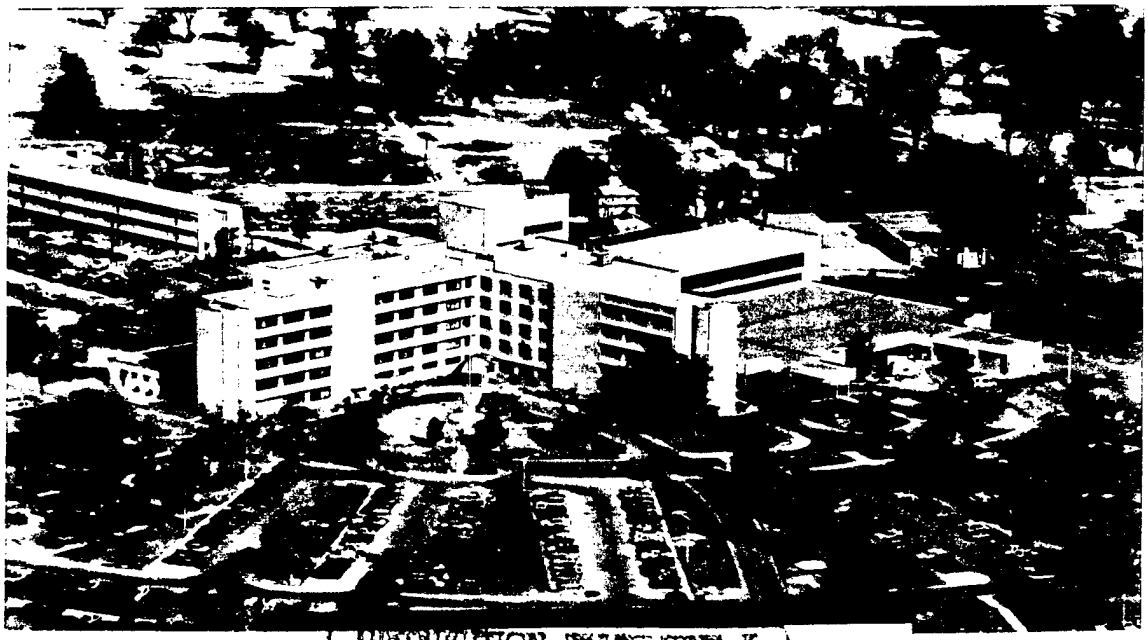
ENERGY ENGINEERING ANALYSIS PROGRAM

FINAL SUBMITTAL



DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

IRWIN ARMY COMMUNITY HOSPITAL
FORT RILEY, KANSAS

PREPARED FOR

DEPARTMENT OF THE ARMY
KANSAS CITY DISTRICT
CORPS OF ENGINEERS
CONTRACT NO. DACA41-90-C-0114

19971022 129

PREPARED BY

MASSAGLIA.NEUSTROM.BREDSON, INC.
CONSULTING ENGINEERS
KANSAS CITY, MISSOURI

THE GAW COMPANY
ARCHITECTS

VOLUME 1 OF 3
EXECUTIVE SUMMARY
JANUARY 1992

Received
06/11/92

DEPARTMENT OF THE ARMY
CONSTRUCTION ENGINEERING RESEARCH LABORATORIES, CORPS OF ENGINEERS
P.O. BOX 9005
CHAMPAIGN, ILLINOIS 61826-9005

REPLY TO
ATTENTION OF: TR-I Library

17 Sep 1997

Based on SOW, these Energy Studies are unclassified/unlimited.
Distribution A. Approved for public release.

Marie Wakefield,
Librarian Engineering

FINAL SUBMITTAL REPORT DOCUMENTS

For convenience, final submittal report documents are bound in three volumes. Final submittal report documents consist of the following:

VOLUME 1 OF 3: EXECUTIVE SUMMARY

VOLUME 2 OF 3: NARRATIVE

VOLUME 3 OF 3: PROJECT DOCUMENTATION

DISTRIBUTION STATEMENT A
Approved for public release
Distribution Unlimited

DTIC QUALITY INSPECTED 5

INDEX

SECTION I - INTRODUCTION

SECTION 2 - BUILDING DATA

SECTION 3 - PRESENT ENERGY CONSUMPTION

SECTION 4 - HISTORICAL ENERGY CONSUMPTION

SECTION 5 - ENERGY CONSERVATION ANALYSIS

SECTION 6 - ENERGY AND COST SAVINGS

SECTION I - INTRODUCTION

SECTION 1

INTRODUCTION

1.1 GENERAL:

A. This report covers the Final Submittal for Study of Irwin Army Community Hospital Energy Engineering Analysis Program, Fort Riley, Kansas.

B. This study was initiated by the establishment of a computer model of the five building hospital complex as it now exists. Utility data was collected and analyzed to ascertain the present levels of gas and electricity consumption. The project team constructed an energy profile for the hospital complex using inputs from the building drawings, data gathered from the site visits, profile was validated by comparing the results to the utility bills and making minor adjustments to some parameters.

C. An Interim Submittal covering the field survey data and preliminary analysis of all identified Energy Conservation Measures (ECO's) was submitted for review May 3, 1991. A design review conference was accomplished at Fort Riley, Kansas on July 16, 1991. A Prefinal Submittal covering the finalized ECO calculations and preliminary project development

brochures was submitted for review September 1991. A review conference was held at Fort Riley in November 1991. The Final Submittal is a finalizing of project calculations incorporating the reviewing agencies' comments.

SECTION II - BUILDING DATA

SECTION 2

BUILDING DATA

2.1 GENERAL:

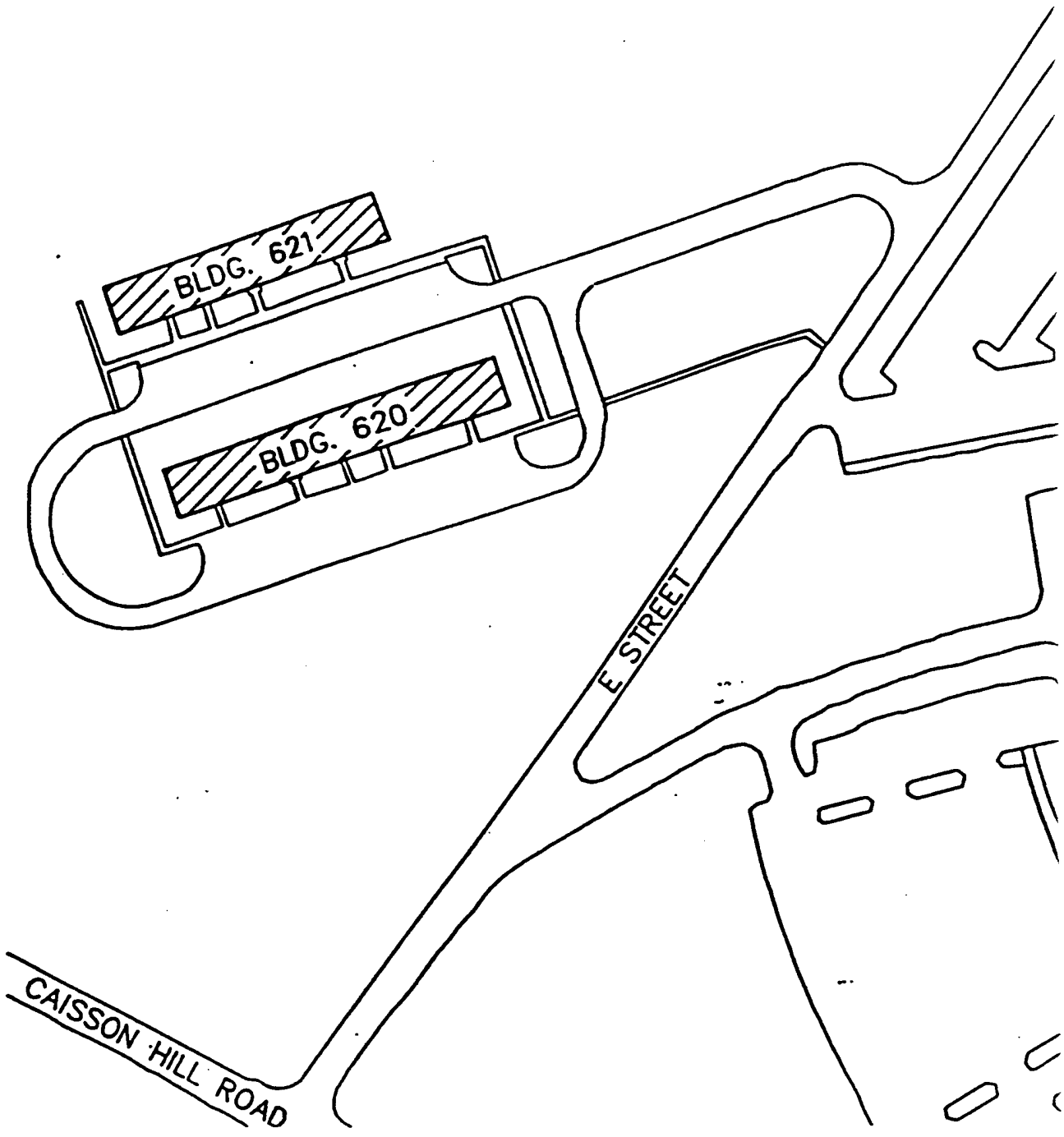
A. This project consisted of study and analysis of five separate buildings as identified as the hospital complex. These buildings are known as the Hospital (Building 600), the Energy Plant (Building 615), Nurses Quarters (Building 610), family housing barracks Barnes Hall (Building 620) and Kimball Hall (Building 621). Illustrated in Exhibit No. 1 is the site plan showing the general location of the five buildings in the hospital complex.

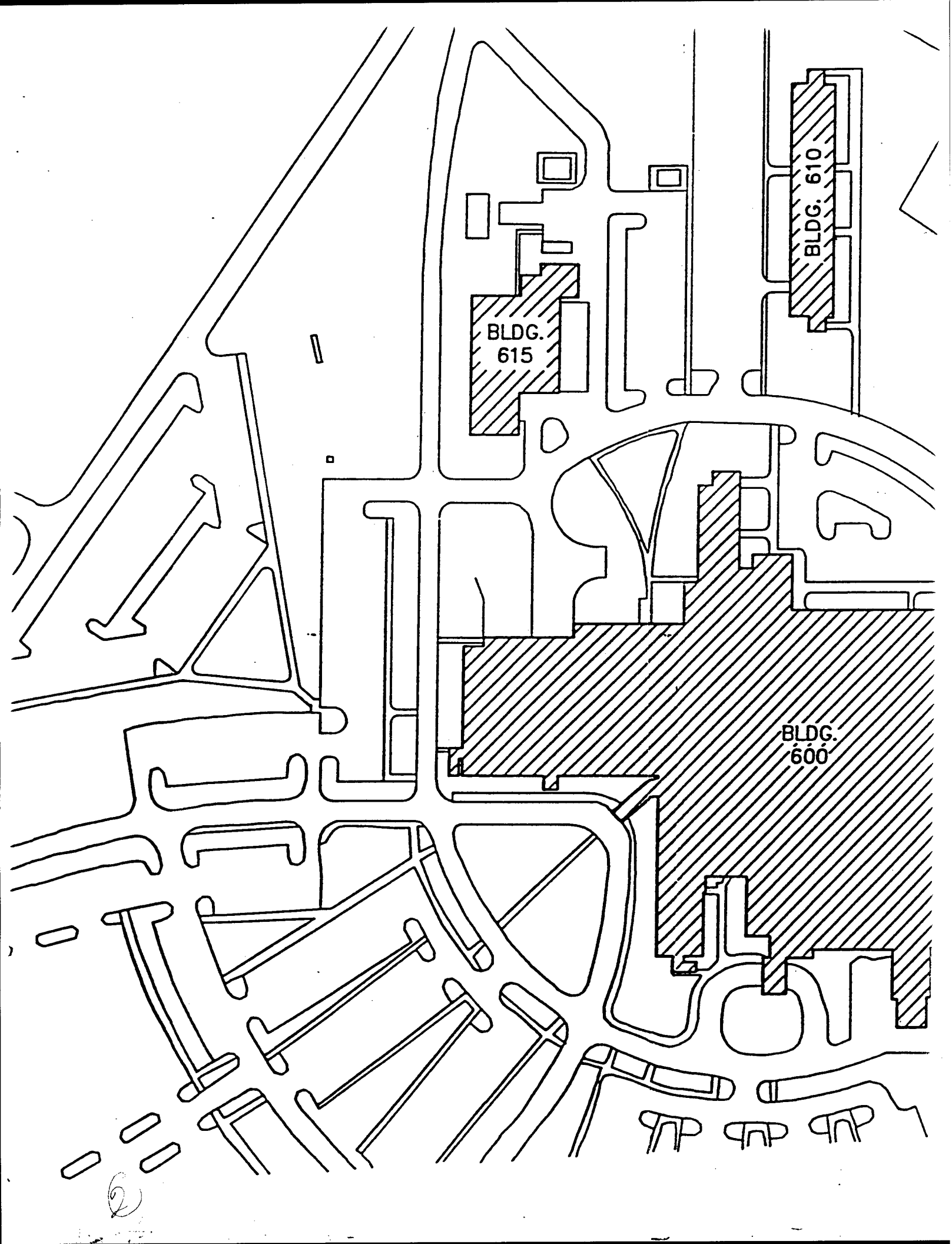
B. Table Nos. 1 through 5 provide a description of pertinent building information used in this study and analysis.

SITE PLAN
NOT TO SCALE

N

EXHIBIT NO. 1 — LOCATION MAP




BLDG. 610
BLDG. 615
BLDG. 600

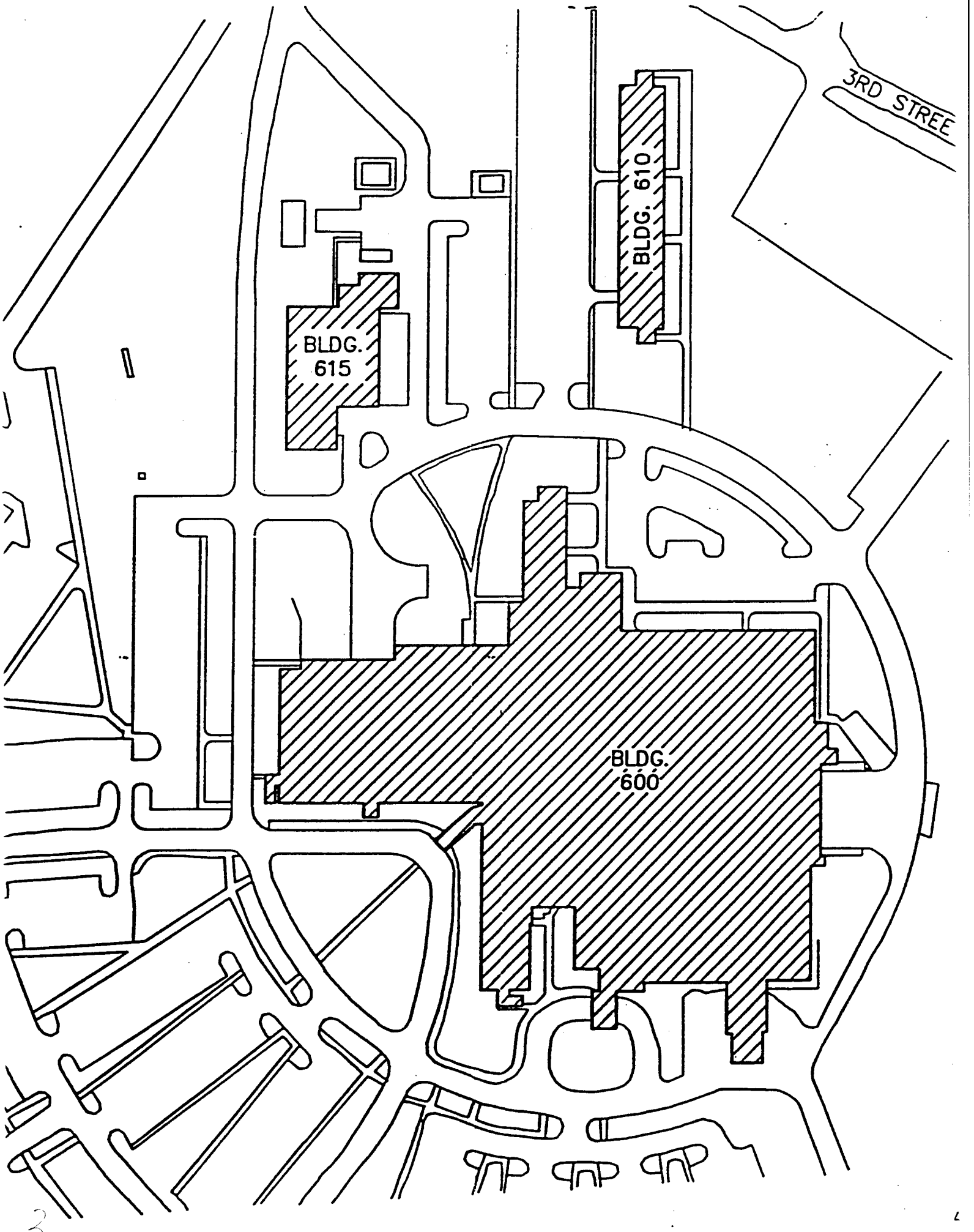

3RD STREE
BLDG. 610
BLDG. 615
BLDG. 600

TABLE NO. 1

BUILDING DESCRIPTION

BUILDING: Irwin Army Community Hospital (Building 600)

ESTIMATED USEFUL LIFE: 50 years

BUILDING SIZE

Total Building Area 367,000 Gross Square Feet

			Heated		Cooled	
Original:	Year	1955	173,000	Sq. Ft.	165,000	Sq. Ft.
Addition 1:	Year	1975	176,200	Sq. Ft.	164,500	Sq. Ft.
Addition 2:	Year	1985	17,000	Sq. Ft.	N/A	Sq. Ft.
Addition 3:	Year			Sq. Ft.		Sq. Ft.
Addition 4:	Year			Sq. Ft.		Sq. Ft.

Number of People in Building 825

EXISTING OPERATING SCHEDULE OF BUILDING

	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
Starting time (am/pm)	Varies depending on individual departments.						
Hours maintained	24	24	24	24	24	24	24

Occupied Temperature - Winter 68,70,75 °F - Summer 68,75,78 °F
Unoccupied Temperature - Winter 68 °F - Summer 78 °F
} REFER: TM5-838-2

Boiler combustion efficiency * %

Cooling system COP **

Month you turn the boiler ON N/A OFF N/A

Month you turn the cooling equipment ON N/A OFF N/A

PROPOSED OPERATING SCHEDULE OF BUILDING

	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
Starting time (am/pm)	Varies depending on individual departments.						
Hours maintained	24	24	24	24	24	24	24

Occupied Temperature - Winter 68,70,75 °F - Summer 68,75,78 °F
Unoccupied Temperature - Winter 68 °F - Summer 78 °F
} REFER: TM5-838-2

Boiler efficiency N/A %

Cooling system COP N/A

Month you turn the boiler ON N/A OFF N/A

Month you turn the cooling equipment ON N/A OFF N/A

* Heating provided by boiler in energy plant.
** Cooling provided by chillers in energy plant.

TABLE NO. 2

BUILDING DESCRIPTION

BUILDING: Energy Plant (Building 615)

ESTIMATED USEFUL LIFE: 50 years

BUILDING SIZE

Total Building Area 10,300 Gross Square Feet

			Heated		Cooled	
Original:	Year	1955	7,800	Sq. Ft.	N/A	Sq. Ft.
Addition 1:	Year	1975	2,500	Sq. Ft.	N/A	Sq. Ft.
Addition 2:	Year			Sq. Ft.		Sq. Ft.
Addition 3:	Year			Sq. Ft.		Sq. Ft.
Addition 4:	Year			Sq. Ft.		Sq. Ft.

Number of People in Building 2

EXISTING OPERATING SCHEDULE OF BUILDING

	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
Starting time (am/pm)							
Hours maintained	24	24	24	24	24	24	24

Occupied Temperature - Winter 68 °F - Summer N/A °F

Unoccupied Temperature - Winter N/A °F - Summer N/A °F

Boiler combustion efficiency 69 %

Cooling system COP 3.6 ELEC. DRN CENTR./.92 STEAM DRN CENTR.

Month you turn the boiler ON * OFF

Month you turn the cooling equipment ON ** OFF

PROPOSED OPERATING SCHEDULE OF BUILDING

	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
Starting time (am/pm)							
Hours maintained	24	24	24	24	24	24	24

Occupied Temperature - Winter 68 °F - Summer N/A °F

Unoccupied Temperature - Winter N/A °F - Summer N/A °F

Boiler efficiency 78 %

Cooling system COP 3.6 ELEC. DRN CENTR./.92 STEAM DRN CENTR.

Month you turn the boiler ON * OFF

Month you turn the cooling equipment ON ** OFF

* One of two boilers will operate continuously year around due to base steam load.

** Minimum of one chiller operates year around due to surgery, labor/delivery, and ICU requirements.

TABLE NO. 3

BUILDING DESCRIPTION

BUILDING: Nurses Quarters (Building 610)

ESTIMATED USEFUL LIFE: 50 years

BUILDING SIZE

Total Building Area 26,890 Gross Square Feet

			Heated		Cooled	
Original:	Year	1957	26,890	Sq. Ft.	24,800	Sq. Ft.
Addition 1:	Year			Sq. Ft.		Sq. Ft.
Addition 2:	Year			Sq. Ft.		Sq. Ft.
Addition 3:	Year			Sq. Ft.		Sq. Ft.
Addition 4:	Year			Sq. Ft.		Sq. Ft.

Number of People in Building 157

EXISTING OPERATING SCHEDULE OF BUILDING

	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
Starting time (am/pm)							
Hours maintained	24	24	24	24	24	24	24

Occupied Temperature - Winter 68 °F - Summer 78 °F

Unoccupied Temperature - Winter N/A °F - Summer N/A °F

Boiler combustion efficiency * %

Cooling system COP 3.3

Month you turn the boiler ON N/A OFF N/A

Month you turn the cooling equipment ON April OFF Oct.

PROPOSED OPERATING SCHEDULE OF BUILDING

	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
Starting time (am/pm)							
Hours maintained	24	24	24	24	24	24	24

Occupied Temperature - Winter 68 °F - Summer 78 °F

Unoccupied Temperature - Winter N/A °F - Summer N/A °F

Boiler efficiency * %

Cooling system COP 3.3

Month you turn the boiler ON N/A OFF N/A

Month you turn the cooling equipment ON April OFF Oct.

* Energy for domestic water heating and building heating is provided by boiler in energy plant.

TABLE NO. 4

BUILDING DESCRIPTION

BUILDING: Family Housing Barracks - Barnes Hall (Building 620)

ESTIMATED USEFUL LIFE: 50 years

BUILDING SIZE

Total Building Area 12,520 Gross Square Feet

			Heated		Cooled	
Original:	Year	1960	12,520	Sq. Ft.	11,420	Sq. Ft.
Addition 1:	Year			Sq. Ft.		Sq. Ft.
Addition 2:	Year			Sq. Ft.		Sq. Ft.
Addition 3:	Year			Sq. Ft.		Sq. Ft.
Addition 4:	Year			Sq. Ft.		Sq. Ft.

Number of People in Building 24

EXISTING OPERATING SCHEDULE OF BUILDING

	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
Starting time (am/pm)							
Hours maintained	24	24	24	24	24	24	24

Occupied Temperature - Winter 68 °F - Summer 78 °F

Unoccupied Temperature - Winter N/A °F - Summer N/A °F

Boiler combustion efficiency * %

Cooling system COP 2.7

Month you turn the boiler ON N/A OFF N/A

Month you turn the cooling equipment ON N/A OFF N/A

PROPOSED OPERATING SCHEDULE OF BUILDING

	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
Starting time (am/pm)							
Hours maintained	24	24	24	24	24	24	24

Occupied Temperature - Winter 68 °F - Summer 78 °F

Unoccupied Temperature - Winter N/A °F - Summer N/A °F

Boiler efficiency * %

Cooling system COP 2.7

Month you turn the boiler ON N/A OFF N/A

Month you turn the cooling equipment ON April OFF Oct.

* Energy for domestic water heating and building heating is provided by boilers in energy plant.

TABLE NO. 5

BUILDING DESCRIPTION

BUILDING: Family Housing Barracks - Kimball Hall (Building 621)

ESTIMATED USEFUL LIFE: 50 years

BUILDING SIZE

Total Building Area 10,620 Gross Square Feet

			Heated		Cooled	
Original:	Year	1960	10,620	Sq. Ft.	9,520	Sq. Ft.
Addition 1:	Year			Sq. Ft.		Sq. Ft.
Addition 2:	Year			Sq. Ft.		Sq. Ft.
Addition 3:	Year			Sq. Ft.		Sq. Ft.
Addition 4:	Year			Sq. Ft.		Sq. Ft.

Number of People in Building 24

EXISTING OPERATING SCHEDULE OF BUILDING

	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
Starting time (am/pm)							
Hours maintained	24	24	24	24	24	24	24

Occupied Temperature - Winter 68 °F - Summer 78 °F

Unoccupied Temperature - Winter N/A °F - Summer N/A °F

Boiler combustion efficiency * %

Cooling system COP 2.7

Month you turn the boiler ON N/A OFF N/A

Month you turn the cooling equipment ON N/A OFF N/A

PROPOSED OPERATING SCHEDULE OF BUILDING

	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
Starting time (am/pm)							
Hours maintained	24	24	24	24	24	24	24

Occupied Temperature - Winter 68 °F - Summer 78 °F

Unoccupied Temperature - Winter N/A °F - Summer N/A °F

Boiler efficiency * %

Cooling system COP 2.7

Month you turn the boiler ON N/A OFF N/A

Month you turn the cooling equipment ON April OFF Oct.

* Energy for domestic water heating and building heating is provided by boilers in energy plant.

SECTION III - PRESENT ENERGY CONSUMPTION

SECTION 3

PRESENT ENERGY CONSUMPTION

3.1 ANNUAL ENERGY USED:

A. Electricity for hospital complex is metered on the primary side of the transformer located at the hospital substation. Electrical billing data from this point does not represent a totally accurate picture because this substation also serves other facilities in the area; however, since the hospital is by far the largest load on the substation, general conclusions can be drawn from this data.

B. The current energy consumption indicates that energy from natural gas accounts for 75 percent of total consumption with remaining 25 percent energy being supplied by electricity; however due to the higher costs of electricity, the electrical energy costs are 54 percent of the total energy costs for the five building hospital complex. The natural gas consumption peaks in the summer due to heavy use of steam boilers which generate steam to satisfy the demands for the steam turbine driven chillers. The electrical energy consumption also peaks in summer due to the use of electric refrigeration equipment and accessories. The monthly billing demand varies 31 percent between minimum

percent between minimum billing demand and maximum demand. Table No. 6 gives the annual energy consumed in millions of BTU's and the costs for electricity and natural gas during fiscal year 1990.

TABLE NO. 6

ANNUAL ENERGY CONSUMPTION AND COST

		COST	BTU x 10^6
Electricity	14.133 x 10^6 KWH	$537,054	48,235
Natural Gas	143,700 MCF	$434,764	148,154.7

3.2 ENERGY CONSUMPTION BY SYSTEMS:

A. Table No. 7 is a compilation of the total annual energy consumed at the hospital complex based on actual equipment nameplate ratings and computer modeling. Space heating and cooling consume 55 percent of the energy. Of that 55 percent, 14 percent is for AHU fans. The remaining 86 percent is for the boilers, chillers, cooling towers, pumps, etc. Lighting is 4 percent of the energy, and total miscellaneous equipment consumption comprises 28 percent of total energy. Hot water requirements constitute 14 percent of consumption.

TABLE NO. 7

HOSPITAL COMPLEX ANNUAL ENERGY USE PROFILE

FUNCTION	*ELECTRICITY*	*GAS*
Cooling/Heating	7.851×10^6 KWH	74,637 MCF
Miscellaneous Equipment	4.026×10^6 KWH	37,845 MCF
Domestic Hot Water	—	25,397 MCF
Lighting	2.256×10^6 KWH	—
TOTAL	14.133×10^6 KWH	137,879 MCF

14.133×10^6 KWH x 3413 BTU/KWH	$= 4.8235 \times 10^{10}$ BTU
137,879 MCF x 1,031,000 BTU/MCF	$= 1.4215 \times 10^{11}$ BTU
TOTAL	1.90389×10^{11} BTU

SECTION IV - HISTORICAL ENERGY CONSUMPTION

SECTION 4

HISTORICAL ENERGY CONSUMPTION

4.1 GENERAL:

A. Historical energy consumption data for the hospital complex while available, was not used due to the construction which has taken place at Irwin Army Community Hospital. Starting in October 1985 the complete mechanical and electrical systems in the 1955 Hospital building were upgraded or replaced to current design standards. This work included replacing existing failed or failing plumbing, heating, ventilating, and air conditioning, and electrical systems in "A", "B", and "C" wings of the hospital. Also included was associated architectural and structural work, fire alarm systems, communications systems, and central clock system. Work in the energy plant included primary/ secondary pumping for chilled water system and new boiler auxiliaries. The full hospital facility was not reoccupied until the fall of 1989 at the completion of the construction project. Fiscal year 1990 is the first year that energy consumption for the remodeled hospital was available. Fiscal year 1990 is the base year energy consumption data used in the study.

SECTION V - ENERGY CONSERVATION ANALYSIS

SECTION 5

ENERGY CONSERVATION ANALYSIS

5.1 GENERAL:

A. Initially a total of 37 different energy conservation opportunities (ECO's) were evaluated in detail for the five building hospital complex. Each ECO was computer-simulated or manually calculated where applicable to ascertain the potential impact on the hospital complex energy consumption. As a result of the initial calculations and reviewing agencies' comments the total number of ECO's was reduced. The ECO's were then combined into proposed construction projects and entered onto 1391 forms.

B. Table No. 8 summarizes the recommended projects that meet the funding guidelines. The ECIP projects are recommended based on ECIP Guidance dated 28 June 1991 per the following criteria:

1. Simple payback of 10 years or less. This simple payback is calculated using all energy dollar savings including energy demand charge and time of day savings.
2. Savings to Investment Ratio (SIR) of greater than unity.

C. The operational or policy change recommendation based on the site observations and project analysis is with regard to the operation of the hospital kitchen hood exhaust system and domestic hot water heaters in the hospital. As currently operated the kitchen hood exhaust fan runs the entire 16-hour occupancy of the kitchen. A simple operational change of turning off the exhaust fan when not required for cooling purposes will save approximately $10,600 per year. Based on the criteria established in the Architectural and Engineering Instruction Manual dated 14 July 1989 and revised 24 December 1990, the hospital can shutdown one of the four domestic water heaters and reset the water temperature in two of the units from 140 degrees F. to 125 degrees F. This will save approximately $12,976 per year.

TABLE NO. 8

SUMMARY OF PROJECTS

ECO # AND TITLE	SIMPLE PAYBACK YEARS	SAVINGS TO INVESTMENT RATIO (SIR)	TOTAL PROJECT SAVINGS BTU/YR ($x10^6$)	TOTAL PROJECT SAVINGS $/YR	RECOMMENDED IMPLEMENTATION YES	RECOMMENDED IMPLEMENTATION NO
4 Boiler Burners/ Modular Boiler	5.0	2.65	28,949.9	105,613	X	
5 Chiller Replacement	8.93	1.19	2,464	49,494	X	
1 Window/Door Upgrade & Lighting Revision	9.9	1.7	2,990.5	17,943	X	
3 Boiler Controls	3.5	2.9	5,845.6	21,796	X	
2 HVAC System Modifications	5.2	1.69	23,979.3	167,690	X	

SECTION VI - ENERGY AND COST SAVINGS

SECTION 6

ENERGY AND COST SAVINGS

6.1 POTENTIAL ENERGY AND COST SAVINGS:

A. Based on the analysis and calculations with interaction the potential savings resulting from the recommended ECO's are as follows:

ELECTRICITY:	1.7495×10^{10}
NATURAL GAS:	4.6734×10^{10}
TOTAL ANNUAL ENERGY:	6.4229×10^{10} BTU's
ELECTRICITY:	$194,761
NATURAL GAS:	$167,775
TOTAL ANNUAL SAVINGS:	$362,536

B. The percentage of the total calculated and billed energy conserved at the five building hospital complex is 33 percent of the total energy used in fiscal year 1990. Of this total energy saved 27 percent is electricity and 73 percent is natural gas.

C. The implementation of all recommended Energy Conservation Opportunities calculated at fiscal year 1990 energy prices would result in reduction of the total billed energy costs from $1,251,022 to $888,486. This calculation is based on energy bills for the hospital substation and gas meters #10 and #12 at the hospital Energy Plant.