.358% of B.1, B.2	1,244,370
	End of 1979 Total Pyrolysis Investment	<u>\$12,265,743</u>
V.	Option III - Add-on Hot Water Revisions	
A.	Option III - 1977 Costs in Hot Water Revisions	
1.	Construction and materials	\$ 1,270,000
2.	Engineering: Phase I - In Basic Plan	0
	Phase II - Completed 1977	30,349
	Phase III - Completed 1978	105,363
3.	Contingencies @ 12.358% of A.1	156,945
	End of 1977 Costs for Hot Water	<u>\$ 1,562,657</u>

B. Option III - End of 1979 Costs in Hot Water	
1. Construction and materials	\$ 1,447,800
2. Engineering: Phase I - In Basic Plan	0
Phase II - Completed 1977	30,349
Phase III - Completed 1978	116,131
3. Contingencies @ 12.358% of B.1	178,920
End of 1979 Costs for Hot Water	<u>\$ 1,773,200</u>

OVERALL PROJECT COST SUMMARYPLANT INVESTMENT

	<u>Basic Plan Co-Generation</u>	<u>Option I Add-On</u>	<u>Option II 130 T/D</u>	<u>Option II 250 T/D</u>	<u>Option III Hot Water</u>
**1977 Plant Invest.	\$16,730,000	\$ 1,648,000	\$ 6,957,000	\$ 8,832,780	\$ 1,270,000
1977 Engineering	1,479,087	280,795	746,393	875,800	135,712
1977 Contingencies	<u>1,684,400</u>	<u>207,318</u>	<u>859,745</u>	<u>1,091,555</u>	<u>156,945</u>
TOTAL INVESTMENT	\$19,893,487	\$ 2,136,113	\$ 8,563,138	\$10,800,135	\$ 1,562,657
End of 1979 Escala- tion (Bid Letting)	<u>\$ 2,268,813</u>	<u>281,935</u>	<u>1,157,322</u>	<u>1,465,608</u>	<u>210,543</u>
End of 1979 Invest. (Bid Letting)	\$22,162,300	\$ 2,418,048	\$ 9,720,460	\$12,265,743	\$ 1,773,200

OPERATING COSTS*Plan "D"

1977 Prin. & Int.	\$ 593,382	
1977 Operating & Maintenance	1,794,615	
1977 Fuel	2,660,500	
1977 Revenues (Elec)	(662,400)	
1977 Revenues (Steam)	<u>(4,008,750)</u>	
1977 Sub-total, Net Operating	\$ 377,347.	\$ 377,347
****Escalation to 1981		
***1981 Prin. & Int.	\$ 593,382	
***1981 Escalation O&M	1,170,757	
***1981 Escalation Rev. (Electric)	(73,129)	
1981 Escalation Rev. (Steam)	<u>(1,034,819)</u>	
1981 Sub-Total Escalation	\$ 1,952,120.	\$ 1,952,120
Total Escalation Net Operating Loss		\$ 2,329,467

FOR STAGE 2 REPORT--

--WILL BE COMPLETED

PROGRAM COST, END OF 1981 - For 1 Year of Operation

1979 Plant Invest.	\$22,162,300
1981 Escalation	2,329,467
1981 Contingencies @ 10%	<u>232,947</u>
Total Program Cost End of 1981 - For one year Operation	\$24,724,714

*****See Note on following page for asterick explanations.

*Plan "D" Section 2.7.1, 1977 costs are rearranged to indicate a totally integrated co-generation plant. The T-G does not pay for fuel nor does the steam side pay for generated electricity.

**Depreciation is escalated in the O & M figures.

***Assume the plant will be built at the end of 1980 and will have one year of operating experience at the end of 1981.

****O & M, fuel, revenues are escalated at the annual escalation rates of individual costs shown in the life cycles analysis.

Principal and Interest is not escalated at any rate. Over the period involved little change would be made.

Phase IV, V and VI costs not included.

Referring to Basic Plan, we will compare a life cycle analysis to the same plan for a co-generation plant with by-product electric power to determine the cost benefit, Benefit-to-Cost and payback period.

Annual escalation rates of the various components making up the annual O & M costs and steam sales will be assumed to determine the effect upon the aforementioned variables.

Let:

PW(x)	Annual Escalation Item	%
Z1	Annual YEAR (0) investment escalation	7 %
Z2	Annual labor cost escalation	10.22%
Z3	Annual sewer and water escalation	12.09%
Z4	Annual purchased electricity escalation	15 %
Z5	Annual purchased supplies escalation	7 %
Z6	Annual maintenance escalation	7 %
Z7	Annual ash removal escalation	30 %
Z8	Annual insurance escalation	20 %
Z9	Annual administration escalation	12.5 %
	Annual Fuel Escalation Factors	
Z10	Coal	8.26%
Z11	Oil	13 %
Z12	Gas	28 %
Z13	Annual escalation in pool credits	5.54%
Z14	Annual escalation in steam costs	12.907%

D = Depreciation increase
(Unless YEAR (0) Construction is being escalated) = 7%

i_s = Basic Steam Plant Loan Interest = 9.96256%

i_g = Turbine Generator Loan Interest = 13.5866%

PW(x) = present worth of year (0) cost for x periods where Year (0) cost is individual costs of Plans.

PWF = present worth factor = (YEAR (0) Cost) $\frac{y (y^n - 1)}{y - 1}$ where:

$$y = \frac{1 + Z_n}{1 + i_x} \text{ and } Z = Z_1 \dots Z_n$$

Present worth of cost at n years = YEAR (0) cost x PWF

I-0625000

N	Z 1 .07000	Z 2 .10220	Z 3 .12090	Z 4 .15000	Z 5 .07000	Z 6 .07000	Z 7 .30000	Z 8 .20000	Z 9 .12500	Z 10 .08260	Z 11 .13000	Z 12 .28000	Z 13 .05540	Z 14 .12907
1	1.007	1.037	1.055	1.082	1.007	1.007	1.224	1.129	1.052	1.019	1.064	1.235	.993	1.063
2	2.021	2.113	2.168	2.254	2.021	2.021	2.721	2.405	2.150	2.057	2.195	2.656	1.990	2.192
3	3.043	3.230	3.342	3.522	3.043	3.043	4.252	3.846	3.317	3.115	3.323	4.304	2.992	3.322
4	4.071	4.353	4.531	4.874	4.071	4.071	5.793	5.473	4.824	4.493	4.677	6.011	3.934	4.667
5	5.107	5.589	5.887	6.390	5.107	5.107	7.535	7.310	6.595	6.221	6.033	8.048	4.901	6.022
6	6.150	6.835	7.366	7.987	6.150	6.150	9.386	9.386	8.524	8.110	7.495	10.105	5.861	7.462
7	7.200	8.128	9.720	9.727	7.200	7.200	11.730	11.730	10.835	10.224	10.224	12.783	6.815	8.992
8	8.258	9.469	10.255	11.611	8.258	8.258	14.377	14.377	13.436	12.712	12.712	15.436	7.763	10.618
9	9.324	10.860	11.934	13.649	9.324	9.324	17.367	17.367	16.313	15.489	15.489	18.569	8.725	12.344
10	10.397	12.304	13.581	15.356	10.397	10.397	20.744	20.744	19.579	18.523	18.523	21.933	9.640	14.182
11	11.477	13.801	15.382	18.244	11.477	11.477	24.581	24.581	23.231	21.972	21.972	25.169	10.569	16.134
12	12.565	15.354	17.283	20.829	12.565	12.565	28.866	28.866	27.430	25.983	25.983	29.316	11.491	18.207
13	13.661	16.965	19.288	23.626	13.661	13.661	33.731	33.731	32.194	30.657	30.657	33.968	12.408	20.311
14	14.764	18.636	21.403	26.655	14.764	14.764	39.225	39.225	37.492	35.855	35.855	39.930	13.318	22.752
15	15.874	20.372	23.434	29.932	15.874	15.874	45.431	45.431	43.495	41.758	41.758	46.949	14.223	25.240
16	16.995	22.168	25.988	33.477	16.995	16.995	52.460	52.460	50.339	48.402	48.402	53.952	15.121	27.834
17	18.122	24.034	29.471	37.317	18.122	18.122	60.355	60.355	57.923	55.786	55.786	61.944	16.013	30.424
18	19.257	25.969	31.091	41.474	19.257	19.257	69.295	69.295	66.551	64.314	64.314	70.936	16.899	33.080
19	20.400	27.977	33.855	45.972	20.400	20.400	79.392	79.392	75.324	72.987	72.987	80.928	17.780	35.851
20	21.551	30.040	36.771	50.941	21.551	21.551	90.796	90.796	85.490	82.953	82.953	91.920	18.654	38.724
21	22.712	32.220	39.847	56.410	22.712	22.712	103.625	103.625	97.027	94.290	94.290	104.912	19.553	41.807
22	23.877	34.461	43.092	61.813	23.877	23.877	118.222	118.222	110.293	106.456	106.456	118.908	20.436	45.114
23	25.053	36.786	46.516	67.786	25.053	25.053	134.650	134.650	125.022	120.085	120.085	134.909	21.243	48.640
24	26.237	39.198	50.127	74.667	26.237	26.237	153.205	153.205	142.094	136.157	136.157	152.903	22.094	52.360
25	27.429	41.700	53.938	81.898	27.429	27.429	174.161	174.161	161.133	154.196	154.196	172.907	22.940	56.278
Y 1	Y 2	Y 3	Y 4	Y 5	Y 6	Y 7	Y 8	Y 9	Y 10	Y 11	Y 12	Y 13	Y 14	
1.0071	1.0374	1.0550	1.0824	1.0071	1.0071	1.2235	1.1294	1.0568	1.0189	1.0635	1.2047	.9933	1.0627	

I-0994254

N	Z 1 .07000	Z 2 .10220	Z 3 .12090	Z 4 .15000	Z 5 .07000	Z 6 .07000	Z 7 .30000	Z 8 .20000	Z 9 .12500	Z 10 .08260	Z 11 .13000	Z 12 .28000	Z 13 .05540	Z 14 .12907
1	.973	1.002	1.019	1.044	.973	.973	1.182	1.091	1.023	.985	1.028	1.164	.940	1.027
2	1.920	2.007	2.058	2.140	1.920	1.920	2.580	2.282	2.070	1.954	2.084	2.518	1.881	2.021
3	2.841	3.014	3.118	3.283	2.841	2.841	4.232	3.582	3.141	2.908	3.167	4.096	2.765	3.164
4	3.738	4.023	4.197	4.480	3.738	3.738	6.184	5.000	4.216	3.848	4.284	5.932	3.614	4.275
5	4.610	5.035	5.298	5.731	4.610	4.610	8.495	6.548	5.357	4.772	5.430	8.069	4.428	5.416
6	5.459	6.049	6.420	7.039	5.459	5.459	11.225	8.237	6.504	5.483	6.408	10.557	5.210	6.588
7	6.295	7.066	7.563	8.407	6.295	6.295	14.453	10.080	7.677	6.580	7.818	13.453	5.960	7.791
8	7.289	8.085	8.729	9.835	7.289	7.289	18.262	13.021	9.372	7.667	9.261	17.421	6.680	9.027
9	7.871	9.106	9.917	11.335	7.871	7.871	22.780	16.284	10.105	8.331	10.339	20.747	7.371	10.295
10	8.632	10.130	11.128	12.900	8.632	8.632	28.113	20.681	11.331	9.187	11.652	25.314	8.035	11.598
11	9.372	11.156	12.363	14.536	9.372	9.372	34.418	25.295	12.644	10.029	13.002	30.831	8.671	12.935
12	10.093	12.184	13.621	16.248	10.093	10.093	41.872	31.148	13.941	10.858	14.349	36.819	9.282	14.308
13	10.794	13.215	14.904	18.038	10.794	10.794	50.684	38.261	15.307	11.675	15.814	44.023	9.869	15.718
14	11.476	14.248	16.212	19.910	11.476	11.476	61.102	46.683	16.683	12.478	17.278	52.408	10.432	17.164
15	12.140	15.284	17.545	21.868	12.140	12.140	73.418	56.365	18.071	13.270	18.793	62.160	10.972	18.652
16	12.784	16.322	18.904	23.916	12.784	12.784	87.972	67.411	19.511	14.049	20.339	73.530	11.490	20.178
17	13.415	17.363	20.289	26.057	13.415	13.415	105.192	80.826	21.005	14.816	21.919	86.755	11.998	21.745
18	14.024	18.404	21.701	28.292	14.024	14.024	125.543	95.444	22.531	15.571	23.552	102.150	12.464	23.354
19	14.621	19.451	23.140	30.639	14.621	14.621	149.601	112.001	24.076	16.314	25.230	120.070	12.924	25.007
20	15.201	20.499	24.607	33.085	15.201	15.201	177.044	131.439	25.649	17.046	26.954	139.310	13.344	26.703
21	15.764	21.549	26.102	35.650	15.764	15.764	211.869	157.900	27.268	17.767	28.727	160.211	13.764	28.445
22	16.312	22.602	27.627	38.329	16.312	16.312	251.322	189.733	28.926	18.476	30.548	182.472	14.192	30.233
23	16.846	23.657	29.181	41.131	16.846	16.846	298.419	227.189	30.570	19.175	32.419	206.375	14.581	32.069
24	17.365	24.715	30.765	44.061	17.365	17.365	353.329	281.327	32.319	19.862	34.342	231.672	14.954	33.955
25	17.870	25.775	32.379	47.125	17.870	17.870	419.664	342.207	34.088	20.539	36.319	259.250	15.312	35.891
Y 1	Y 2	Y 3	Y 4	Y 5	Y 6	Y 7	Y 8	Y 9	Y 10	Y 11	Y 12	Y 13	Y 14	
.9731	1.0023	1.0193	1.0458	.9731	.9731	1.1823	1.0913	1.0231	.9845	1.0276	1.1640	.9398	1.0268	

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N	Z 1	Z 2	Z 3	Z 4	Z 5	Z 6	Z 7	Z 8	Z 9	Z 10	Z 11	Z 12	Z 13	Z 14
	.07000	.10220	.12090	.15000	.07000	.07000	.30000	.20000	.12500	.08260	.13000	.28000	.05540	.12907
1	.947	.970	.987	1.012	.947	.947	1.145	1.055	.985	.957	.985	1.127	.970	.993
2	1.829	1.912	1.961	2.037	1.829	1.829	2.454	2.173	1.971	1.852	1.985	2.397	1.772	1.992
3	2.685	2.826	2.922	3.025	2.685	2.685	4.254	3.352	2.943	2.727	2.969	3.828	2.595	2.964
4	3.453	3.712	3.870	4.126	3.453	3.453	6.353	4.997	3.915	3.553	3.940	5.440	3.340	3.941
5	4.195	4.523	4.826	5.192	4.195	4.195	8.723	6.913	4.838	4.439	4.828	7.252	4.031	4.711
6	4.893	5.407	5.729	6.257	4.893	4.893	11.353	9.041	6.504	5.722	6.005	9.005	4.676	5.876
7	5.557	6.233	6.634	7.287	5.557	5.557	14.223	11.353	7.722	6.722	7.113	10.513	5.284	6.814
8	6.177	6.984	7.466	8.257	6.177	6.177	17.343	13.823	8.902	7.722	8.213	12.413	5.850	7.723
9	6.753	7.763	8.427	9.377	6.753	6.753	20.793	16.593	10.082	8.722	9.313	14.513	6.376	8.573
10	7.285	8.503	9.303	10.377	7.285	7.285	24.583	19.643	11.262	9.722	10.413	16.813	6.852	9.373
11	7.773	9.225	10.115	11.377	7.773	7.773	28.813	22.993	12.442	10.722	11.513	19.313	7.271	10.313
12	8.215	9.825	10.815	12.517	8.215	8.215	33.483	26.543	13.622	11.722	12.613	21.913	7.631	11.243
13	8.613	10.485	11.575	13.697	8.613	8.613	38.593	30.293	14.802	12.722	13.713	24.613	7.951	12.173
14	8.965	11.195	12.385	14.917	8.965	8.965	44.143	34.143	15.982	13.822	14.813	27.413	8.271	13.103
15	9.273	11.955	13.245	16.177	9.273	9.273	50.143	38.193	17.162	14.942	15.933	30.313	8.591	14.033
16	9.535	12.765	14.155	17.477	9.535	9.535	56.593	42.343	18.342	16.062	17.053	33.313	8.911	14.963
17	9.753	13.615	15.095	18.817	9.753	9.753	63.393	46.593	19.522	17.182	18.173	36.313	9.231	15.893
18	9.925	14.505	16.075	20.197	9.925	9.925	70.643	50.943	20.692	18.302	19.293	39.313	9.551	16.823
19	10.053	15.435	17.095	21.617	10.053	10.053	78.343	55.493	21.872	19.422	20.473	42.313	9.871	17.753
20	10.135	16.405	18.215	23.177	10.135	10.135	86.493	60.143	23.052	20.542	21.653	45.313	10.191	18.683
21	10.173	17.415	19.435	24.877	10.173	10.173	95.093	64.893	24.232	21.612	22.833	48.313	10.511	19.613
22	10.173	18.465	20.585	26.717	10.173	10.173	104.143	69.743	25.412	22.562	23.913	51.313	10.831	20.543
23	10.135	19.555	21.775	28.697	10.135	10.135	113.643	74.693	26.592	23.292	24.993	54.313	11.151	21.473
24	10.053	20.685	22.995	30.817	10.053	10.053	123.593	79.743	27.772	24.022	26.073	57.313	11.471	22.403
25	9.925	21.855	24.245	33.077	9.925	9.925	133.993	84.893	28.952	24.902	27.153	60.313	11.791	23.333
	.Y 1	.Y 2	.Y 3	.Y 4	.Y 5	.Y 6	.Y 7	.Y 8	.Y 9	.Y 10	.Y 11	.Y 12	.Y 13	.Y 14
	.9470	.9704	.9888	1.0124	.9470	.9470	1.1445	1.0555	.9854	.9531	.9848	1.1269	.9772	.9940

The aforementioned equations of Section 2.10.4 were put on the computer to determine the present worth factors, $PWF(x)$. They are shown on the following pages for all interest rates, escalation factors and varying lifetime, N from 1 to 25 years.

These factors will be used to determine the life cycle benefits of the following plans.

BASIC PLAN "B"LIFE CYCLE CASE 1

- a. The life, N for 5 years (1977 costs @ end of 1982)
- b. Interest rate @ 6.25%
- c. Construction escalation at 7%. The life cycle will be studied for 1977 costs escalated to 1979.
- d. Fuel will be coal.
- e. The analysis will be computed two ways: (1) For the turbine generator being self-supporting. It purchases steam from the steam side of the plant at the steam production cost. The steam side will buy its electricity from the turbine at its production cost. (2) For an integrated plant wherein no cash flow occurs between either side of the plant.

LIFE CYCLE CASE 2

- a. Based upon 1977 plant investment at 6.25% interest, the life cycle for 25 years will be studied. Year 2012.

BASIC PLAN "C"

Life Cycle study conditions of Basic Plan "B", Case 1 and 2, will be analyzed for Basic Plan "C".

BASIC PLAN "D"

Life Cycle study conditions of Basic Plan "B", Case 1 and 2 will be analyzed for Basic Plan "D".

LIFE CYCLE OF BASIC PLAN "B" - CASE 1

N = 5 Years, 1977 to end of 1982
 10 Year Amortization @ 6.25% interest
 1977 Construction escalated to the end of 1979

		Steam Side Non-Integrated Plant	Turbine- Generator Side	Steam Side Co-Generation Plant
1977 Year (0) Investment		\$15,744,600	\$ 2,620,800	\$15,744,600
2 Year Escalation @ 7% per annum, 1979		\$17,948,844	\$ 2,987,712	\$17,948,844
Principal & Interest, 1979		\$ 2,467,639	\$ 410,756	\$ 2,467,639
Depreciation (1979)		516,849	29,472	516,849
<u>O & M Expenses</u>	<u>PWF</u>	<u>Present Worth Expenses - Year 1982</u>		
Labor	5.589	\$ 3,523,306	\$ 409,450	\$ 3,523,306
Sewer	5.887	353,220	0	353,220
Purchases Electricity	6.380	323,817	0	323,817
Plant Pool Electricity	4.901	995,001	24,505	792,345
Purchased Supplies	5.107	627,344	153,210	627,344
Maintenance	5.107	510,700	0	510,700
Ash Removal	9.535	633,486	0	686,425
Insurance	7.310	204,680	21,930	204,680
Administration	5.955	595,500	119,100	595,500
Fuel 5.291, 6.022, 5.291		<u>12,991,059</u>	<u>2,988,460</u>	<u>14,076,718</u>
Total PW 1982 O & M Expenses		\$20,758,113	\$ 3,716,655	\$21,694,055
		<u>Present Worth Revenues - Year 1982</u>		
Electric Credits				
Pool	4.901	\$ 0	\$ 3,246,422	\$ 0
Plant	4.901	0	802,328	0
Steam Credits				
Turbine	6.022	\$ 0	\$ 0	\$ 2,988,460
Grid	6.022	33,738,255	0	33,738,255
Interest on Drepeciation For One Year		41,348	2,358	41,348

LIFE CYCLE BENEFITS - CASE 1
BASIC PLAN "B"
CASE 1

	Total 1982 Present Worth		
	Steam Side Non-Integrated Plant	Turbine- Generator Side	Steam Side Co-Generation Plant
1979 Principal & Interest	\$ 2,467,639	\$ 410,756	\$ 2,467,639
1979 Depreciation	516,849	29,472	516,849
PW (1982) O & M Expenses	<u>20,758,113</u>	<u>3,716,655</u>	<u>21,694,055</u>
Total 1982 PW Expenses	\$23,742,601	\$ 4,156,883	\$24,678,543
1982 PW Revenues of a Plant Aligned for Self-Supporting Functions:			
Electric Revenues			
Pool	\$ 0	\$ 3,246,422	\$ 0
Plant	0	802,328	0
Depreciation Interest	0	2,358	0
Steam Revenues			
Turbine	0	\$ 0	\$ 2,988,460
Grid	33,738,255	0	33,738,255
Depreciation Interest	<u>41,348</u>	<u>0</u>	<u>41,348</u>
Total 1982 PW Revenues	\$33,779,603	\$ 4,051,108	\$36,768,063
A. Net 1982 PW Gain (+)	+\$10,037,002	-\$ 105,775	+\$12,089,520

Net PW Cost Benefit 1982 of
Steam Side of Co-Generation
Plant = \$12,089,520 - 10,037,002 = \$2,052,518

∴ The net PW Benefit of the steam side of a co-generation plant favors the basic steam plant by \$2,052,518 in 1982. If the benefit of the turbine-generator is added the total benefit decreases to:
\$2,052,518 - 105,775 = \$1,946,743

- B. Realigned Plant for a total integrated plant versus a straight Steam Plant.
Added coal to Turbine-Generator = 12,070 Tons @ \$205,190.

	Steam Side Non-Integrated Plant	Turbine- Generator Side	Steam Side Co-Generation Plant
Total 1982 PW Expenses	\$23,742,601	\$ 4,133,879	\$24,678,543
less Fuel	0	- 2,988,460	0
less electric (Pool)	0	- 24,505	- 802,328
plus turbine	0	0	1,120,914
Realigned 1982 PW Expenses	<u>\$23,742,601</u>	<u>\$ 1,120,914</u>	<u>\$24,997,129</u>

	Steam Side Non-Integrated Plant	Turbine- Generator Side	Steam Side Co-Generation Plant
Realigned 1982 PW Revenues			
Electric Revenues			
Pool	\$ 0		\$ 3,246,422
Plant	0		0
Drepeciation Interest	0		2,358
Steam Revenues			
Turbine	\$ 0		\$ 0
Grid	33,738,255		33,738,255
Depreciation Interest	41,348		41,348
Total PW 1982 Revenues	<u>\$33,779,603</u>		<u>\$37,028,383</u>
Net 1982 PW Operating Gain	\$10,037,002	(-\$1,120,914)	\$12,031,254

∴ Total Integrated Plant has 1982 PW Gain of (12,031,254 - 10,037,002) = \$1,994,252 over straight steam plant. The turbine-generator, however is losing \$983,232 annually. \$1,994,252 - 983,232 = \$1,011,020

$$C. \text{ Benefit-to-Cost Ratio of Total Integrated Plant} = \frac{\text{Total 25 Year Savings}}{\text{Additional Capital Cost}}$$

where \$1,011,020 is a 3 year savings.

$$B/C = \frac{\$1,011,020 \times 25}{3 \times \$2,620,800}$$

$$B/C = 3.215$$

∴ The benefit-to-cost ratio of this plan indicates that it would probably be beneficial to undertake it.

D. Payback Period

To find out how long it will take to payback the additional capital investment for the turbine-generator assume that the average savings in year (1) - 1980 escalate as follows.

$$\begin{aligned} \text{Annual Average PW Savings} &= \frac{\$1,011,020}{3} \\ &= \$337,007 \end{aligned}$$

$$\begin{aligned} \text{Combined Escalation Rate CER.} &= 14.0517\% \\ &(\text{Sum of Annual Escalation Rates} \div \text{by } 10) \end{aligned}$$

In Stage II we will determine weighted CER.

$$n = \text{payback period} = \frac{\log \left[\frac{C}{a S} (a - 1) + 1 \right]}{\log a}$$

where:

C = added capital investment
= \$2,620,800

S = Average annual gain

and

$$a = \frac{1 + .140517}{1 + .0625} = 1.07343$$

$$\begin{aligned} n &= \frac{\log \left[\frac{2,620,800}{1.07343 (\$337,007)} (1.07343 - 1) + 1 \right]}{\log 1.07343} \\ &= \frac{\log 1.53197933}{\log 1.07343} = \frac{.18525291}{.0307737286} \end{aligned}$$

$$n = 6.019 \text{ years}$$

∴ The added capital investment for a turbine-generator not required to purchase steam is 6.019 years.

LIFE CYCLE OF BASIC PLAN "B" - CASE 2

N = 25 years (1977 to 2012)
 i = 6.25%, 10 year Amortization
 Based upon 1977 Costs

		Steam Side Non-Integrated Plant	Turbine- Generator Side	Steam Side Co-Generation Plant
1977 Year (0) Investment		\$ 15,744,600	\$ 2,620,800	\$ 15,744,600
1977 Principal & Interest		2,164,596	360,312	2,164,596
1977 Depreciation		453,377	25,853	453,377
Total Year (0), 1977 Costs		\$ 2,617,973	\$ 386,165	\$ 2,617,973
<u>O & M Expense</u>	<u>PWF</u>	<u>Present Worth Expenses - Year 2012</u>		
Labor	41.70	\$ 26,287,680	\$ 3,054,942	\$ 26,287,680
Sewer and Water	53.94	3,236,400	0	3,236,400
Purchased Electricity	81.90	4,156,835	0	4,156,835
Plant Pool Electricity	22.94	0	114,700	3,755,439
Purchased Supplies	27.43	3,369,501	822,900	3,369,501
Maintenance	27.43	2,743,000	0	2,743,000
Ash Removal	843.00	56,007,234	0	60,687,570
Insurance	174.16	4,876,480	522,480	4,876,480
Administration	57.14	5,714,000	1,142,800	5,714,000
Fuel (Steam = 60.528)	32.19	79,036,429	30,037,444	85,641,495
Total PW (2012) O & M Expenses		\$185,427,559	\$35,695,266	\$200,468,400
		<u>Present Worth Revenues - Year 2012</u>		
Electric Credits				
Pool	22.94	\$ 0	\$15,195,456	\$ 0
Plant	22.94	0	3,755,439	0
Steam Credits				
Turbine	60.53	\$ 0	\$ 0	\$ 30,038,436
Grid	60.53	339,119,325	0	339,119,325
Depreciation Interest		21,810,175	1,243,675	21,810,175
Total PW (2012) Revenues		\$360,929,500	\$20,194,570	\$390,967,936

LIFE CYCLE BENEFITS - Case 2
BASIC PLAN "B"
CASE 2

	Total 1981 Present Worth		
	Steam Side Non-Integrated Plant	Turbine- Generator Side	Steam Side Co-Generation Plant
1977 Principal & Interest	\$ 2,164,596	\$ 360,312	\$ 2,164,596
1977 Depreciation	<u>453,377</u>	<u>25,853</u>	<u>453,377</u>
Total 1977 Costs	\$ 2,617,973	\$ 386,165	\$ 2,617,973
PW (2012) O & M Expense	<u>\$185,427,559</u>	<u>\$35,695,266</u>	<u>\$200,468,400</u>
Total PW (2012) Expenses	\$188,045,532	\$36,081,431	\$203,086,373
Total PW (2012) Revenues	<u>360,929,500</u>	<u>20,194,570</u>	<u>390,967,936</u>
A. Net PW (2012) Gains (Self Supporting Systems)	\$172,883,968	-\$15,886,861	\$187,881,563
Cost Benefit Year (2012) of Steam Side Co-Generation Plant = \$187,881,563 - 172,883,968 = \$14,997,595			

The steam side of the Co-Generation Plant gains \$14,997,595 over 25 years compared to the Non-Integrated Steam Plant. However, because the price of steam is increasing rapidly the turbine has to buy more expensive steam and loses \$15,886,861 at the end of the 25th year.

Assuming the steam side has to recoup those losses, its net benefit is reduced by the turbine loss of \$15,694,048 to a net plant loss in the 25th year of \$889,266.

B. Realigned Plant for a total integrated system versus a straight steam plant.

There is no cash flow within plant for turbine steam and plant electricity.

	Steam Side Non-Integrated Plant	Turbine- Generator Side	Steam Side Co-Generation Plant
Total Realigned PW (2012) Expenses	\$188,045,532	\$36,081,431	\$203,086,373
less fuel	0	- 30,037,444	0
less Pool Electricity	0	- 114,700	- 3,755,439
plus turbine	0	0	+ 5,929,287
Total PW (2012) Expenses	<u>\$188,045,532</u>	<u>\$ 5,929,287</u>	<u>\$205,260,221</u>

B. (Continued)

	Steam Side Non-Integrated Plant	Turbine- Generator Side	Steam Side Co-Generation Plant
Realigned PW (2012) Revenues			
Electric Revenues			
Pool	\$ 0	\$ 0	\$ 15,195,456
Plant	0	0	3,755,439
Depreciation Interest	0	0	1,243,675
Steam Revenues			
Turbine	\$ 0	\$ 0	\$ 0
Grid	339,119,325	0	339,119,325
Depreciation Interest	<u>21,810,175</u>	<u>0</u>	<u>21,810,175</u>
Total PW (2012) Revenues	\$360,929,500	\$ 0	\$381,124,070

Net PW (2012) Operating Gain = \$381,124,070 - 360,929,500 = \$20,194,570

∴ The totally integrated plant has a 25 year total operating gain of \$20,194,570 over a straight steam plant. This occurred because the turbine did not have to purchase steam which was going up at a high rate of escalation.

$$\begin{aligned}
 \text{C. Benefit-to-Cost Ratio of Total Integrated Plant} &= \frac{\text{Total 25 Year Savings}}{\text{Additional Capital Cost}} \\
 &= \frac{\$20,194,570}{2,620,600}
 \end{aligned}$$

$$B/C = 7.706$$

This is an excellent Benefit-to-Cost ratio

D. Payback Period

To find out how long it will take to payback the additional capital investment for the turbine-generator assume that the average savings in year (1) escalate as follows:

$$\begin{aligned}
 \text{Annual Average PW Savings} &= \frac{\$20,194,570}{25} \\
 &= \$807,783
 \end{aligned}$$

$$\begin{aligned}
 \text{Combined Escalation Rate} &= 14.0517\% \\
 (\text{Sum of Annual Escalation Rates} \div 10)
 \end{aligned}$$

$$n = \text{payback period} = \frac{\log \left[\frac{C}{aS} (a - 1) + 1 \right]}{\log a}$$

where:

C = added capital cost

S = average annual gain

and

$$a = \frac{1 + .140517}{1 + .0625} = 1.07343$$

$$n = \frac{\log \left[\frac{\$2,620,800}{1.07343 (807,783)} (1.07343 - 1) + 1 \right]}{\log 1.07343}$$

$$n = \frac{\log 1.221941732}{\log 1.07343} = \frac{.0870504971}{.0307737286}$$

$$n = 2.83 \text{ years}$$

∴ Payoff on the turbine-generator is 2.83 years

N = 4 years, 1979 to 1981

1977 Construction escalated to end of 1979

	Steam Side Non-Integrated Plant	Turbine- Generator Side	Steam Side Co-Generation Plant
1977 Year (0) Investment	\$15,744,600	\$ 2,620,800	\$15,744,600
1979 Year (0) Escalation (14%)	17,948,844	2,987,712	17,948,844
Principal & Interest - 1979 Cost	1,788,164	405,928	1,788,164
Depreciation Expense	516,849	29,472	516,849
<hr/> Present Worth Expenses - 1981 <hr/>			
PW O & M Expenses	\$15,004,610	\$ 2,083,867	\$15,656,962
<hr/> Present Worth Revenues - 1981 <hr/>			
Electric Credits			
Plant	\$ 0	\$ 562,150	\$ 0
Pool	0	2,393,914	0
Steam Credits			
Grid	\$21,537,984	\$ 0	\$21,537,984
Turbine	0	0	1,599,745
Interest on Depreciation	<u>0</u>	<u>0</u>	<u>0</u>
Total PW 1981 Revenues	\$21,537,984	\$ 2,956,064	\$23,137,729

LIFE CYCLE BENEFITS - CASE 1

BASIC PLAN "C"

	Total PW - 1981		
	Steam Side Non-Integrated Plant	Turbine- Generator Side	Steam Side Co-Generation Plant
1979 Principal & Interest	\$ 1,788,164	\$ 405,928	\$ 1,788,164
1979 Depreciation	516,849	29,472	516,849
PW 1981 O & M	<u>\$15,004,610</u>	<u>\$ 2,083,867</u>	<u>\$15,656,962</u>
Total 1981 PW Expenses	\$17,309,628	\$ 2,519,267	\$17,961,975
Total 1981 PW Revenues	<u>21,537,984</u>	<u>2,956,064</u>	<u>23,137,729</u>
Net 1981 PW Gain	\$ 4,228,361	\$ 436,797	\$ 5,175,754

Net 1981 PW Cost Benefit of
Co-Generation Plant on Steam
Side = \$5,175,754 - 4,228,361 = \$947,393

Total 1981 PW Cost Benefit
of an Integrated Plant = \$947,393 + 436,797 = \$1,384,190

Benefit-to-Cost Ratio = $\frac{\$1,384,190 \times 12.5}{2,620,800}$ = 6.60

Average Annual Savings = $\frac{\$1,384,190}{2}$ = \$692,095

Payback Period = $\frac{\log \left[\frac{2,620,800}{1.07343 (692,095)} (1.07343 - 1) + 1 \right]}{\log 1.07343}$
= 3.25 Years

N = 25 Years (1977 to 2012)

	Total PW - 2012		
	Steam Side Non-Integrated Plant	Turbine- Generator Side	Steam Side Co-Generation Plant
1977 Principal & Interest	\$ 1,568,565	\$ 356,078	\$ 1,568,565
1977 Depreciation	453,377	25,853	453,377
PW 2012 O & M	<u>112,467,438</u>	<u>8,705,517</u>	<u>118,284,919</u>
Total 2012 PW Expenses	\$114,489,380	\$ 9,087,448	\$120,306,861
Total 2012 PW Revenues	<u>182,438,439</u>	<u>9,686,036</u>	<u>198,598,434</u>
Net 2012 PW Gains	\$ 67,949,059	\$ 598,588	\$ 78,291,573

Net 2012 PW Cost Benefit of
Steam Side of Co-Generation
Plant

$$= \$78,291,573 - 67,949,059 = \$10,342,514$$

Net 2012 PW Cost Benefit of
Integrated Co-Generation
Plant

$$= \$10,342,514 + 598,588 = \$10,941,102$$

$$\text{Benefit-to-Cost Ratio} = \frac{\$10,941,102}{2,620,800} = 4.175$$

$$\text{Average Annual Saving} = \frac{10,941,102}{25} = 437,645$$

$$\text{Payback Period} = \frac{\log \left[\frac{2,620,800}{1.07343 (437,645)} (1.07343 - 1) + 1 \right]}{\log 1.07343}$$

$$= 4.85 \text{ years}$$

2.10.10

LIFE CYCLE OF BASIC PLAN 'D' - CASE 1University Plant for a Cost Shared Program

N = 4 years, 1977 to 1981

	Steam Side Non-Integrated Plant	Turbine- Generator Side	Steam Side Co-Generation Plant
1977 Year (0) Investment	\$ 3,349,781	\$ 1,911,136	\$ 3,349,781
1979 Year (0) Escalation	3,818,750	2,178,695	3,818,750
Principal & Interest - 1979	380,445	296,011	380,445
Depreciation Expense	516,849	29,472	516,849
PW O & M Expenses - 1981	<u>\$15,004,610</u>	<u>\$ 1,745,739</u>	<u>\$15,545,185</u>
Total PW Expenses - 1981	\$15,901,904	\$ 2,071,222	\$16,442,479
PW Revenues - 1981	\$17,137,406	\$ 2,844,287	\$18,655,394
Depreciation - 1981	<u>0</u>	<u>0</u>	<u>0</u>
Total PW Revenues - 1981	\$17,137,406	\$ 2,844,287	\$18,655,394
Net PW Gains - 1981	\$ 1,235,502	\$ 773,065	\$ 2,212,915

Net 1981 Cost Benefit to
Steam Side of a Co-
Generation Plant

$$= \$2,212,915 - 1,235,502 = \underline{\$977,413}$$

Net 1981 Cost Benefit of
Integrated Plant

$$= \$977,413 + 773,065 = \underline{\$1,750,478}$$

$$\text{Benefit-to-Cost Ratio} = \frac{\$1,750,428 \times 12.5}{2,620,800} = 8.35$$

$$\text{Average Annual Saving} = \frac{\$1,750,478}{2} = \$875,239$$

$$\text{Payback Period} = \frac{\log \left[\frac{2,620,800}{1.07343 (875,239)} (1.07343 - 1) + 1 \right]}{\log 1.07343}$$

$$= 2.63$$

University Cost Shared Plan

N = 25 Year (1977 to 2012)

	Steam Side Non-Integrated Plant	Turbine= Generator Side	Steam Side Co-Generation Plant
1977 Principal & Interest	\$ 333,724	\$ 259,658	\$ 333,724
1977 Depreciation	453,377	25,853	453,377
PW 2012 O & M Expenses	<u>112,031,767</u>	<u>7,353,480</u>	<u>117,375,663</u>
Total 2012 PW Expenses	\$112,818,868	\$ 7,638,721	\$118,162,764
2012 PW Revenues	\$143,878,046	\$ 8,678,458	\$156,622,402
Total Depreciation Interest	<u>21,810,175</u>	<u>1,243,675</u>	<u>21,810,175</u>
Total 2012 PW Revenues	\$165,688,221	\$ 9,922,133	\$178,432,577
Net 2012 PW Gains	\$ 52,869,353	\$ 2,283,412	\$ 60,269,813

Net 2012 PW Gains in the
Steam Side of a Co-Generation
Plant = \$60,269,813 - 52,869,353 = \$7,400,460

Net 2012 PW Gain in Total
Integrated Co-Generation
Plant = \$7,400,460 + 2,283,412 = \$9,683,872

Benefit-to-Cost Ratio = $\frac{9,683,872}{2,620,800} = 3.70$

Payback Period = $\frac{\log \left[\frac{2,620,800}{1.07343 (387,354)} (1.07343 - 1) + 1 \right]}{\log 1.07343}$

= 5.37 Years