ENERGY ENGINEERING ANALYSIS PROGRAM

COPY

INTERIM

Seneca Army Depot
NEW YORK

FEASIBILITY STUDY CENTRAL COAL-FIRED HEATING PLANTS

INCREMENT E

Contract No. DACA 65-80-C-0003
NORFOLK DISTRICT
CORPS OF ENGINEERS

REYNOLDS, SMITH AND HILLS
Architects-Engineers-Planners, Incorporated

ENERGY ENGINEERING ANALYSIS

FORT DEVENS
SENECA ARMY DEPOT
LETTERKENNY ARMY DEPOT

CONTRACT NO. DACA65-80-C-0003

FEASIBILITY STUDY

CENTRAL COAL-FIRED HEATING PLANTS
SENECA ARMY DEPOT

July 1981

Reynolds, Smith and Hills
Architects-Engineers-Planners,
Incorporated

INTERIM SUBMITTAL

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1.0 INTRODUCTION

In February 1980, the Norfolk District Corps of Engineers initiated Contract No. DACA65-80-C-0003 with Reynolds, Smith and Hills of Jacksonville, Florida. This contract called for the performance of Energy Engineering Analysis Programs of three U.S. Army installations: Fort Devens, Massachusetts; Letterkenny Army Depot, Pennsylvania; and Seneca Army Depot, New York. The objective of these Programs was the identification, evaluation, and development of programming documents for energy conservation projects which meet the criteria of the Army's Energy Conservation Investment Program (ECIP).

In August 1980, the Contract was expanded to include the services related to the development and economic evaluation of the most practical method of constructing a coal-fired central boiler plant at Seneca Army Depot and at Letterkenny Army Depot.

This Interim Report presents the results of Increment E Central Boiler Plants Project performed at Seneca Army Depot.

2.0 SUMMARY

The Increment E Central Boiler Plant Study for the Seneca Army Depot was initiated with a site survey performed by a team of engineers and an economist. The purpose of this survey was to collect data pertinent to the energy requirements of the facility and to obtain information regarding the condition of the existing heating plants at SEAD. The data collected from this visit and from contacts with plant personnel and local authorities were used to establish the energy related characteristics of the facility. Specifically, the data were used to determine the loads which the central heating plant would have to supply, and the fuels and energy sources which are available to provide the energy input to these alternate systems.

Utilizing this information a preliminary evaluation was made of the existing heating plants in order to determine the alternates which were sufficiently viable to warrant a more in-depth evaluation.

As a result of this evaluation, a "base case" was established for each of the two base areas at SEAD, thus providing a basis for comparison between the existing heating plants and several alternate central heating plant designs.

The alternate fuels considered viable for SEAD were coal and coal with supplemental firing of wood or solid waste (RDF). The conversion techniques which could utilize these fuels to supply the heating requirements of each of the base areas at SEAD and which warranted a detailed technical and economic analysis were the following:

"Option 2:" Central Coal-Fired Steam Plant utilizing conventional boilers with necessary flue gas clean-up equipment.

"Option 3:" Central Coal-Fired Steam Plant utilizing atmospheric fluidized bed boilers.

"Sub-Options:" Refuse Derived Fuel to be utilized as a supplemental fuel to "Option 2."

Wood and woody/biomass to be used as a supplemental fuel to "Option 2."

Schematics were developed for each alternate in order to estimate capital costs. Operating and maintenance expenses were developed, as were the annual fuel consumption and electric purchases for each alternate. Landfill fee credits were developed for the solid waste cases.

A detailed economic analysis for each case was then performed using these capital and annual costs and appropriate escalation and interest rates. The economic analysis was based on a comparison of the total life cycle costs associated with each of the alternates compared with the base case which assumed that SEAD would continue to use the present equipment burning fuel oil 100 percent of the time. Results of this economic analysis are summarized in Section 5.3.

In addition to the central heating plant study discussed above, a conceptual design was developed for a central coal-fired high temperature water distribution plant for comparison to the Option 2 case at the North Base area. Also, a life cycle analysis was conducted comparing a direct burial distribution system to a heating channel distribution system at the South Base area. Detailed economic analyses of these cases are summarized in Section 5.3.

3.0 DESCRIPTION OF THE FACILITY

3.1 LOCATION

Seneca Army Depot (SEAD) is located in Seneca County in the heart of the Finger Lakes Region of New York State. It occupies a site that lies on relatively flat land midway between Seneca and Cayuga Lakes at the approximate center of Seneca County and near the geographical center of New York State. The nearest city is Geneva, located approximately 15 miles north of the installation. SEAD abuts the village of Romulus.

SEAD is essentially broken down into two major areas separated by approximately six miles. The administrative area, or South Base, consists primarily of administrative buildings, maintenance shops, warehouses, and family housing units. The troop area, or North Base, consists primarily of a high security, special weapons area called the Q Area and troop billeting with related support facilities such as the commissary, PX, theater, library, mess hall, gymnasium, etc. In addition to these two major areas of activity, there is a family housing area on Seneca Lake, an airfield, and a munitions storage area.

The scope of the Increment E Central Boiler Plant Study for SEAD was limited to the North and South Base areas.

Electricity for SEAD is purchased from the New York State Electric and Gas Corporation, whose energy sources include coal and hydro-electric.

Fuel oil is the primary boiler fuel at SEAD with No. 6 fuel oil being used in the central heating plants and No. 2 fuel oil being used in all of the other boilers or furnaces at SEAD. The oil is purchased from commercial suppliers on the open market with bidding and contract awards handled by the Defense Fuel Supply Center (DFSC).

3.2 EXISTING ENERGY SYSTEMS

3.2.1 North Base Steam Systems

The majority of the steam produced at the North Base is generated in the central heating plant - Building No. 718, which serves almost the entire North Base, excluding the Q Area. Buildings not supplied by the central heating plant are equipped with individual No. 2 fuel oil furnaces or boilers.

Building No. 718 is a central steam plant which houses most of the North Base steam production capability. The steam plant is equipped with three Kewanee Ross 310 HP packaged boilers, all in good condition. All of the units fire No. 6 fuel oil. Steam is generated nominally at 50 psig, saturated, and is distributed through underground and overhead lines to Building Nos. 701, 702, 704, 705, 706, 707, 708, 714, 718, 719, 720, 722, 723, 724, and 732. In addition, a new ammunition training facility presently under construction and a new barracks will be tied into the steam distribution system.

Building No. 729 is a fire station which houses a low pressure, low capacity Weil-McLain boiler and steam system. This boiler fires No. 2 fuel oil.

Building No. 802 is a technical office which houses a low pressure, low capacity boiler and steam system. This boiler fires No. 2 fuel oil.

Building No. 805 is a boiler plant which provides heat for Building No. 804. The low pressure, low capacity heater is fired on No. 2 fuel oil.

Building No. 810 is a warehouse which houses a low pressure, low capacity boiler fired on No. 2 fuel oil.

Building No. 812 is a guard house which houses a furnace fired on No. 2 fuel oil.

The Tennis Bubble is an inflatable cover which houses two regulation size tennis courts. Heating is provided by an Applied Air System, Inc., heating coil/unit which is fired on No. 2 fuel oil.

3.2.2 North Base Loads

The total annual production of steam on the North Base is not known; however, estimates of the average and peak steam demands have been made based on existing fuel oil consumption records.

The total annual consumption of No. 6 fuel oil by Building No. 718, including the additional load anticipated for the new barracks, is estimated to be 233,200 gallons per year before and 177,400 gallons per year after the implementation of temperature setback control procedures currently being recommended at SEAD. Based on these fuel consumption rates, the future peak steam load is estimated to be 13,016 pounds per hour and the average steam demand is as indicated on Table 3-1.

The total annual consumption of No. 2 fuel oil by Building Nos. 729, 802, 805, 810, 812 and the Tennis Bubble, as well as the load anticipated for the new ammunition training facility, is estimated to be 55,500 gallons per year before and 40,823 gallons per year after temperature setback procedures have been implemented. Based on these fuel consumption rates, the total future peak steam load for these facilities is estimated to be 2,469 pounds per hour and the average steam demand is as indicated on Table 3-1.

3.2.3 South Base Steam Systems

The majority of the steam produced at the South Base is generated at one of two central heating plants located in Building Nos. 121 and 319. The buildings not supplied by these central heating plants are equipped with individual No. 2 oil-fired furnaces or boilers.

TABLE 3-1

ESTIMATED STEAM AND ELECTRICITY DEMAND

	Building No. 718, Ammunitions Facility, and Barracks		Building Nos. 729, 802, 805, 810, 812, and Tennis Bubble	
Month	Average Hourly Steam Demand (lbs/hr)	Electric Consumption (KWH)	Average Hourly Steam Demand (lbs/hr)	Electric Consumption (KWH)
Jan	5,360	13,838	1,020	1,231
Feb	6,080	12,499	1,150	1,388
Mar	4,580	11,086	870	1,050
Apr	3,950	10,728	750	905
May	2,730	11,086	520	628
Jun	1,240	9,000	230	278
Jul	1,120	9,300	210	253
Aug	1,150	9,300	220	266
Sep	1,760	9,000	330	398
Oct	2,790	11,086	530	640
Nov	4,230	10,728	800	966
Dec	5,030	11,086	950	1,147
		128,737		9,150

Building No. 121 is a central steam plant which provides steam to most of the administrative area at the South Base. This steam plant is equipped with two Kewanee Type "C" package boilers, rated at 199 HP each and one Crane Co. (National) coal-fired boiler rated at 12,600 pounds per hour. The Crane Co. boiler has been unoperative for an extended period of time and is isolated from the plant. The Kewanee boilers are in good condition. Each of the two operating boilers are fired on No. 6 fuel oil, with steam generated at a nominal 15 psig, saturated. The steam is distributed to Building Nos. 115, 117, 119, 120, 122, 123, 124, 125 and 127 through underground and overhead lines.

Building No. 319 is a central steam plant which provides steam to various warehouses and maintenance shops at the South Base. This steam plant is equipped with one International boiler works package boiler, rated at 356 HP and one Keeler packaged boiler rated at 15,000 pounds per hour.

The International boiler is in need of general repairs. The Keeler boiler was installed in 1978 and is in excellent condition. However, this boiler is considerably oversized for present and future anticipated loads and can only be operated during the coldest weather and then only at partial loads. Both of these boilers are fired on No. 6 fuel oil and generate steam at a nominal 100 psig, saturated. The steam is distributed to Building Nos. 316, 317, 318, 320, 321, and 323 through overhead lines, at 50 psig, sat.

Building No. 101 is the SEAD Headquarters Building and houses a relatively old steam boiler and distribution system. The boiler is a No. 2 fuel oil-fired Burnham Pace King which produces steam at a nominal 6 psig, saturated.

Building No. 103 is the South Base fire station and houses an 800 pound per hour Weil-McLain steam boiler which generates steam at a nominal 8 psig, saturated and is fired on No. 2 fuel oil.

Building No. 113 is the SEAD carpenter shop and houses a low pressure, low capacity Crane Company 80-Series steam boiler, which is fired on No. 2 fuel oil.

Building No. S-142 is the SEAD NCO Club and houses a hydronic heating system including both wall units and space heaters suspended from the ceiling. Heat to the system is provided by a furnace which is fired on No. 2 fuel oil.

3.2.4 South Base Loads

The total annual production of steam on the South Base is not known; however, estimates of the average and peak steam demands have been made based on existing fuel oil consumption records.

The total annual consumption of No. 6 fuel oil by the central steam plants housed in Building Nos. 121 and 319 is estimated to be 322,300 gallons per year before and 151,967 gallons per year after the implementation of temperature setback control procedures currently being recommended at SEAD. Based on these fuel consumption rates, the future peak steam load for the Building No. 121 central plant is 6,377 pounds per hour and the future peak steam load for the Building No. 319 central plant is 10,624 pounds per hour. The average steam demand for each of these central plants is as indicated on Table 3-2.

The total annual consumption of No. 2 fuel oil by Building Nos. 101, 103, 113 and S-142 is estimated to be 50,500 gallons per year before and 29,159 gallons per year after temperature setback procedures have been implemented. Based on these fuel consumption rates, the total future peak steam load for these buildings is estimated to be 2,445 pounds per hour and the total average steam demand for these buildings is as indicated on Table 3-2.

TABLE 3-2

ESTIMATED STEAM AND ELECTRICITY DEMAND

	Bldg. No. 121 Central Plant		Bldg. No. 319 Central Plant		Total - Building Nos. 101, 103, 113, and S-142	
Month	Average Hourly Steam Demand (lbs/hr)	Electric Consumption (KWH)	Average Hourly Steam Demand (lbs/hr)	Electric Consumption (KWH)	Average Hourly Steam Demand (lbs/hr)	Electric Consumption (KWH)
Jan	3,945	9,077	6,886	11,383	1,638	1,446
Feb	3,781	8,198	7,411	10,282	1,692	1,494
Mar	2,823	7,291	5,226	9,077	1,217	1,075
Apr	1,601	5,904	3,431	8,784	761	672
May	1,109	6,100	574	7,589	254	224
Jun	479	5,904	---	---	72	64
Jul-Sep	---	---	---	---	---	---
Oct	1,109	6,100	1,294	7,589	363	321
Nov	2,533	7,056	3,077	8,784	848	749
Dec	3,365	7,291	6,227	11,383	1,450	1,279
		62,921		74,871		7,324

4.0 DESCRIPTION OF THE OPTIONS

The selection of the optimum energy source(s) for the Seneca Army Depot is based on the comparative energy savings and economics of the options under consideration. Thus, the analysis of these options must be done in sufficient depth to provide an accurate assessment of the capital cost, operating and maintenance costs, and annual energy consumption of each option while meeting the required loads.

The development of the costs for any option starts with the definition of the system. The system components are selected and sized based on the loads which the system must meet. A conceptual arrangement of the facility is then developed in order to define space requirements for site selection. Capital costs are determined using pro-forma proposals from various manufacturers for the major components or systems and proven estimating techniques for auxiliary components, systems and support facilities. Operating and maintenance costs for both labor and material are estimated based on data available from similar facilities. System heat balances are developed and utilized to determine the annual fuel consumption of the system while meeting the required loads. The appropriate energy costs are then applied to this energy consumption and all the costs are then used to develop the life cycle costs required for economic comparison and evaluation.

This section deals with the development of the capital and recurring costs for each of the options. The options are defined and information is presented to provide an understanding of the system components and configuration. Appropriate drawings and diagrams are included to facilitate understanding the proposed systems. Finally, the capital cost and annual consumption are presented for each case. The detailed economic analysis utilizing these values is found in Section 5.

4.1 GENERAL

This analysis considers several alternate designs for a central coal-fired steam plant for each of the two bases at SEAD, as well as various sub-options which may enhance the economic feasibility of the option. The conversion back to coal of any existing boilers which are realistic candidates for conversion also is considered.

In addition to the above options, which are considered separately for each base, this analysis compares the design of the coal-fired steam distribution system to a similar high pressure/high temperature hot water distribution system at the North Base and compares the design of a direct burial distribution system to a heating channel distribution system at the South Base.

4.2 NORTH BASE

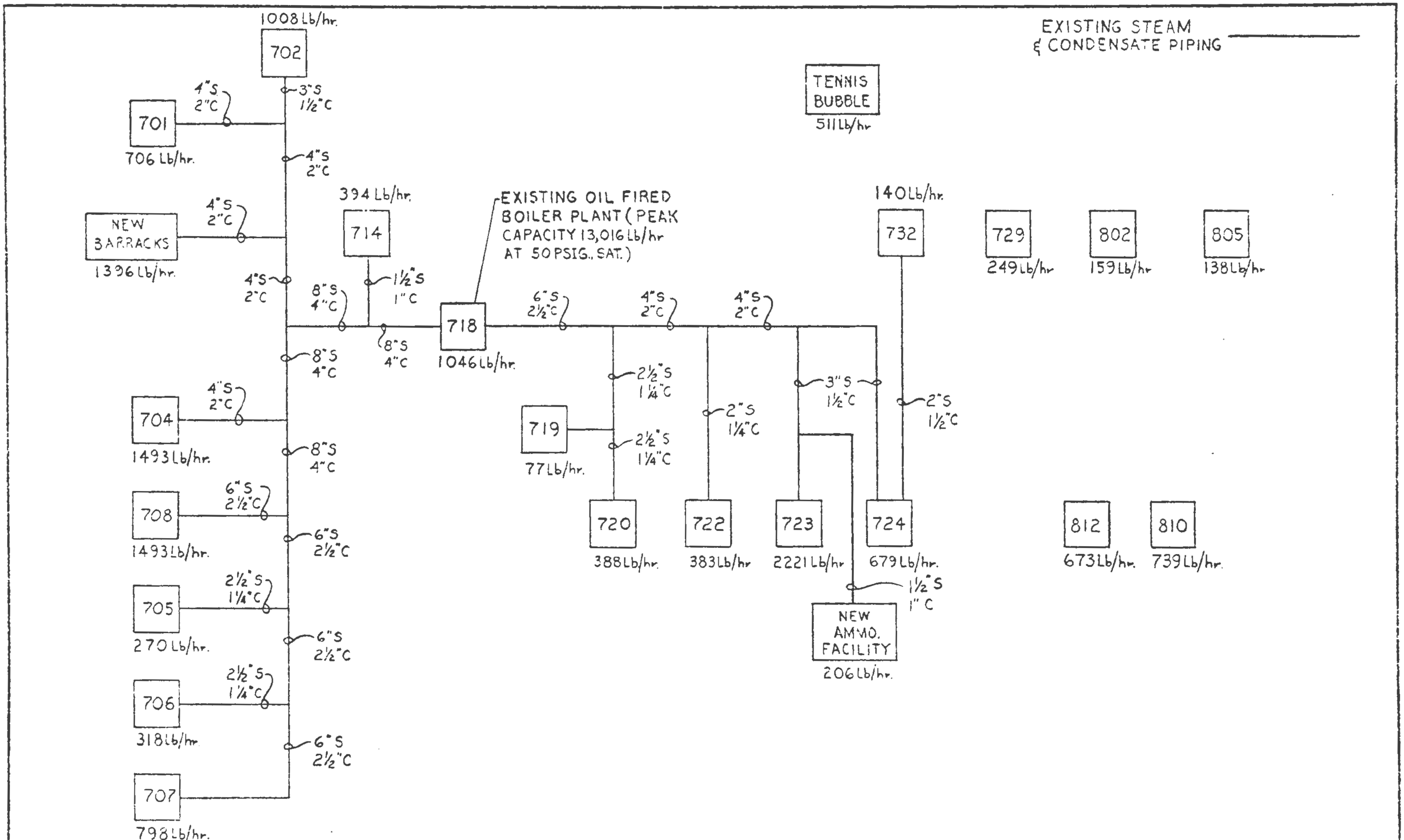
4.2.1 Base Case

This case considers that the existing central steam plant in Building No. 718, its associated steam distribution system(s), and the individual heating plants located in Building Nos. 729, 802, 805, 810, 812, and the Tennis Bubble will be maintained in a good, operable state, assuming that all practical energy conservation measures developed by the basewide energy studies have been implemented.

The existing base case steam and condensate distribution systems are as shown on Exhibit IV-1.

4.2.1.1 Economic Life of Existing Systems

Based on observations made during a field survey of the North Base area, and applying the assumption that the equipment in the buildings in the Q-Area is of similar age and condition as in the rest of the



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REFERENCE DRAWINGS

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TITLE
SENECA ARMY DEPOT
NORTH BASE
FLOW DIAGRAM - STEAM & CONDENSATE SYSTEMS
BASE CASE

DRAWING NO
M-3

FILE NO
80122-000

EXHIBIT IV-1

North Base independent heating systems, the following assumptions were made concerning the economic life of the existing system(s): (1) the major equipment located in Building No. 718 has an economic life of 30 years and will require replacement within the next five years; (2) the piping systems as presently installed will require replacement within the next five years and will have an economic life of 25 years; (3) the independent heating plants will require replacement within the next 15 years and will have an economic life of 20 years.

4.2.1.2 Energy Analysis and Capital Cost

Based on the fuel consumption data in Table 4-1, the total annual fuel oil consumed by the present system is 40,823 gallons of No. 2 fuel oil and 177,400 gallons of No. 6 fuel oil. The total electricity consumption, including steam plant auxiliaries, is 137,887 KWH per year. There is no initial capital cost expenditure required.

4.2.2 Option 1

This case was intended to identify existing boilers which are realistic candidates for conversion to coal firing. Based on observations made during a field survey of the North Base facilities, it was determined that no such boilers would be considered.

4.2.3 Option 2

This case considers a new coal-fired steam plant located at a central site and designed for the production of process steam only. All electrical power will be purchased from the utility company.

Exhibits IV-2 and IV-3 indicate the proposed site location and the steam and condensate distribution systems for Option 2.

TABLE 4-1

ESTIMATED ANNUAL FUEL CONSUMPTION
SEAD - NORTH BASE EXISTING SYSTEMS

Building No.	Fuel Oil Type	Est. Fuel Use Before Setback (Gals/Yr)	Setback Savings (MBtu/Yr)	Est. Fuel Use After Setback (Gals/Yr)
718	No. 6	233,200	8,370	177,400
Tennis Bubble	No. 2	12,300	430	9,200
729	No. 2	5,000	240	3,270
802	No. 2	3,200	150	2,119
805	No. 2	3,700	170	2,474
810	No. 2	17,800	840	11,744
812	No. 2	13,500	640	8,886
Ammo Facility	No. 2	4,500	190	3,130

Total No. 6 Fuel Oil = 177,400 Gals/Yr

Total No. 2 Fuel Oil = 40,823 Gals/Yr

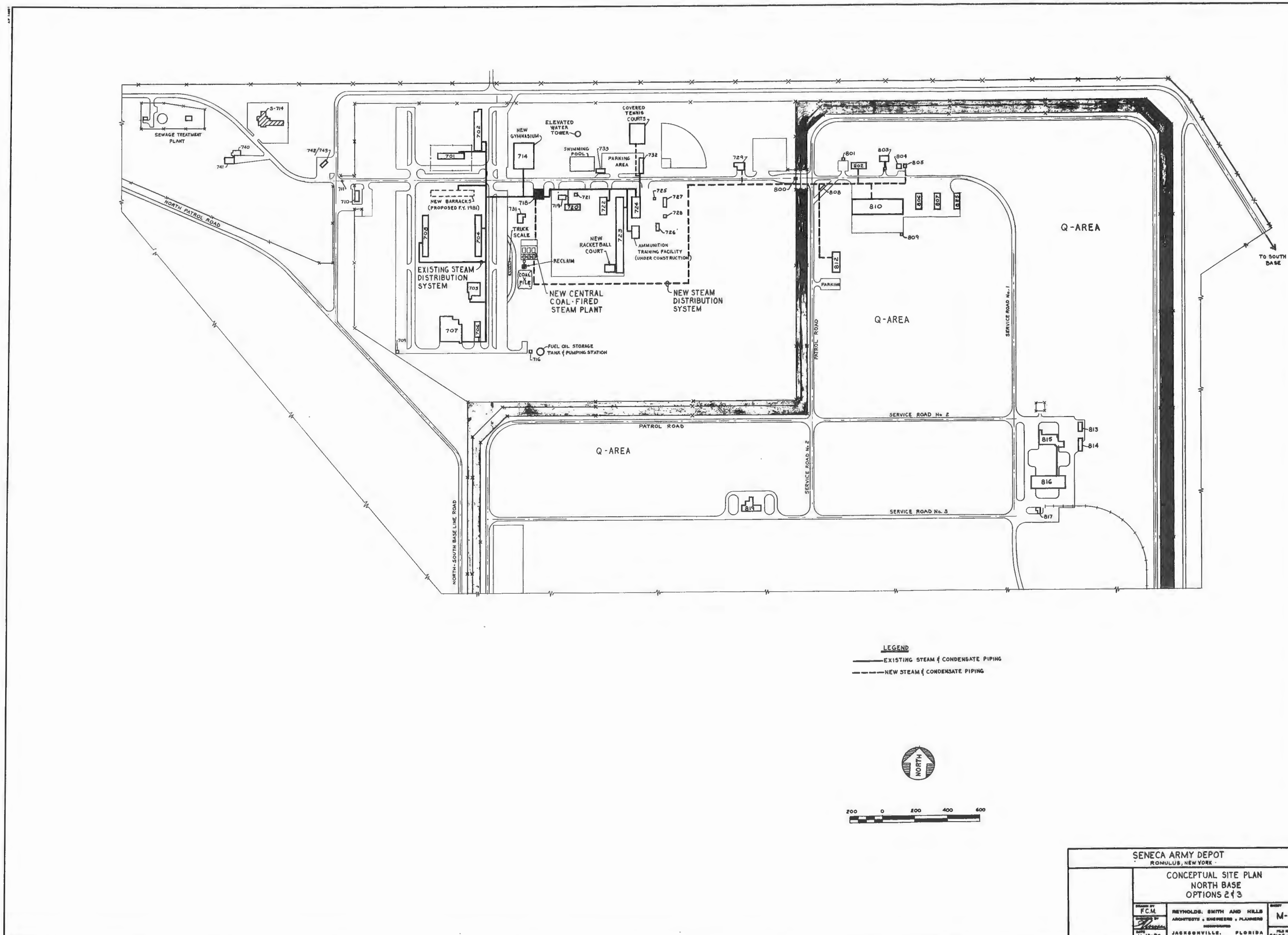
SEWAGE TREATMENT PLANT
NORTH PATROL ROAD
NEW GYMNASIUM
ELEVATED WATER TOWER
COVERED TENNIS COURTS
SWIMMING POOL
PARKING AREA
NEW BARRACKS (PROPOSED F.Y. 1981)
TRUCK SCALE
RECLAIM
COAL PILE
NEW RACKETBALL COURT
AMMUNITION TRAINING FACILITY (UNDER CONSTRUCTION)
EXISTING STEAM DISTRIBUTION SYSTEM
NEW CENTRAL COAL-FIRED STEAM PLANT
NEW STEAM DISTRIBUTION SYSTEM
FUEL OIL STORAGE TANK & PUMPING STATION
PARKING
Q-AREA
Q-AREA
Q-AREA
PATROL ROAD
PATROL ROAD
SERVICE ROAD No. 1
SERVICE ROAD No. 2
SERVICE ROAD No. 2
SERVICE ROAD No. 3
NORTH-SOUTH BASE LINE ROAD
TO SOUTH BASE
LEGEND
EXISTING STEAM & CONDENSATE PIPING
NEW STEAM & CONDENSATE PIPING
NORTH
200 0 200 400 600
SENECA ARMY DEPOT
ROMULUS, NEW YORK
CONCEPTUAL SITE PLAN
NORTH BASE
OPTIONS 2 & 3
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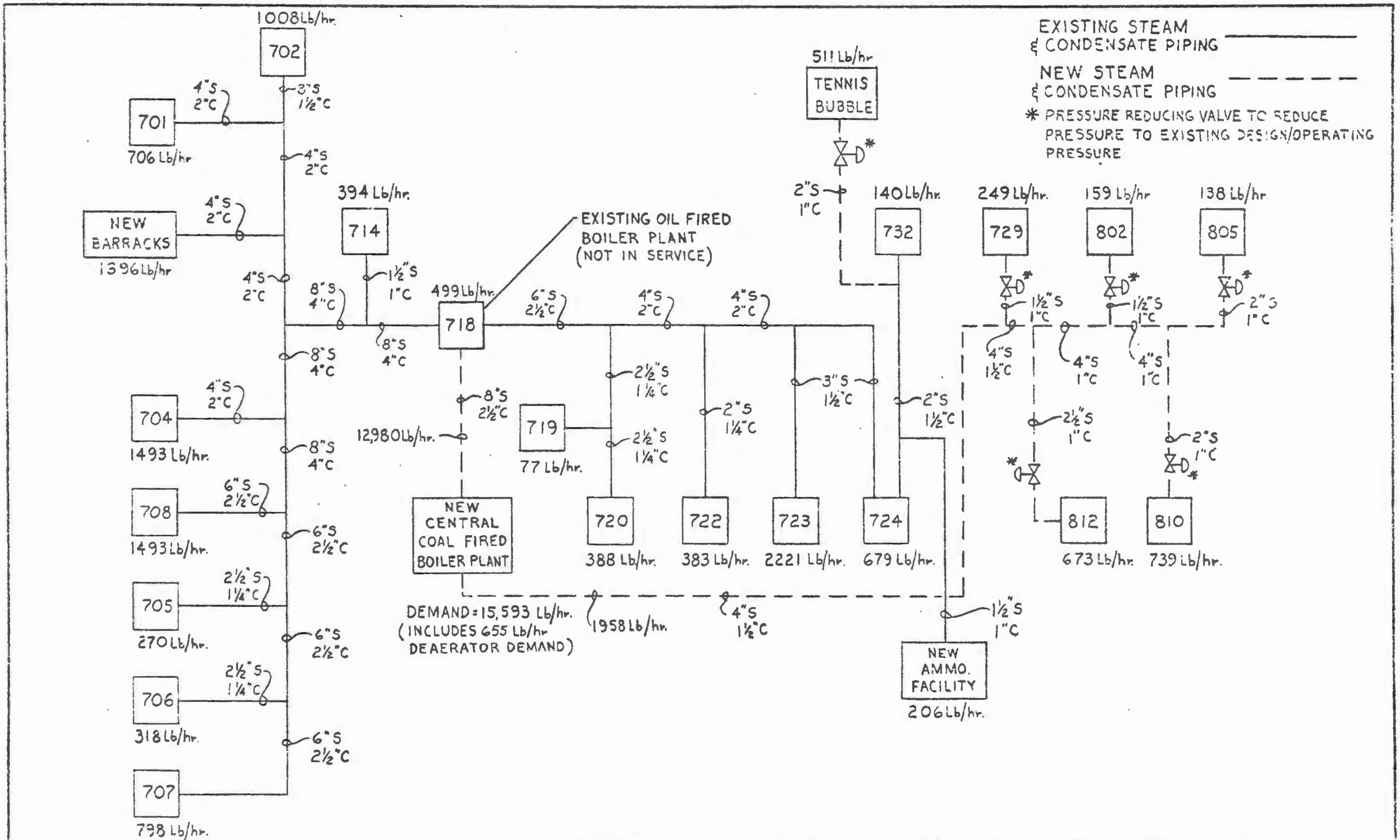
EXHIBIT IV-2



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NORTH BASE
FLOW DIAGRAM - STEAM & CONDENSATE SYSTEMS
OPTIONS No. 2 & 3

DRAWING NO M-4
FILE NO 80122-000

EXHIBIT IV-3

4.2.3.1 Mechanical Systems

The majority of the steam produced on the North Base is for building heating purposes. The average system demand is as shown on Table 4-2 and indicates a maximum average load of 7,599 pounds per hour in February and a minimum average load of 1,400 pounds per hour in July. The peak system demand required by the new central coal-fired plant is estimated at 15,593 pounds per hour. Based on this data, three (3) fifty percent capacity boilers will be utilized by the steam plant, each rated at 8,500 pounds per hour. Saturated steam will be generated at 50 psig and will be supplied to a piping system for distribution to the steam consumers at the North Base. The distribution system will consist of new steam and condensate piping tied-in to the existing distribution system(s), wherever practical. The arrangement of the distribution system is as shown on Exhibit IV-2.

The boilers considered for this option are stoker coal-fired, watertube, packaged boilers, as manufactured by the Babcock and Wilcox Company.

The steam and condensate systems flow diagram is shown on Exhibit IV-4.

The coal handling system flow diagram is shown as Exhibit IV-5.

The central plant considered in Option 2 includes equipment and systems with features as follows:

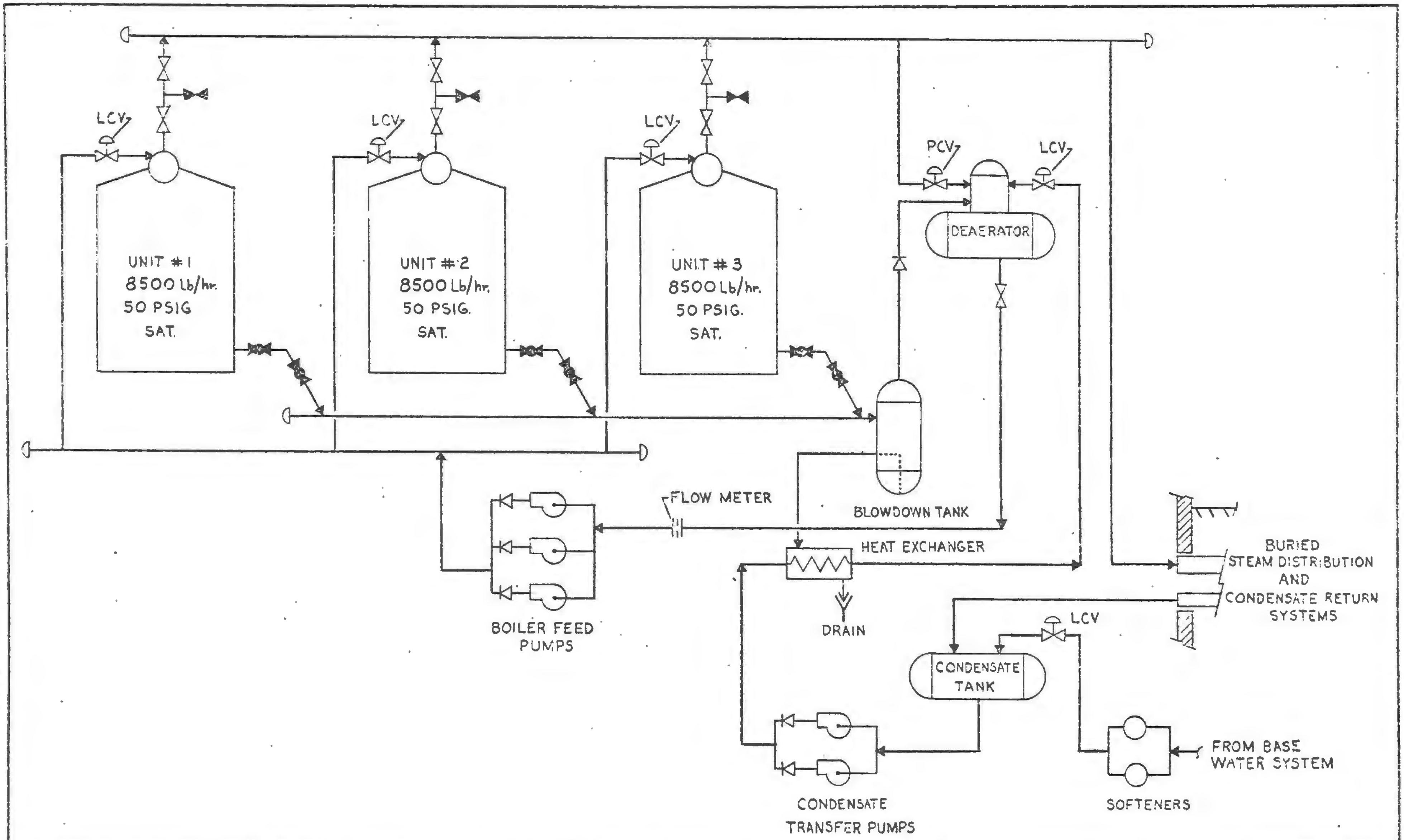
(1) Three 8,500 pound per hour stoker coal-fired boilers, each with:

- o Combustion Controls and Flame Safeguards
- o Forced Draft Fan
- o Induced Draft Fan
- o Tubular Air Heater
- o Coal Screw Feeder

TABLE 4-2

ESTIMATED STEAM AND ELECTRICITY DEMAND
OPTION 2 - CENTRAL COAL-FIRED STEAM PLANT

Month	Avg. Hourly Steam Demand (lbs/hr)	Electricity Consumption (KWH)
Jan	6,707	51,336
Feb	7,599	46,368
Mar	5,726	51,336
Apr	4,945	49,680
May	3,417	40,920
Jun	1,545	33,120
Jul	1,400	34,224
Aug	1,437	34,224
Sep	2,200	33,120
Oct	3,489	40,920
Nov	5,291	49,680
Dec	6,291	51,336
		516,264



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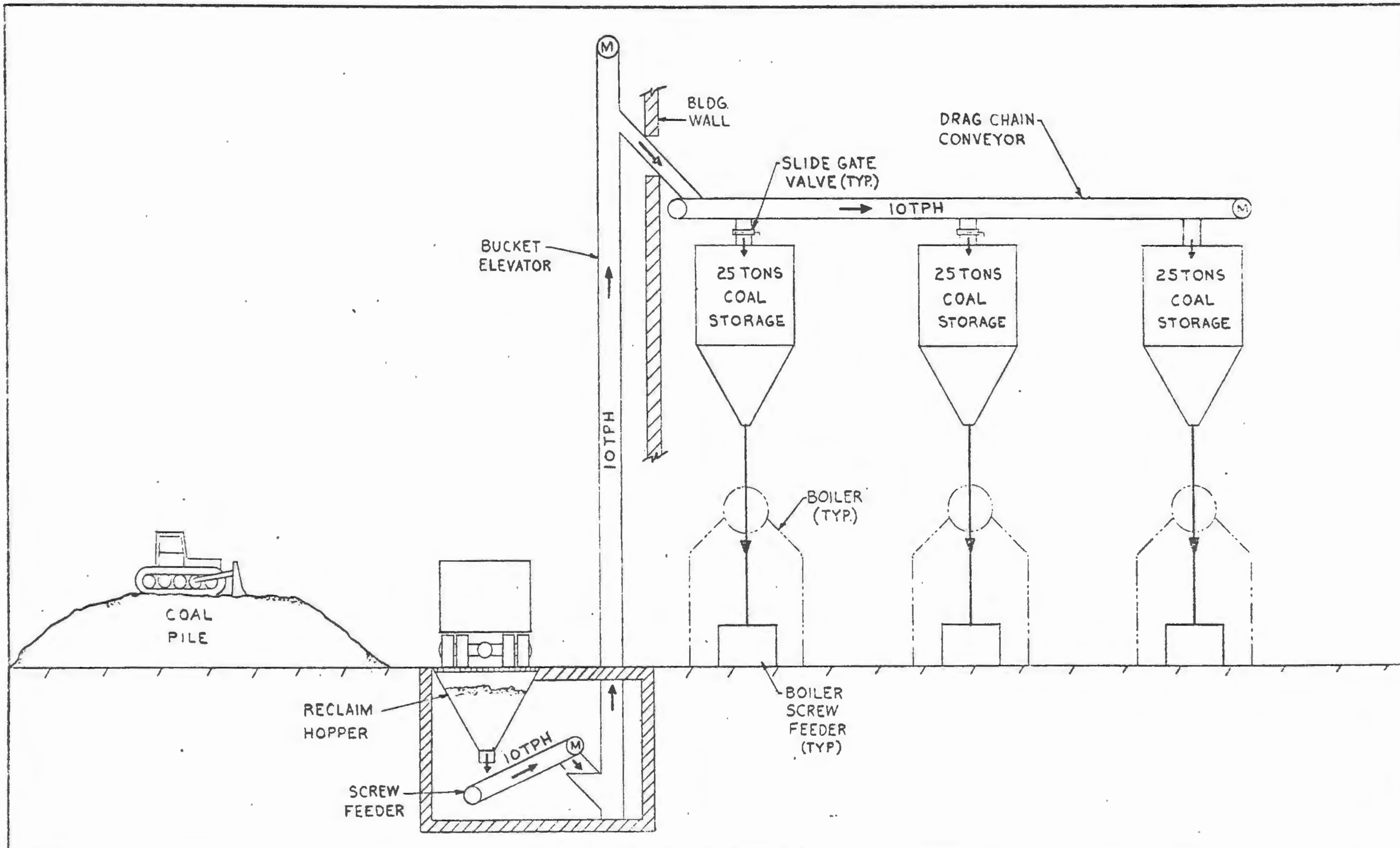
TITLE: SENECA ARMY DEPOT
NEW BOILER PLANT NORTH BASE
CONCEPTUAL FLOW DIAGRAM – STEAM, CONDENSATE, FEEDWATER & BLOWDOWN SYSTEMS

DRAWING NO: M-5
FILE NO: 80122-000

EXHIBIT IV-4



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TITLE
SENECA ARMY DEPOT
NORTH BASE
CONCEPTUAL - FLOW DIAGRAM
COAL HANDLING SYSTEMS
OPTION No 2

DRAWING NO: M-6

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EXHIBIT IV-5

- o Ash Screw Feeder
- o Sootblowing and Blowdown Systems
- o Cyclone Dust Collector
- o Flue Gas Ductwork and Stack

(2) Three motor driven feedwater pumps (one standby)

(3) Two motor driven condensate transfer pumps (one standby)

(4) Blowdown tank and energy recovery system, common for all three boilers

(5) One deaerating feedwater heater

(6) One condensate storage tank

(7) One duplex automatic water softener, common for all three boilers

(8) Ash handling system (dry fly ash and dry bottom ash), common for all three boilers

(9) Coal unloading and storage system

(10) Compressed air system

(11) Plant start-up fuel system

(12) Electrical equipment, controls and instrumentation

(13) Plant building with control room and bathroom facilities

(14) Site preparation

4.2.3.2 Energy Analysis and Capital Cost

Based on the fuel consumption data in Table 4-1, and assuming that coal with an HHV of 12,500 Btu's per pound is to be consumed by the new central plant, the annual coal consumption for this plant will be 1,295 tons. The total electricity consumption will be 516,264 KWH per year. The initial capital expenditure for the new central plant is estimated to be $3,358,119 in December 1980 dollars.

4.2.4 Option 3

This case considers a new central coal-fired steam plant utilizing atmospheric fluidized bed boilers. The plant will be located at a central site and designed for the production of process steam only. All electrical power will be purchased from the utility company.

Exhibits IV-2 and IV-3 indicate the proposed site location and the steam and condensate systems for Option 3.

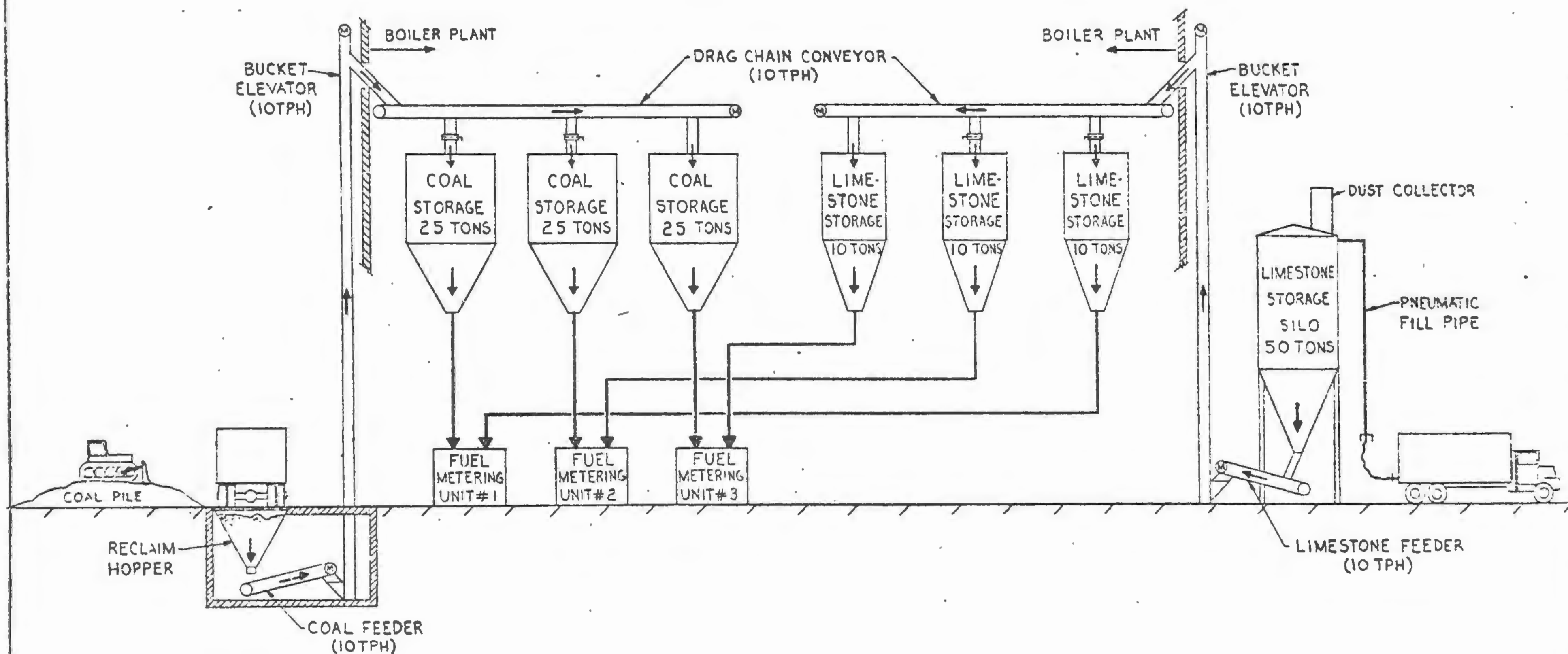
4.2.4.1 Mechanical Systems

The atmospheric fluidized bed boilers were selected based on the same criteria used in selecting the conventional coal-fired boiler, as discussed in Section 4.2.4.3 of this study. Hence, three (3) fifty percent capacity boilers will be utilized by the steam plant. However, since the AFBC boilers are manufactured in "standard size packages," each boiler will be rated at a nominal 10,000 pounds per hour and will generate saturated steam at 50 psig. The steam will be supplied to the steam consumers at the North Base through a distribution system which will consist of new steam and condensate piping tied-in to the existing distribution system(s), wherever practical. The arrangement of the distribution system is as shown on Exhibit IV-2.

The boilers considered for this option are shop-fabricated, multi-cell, atmospheric fluidized bed packaged boilers, as manufactured by the Johnston Boiler Company.

The coal and limestone handling systems are detailed on Exhibit IV-6.

The plant considered in Option 3 includes equipment and systems with features as follows:



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TITLE
SENECA ARMY DEPOT
NORTH BASE
CONCEPTUAL - FLOW DIAGRAM
FUEL HANDLING SYSTEMS
OPTION No. 3

DRAWING NO
M-7

FILE NO
80122-000

4-14

EXHIBIT IV-6

(1) Three 10,000 pound per hour atmospheric fluidized bed packaged boilers, each with:

- o Combustion controls and safeguards
- o Three forced draft fans
- o Induced draft fan
- o Steam boiler trim
- o Coal metering and feed system
- o Limestone metering and feed system
- o Multiclone mechanical dust collectors
- o Ash and spent bed removal systems
- o Sootblowing and blowdown system
- o Standby gas/oil firing capability
- o Flue gas ductwork and stack

(2) Three motor driven feedwater pumps (one standby)

(3) Two motor driven condensate transfer pumps (one standby)

(4) Blowdown tank and energy recovery system, common for all three boilers

(5) One deaerating feedwater heater

(6) One condensate storage tank

(7) One duplex water softener, common for all three boilers

(8) Coal unloading and storage system

(9) Limestone unloading and storage system

(10) Compressed air system

(11) Plant start-up fuel system

(12) Electrical equipment, controls and instrumentation

(13) Plant building with control room and bathroom facilities

(14) Site preparation

4.2.4.2 Energy Analysis and Capital Cost

Based on the fuel consumption data in Table 4-1 and assuming that coal with an HHV of 12,500 Btu per pound is to be consumed by the new central plant and that the boiler efficiency will be 80% rather than the 70% assumed for the conventional coal-fired boilers of the same size, the annual coal consumption for this plant will be 1,133 tons. The annual limestone consumption of the plant will be 283 tons. The total electricity consumption will be 889,103 KWH per year as indicated on Table 4-3. The initial capital expenditure for the central plant is estimated to be $4,091,492 in December 1980 dollars.

4.2.5 <u>Suboptions</u>

The use as a supplemental fuel of wood, biomass and refuse derived fuels was considered in order to identify their potential for increasing the economic feasibility of a central steam plant.

Since significant modifications would have to be made to the feed systems of the fluidized bed boilers and since the amount of available fuel from these sources is limited in the area of the SEAD, the firing of these fuels was considered only as a suboption to the conventional coal-fired boiler discussed in Section 4.2.3 of this study.

4.2.5.1 Wood and Biomass

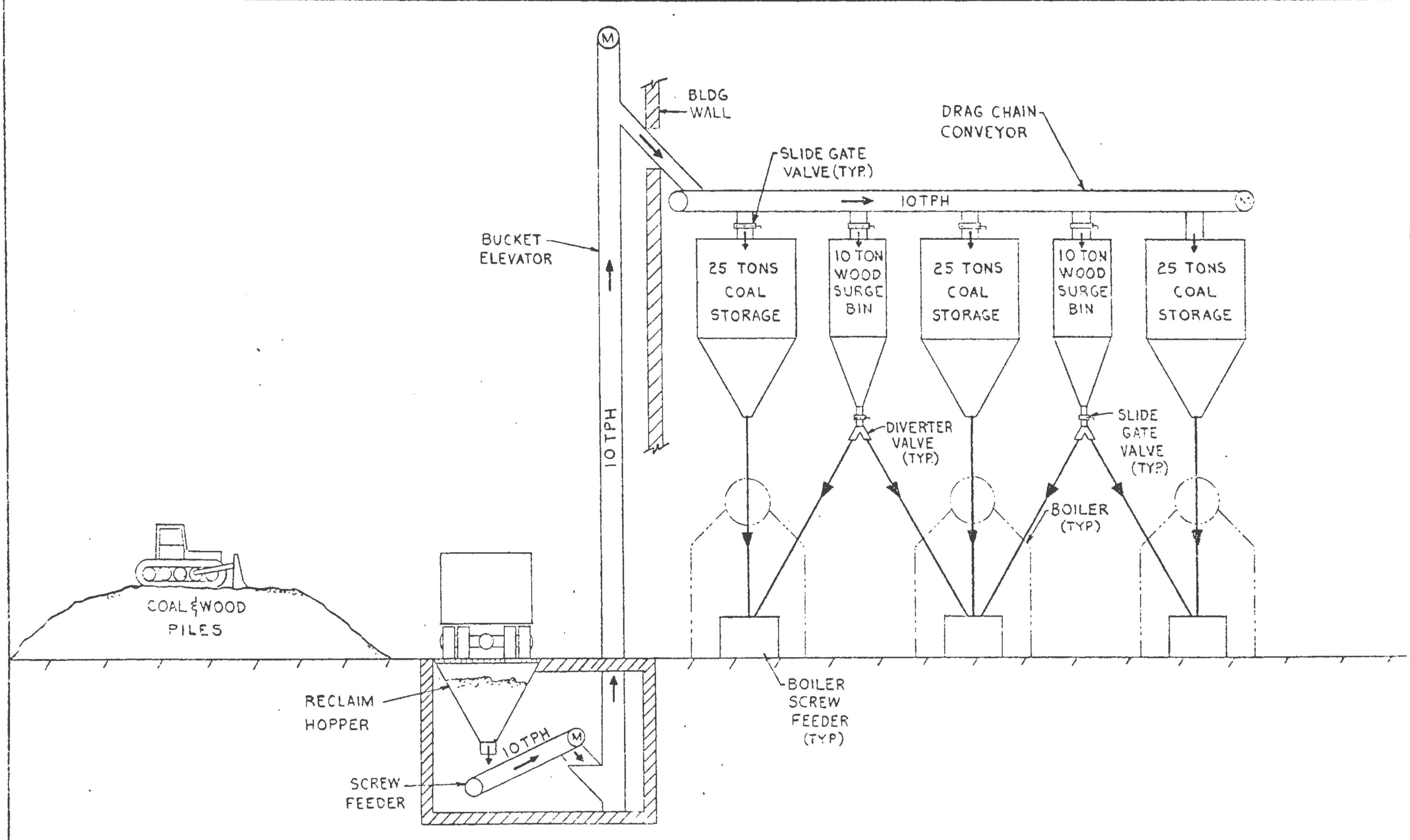
4.2.5.1.1 Mechanical Systems -- The stoker coal-fired boilers selected for the central steam plant presented in Option 2 herein were considered to be fired with up to a 10 percent fuel input of wood chips and/or woody biomass. Therefore, this case assumes a firing rate of 10 percent wood/woody biomass and 90 percent coal on a single shift, five-days per week. The only additional equipment required consists of two surge bins, four gate valves, two diverting valves, and four feed chutes, all as indicated on Exh. IV-7.

TABLE 4-3

ESTIMATED STEAM AND ELECTRICITY DEMAND
OPTION 3 - CENTRAL AFBC COAL-FIRED STEAM PLANT

Month	Avg. Hourly Steam Demand (lbs/hr)	Electricity Consumption (KWH)
Jan	6,707	90,470
Feb	7,599	81,715
Mar	5,726	87,552
Apr	4,945	69,840
May	3,417	72,168
Jun	1,545	58,320
Jul	1,400	60,264
Aug	1,437	60,264
Sep	2,200	58,320
Oct	3,489	72,168
Nov	5,291	87,552
Dec	6,291	90,470
		889,103

EXHIBIT IV-7



NO	DATE	REVISION	BY	APP	REFERENCE DRAWINGS	REYNOLDS, SMITH AND HILLS	TITLE	DRAWING NO
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2						DRAWN: F.C.M. / CHECKED: [illegible] / DATE: 2/1/81	CONCEPTUAL - FLOW DIAGRAM COAL HANDLING SYSTEMS WOOD & BIOMASS SUBOPTIONS	FILE NO 80[illegible]
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4.2.5.1.2 Energy Analysis and Capital Cost -- Based on the fuel consumption data in Table 4-1, and assuming that 37.5 percent moisture wood/woody biomass with an HHV of 5,528 Btu's per pound is consumed along with the 12,500 Btu's per pound coal, the annual wood/woody biomass consumption will be 112 tons and the annual coal consumption will be 1,246 tons. The total electricity consumption will be 516,264 KWH per year. The initial capital expenditure for the new central plant is estimated to be $3,386,261 in December 1980 dollars.

4.2.5.2 Refuse Derived Fuels

4.2.5.2.1 Mechanical Systems -- The stoker coal-fired boilers selected for the central steam plant presented as Option 2 herein were considered to be fired with up to a 25 percent fuel input of refuse derived fuels (RDF). Solid waste is collected at SEAD only two days per week and storage of RDF for future use is not a dependable operating method. In addition, because of the seasonal loading of the steam plant, the total amount of solid waste collected on SEAD (17.6 tons per week) cannot be disposed of by the steam plant during the months of May through October. Therefore, it has been assumed that the firing rate of the boilers between November and April will be 25 percent RDF and 75 percent coal.

The additional equipment required for the firing of RDF as a supplemental fuel is as follows:

- Trommel Screen Discharge Conveyor
- Shredder Feed Conveyor
- Shredder Discharge Conveyor
- Magnetic Separator Conveyor
- Glass Conveyor
- Two Nine-Ton Storage Bunkers

- Shredder, Three TPH
- Magnetic Separator
- Trommel Screen

4.2.5.2.2 Energy Analysis and Capital Cost -- Based on the fuel consumption data in Table 4-1 and assuming that RDF with an HHV of 4,500 Btu per pound is consumed along with the 12,500 Btu's per pound coal, the annual RDF consumption will be 458 tons and the annual coal consumption will be 1,130 tons. The total electricity consumption will be 536,774 KWH per year. The initial capital expenditure for the new central plant will be $4,093,799 in December 1980 dollars.

4.3 SOUTH BASE

4.3.1 Base Case

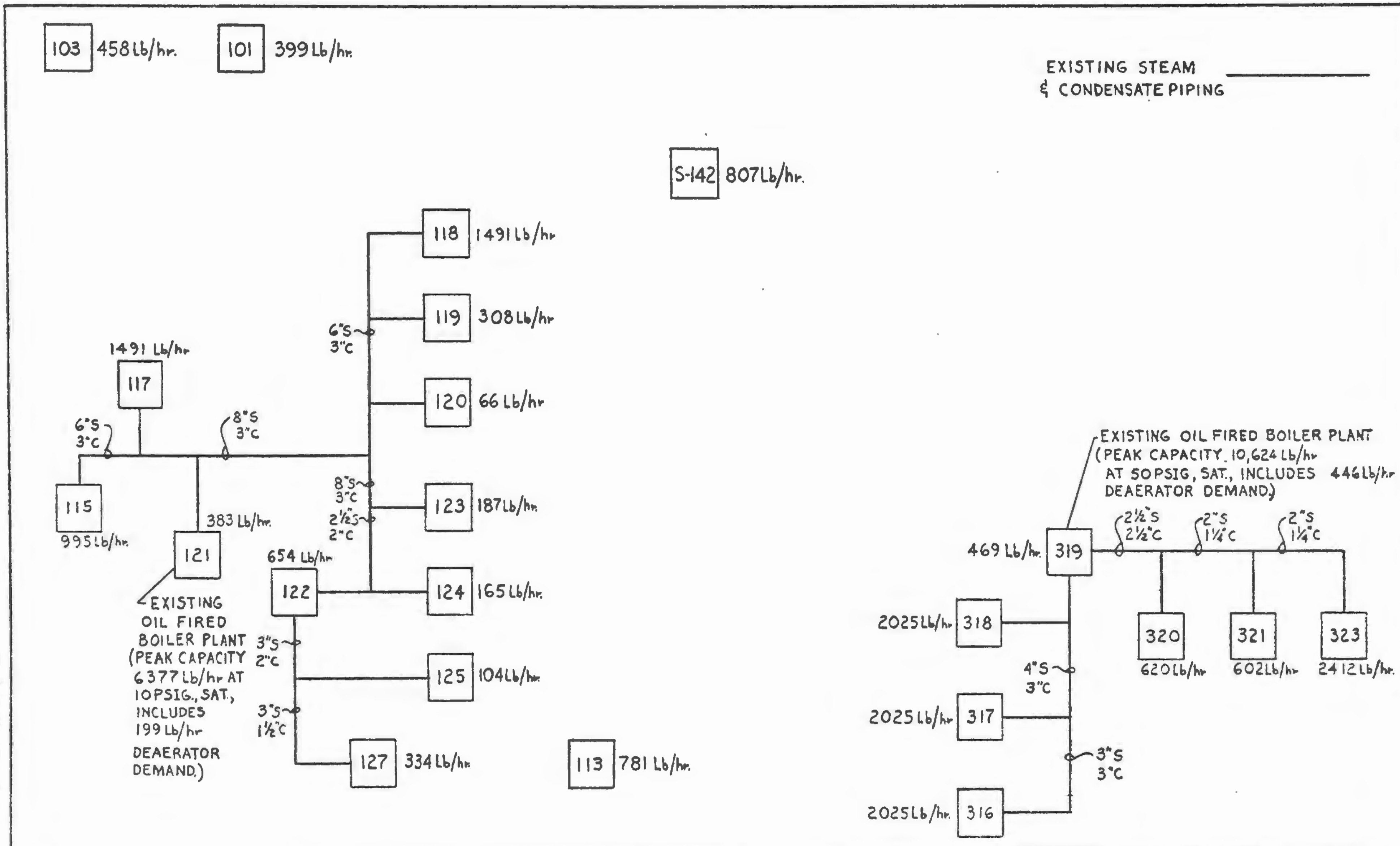
This case considers that the existing central steam plants in Building Nos. 121 and 319, their associated steam distribution systems, and the individual heating plants located in Building Nos. 101, 103, 113 and S-142 will be maintained in a good, operable state, assuming that all practical energy conservation measures developed by the basewide energy studies have been implemented.

The existing base case steam and condensate distribution systems are as shown on Exhibit IV-8.

4.3.1.1 Economic Life of Existing Systems

Based on observations made during a field survey of the South Base area, the following assumptions were made concerning the economic life of the existing systems: (1) the major

EXHIBIT IV-8



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TITLE SENECA ARMY DEPOT
SOUTH BASE
FLOW DIAGRAM - STEAM & CONDENSATE SYSTEMS
BASE CASE

DRAWING NO M-9

FILE NO 80122-000

equipment located in Building No. 121 has an economic life of 30 years and will require replacement within the next 10 years; (2) the major equipment located in Building No. 319 has an economic life of 30 years and will require replacement within the next 10 years; (3) the existing piping systems as presently installed will require replacement within the next 15 years and will have an economic life of 25 years; (4) the independent heating plants in Building Nos. 101 and 103 have an economic life of 20 years and will require replacement within the next 10 years; and (5) the independent heating plants in Building Nos. 113 and S-142 have an economic life of 20 years and will require replacement within the next 15 years.

4.3.1.2 Energy Analysis and Capital Cost

Based on the fuel consumption data in Table 4-4, the total annual fuel oil consumed by the present system is 29,159 gallons of No. 2 fuel oil and 151,967 gallons of No. 6 fuel oil. The total electricity consumption, including steam plant auxiliaries, is 145,116 KWH per year. There is no capital cost expenditure required.

4.3.2 Option 1

This case was intended to identify existing boilers which are realistic candidates for conversion to coal firing. Based on observations made during a field survey of the South Base facilities, it was determined that no such boilers would be considered.

4.3.3 Option 2

This case considers a new coal-fired steam plant located at a central site and designed for the production of process steam only. All electrical power will be purchased from the utility company.

TABLE 4-4

ESTIMATED ANNUAL FUEL CONSUMPTION
SEAD - SOUTH BASE EXISTING SYSTEMS

Building No.	Fuel Oil Type	Est. Fuel Use Before Setback (gals/yr)	Setback Savings (MBtu/yr)	Est. Fuel Use After Setback (gals/yr)
121	No. 6	120,000	8,720	61,867
319	No. 6	202,300	16,830	90,100
101	No. 2	8,000	170	6,774
103	No. 2	9,200	---	9,200
113	No. 2	17,100	1,330	7,511
S-142	No. 2	16,200	1,460	5,674

Total No. 6 Fuel Oil = 151,967 gals/yr

Total No. 2 Fuel Oil = 29,159 gals/yr

Exhibits IV-9 and IV-10 indicate the proposed site location and the steam and condensate distribution systems for Option 2.

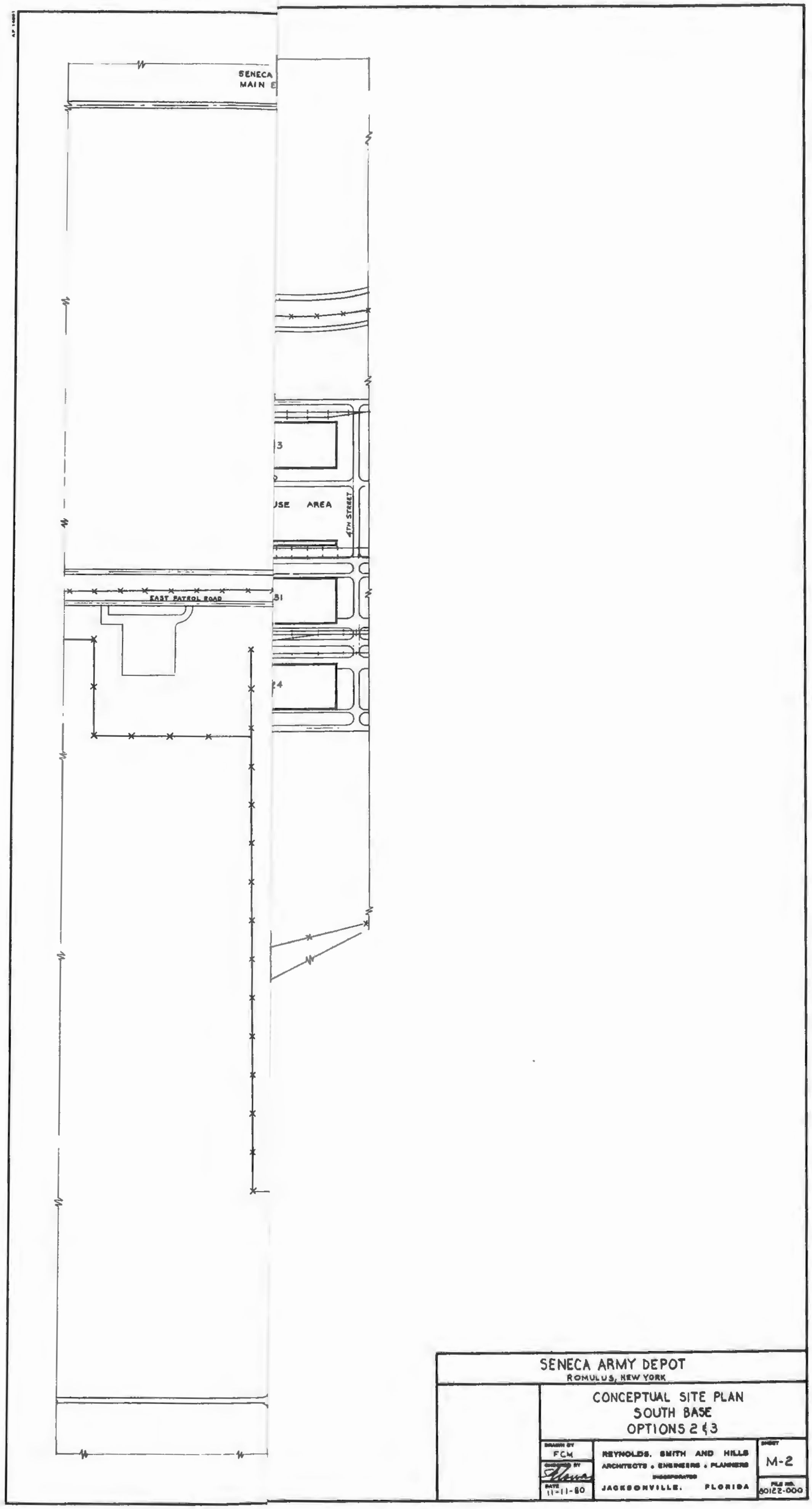
4.3.3.1 Mechanical Systems

Primarily all of the steam produced on the South Base is for building heating purposes. The average system demand for the proposed central plant is as shown on Table 4-5 and indicates a maximum average load of 13,239 pounds per hour in February and a minimum average load of 567 pounds per hour in June. There is no steam demand during the months of July, August or September. The peak system demand required by the new central coal-fired plant is estimated at 19,130 pounds per hour. Based on this data, three (3) boilers will be utilized in the steam plant, two (2) rated at 15,000 pounds per hour and one (1) rated at 8,000 pounds per hour, providing 50 percent redundancy at the peak demand rate. Saturated steam will be generated at 50 psig and will be supplied to a piping system for distribution to the steam consumers at the South Base. The distribution system will consist of new steam and condensate piping tied-in to the existing distribution systems, wherever practical. The arrangement of the distribution system is as shown in Exhibit IV-9.

The boilers considered for this option are stoker coal-fired, watertube, packaged boilers, as manufactured by the Babcock and Wilcox Company.

The steam and condensate systems flow diagram is shown on Exhibit IV-11.

The coal handling system flow diagram is shown on Exhibit IV-12.


SENECA
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USE AREA
4TH STREET
EAST PATROL ROAD
SENECA ARMY DEPOT
ROMULUS, NEW YORK
CONCEPTUAL SITE PLAN
SOUTH BASE
OPTIONS 2 & 3
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EXHIBIT IV-9

EXHIBIT IV-10

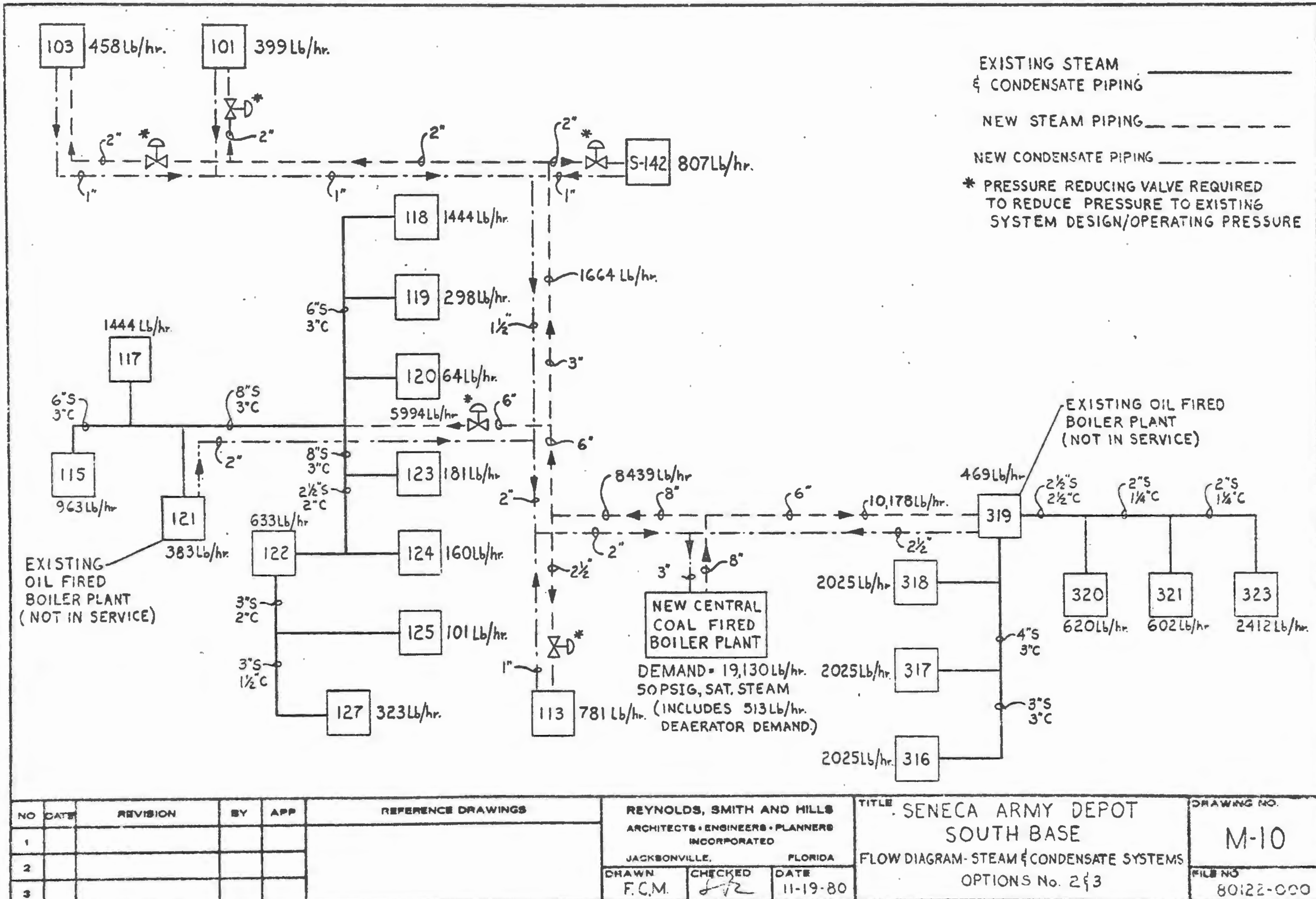
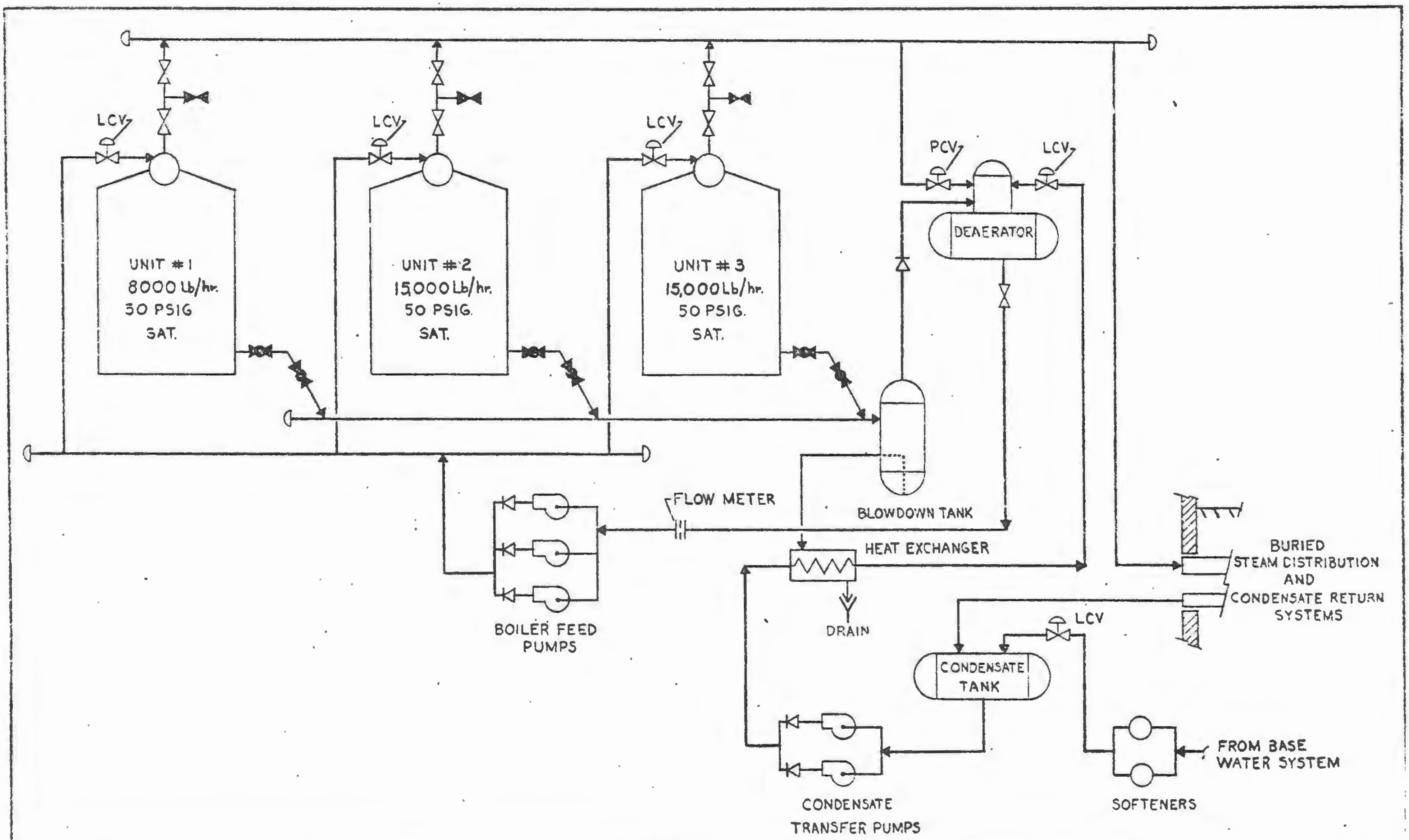


TABLE 4-5

ESTIMATED STEAM AND ELECTRICITY DEMAND
OPTION 2 - CENTRAL COAL-FIRED STEAM PLANT

Month	Avg. Hourly Steam Demand (lbs/hr)	Electricity Consumption (KWH)
Jan	12,812	68,448
Feb	13,239	61,824
Mar	9,521	68,448
Apr	5,952	46,080
May	1,991	31,903
Jun	567	30,874
Jul	---	---
Aug	---	---
Sep	---	---
Oct	2,843	38,093
Nov	6,636	46,080
Dec	11,346	68,448
		460,198

EXHIBIT IV-11



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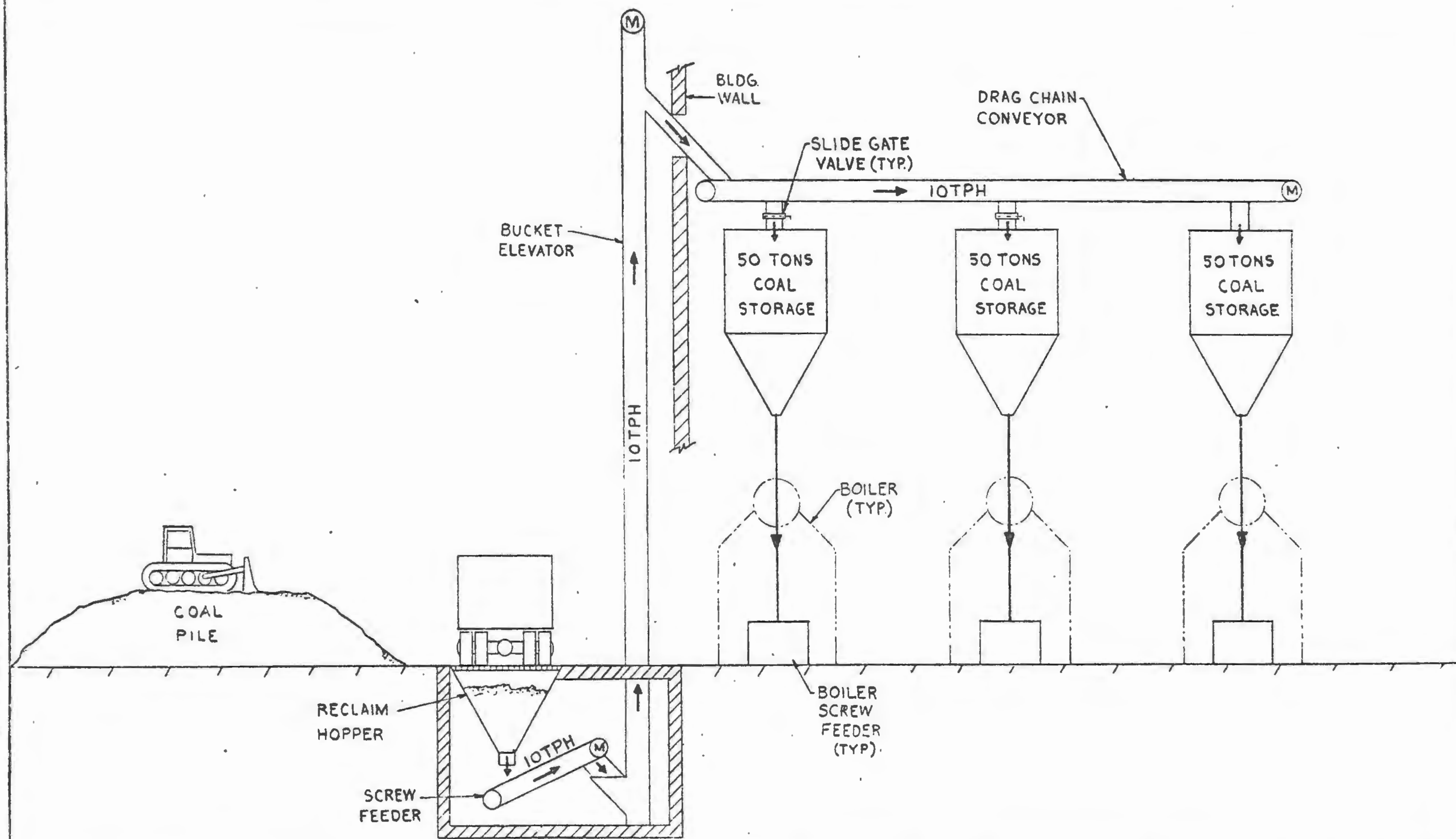
TITLE
SENECA ARMY DEPOT
NEW BOILER PLANT SOUTH BASE
CONCEPTUAL FLOW DIAGRAM - STEAM, CONDENSATE, FEEDWATER & BLOWDOWN SYSTEMS

DRAWING NO M-11

FILE NO 80122-000

EXHIBIT IV-12



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TITLE
SENECA ARMY DEPOT
SOUTH BASE
CONCEPTUAL - FLOW DIAGRAM
COAL HANDLING SYSTEMS
OPTION No. 2

DRAWING NO M-12

FILE NO 80122-000

The plant considered in Option 2 includes equipment and systems with features as follows:

(1) Two 15,000 pound per hour and one 8,000 pound per hour stoker coal-fired boilers, each with:

- o Combustion Controls and Flame Safeguards
- o Forced Draft Fan
- o Induced Draft Fan
- o Tubular Air Heater
- o Coal Screw Feeder
- o Ash Screw Feeder
- o Sootblowing and Blowdown Systems
- o Cyclone Dust Collector
- o Flue Gas Ductwork and Stack

(2) Three motor driven feedwater pumps (one standby)

(3) Two motor driven condensate transfer pumps (one standby)

(4) Blowdown tank and energy recovery system, common for all three boilers

(5) One deaerating feedwater heater

(6) One condensate storage tank

(7) One duplex automatic water softener, common for all three boilers

(8) Ash handling system (dry fly ash and dry bottom ash), common for all three boilers

(9) Coal unloading and storage system

(10) Compressed air system

(11) Plant start-up fuel system

(12) Electrical equipment, controls and instrumentation

(13) Plant building with control room and bathroom facilities

(14) Site preparation

4.3.3.2 Energy Analysis and Capital Cost

Based on the fuel consumption data in Table 4-4, and assuming that coal with an HHV of 12,500 Btu's per pound is to be consumed by the new central plant, the annual coal consumption for this plant will be 1,074 tons. The total electricity consumption will be 460,198 KWH per year. The initial capital expenditure for the new central plant is estimated to be $3,882,044 in December 1980 dollars.

4.3.4 Option 3

This case considers a new coal-fired steam plant utilizing atmospheric fluidized bed boilers. The plant will be located at a central site and designed for the production of process steam only. All electrical power will be purchased from the utility company.

Exhibits IV-9 and IV-10 indicate the proposed site location and the steam and condensate systems for Option 3.

4.3.4.1 Mechanical Systems

The atmospheric fluidized bed boilers were selected based on the same criteria used in selecting the conventional coal-fired boilers, as discussed in Section 4.3.4.3. Hence, three (3) boilers will be utilized in the steam plant. Two will be rated at 15,000 pounds per hour but since the AFCB boilers are manufactured in "standard size packages," the third unit will be rated at a nominal 10,000 pounds per hour. Saturated steam will be generated at 50 psig. The steam will be supplied to the steam consumers at the South Base through a distribution system which will consist of new steam and condensate piping tied into the existing distribution systems, wherever practical. The arrangement of the distribution system is shown on Exhibit IV-9.

The boilers considered for this option are shop-fabricated, multi-cell, atmospheric fluidized bed packaged boilers, as manufactured by the Johnston Boiler Company.

The coal and limestone handling systems are detailed on Exhibit IV-13.

The plant considered in Option 3 includes equipment and systems with features as follows:

(1) Two 15,000 pound per hour and one 10,000 pound per hour atmospheric fluidized bed packaged boilers, each with:

- o Combustion Controls and Safeguards
- o Three Forced Draft Fans
- o Induced Draft Fan
- o Steam Boiler Trim
- o Coal Metering and Feed System
- o Limestone Metering and Feed System
- o Multiclone Mechanical Dust Collectors
- o Ash and Spent Bed Removal Systems
- o Sootblowing and Blowdown System
- o Standby Gas/Oil Firing Capability
- o Flue Gas Ductwork and Stack

(2) Three motor driven feedwater pumps (one standby)

(3) Two motor driven condensate transfer pumps (one standby)

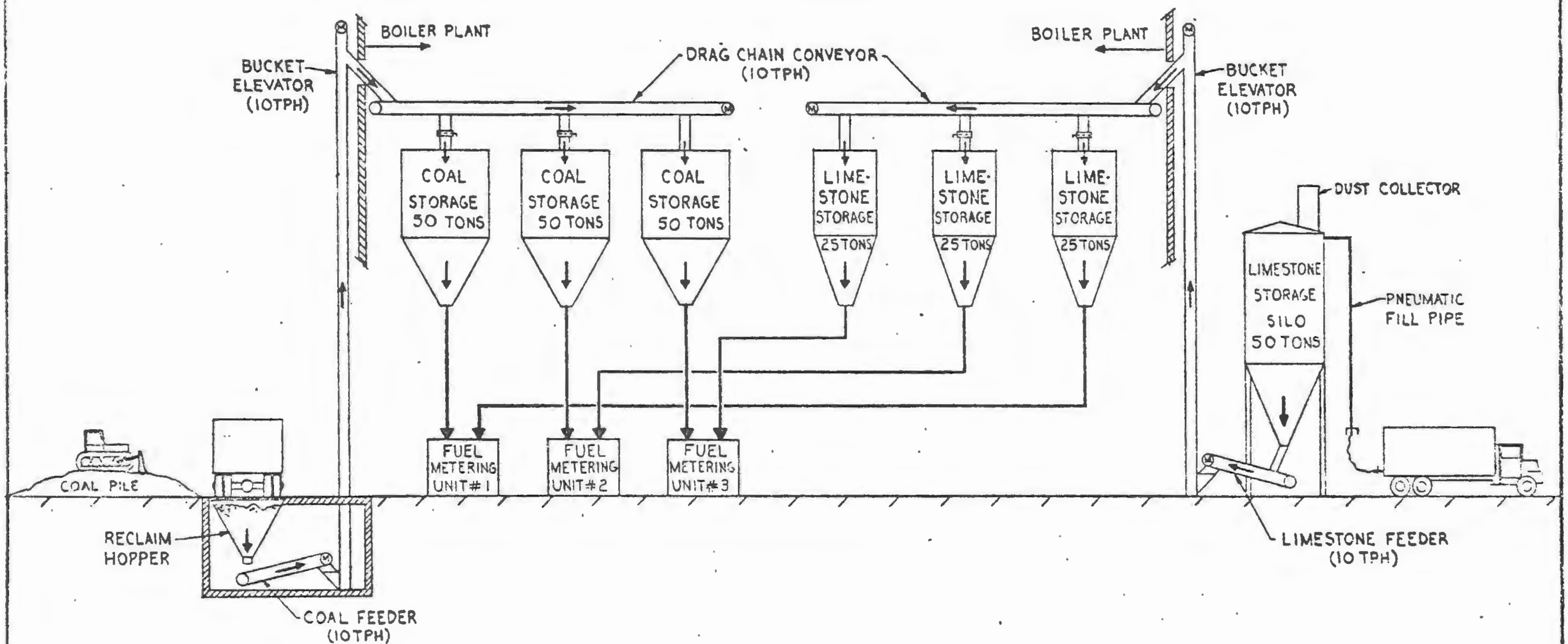
(4) Blowdown tank and energy recovery system, common for all three boilers

(5) One deaerating feedwater heater

(6) One condensate storage tank

(7) One duplex water softener, common for all three boilers

EXHIBIT IV-13



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TITLE
SENECA ARMY DEPOT
SOUTH BASE
CONCEPTUAL - FLOW DIAGRAM
FUEL HANDLING SYSTEMS
OPTION No. 3

DRAWING NO. M-13

FILE NO. 80122-000

(8) Coal unloading and storage system

(9) Limestone unloading and storage system

(10) Compressed air system

(11) Plant start-up fuel system

(12) Electrical equipment, controls and instrumentation

(13) Plant building with control room and bathroom facilities

(14) Site preparation

4.3.4.2 Energy Analysis and Capital Cost

Based on the fuel consumption data in Table 4-4, and assuming that coal with an HHV of 12,500 Btu's per pound is to be consumed by the new central plant and that the boiler efficiency will be 80% rather than the 70% assumed for the conventional coal-fired boilers of the same size, the annual coal consumption for this plant will be 940 tons. The annual limestone consumption of the plant will be 235 tons. The total electricity consumption will be 757,214 KWH per year as indicated on Table 4-6. The initial capital expenditure for the central plant is estimated to be $4,593,454 in December 1980 dollars.

4.3.5 Suboptions

The use as a supplemental fuel of wood, biomass and refuse derived fuels was considered in order to identify their potential for increasing the economic feasibility of the central steam plant.

Since significant modifications would have to be made to the feed systems of the fluidized bed boilers and since the amount of available fuel from these sources is limited in the area of the SEAD, the firing of these fuels was considered only as a

TABLE 4-6

ESTIMATED STEAM AND ELECTRICITY DEMAND

OPTION 3 - CENTRAL AFBC COAL-FIRED STEAM PLANT

Month	Avg. Hourly Steam Demand (lbs/hr)	Electricity Consumption (KWH)
Jan	12,812	103,639
Feb	13,239	93,610
Mar	9,521	90,470
Apr	5,952	87,552
May	1,991	60,264
Jun	567	58,320
Jul	---	---
Aug	---	---
Sep	---	---
Oct	2,843	72,168
Nov	6,636	87,552
Dec	11,346	103,639
		757,214

suboption to the conventional coal-fired boiler discussed in Section 4.3.3.

4.3.5.1 Wood and Biomass

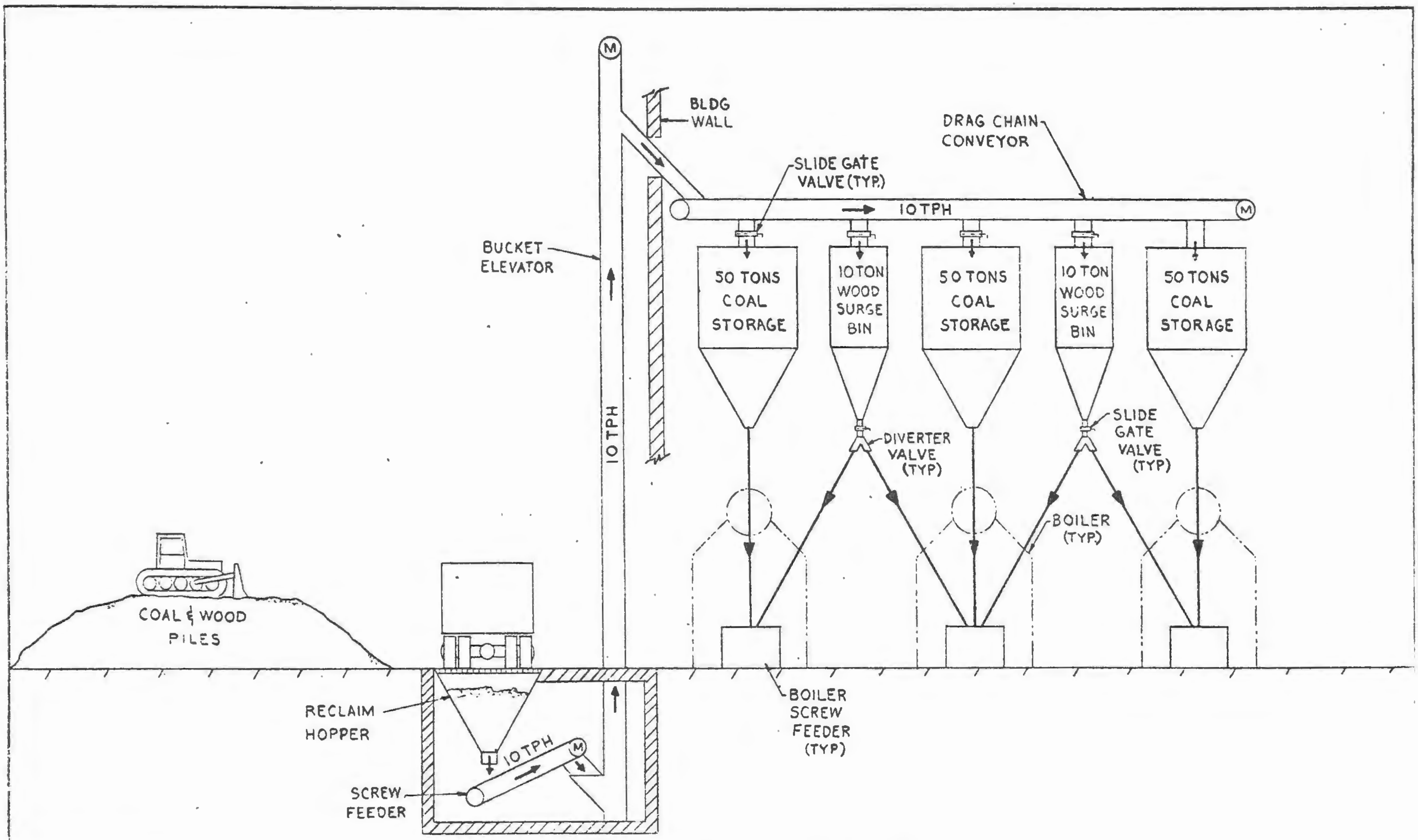
4.3.5.1.1 Mechanical Systems -- The stoker coal-fired boilers selected for the central steam plant presented in Option 2 herein were considered to be fired with up to a 10 percent fuel input of wood chips and/or woody biomass. Therefore, this case assumes a firing rate of 10 percent wood/woody biomass and 90 percent coal on a single shift, five-days per week. The only additional equipment required consists of two surge bins, four gate valves, two diverting valves, and four feed chutes, all as indicated on Exhibit IV-14.

4.3.5.1.2 Energy Analysis and Capital Cost -- Based on the fuel consumption data in Table 4-4, and assuming that 37.5 percent moisture wood/woody biomass with an HHV of 5,528 Btu's per pound is consumed along with the 12,500 Btu's per pound coal, the annual wood/woody biomass consumption will be 141 tons and the annual coal consumption will be 1,011 tons. The total electricity consumption will be 460,198 KWH per year. The initial capital expenditure for the new central plant is estimated to be $3,910,186 in December 1980 dollars.

4.3.5.2 Refuse Derived Fuels

4.3.5.2.1 Mechanical Systems -- The stoker coal-fired boilers selected for the central steam plant presented as Option 2 herein were considered to be fired with up to a 25 percent fuel input of refuse derived fuels (RDF). Solid waste is collected at SEAD only two days per week and storage of RDF for future use is not a dependable operating method. In addition, because of the seasonal

EXHIBIT IV-14



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TITLE
SENECA ARMY DEPOT
SOUTH BASE
CONCEPTUAL - FLOW DIAGRAM
COAL HANDLING SYSTEMS
WOOD & BIOMASS SUBOPTIONS

DRAWING NO
M-14

FILE NO
80122-000

loading of the steam plant, the total amount of solid waste collected on SEAD (17.6 tons per week) cannot be disposed of by the steam plant during the months of May through October. Therefore, it has been assumed that the firing rate of the boilers between November and April will be 25 percent RDF and 75 percent coal.

The additional equipment required for the firing of RDF as a supplemental fuel is as follows:

- o Trommel Screen Discharge Conveyor
- o Shredder Feed Conveyor
- o Shredder Discharge Conveyor
- o Magnetic Separator Conveyor
- o Glass Conveyor
- o Two Nine-Ton Storage Bunkers
- o Shredder, 3 TPH
- o Magnetic Separator
- o Trommel Screen

4.3.5.2.2 Energy Analysis and Capital Cost -- Based on the fuel consumption data in Table 4-4, and assuming that RDF with an HHV of 4,500 Btu's per pound is consumed along with the 12,500 Btu's per pound coal, the annual RDF consumption will be 458 tons and the annual coal consumption will be 909 tons. The total electricity consumption will be 480,728 KWH per year. The initial capital expenditure for the new central plant will be $4,617,724 in December 1980 dollars.

4.4 HIGH TEMPERATURE WATER DISTRIBUTION SYSTEM

This case considers the installation of a High Temperature Water (HTW) distribution system as an alternate to the typical steam/condensate system detailed in SEAD - North Base Option 2.

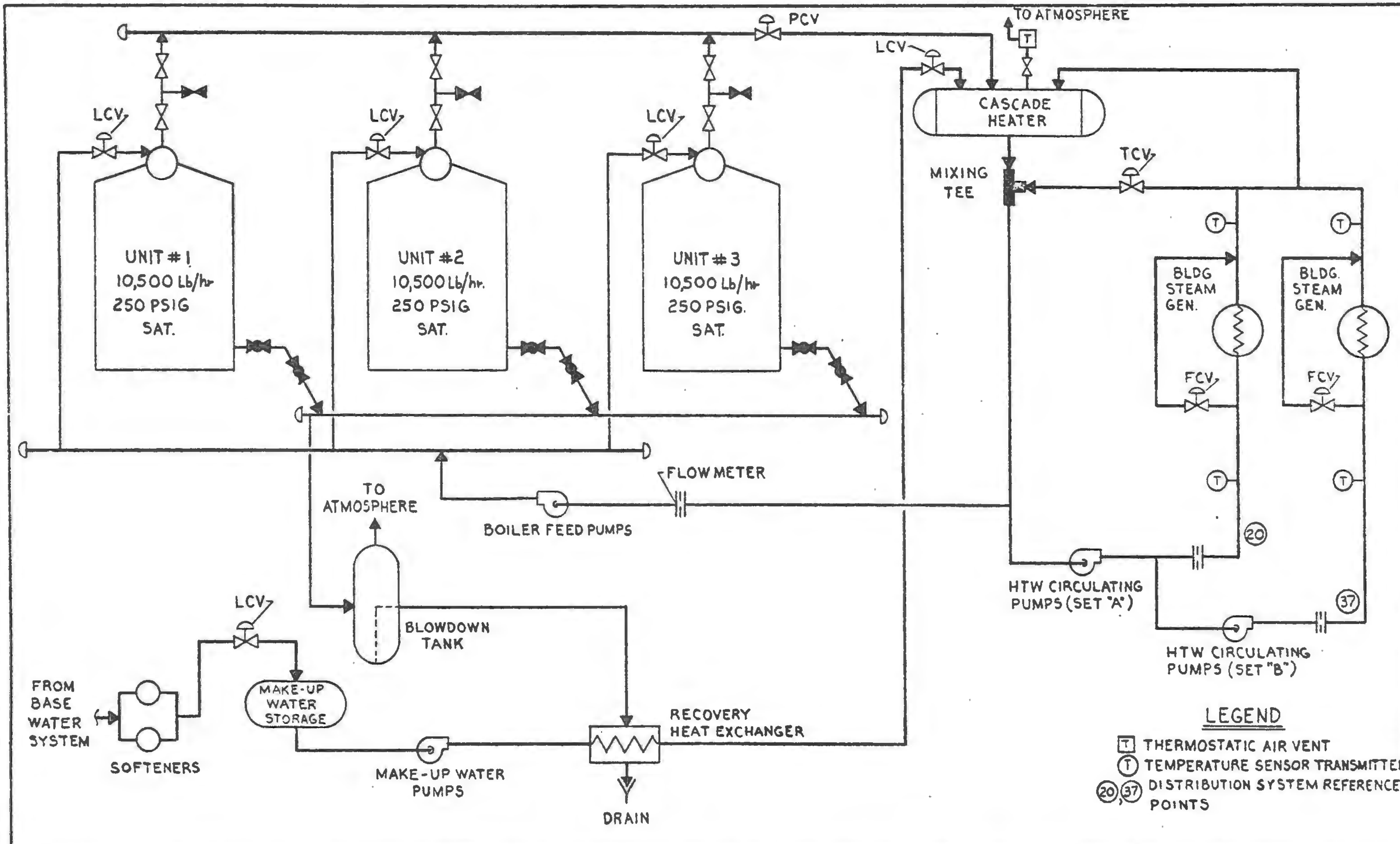
High temperature water is generated in the central boiler plant and then is distributed to the buildings where it acts as the driving force in unfired steam generators to produce low pressure steam required by the buildings' existing systems. The location of an unfired steam generator in each building is considered as the best method to convert the existing steam/condensate system to HTW.

The central plant configuration is as shown in Exhibit IV-15.

4.4.1 Mechanical Systems

The average hourly system demand for each month is as shown on Table 4-7, which indicates a maximum average building HTW demand of 53,014 pounds per hour. The peak system HTW demand is estimated at 116,016 pounds per hour. The central plant steam load required is 8,933 pounds per hour average and 19,560 pounds per hour peak. Based on this data and assuming a 20 percent safety margin, three (3) fifty percent capacity boilers, each rated at 10,500 pounds per hour are required, generating saturated steam at 250 psig.

The HTW produced in the central plant is continuously circulated through the distribution network via the HTW circulation pumps, the HTW supply and return pipeline and the unfired steam generators. The distribution system as shown in Exhibit IV-16 will consist of new HTW supply and return piping to serve buildings that are not presently connected to the Building 718 steam plant. The existing steam/condensate piping originating



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DRAWN	CHECKED	DATE
F.C.M.	BJJ	1/29/81

TITLE: SENECA ARMY DEPOT
NORTH BASE
CONCEPTUAL FLOW DIAGRAM
HTW SYSTEM

DRAWING NO: M-15

FILE NO: 80122-000

EXHIBIT IV-15

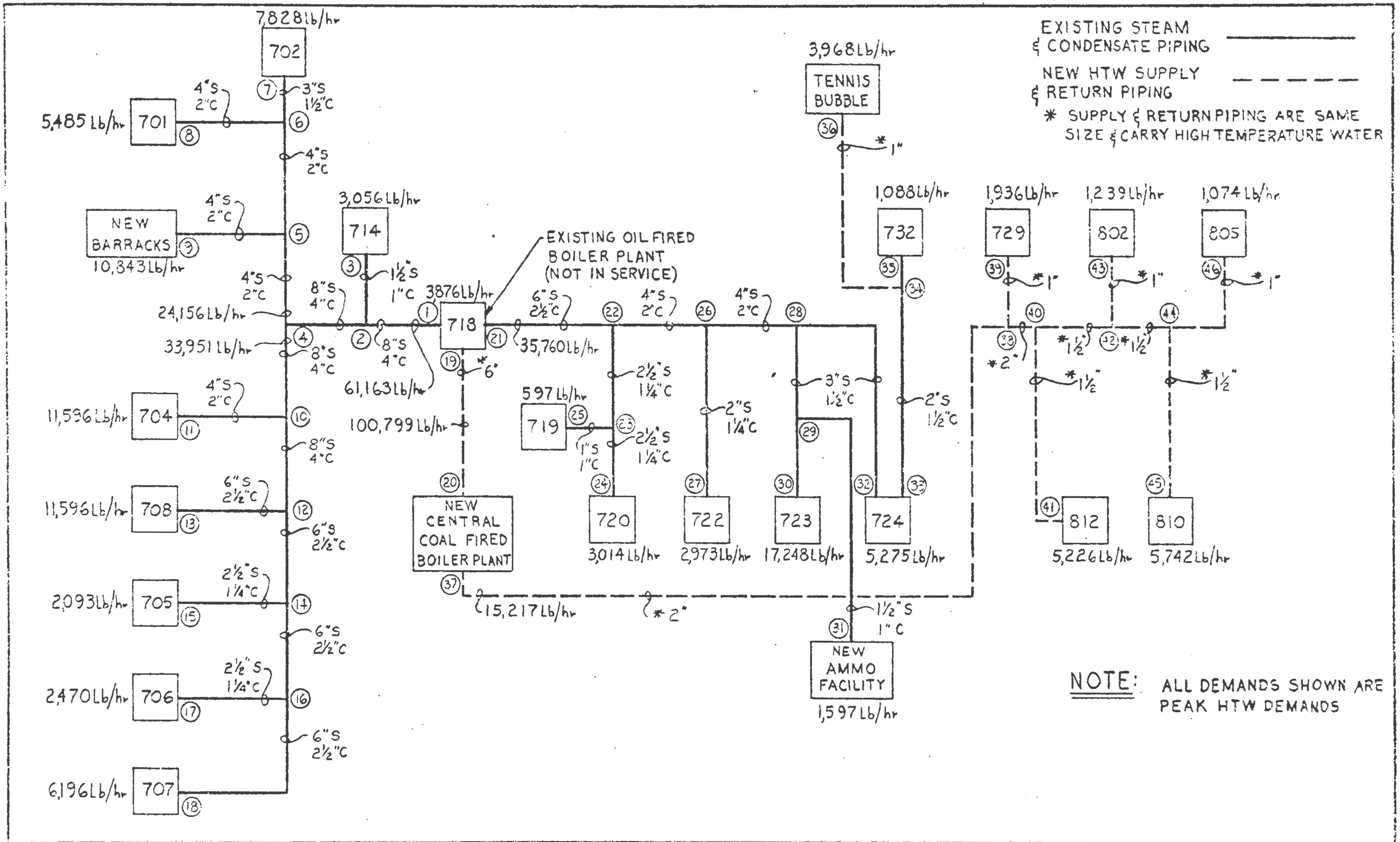
TABLE 4-7

ESTIMATED HTW AND STEAM DEMANDS

AND

BOILER PLANT ELECTRICITY CONSUMPTION

Month	Avg. Hourly HTW Demand (lbs/hr)	Avg. Hourly Steam Demand (lbs/hr)	Electricity Consumption (KWH)
Jan	48,462	8,166	54,089
Feb	53,014	8,933	50,599
Mar	41,365	6,970	54,089
Apr	35,802	6,033	52,344
May	24,769	4,174	43,301
Jun	11,154	1,879	35,064
Jul	10,106	1,703	36,233
Aug	10,373	1,748	36,233
Sep	15,937	2,685	41,904
Oct	25,295	4,262	43,301
Nov	38,325	6,458	52,344
Dec	36,749	6,192	54,089
			661,768



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TITLE: SENECA ARMY DEPOT
NORTH BASE
FLOW DIAGRAM - HTW DISTRIBUTION SYSTEM

DRAWING NO: M-16

FILE NO: 80122-000

4-42

EXHIBIT IV-16

from Building No. 718 also will be used to transport HTW. (Note that the use of this existing piping for HTW will eliminate the future use of Building No. 718 as "back-up" capability). Due to the difference in distribution pipeline pressure drops, it is necessary to divide the distribution system into two subsystems, each being supplied by different HTW circulating pumps. The individual buildings are connected to the HTW distribution system in parallel. Since the system flow rate is constant, each unfired steam generator is provided with an HTW bypass line and flow control valve. A portion of the HTW returned to the boiler plant is used to temper the boiler and HTW distribution system circulating water. The remainder of the HTW is returned to the Cascade Heater.

The Cascade Heater has a multifold purpose in that it: (1) acts as a direct contact heater used to reheat the HTW to supply temperature; (2) supplies expansion volume for the system; (3) functions as the system pressurizer; (4) releases entrained air and (5) accepts system make-up water. The coal-fired, forced circulation boiler generates saturated steam which is "dumped" into the Cascade Heater to heat the HTW return and maintain system pressure.

The coal handling system flow diagram is as shown on Exhibit IV-5.

The central plant considered in this investigation includes equipment and systems with features as follows:

(1) Three 10,500 pound per hour stoker coal-fired firetube boilers, each with:

- Combustion Controls and Flame Safeguards
- Forced Draft Fan
- Induced Draft Fan
- Coal Screw Feeder
- Ash Screw Feeder

- o Cyclone Dust Collector
- o Flue Gas Ductwork and Stack

(2) Two motor driven feedwater pumps (one standby)

(3) Four motor driven HTW circulation pumps (two standby, one per each size pump)

(4) Blowdown tank and energy recovery system, common for all three boilers

(5) Two Cascade Heaters (one standby)

(6) One condensate storage tank

(7) One duplex automatic water softener, common for all three boilers

(8) Ash (dry fly and bottom ash) collection system

(9) Coal unloading and storage system including a truck weigh scale

(10) All necessary boiler, distribution system, and interface controls and instrumentation

(11) Building foundation, structural steel and enclosure

(12) Compressed air system

(13) Plant start-up fuel system

(14) Electrical equipment and switchgear

(15) Control room and bathroom facilities in the boiler building

(16) Service and fire water systems

In addition to the central plant equipment listed above, the economic analysis includes all new piping (insulated distribution piping buried in conduit), one unfired steam generator and one condensate receiver/steam generator feed pump package in each building, civil work and site preparation, engineering design costs, and all required material and labor mark-ups.

4.4.2 Energy Analysis and Capital Cost

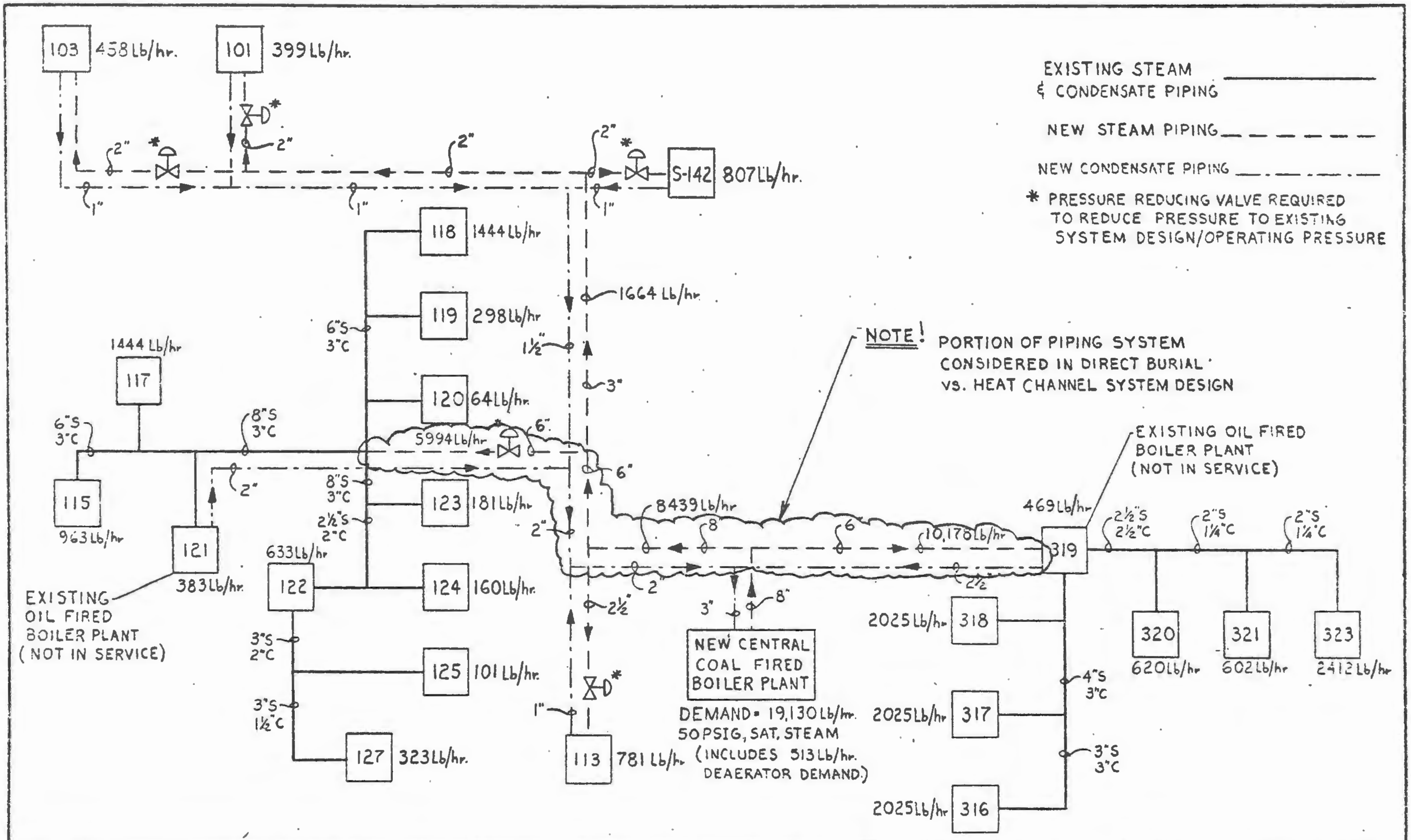
Based on the fuel consumption data in Table 4-1, and assuming that coal with an HHV of 12,500 Btu's per pound is to be consumed by the new central plant, the annual coal consumption for this plant will be 1,269 tons. The total electricity consumption will be 661,768 KWH per year. The initial capital expenditure for the new central plant is estimated to be $3,523,806 in December 1980 dollars.

4.5 DIRECT BURIAL AND HEAT CHANNEL DISTRIBUTION SYSTEMS

This analysis was performed to compare the economic benefits of two different types of heating distribution systems: an underground conduit system (direct burial) and an underground channel or trench system. A portion of the heating distribution system for the South Base at SEAD was selected for this analysis as shown on Exhibit IV-17.

4.5.1 Direct Burial Distribution System

The underground conduit system considered is a "Class A" system conforming to the tri-service publication, "Procedures for Establishing Acceptability of Underground Heat-Distribution Conduit Systems." This system consists of insulated steam and condensate lines in separate conduits protected from galvanic corrosion by a cathodic protected system. It is estimated that the economic life of this system is 25 years after which the entire system would be abandoned and replaced.



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DRAWN: F.C.M CHECKED: DATE: 11-19-80

TITLE: SENECA ARMY DEPOT SOUTH BASE
CONCEPTUAL - FLOW DIAGRAM
DIRECT BURIAL AND HEAT CHANNEL DISTRIBUTION SYSTEMS

DRAWING NO: M-17
FILE NO: 80122-000

4-46

EXHIBIT IV-17

4.5.2 Heat Channel Distribution System

The channel system examined consists of insulated steam and condensate lines installed in a precast concrete channel as manufactured by Trenwa Products, Inc. Each section of channel consists of two precast concrete vertical side pieces, a precast concrete lid and two precast concrete struts at the bottom for lateral support of the sides. The bottom of the channel is open. Pipe is hung from "Unistrut" type supports. The channel is installed with the top of the concrete lid a few inches below grade. The economic life of the concrete support is in excess of 40 years. The piping will require replacing after 25 years.

There are two definite advantages to the channel system as compared to the conduit system. One is the ease of getting to the pipe in the channel if necessary for maintenance or repair. The other advantage is the replacement cost after the initial 25 years. In the case of the conduit system, the entire system must be replaced. With the channel system, only the pipe needs to be replaced.

4.5.3 Capital Cost

The initial capital expenditure for the Direct Burial Distribution System, as described herein, is $600,316. The initial capital expenditure for the Heat Channel Distribution System, as described herein, is $555,693.

5.0 ECONOMIC EVALUATION OF THE OPTIONS

In order to properly evaluate and compare the base case at each of the North and South Base areas at SEAD to the optional systems as described previously, a detailed economic analysis was performed using capital costs, fuel costs, electric costs, and operating maintenance costs. The methods and data presented in this report form the basis of the cost levels utilized. These costs were combined through accepted techniques to form comparable bases.

5.1 APPROACH

The economic analysis is based on a comparison of the total life cycle costs associated with each of the options being studied. The methodology used to define the life cycle parameters is the criteria included in "Engineering Instruction for Preparation of Feasibility Studies for Total Energy, Selective Energy, and Heat Pump Systems, 1 July 1977." In addition, the criteria for the life cycle analyses using the rate changes from 1970 to 1980 are based on data obtained from the American Petroleum Institute, the electric utilities in the region near SEAD, and on DOE published rates.

Because of the duplicity of cases for the two distinct base areas at SEAD, each area was treated as a separate analysis. In addition, the studies comparing the high temperature water system to a conventional steam heating system, and the comparison between the direct burial distribution systems and heat channel distribution system are included as a separate analyses.

5.1.1 North Base

The 25 year and 40 year total life cycle costs of the base case and of the four optional cases are compared using the escalation rates contained in the document referenced above as well as the rate changes experienced for the period from 1970 to 1980. The results of that comparison are presented in Tables 5-1 through 5-4. In addition, an analysis was performed to determine the length of time that is required for a central coal-fired plant (Option 2) to breakeven with the existing system, using both the COE escalation rates and the 1970-1980 escalation rates. The results of this analysis are presented in Table 5-5.

5.1.2 South Base

The 25 year and 40 year total life cycle costs of the base case and of the four optional cases are compared using the escalation rates contained in the document referenced above as well as the rate changes experienced for the period from 1970 to 1980. The results of that comparison are presented in Tables 5-6 through 5-9. In addition, an analysis was performed to determine the length of time that is required for a central coal-fired plant (Option 2) to breakeven with the existing system, using both the COE escalation rates and the 1970-1980 escalation rates. The results of this analysis are presented in Table 5-10.

5.1.3 High Temperature Water Distribution System

In this analysis, the 25 year total life cycle costs of the central coal-fired steam distribution system (Option 2) at the North Base are compared to those for a central high temperature water distribution system of identical scope, using both the COE and 1970-1980 escalation rates. The results of that comparison are presented in Tables 5-11 and 5-12.

5.1.4 Direct Burial and Heat Channel Distribution Systems

In this analysis, the 40 year total life cycle costs of an underground conduit system located on the South Base are compared to

TABLE 5-1

PRESENT VALUE LIFE CYCLE COSTING - SEAD - NORTH BASE

(25 Year Life/1970-80 Escalation Rates)

($000)

	Base Case	Option 2	Option 3	Opt. 2 + RDF	Opt. 2 + Wood
Capital Cost	$ ---	$ 3,358	$ 4,091	$ 4,094	$ 3,386
Operation and Maintenance Cost	1,219	2,202	2,361	2,338	2,391
Cyclical Maintenance or Replacement Cost	358	58	58	58	58
Fuel Cost:					
Coal --	---	2,459	2,152	2,146	2,366
No. 6 Fuel Oil --	3,742	---	---	---	---
No. 2 Fuel Oil --	1,625	---	---	---	---
Wood --	---	---	---	---	50
Limestone --	---	---	28	---	---
Electrical Consumption Cost	37	139	239	144	139
Electrical Demand Cost	20	73	117	151	73
TOTAL - Present Value Life Cycle Cost	$ 7,001	$ 8,289	$ 9,046	$ 8,931	$ 8,463

TABLE 5-2
PRESENT VALUE LIFE CYCLE COSTING - SEAD - NORTH BASE
(25 Years Life/COE Escalation Rates)
($000)

	Base Case	Option 2	Option 3	Opt. 2 + RDF	Opt. 2 + Wood
Capital Cost	$ ---	$ 3,358	$ 4,091	$ 4,094	$ 3,386
Operation and Maintenance Cost	1,219	2,202	2,361	2,338	2,391
Cyclical Maintenance or Replacement Cost	358	58	58	58	58
Fuel Cost:					
Coal --	---	1,175	1,025	1,025	1,130
No. 6 Fuel Oil --	2,359	---	---	---	---
No. 2 Fuel Oil --	1,024	---	---	---	---
Wood --	---	---	---	---	50
Limestone --	---	---	33	---	---
Electrical Consumption Cost	85	316	545	329	316
Electrical Demand Cost	30	109	174	224	109
TOTAL - Present Value Life Cycle Cost	$ 5,075	$ 7,218	$ 8,287	$ 8,068	$ 7,440

TABLE 5-3

PRESENT VALUE LIFE CYCLE COSTING - SEAD - NORTH BASE

(40 Year Life/1970-80 Escalation Rates)

($000)

	Base Case	Option 2	Option 3	Opt. 2 + RDF	Opt. 2 + Wood
Capital Cost	$ ---	$ 3,358	$ 4,091	$ 4,094	$ 3,386
Operation and Maintenance Cost	1,312	2,369	2,540	2,515	2,572
Cyclical Maintenance or Replacement Cost	364	221	245	243	223
Fuel Cost:					
Coal --	---	3,935	3,442	3,433	3,786
No. 6 Fuel Oil --	6,430	---	---	---	---
No. 2 Fuel Oil --	2,792	---	---	---	---
Wood --	---	---	---	---	67
Limestone --	---	---	30	---	---
Electrical Consumption Cost	41	225	262	158	152
Electrical Demand Cost	24	87	140	180	87
TOTAL - Present Value Life Cycle Cost	$10,963	$10,195	$10,750	$10,623	$10,273

TABLE 5-4

PRESENT VALUE LIFE CYCLE COSTING - SEAD - NORTH BASE

(40 Year Life/COE Escalation Rates)

($000)

	Base Case	Option 2	Option 3	Opt. 2 + RDF	Opt. 2 + Wood
Capital Cost	$ ---	$ 3,358	$ 4,091	$ 4,094	$ 3,386
Operation and Maintenance Cost	1,312	2,369	2,540	2,515	2,572
Cyclical Maintenance or Replacement Cost	364	221	245	243	223
Fuel Cost:					
Coal --	---	1,442	1,261	1,258	1,387
No. 6 Fuel Oil --	3,333	---	---	---	---
No. 2 Fuel Oil --	1,447	---	---	---	---
Wood --	---	---	---	---	67
Limestone --	---	---	35	---	---
Electrical Consumption Cost	113	424	730	441	424
Electrical Demand Cost	40	146	234	300	146
TOTAL - Present Value Life Cycle Cost	$ 6,609	$ 7,960	$ 9,136	$ 8,851	$ 8,205

TABLE 5-5

BREAKEVEN ANALYSIS

EXISTING SYSTEMS VS CENTRAL COAL-FIRED PLANT

SEAD - NORTH BASE

The initial cost of Option 2 is represented by the line, y = $3,358,119. During each year of operation, a net contribution towards the initial cost will be generated due to lower annual costs (fuel, etc) associated with Option 2. This net contribution is represented by the sloping lines. At the point at which the sloping line crosses the initial costline, the central coal-fired plant will become cost effective. Assuming 1970-1980 escalation rates, the breakeven point is 34.4 years. Assuming COE escalation rates, the breakeven point is 65.6 years.

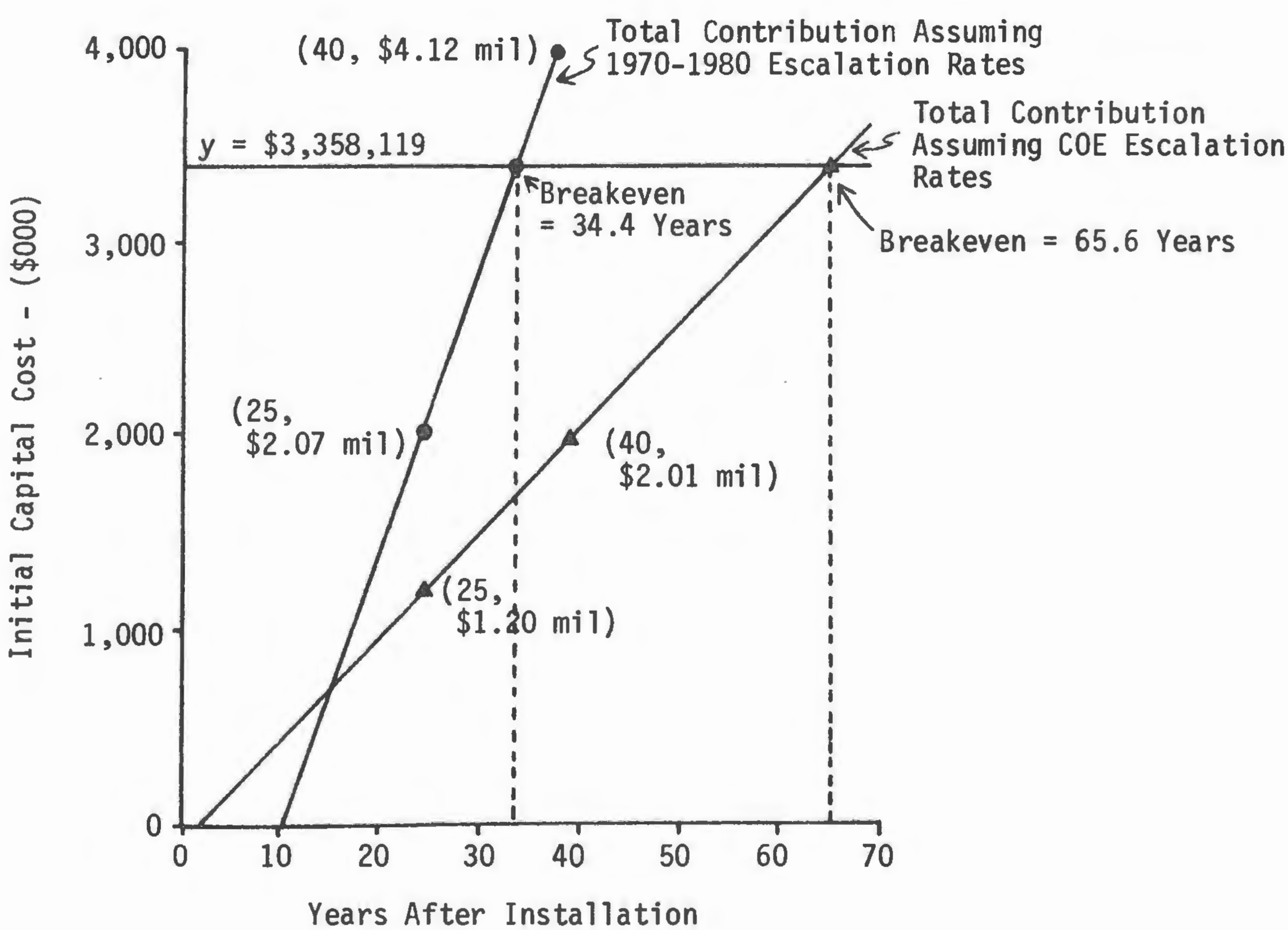

TABLE 5-6

PRESENT VALUE LIFE CYCLE COSTING - SEAD - SOUTH BASE

(25 Year Life/1970-80 Escalation Rates)

($000)

	Base Case	Option 2	Option 3	Opt. 2 + RDF	Opt. 2 + Wood
Capital Cost	$ ---	$ 3,882	$ 4,593	$ 4,618	$ 3,910
Operation and Maintenance Cost	2,013	2,316	2,470	2,451	2,504
Cyclical Maintenance or Replacement Cost	228	68	68	68	68
Fuel Cost:					
Coal --	---	2,040	1,785	1,726	1,920
No. 6 Fuel Oil --	3,205	---	---	---	---
No. 2 Fuel Oil --	1,160	---	---	---	---
Wood --	---	---	---	---	63
Limestone --	---	---	23	---	---
Electrical Consumption Cost	39	124	204	129	124
Electrical Demand Cost	16	88	127	165	88
TOTAL - Present Value Life Cycle Cost	$ 6,661	$ 8,518	$ 9,270	$ 9,157	$ 8,677

TABLE 5-7

PRESENT VALUE LIFE CYCLE COSTING - SEAD - SOUTH BASE

(25 Year Life/COE Escalation Rates)

($000)

	Base Case	Option 2	Option 3	Opt. 2 + RDF	Opt. 2 + Wood
Capital Cost	$ ---	$ 3,882	$ 4,593	$ 4,618	$ 3,910
Operation and Maintenance Cost	2,013	2,316	2,470	2,451	2,504
Cyclical Maintenance or Replacement Cost	228	68	68	68	68
Fuel Cost:					
Coal --	---	974	853	824	917
No. 6 Fuel Oil --	2,021	---	---	---	---
No. 2 Fuel Oil --	731	---	---	---	---
Wood --	---	---	---	---	63
Limestone --	---	---	27	---	---
Electrical Consumption Cost	89	282	464	295	282
Electrical Demand Cost	24	131	189	246	131
TOTAL - Present Value Life Cycle Cost	$ 5,106	$ 7,653	$ 8,664	$ 8,502	$ 7,875

TABLE 5-8

PRESENT VALUE LIFE CYCLE COSTING - SEAD - SOUTH BASE

(40 Year Life/1970-80 Escalation Rates)

($000)

	Base Case	Option 2	Option 3	Opt. 2 + RDF	Opt. 2 + Wood
Capital Cost	$ ---	$ 3,882	$ 4,593	$ 4,618	$ 3,910
Operation and Maintenance Cost	2,166	2,491	2,657	2,637	2,694
Cyclical Maintenance or Replacement Cost	398	263	286	285	264
Fuel Cost:					
Coal --	---	3,263	2,856	2,762	3,072
No. 6 Fuel Oil --	5,508	---	---	---	---
No. 2 Fuel Oil --	1,993	---	---	---	---
Wood --	---	---	---	---	85
Limestone --	---	---	25	---	---
Electrical Consumption Cost	43	136	223	142	136
Electrical Demand Cost	19	105	152	197	105
TOTAL - Present Value Life Cycle Cost	$10,127	$10,140	$10,792	$10,641	$10,266

TABLE 5-9

PRESENT VALUE LIFE CYCLE COSTING - SEAD - SOUTH BASE

(40 Year Life/COE Escalation Rates)

($000)

	Base Case	Option 2	Option 3	Opt. 2 + RDF	Opt. 2 + Wood
Capital Cost	$ ---	$ 3,882	$ 4,593	$ 4,618	$ 3,910
Operation and Maintenance Cost	2,166	2,491	2,657	2,637	2,694
Cyclical Maintenance or Replacement Cost	398	263	286	285	264
Fuel Cost:					
Coal --	---	1,196	1,046	1,012	1,125
No. 6 Fuel Oil --	2,855	---	---	---	---
No. 2 Fuel Oil --	1,033	---	---	---	---
Wood --	---	---	---	---	85
Limestone --	---	---	29	---	---
Electrical Consumption Cost	119	378	622	395	378
Electrical Demand Cost	32	175	254	330	175
TOTAL - Present Value Life Cycle Cost	$ 6,603	$ 8,385	$ 9,487	$ 9,277	$ 8,631

TABLE 5-10

BREAKEVEN ANALYSIS

EXISTING SYSTEMS VS CENTRAL COAL-FIRED PLANT

SEAD - SOUTH BASE

The initial cost of Option 2 is represented by the line, y = $3,882,044. During each year of operation, a net contribution towards the initial cost will be generated due to lower annual costs (fuel, etc.) associated with Option 2. This net contribution is represented by the sloping lines. At the point at which the sloping line crosses the initial cost line, the central coal-fired plant will become cost effective. Assuming 1970-1980 escalation rates, the breakeven point is 40.1 years. Assuming COE escalation rates, the breakeven point is 71.3 years.

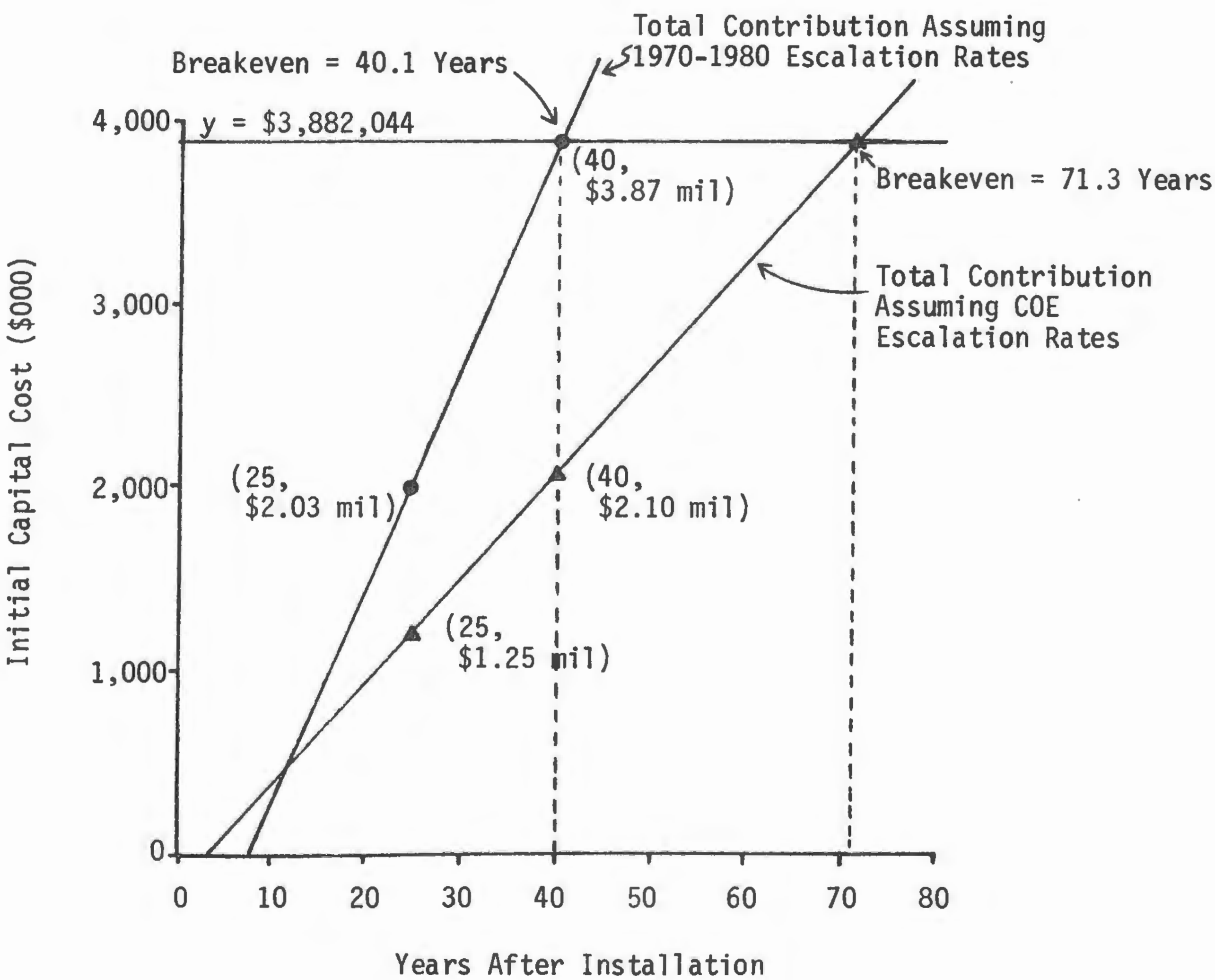

TABLE 5-11

PRESENT VALUE LIFE CYCLE COSTING
(25 Year Life/1970-80 Escalation Rates)

HIGH TEMPERATURE WATER DISTRIBUTION SYSTEM

SEAD - NORTH BASE

($000)

	Central Coal-Fired High Temperature Water Distribution System	Central Coal-Fired Steam Distribution System (Option 2)
Capital Cost	$ 3,524	$ 3,358
Operation and Maintenance Cost	2,238	2,202
Cyclical Maintenance or Replacement Cost	58	58
Fuel Cost:		
Coal --	2,410	2,459
No. 6 Fuel Oil --	---	---
No. 2 Fuel Oil --	---	---
Wood --	---	---
Limestone --	---	---
Electrical Consumption Cost	178	139
Electrical Demand Cost	83	73
TOTAL - Present Value Life Cycle Cost	$ 8,491	$ 8,289

TABLE 5-12

PRESENT VALUE LIFE CYCLE COSTING
(25 Year Life/COE Escalation Rates)

HIGH TEMPERATURE WATER DISTRIBUTION SYSTEM

SEAD - NORTH BASE

($000)

	Central Coal-Fired High Temperature Water Distribution System	Central Coal-Fired Steam Distribution System (Option 2)
Capital Cost	$ 3,524	$ 3,358
Operation and Maintenance Cost	2,238	2,202
Cyclical Maintenance or Replacement Cost	58	58
Fuel Cost:		
Coal --	1,151	1,175
No. 6 Fuel Oil --	---	---
No. 2 Fuel Oil --	---	---
Wood --	---	---
Limestone	---	---
Electrical Consumption Cost	406	316
Electrical Demand Cost	123	109
TOTAL - Present Value Life Cycle Cost	$ 7,500	$ 7,218

those for an underground channel or trench system of identical scope. The results of that comparison are presented in Table 5-13.

5.2 ASSUMPTIONS

5.2.1 Discount Rate

A discount rate of ten percent has been applied to costs during the economic life.

> The rationale for adopting the private sector rate of return for analyzing Government investment proposals turns on the notion that Government investments are funded with money taken from the private sector (via taxation), are made in the ultimate behalf of the private sector (the individuals comprising it), and thus bear an implicit rate of return comparable to that of projects undertaken in the private sector. In this interpretation, ten percent measures the opportunity cost of investment capital foregone by the private sector.[1]

5.2.2 Present Value Concept

The present value concept recognizes the time value associated with money. Money has value directly related to the timing of its receipt or disbursement. This value is determined by the opportunity to earn a profit from a normal investment. Employing the present value concept enables one to make meaningful comparisons of equivalent costs and returns occurring at a single point in time. As such, the costs associated with each option have been evaluated in present value terms for comparative analysis and one should not misinterpret them in preparing budgetary requirements.

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[1]Economic Analysis Handbook, NAVFAC P-422, 2nd Edition, June 1976, Department of the Navy.

TABLE 5-13

PRESENT VALUE LIFE CYCLE COSTING
(40 Year Life)

DIRECT BURIAL AND HEAT
CHANNEL DISTRIBUTION SYSTEMS

SEAD - SOUTH BASE

($000)

	Direct Burial (Conduit) Distribution System	Heat Channel Distribution System
Capital Cost	$ 600	$ 556
Cyclical Maintenance or Replacement Cost	25	14
TOTAL - Present Value Life Cycle Cost	$ 625	$ 570

5.2.3 Capital Cost

The capital costs for major components were determined utilizing manufacturers' pro-forma proposals and the most current cost estimating data available. A six percent design fee has been applied to all installation costs, which are presented in December 1980 dollars. Much of the data and calculations used in determining capital costs are located in the Appendix.

5.2.4 Annual Energy Real Growth Rates for Life Cycle Costing[2]

Escalation rates for 1970-1980 were determined from data provided by the appropriate electric utility, DOE, American Petroleum Institute and the U.S. Bureau of Mines.

Army Corps of Engineers

Coal	5.0 percent
Fuel Oil	8.0 percent
Electricity	7.0 percent
Wood Chips	7.0 percent
Limestone	0.0 percent[3]

Rates for 1970-1980

Coal	10.0 percent
Fuel Oil	11.0 percent
Electricity (energy)	1.0 percent
Electricity (demand)	4.2 percent
Wood Chips	7.0 percent
Limestone	-1.2 percent

---

[2]Based on "Engineering Instructions for Preparation of Feasibility Studies for Total Energy, Selective Energy and Heat Pump Systems," July 1, 1977.

[3]Provided by U.S. Bureau of Mines

5.2.5 Operation and Maintenance Cost

The operation and maintenance costs are based on continuous operation of a three-shift, seven-day week. The utility personnel work a 40-hour week and are allowed vacation and sick leave. The annual operating and maintenance costs for the existing steam plant have been assumed for purposes of this study. The hourly rates for each category of operation and maintenance personnel were provided by SEAD. An additional 10.3 percent above the hourly rate has been applied to cover employee benefits, such as health and life insurance.

The costs and associated calculations used in deriving total operating and maintenance costs are located in the Appendix.

5.2.6 Fuel Cost

The cost of fuel is based on the most recent bills and contracts researched for the SEAD facility. The cost of fuel oil No. 6 has been established at $0.5128 per gallon; the cost of fuel oil No. 2 has been established at $0.9675 per gallon; the cost of sized coal for stoker firing at $54 per ton; the cost of limestone for fluidized bed firing at $13.25 per ton.

5.2.7 Cost of Electricity

The cost of electricity is based on the most recent monthly utility cost information available at SEAD. For study purposes, the cost per KWH has been established at $0.0274, with a demand charge of $3.25 per KW.

5.2.8 Credits

A credit for landfill has been established for the suboptions which utilize refuse derived fuel as an energy source. This credit is based on the assumption that RDF will be utilized for only six months per year due to a low steam demand in the warmer months, and therefore, a credit of 50 percent of the annual landfill cost less the cost of the non-burnable refuse which will still be hauled to landfill (assumed as 30%) will be realized. The present annual cost is $7,800. The credit applied for RDF firing is: (.70)($3,900) = $2,730.

5.2.9 Energy Conversions

For purposes of calculating energy savings, the following conversion factors are assumed:

No. 6 Fuel Oil -	150,000 Btu per gal
No. 2 Fuel Oil -	138,700 Btu per gal
Coal -	12,500 Btu per lb

5.2.10 Economic Life and Study Period

The project life includes both lead time and economic life. The lead time is the time which elapses between the initial investment expenditure and the date of the beneficial occupancy; this period is assumed to be two years. The economic life is the time in which the asset provides positive benefit; for the purposes of this study, economic lives of 25 years and 40 years have been assumed, as previously discussed.

5.3 ECONOMIC SUMMARY

The life cycle cost analyses have identified the most economical alternatives to meet the future energy needs of the Seneca Army Depot and have been based on present value of investment as well as upon operating and maintenance costs and predicted energy consumption, while using escalation rates provided by the Army Corps of Engineers and the historical rates generated in the period 1970 to 1980. The results of those analyses are presented hereinafter.

5.3.1 SEAD North Base

25 Year Life, 1970-80 Rates: A review of the life cycle analysis reveals that the existing oil-fired steam distribution system(s) produce the lowest total life cycle cost (Table 5-1) with the coal-fired central steam plant producing the lowest total life cycle cost of the alternatives.

40 Year Life, 1970-80 Rates: A review of the life cycle analysis reveals that the coal-fired central steam plant produces the lowest total life cycle cost (Table 5-3) with each of the alternatives producing a lower life cycle cost than the existing system. Sensitivity analyses have been performed. The results of varying the energy growth rates (as shown in Table 5-14) indicate the life cycle costs are highly dependent on the actual growth rate of the fuel oil presently consumed by the existing system, and only slightly dependent on the growth rate of coal.

25 Year Life, COE Rates: A review of the life cycle analysis reveals that the existing oil-fired steam distribution system(s) produce the lowest total life cycle cost (Table 5-2) with the coal-fired central steam plant producing the lowest total life cycle cost of the alternatives.

40 Year Life, COE Rates: A review of the life cycle analysis reveals that the existing oil-fired steam distribution system(s) produce the lowest total life cycle cost (Table 5-4) with the coal-fired central

TABLE 5-14

SENSITIVITY ANALYSIS

SEAD NOTH BASE

(40 Year Life / 1970-80 Escalation Rates)

($000)

	Life Cycle Costs From Table 5-3	Coal Increased From 10% to 11% (Oil - 11%)	Coal Decreased From 10% to 9% (Oil - 11%)	Oil Increased From 11% to 12% (Coal - 10%)	Oil Decreased From 11% to 10% (Coal - 10%)
BASE CASE	$ 10,963	$ 10,963	$ 10,963	$ 13,466	$ 9,080
OPTION 2	10,195	11,204	9,421	10,195	10,195
OPTION 3	10,750	11,633	10,074	10,750	10,750
OPTION 2 + RDF	10,623	11,503	9,948	10,623	10,623
OPTION 2 + WOOD	10,273	11,243	9,528	10,273	10,273

steam plant producing the lowest total life cycle cost of the alternatives.

Breakeven Analysis: The analysis presented in Table 5-5 indicates that the central coal-fired steam plant would become cost effective compared to the existing oil-fired plants after a period of 34.4 years based on the 1970-80 escalation rates, or after a period of 65.6 years based on the COE escalation rates.

5.3.2 SEAD South Base

25 Year Life, 1970-80 Rates: A review of the life cycle analysis reveals that the existing oil-fired steam distribution system(s) produce the lowest total life cycle cost (Table 5-6) with the coal-fired central steam plant producing the lowest total life cycle cost of the alternatives.

40 Year Life, 1970-80 Rates: A review of the life cycle analysis reveals that the existing oil-fired steam distribution system(s) produce the lowest total life cycle cost (Table 5-8) with the coal-fired central steam plant producing the lowest total life cycle cost of the alternatives. Sensitivity analyses have been performed. The results of varying the energy growth rates as shown in Table 5-15 indicate that the life cycle costs are highly dependent on the actual growth rate of the fuel oil presently consumed by the existing system, and only slightly dependent on the growth rate of coal.

25 Year Life, COE Rates: A review of the life cycle analysis reveals that the existing oil-fired steam distribution system(s) produce the lowest total life cycle cost (Table 5-7) with the coal-fired central steam plant producing the lowest total life cycle cost of the alternatives.

40 Year Life, COE Rates: A review of the life cycle analysis reveals that the existing oil-fired steam distribution system(s) produce the lowest total life cycle cost (Table 5-9) with the coal-fired central steam plant producing the lowest total life cycle cost of the alternatives.

TABLE 5-15

SENSITIVITY ANALYSIS

SEAD SOUTH BASE

(40 Year Life / 1970-80 Escalation Rates)

($000)

	Life Cycle Costs From Table 5-8	Coal Increased From 10% to 11% (Oil - 11%)	Coal Decreased From 10% to 9% (Oil - 11%)	Oil Increased From 11% to 12% (Coal - 10%)	Oil Decreased From 11% to 10% (Coal - 10%)
BASE CASE	$ 10,127	$ 10,127	$ 10,127	$ 12,131	$ 8,597
OPTION 2	10,140	11,385	9,759	10,140	10,140
OPTION 3	10,792	11,882	10,459	10,792	10,792
OPTION 2 + RDF	10,641	11,754	10,361	10,641	10,641
OPTION 2 + WOOD	10,266	11,052	9,660	10,266	10,266

Breakeven Analysis: The analysis presented in Table 5-10 indicates that the central coal-fired steam plant would become cost effective compared to the existing oil-fired plants after a period of 40.1 years, based on the 1970-80 escalation rates, or after a period of 71.3 years based on the COE escalation rates.

5.3.3 High Temperature Water Distribution System

A review of the life cycle analyses (Tables 5-11 and 5-12) indicates that there is an economic advantage in satisfying the North Base district heating requirements with a central coal-fired steam distribution system discussed as Option 2 hereinbefore, as compared to a central coal-fired HTW distribution system. This economic advantage is realized regardless of the escalation rates used in the analysis; it is based on a 25 year economic life.

5.3.4 Direct Burial and Heat Channel Distribution Systems

A review of the life cycle analysis (Table 5-13) indicates that there is a distinct economic advantage to the Heat Channel Distribution System as compared to a conventional Direct Burial Distribution System, based on a 40 year economic life.