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ENERGY CONSERVATION IN WATER TREATMENT

A Study of Four Water Treatment Plants in Phoenix, Arizona

Energy Task Force
of the Urban Consortium
for Technology Initiatives

Conducted By:

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PREFACE

The Urban Consortium for Technology Initiatives was formed to pursue technological solutions to pressing urban problems. The Urban Consortium conducts its work program under the guidance of Task Forces structured according to the functions and concerns of local governments. The Energy Task Force, with a membership of municipal managers and technical professionals from sixteen Consortium jurisdictions, has sponsored forty-eight applied energy management and technology projects in 28 Consortium member cities and counties since 1978.

To develop in-house energy expertise, individual projects sponsored by the Task Force are managed and conducted by the staff of participating city and county governments. Projects with similar subjects are organized into "Units" of three to five projects each, with each Unit managed by a selected Task Force member. A description of the Units and Projects included in the third year (1981 - 1982) Energy Task Force Program follows:

UNIT -- MUNICIPAL ENERGY TECHNOLOGIES

Designed to identify emerging technologies and innovative uses of proven technologies to aid municipal energy efficiency and productivity, this Unit consisted of four projects:

- Chicago, IL - Assessment and Financing of Municipal Energy Technologies
- Phoenix, AZ - Energy Conservation in Water Treatment and Production
- Indianapolis, IN - Feasibility Study for Fluidized Bed Combustion System Application
- St. Louis, MO - Alternative Energy Sources for Sewer Utilities

UNIT -- ALTERNATIVE FUELS AND TECHNOLOGIES

Designed to identify and overcome technical and institutional barriers to the use of alternative fuels in municipal operations, this Unit consisted of four projects:

- Baltimore, MD - Institutional Barriers to Methanol Use in Vehicle Fleet Operations
- Detroit, MI - Use of Felled City-Owned Trees as a Supplemental Fuel for Coal-Fired Boilers
- Memphis, TN - Obstacles to the Use of Compressed Natural Gas (CNG) in Urban Areas
- Dallas, TX - Use of Methane as a Fuel for Municipal Vehicles

UNIT -- TRANSFER OF COMMUNITY ENERGY MANAGEMENT TECHNIQUES

Designed to develop and transfer practical technologies, management techniques and organizational structures for effective community energy management, this Unit consisted of five projects:

- Columbus, OH - Structures and Strategies for the Implementation of Energy Management Plans
- Cleveland, OH - Coordinated Energy Management Actions in Multiple Local Jurisdictions

- Hennepin County, MN - Coordinating Energy Management Actions in Multiple Local Jurisdictions
- Jefferson County, KY - Systems and Strategies to Improve Community Energy Management Practices
- San Jose, CA - Developing an Energy Management Tracking System

UNIT -- ANALYSIS OF REGULATORY AND FINANCIAL IMPEDIMENTS

Designed to identify governmental actions to reduce regulatory and financial impediments to effective marketplace actions for energy efficiency, this Unit consisted of three projects:

- Houston, TX - Reducing Regulatory and Financial Impediments to Energy Conservation in Building Codes
- King County, WA - Land Use Planning, Regulation and Incentives for Wise Energy Use
- Denver, CO - Reduction of Impediments to Alternative Energy Use

UNIT -- PRIVATE SECTOR FINANCING FOR NEIGHBORHOOD ENERGY EFFICIENCY

Designed to identify techniques to encourage private financial support for residential energy cost reduction programs, this Unit consisted of four projects:

- Kansas City, MO - Financial Options for Energy Efficiency
- New Orleans, LA - Reducing the Energy Cost Burden on Low Income Residents
- San Francisco, CA - Public Housing Energy Efficiency through Private Financing
- Montgomery County, MD - Master Meter Conversion Manual for Multi-Family Structures

UNIT -- ENERGY MANAGEMENT AND ECONOMIC DEVELOPMENT

Designed to identify relationships between energy management and economic development, defining appropriate local government roles and responsibilities in both areas, this Unit consisted of three projects:

- Dade County, FL - Energy Economic Development
- New York, NY - Integrating Energy Management with Economic Development
- San Antonio, TX - Energy and Economic Development

Project and Unit Reports summarize results from each of these projects in a format specifically designed to ease the transfer of proven experience to other local governments. Readers interested in obtaining any of these reports or further information about the Energy Task Force and the Urban Consortium should contact:

Energy Program
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Harold E. Mowry	- Superintendent of Squaw Peak Water Treatment Plant
Frank S. Peworski	- Superintendent of Verde Water Treatment Plant
C. R. (Bob) Shields	- Superintendent of Val Vista Water Treatment Plant

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CHAPTER 1:
OVERVIEW

Abstract

The total annual energy cost for water supply in the City of Phoenix for the fiscal year 1980-81 was $7 million. Of this, energy costs for water treatment for the four water treatment plants serving the City was over 1 million dollars. The study and research performed under this grant focuses on the energy cost saving opportunities in water treatment.

Elements of major energy consuming functions in water treatment include electric motor-driven raw water pumps and treated water booster pumps, and electrical energy consumption from lighting, heating, ventilation, air conditioning and power driven process equipment.

The objective of this project was to study the process and equipment used in water treatment, exclusive of booster pumping, and to identify cost saving alternatives. Both the analytical approaches as well as results are transferable to other urban areas.

The research plan included the identification and analysis of existing water treatment methods and equipment for possible energy savings. It also included energy audits of building heating, ventilating and air-conditioning (HVAC) and lighting systems to identify energy conservation measures (E.C.M.'s).

It was found that pumping constituted the most energy intensive function in the water treatment system, using 70% of the total. Treatment processes such as flocculation and coagulation accounted for 20% of the yearly energy figure, while building related energy usage (HVAC and Lighting) used the remaining 10%. The total energy bill for those functions in Phoenix' four water treatment plants for the test year 1981-82 was $1,472,346 from Table No. 2 (Page 15).

The analysis performed in this report revealed that 15% of the yearly energy usage of the system, or approximately $165,706 per year, can be saved through the implementation of low cost/no cost conservation techniques with moderate capital cost investments, another $65,737 per year savings (6.4%) can be realized.

Combining the Chemical Cost Reduction E.C.M., (non electrical energy) this report identifies total savings in excess of $231,000 per year.

Project Purpose and Work Plan

The purpose of this project was to identify and assess the potential for energy cost reductions in the operation of the four water treatment plants in the City of Phoenix. Additionally, the project sought to develop analytical methods and approaches that could be utilized by other jurisdictions seeking to reduce their water treatment-related energy costs.

Because of concurrent contractual work which focused on the water distribution system, this project was limited to the energy using functions in the water treatment area. Additionally, an effort was made to differentiate between those conservation measures which involve little or no capital cost to implement and those for which a moderate or significant capital cost is required.

Project Purpose and Approach

This project was aimed at identifying and evaluating low cost and capital cost energy conservation measures in the operation of the four City of Phoenix Water Treatment Plants. Emphasis was placed on in-plant pumping and treatment process optimization including:

Peak demand shaving

Pump efficiency evaluation

Improved Maintenance

Off-peak scheduling and similar strategies

Additionally, E.C.M.'s were evaluated for the HVAC and lighting functions of the buildings at the treatment plants.

The work plan for this project was divided into several subtasks as follows:

Task #1 - Data Collection: Data gathering for the project was divided into four groups. Group I includes all raw water pumping equipment. The data consists of make and model, type, horse power, pump capacity curves and driving unit load curve, suction and supply head. Group II involved treatment process data describing the sedimentation, coagulation, flocculation filtration and storage processes. Group III included data pertaining to heating ventilating and air conditioning used in building facilities. Group IV included data pertaining to the lighting system, interior and exterior.

Task #2 - Energy Analyses and Study - Pumping: This task consisted of the study of water pumping systems at the plants. Emphasis was given to pumping strategies with the object of achieving maximum efficiency in all pumping configurations. The energy analysis considered such factors as daily pumpage requirements, frictional head loss, and pump efficiency curves and was done according to professional engineering standards. The analysis included testing and measurements of pilot performance programs. Computation of energy saving opportunities identified as a result of energy audit were included. Design parameters of the proposed modification were developed.

Task #3 - Energy Analysis and Study - Water Treatment Process: In the task the various stages of water treatment such as coagulation, flocculation, sedimentation, filtration and storage were analyzed with regard to improvements in energy efficiency. It included the study of possible changes in operating procedures and management of energy usage in water production. The methodology used involved four steps; the review of plan statistics and records, the comparison of performance vs. design data to establish process efficiencies, the analysis of possible variations in process parameter, and the evaluation of alternatives.

Task #4 - Energy Conservation Analysis of Building Mechanical Systems and Lighting: This task involved audits of energy usage in HVAC, lighting and other utility functions in water treatment plants.

Task #5 - Final Report Preparation: This task involved the publication of a final report. The final report serves the following objectives.

a) Results adoptable by City of Phoenix and transferable to other jurisdictions.
b) Management reporting with recommendations.
c) Technical evaluation study report in support of the recommendations.

Report Organization

This report is divided into eight main chapters as follows:

Chapter 2 presents an overview of energy usage in the Phoenix water treatment plants. The major energy using functions in each of the four treatment plants are described, along with their associated energy usage.

The potential for reducing energy costs in water pumping at the treatment plant is presented in Chapter 3, along with capital costs and possible savings for each alternative.

Chapter 4 presents an analysis of energy conservation measures applicable to specific water treatment processes such as coagulation and filtration. Again, energy and cost savings are identified.

Chapter 5 identifies the energy and cost savings possible through the implementation of energy conservation measures in the heating, ventilation and air conditioning systems of treatment plant buildings.

Energy usage reductions in buildings lighting systems are presented in Chapter 6.

Having identified a number of potential energy and cost saving measures, the City of Phoenix developed a plan, based on local constraints and funding sources, for implementation. This plan is presented in Chapter 7.

Finally, the lessons learned during the course of this project and the suggestions for similar undertakings in other jurisdictions are presented in Chapter 8.

Additional information regarding various aspects of the project is included in the appendices.

CHAPTER 2:
ENERGY USAGE IN PHOENIX WATER TREATMENT PLANTS

Introduction

The City of Phoenix has four water treatment plants, as follows. (See Fig. 1)

Verde Water Treatment Plant

Squaw Peak Water Treatment Plant

Deer Valley Water Treatment Plant

Val Vista Water Treatment Plant

These plants range in output from 30 million gallons per day (MGD) to 110 MGD, with a total output of 320 MGD, and serve an area of 331 sq. miles with a population of 996,340 people.

The City of Phoenix is one of the fastest growing in the country, in one of the fastest growing states. Thus, energy conservation becomes more important each day. Energy Conservation Measures (E.C.M.'s) are defined in this study as pertaining to:

Pumping

Water Treatment Process

Heating, Ventilating and Air Conditioning of the Facility (HVAC)

Lighting (interior & exterior)

These areas were studied and analyzed to identify E.C.M.'s and to interface and evaluate their cost effectiveness.

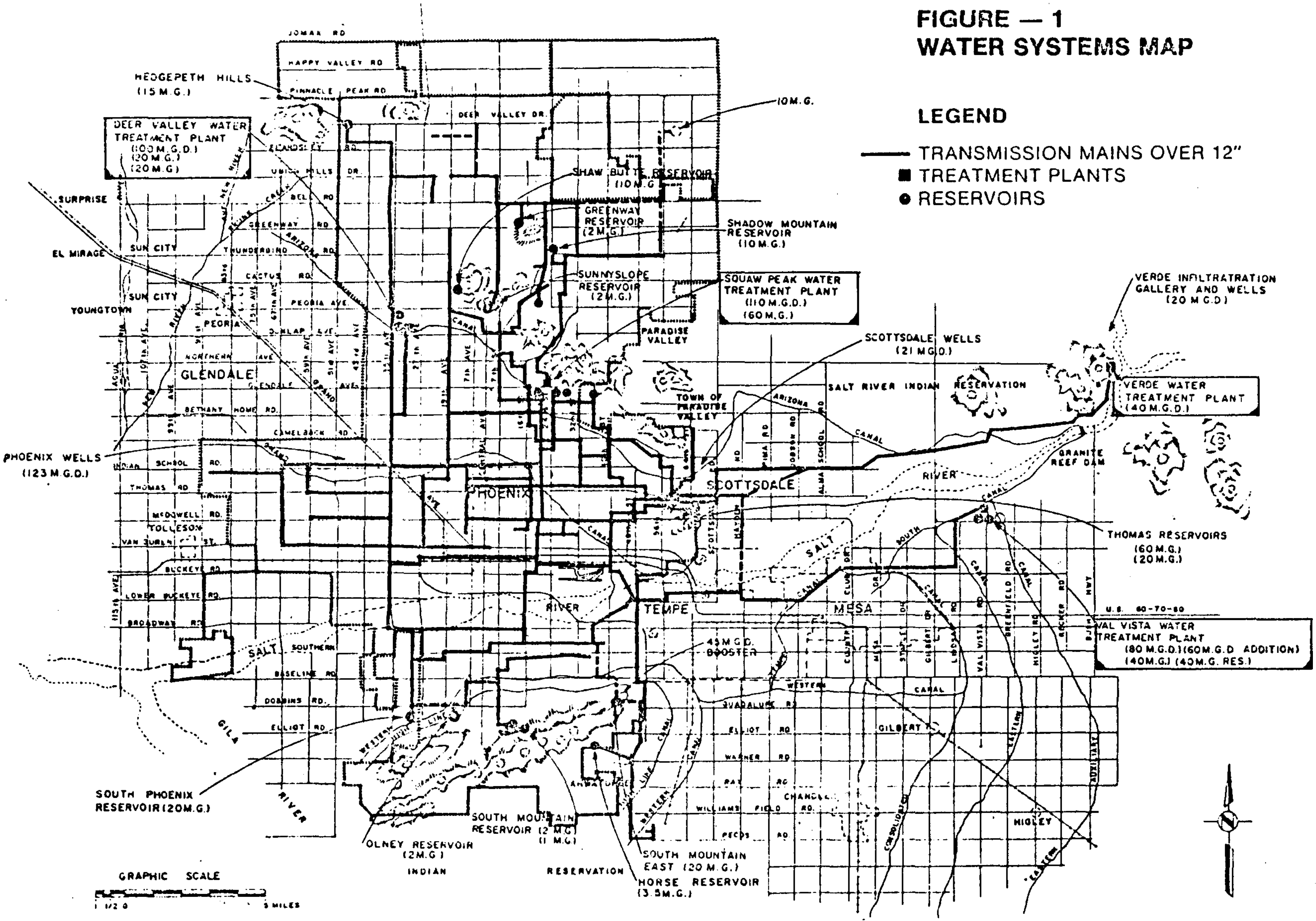


FIGURE — 1
WATER SYSTEMS MAP

History and Overview of Phoenix Water System

The first water works system for the City of Phoenix was developed by a private water company in 1888. The original supply was derived from two wells in what is now the downtown area. This private water system was purchased by the City in 1906, and improvements were made by constructing wells and a pumping station in what is now Verde park. From these humble beginnings the City of Phoenix Water Supply System has grown many fold and is now obtained from multiple sources, namely; an infiltration gallery and 14 shallow wells along the Verde River. The 4 large treatment plants considered here (the 30 MGD Verde Water Treatment Plant, the 110 MGD Squaw Peak Water Treatment Plant, the 100 MGD Deer Valley Water Treatment Plant and the 80 MGD Val Vista Water Treatment Plant with 60 MGD addition nearing completion), and some 114 wells in the Phoenix, Deer Valley, Paradise Valley and Scottsdale areas. The total amount of water that can be produced from all of these sources is 449 million gallons per day.

Storage for the water supply is provided by twelve 20 MG, one 15 MG, one 10 MG, two 5 MG reservoirs and some 37 smaller reservoirs. They provide a total storage capacity of 308 million gallons.

The Water Distribution System which is 331 square miles in area, transports water to some 276,761 homes, businesses and factories through a network of 4,275 miles of pipes varying in size from 2 inches to 108 inches in diameter.

The City of Phoenix served water to more than 996,339 people, who used an average of 234 million gallons of water per day in 1980-81. The daily use varied from a low of 126 million gallons per day in the winter to a high of 400 million gallons per day in the summer. The peak use for a single hour only in the summertime was at the rate of 484 million gallons per day.

A study of the Water Supply System of the City of Phoenix could not be comprehensive without a brief description of the Salt River Project. This entity supplies electric power for a significant portion of the Central Arizona Valley (approx. a 2500 Megawatt utility) but more significantly the SRP controls and operates the 7 main dams on the Salt and

Verde rivers. These rivers supply most of the water to the entire Central Arizona Valley at present, from a 13,000 sq. mi. watershed in Arizona's central and eastern mountain areas. This water is supplied to 3 of the 4 Phoenix water treatment plants through an extensive canal system. River flows and canal maintenance impact on the availability of raw water to the Phoenix system thus affecting each plant's operating time.

As shown in Figure 2, the water supply system of Phoenix can be divided into two major functions; namely, treatment and distribution. The focus of this study is on the treatment aspects of the system which accounts for 16% of the total amount of energy used by the system. The distribution system, which utilizes the other 84% of the total energy requirement, was part of other concurrent studies.

The treatment component of the water supply and distribution system is defined in this study to include the functions of raw water pumping, water treatment processes such as coagulation and filtration and the HVAC functions and lighting of treatment plant buildings. In one of the treatment plants, pumps used to supply water to the distribution system are included because of a common utility meter.

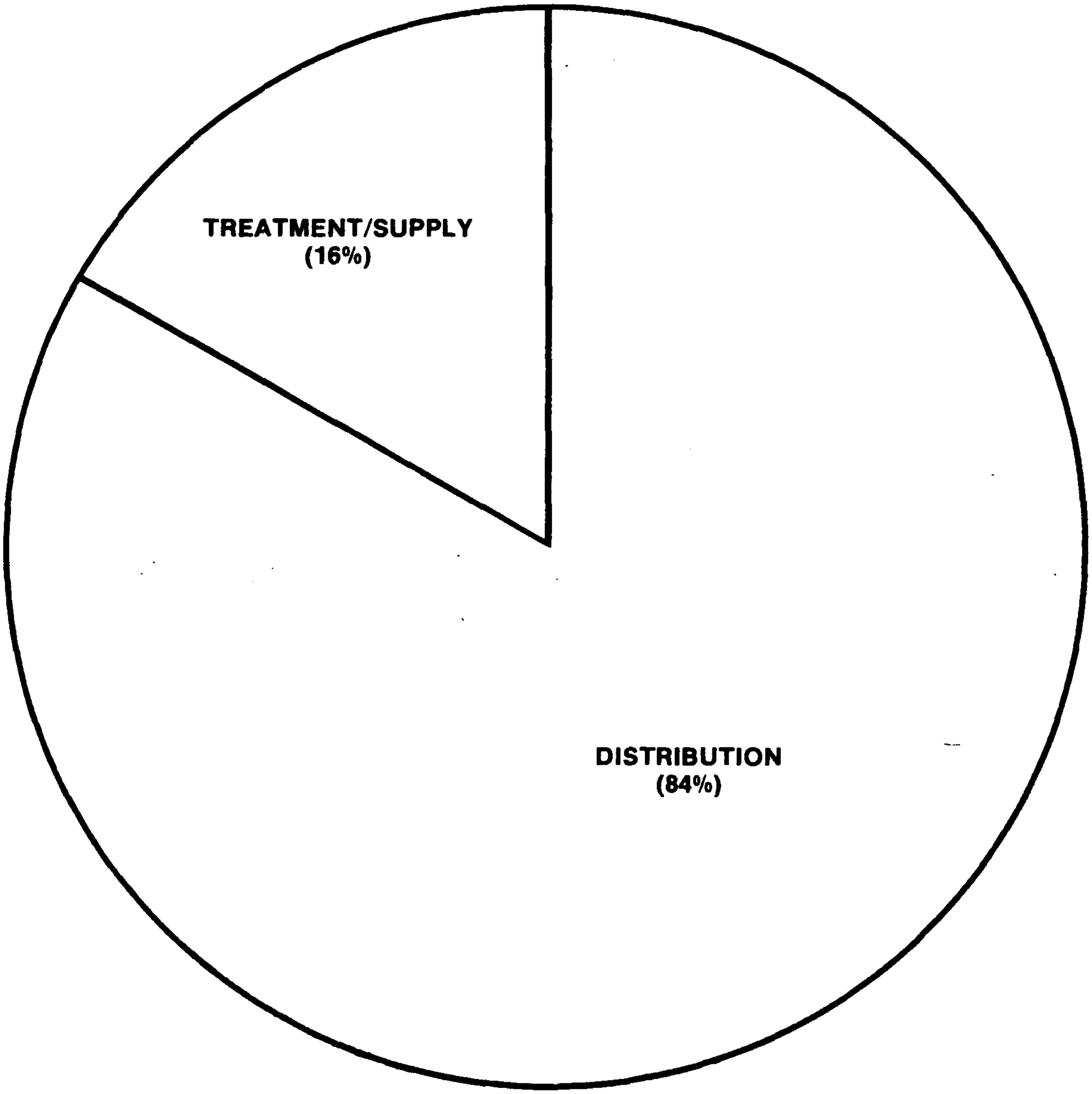
Description of Phoenix Water Treatment Plants

Each of the four major treatment plants which supply potable water to the Phoenix water system are described below.

Verde Water Treatment Plant

The Verde Water Treatment Plant is located approximately 30 miles east of downtown Phoenix on the Salt River Indian Reservation near the confluence of the Verde and Salt Rivers. This system was first established in the early 1920's when the City of Phoenix constructed 30 miles of redwood pipeline from the Verde River on the Ft. McDowell Indian Reservation to what is now central Phoenix. This system supplied through gravity feed 14 million gallons per day (MGD) of water to the growing city. In 1930 a larger concrete pipe system was installed, some of which is still operable today. In 1948 the 30 MGD water treatment plant was

FIGURE — 2
ENERGY USAGE IN THE PHOENIX WATER SUPPLY AND DISTRIBUTION SYSTEM



constructed which takes raw river water from the Verde River just upstream of the confluence and from the Salt River just downstream of the confluence. Pumping is required to lift the water from both river intakes, however, it is gravity fed to the distribution from that point on. Over and above the 30 MGD normal operating level, the plant can produce up to 40 MGD. This capacity can be delivered through the aid of the Evergreen Booster Station located approximately 12 miles west of the plant.

The Verde Plant is important in the system because it is the only plant that can operate independently of the Salt River Project (SRP) canal system. The SRP canals are "dried up" once per year for maintenance during the low demand season of October, November and December. Thus the Verde Plant and the well system take on adding importance at this time as the City's source of water.

Squaw Peak Water Treatment Plant

The Squaw Peak Water Treatment Plant, located in the central Phoenix area, was built in 1954 with an initial capacity of 30 million gallon per day. In 1960, a 60 MGD addition was placed into service increasing the total to 90 MGD and in 1964, an additional 20 MGD capability was added, bringing a peak output capability to date of 110 MGD. A booster station was added in 1975, to supply up to 48 MGD to the expanding Paradise Valley area north of the Phoenix Mountains. Raw water is supplied to the plant from the Salt River Project Arizona Canal, which flows westward just south of the plant. Production water is supplied to the distribution system by 5 main lines, 2 of which are gravity fed and 3 which utilized booster pumps. As in three of the four water treatment plants addressed in this study, Squaw Peak is making increased use of liquid alum and other liquid chemicals, replacing the dry type chemical feed process. This activity is an energy conservation measure in that hoisting, conveying and electrical material handling equipment is not operated as much, thus conserving power.

Deer Valley Water Treatment Plant

The Deer Valley Water Treatment Plant is located in Phoenix, west of the interchange at Dunlap and Interstate 10. The plant was built in 1964 with an initial capacity of 80 million gallons per day. In 1981, a 20 MGD filtering modification was affected, bringing the plant to its present 100 MGD capacity. Raw water is supplied to the plant from the Salt River Project Arizona Canal, which flows just to the north of the plant. The raw water is pumped to the sedimentation basin area and flows through the plant to a finished water pumping station for distribution to the system.

There are eight primary sedimentation basins followed by eight coagulation basins. Effluent from the basins goes to eight double fillers. Plant chemical use includes alum, lime, carbon and chlorine. Increased use is made of liquid alum and other chemicals, replacing the dry type chemical feed process. This conserves energy as hoisting, conveying and other electrical material handling equipment are not operated.

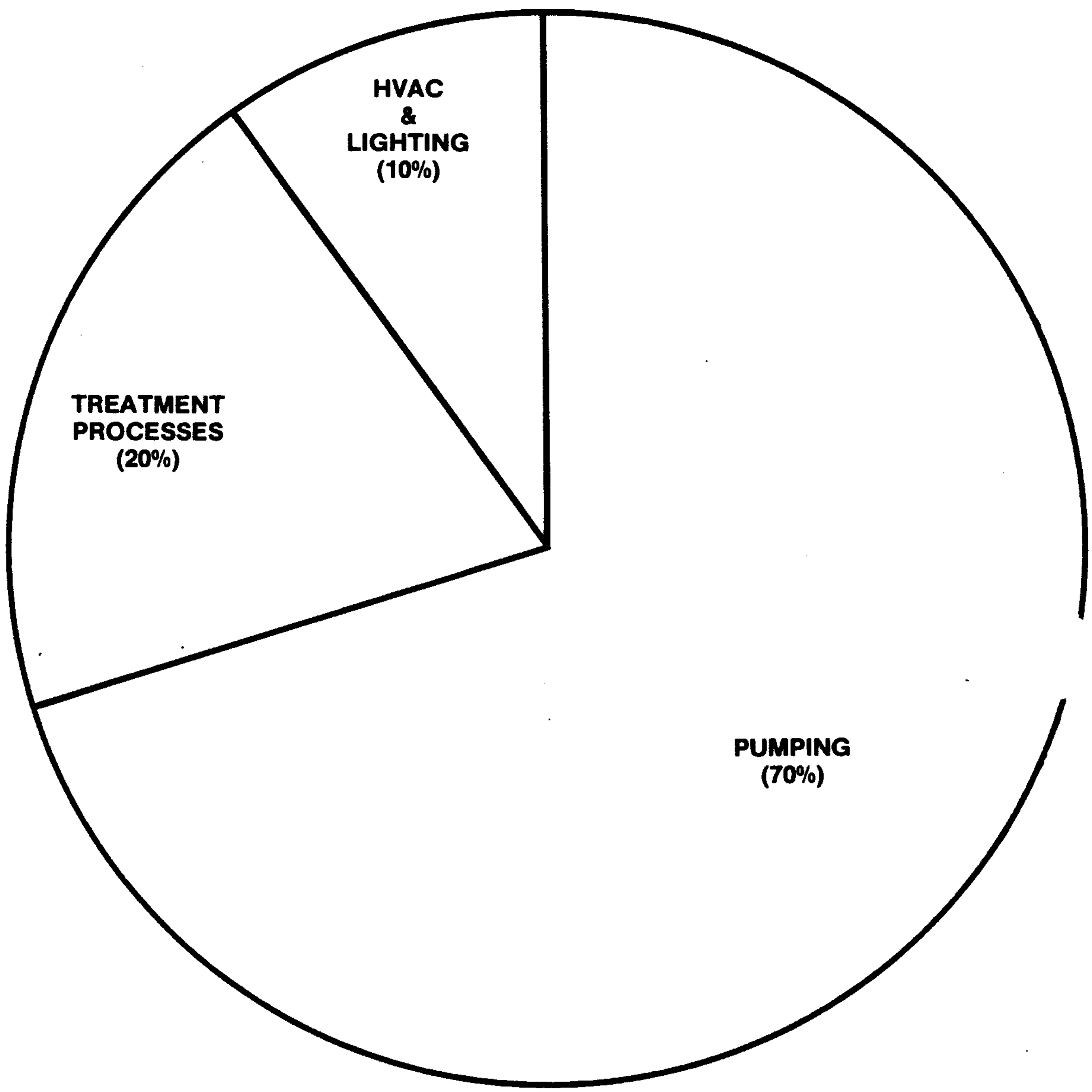
Val Vista Water Treatment Plant

The Val Vista Water Treatment Plant is located east of Phoenix and northeast of the City of Mesa, Arizona, near the intersection of each McDowell Road and Val Vista Road. The plant was built in 1974, with an initial capacity of 80 million gallons per day. A 60 MGD addition to the facility (90% complete) is scheduled to go into operation sometime in 1983. Raw water is supplied to the plant from the Salt River Project Southern Canal, which flows along the north boundary of the plant. Production water is supplied to the Phoenix distribution system by gravity flow through approximately 15 miles of transmission lines varying in size from 108 to 72 inches. Water can also be delivered to the City of Mesa system from these same lines.

Treatment Plant Energy Intensive Functions

The chart in Figure 3 illustrates the relative amounts of energy used by the energy intensive functions of the Phoenix water Treatment plants. As can be seen, 'pumping accounts for the major portion of energy utilized, about 70% of the total energy figure. Pumps are mainly used to move raw water from the water source (rivers or canals) into the treatment plant as well as move water through the plant.

FIGURE — 3
TREATMENT PLANT ENERGY USAGE



Treatment processes account for another 20% of the total energy usage. These processes include flocculation, sedimentation, filtration and disinfection. Flocculation and sedimentation are processes that are jointly used to remove fine suspended particles from the water. Filtration is used to remove even finer particles that remain in the water following the first two processes. Finally, treated water is disinfected to kill potentially harmful bacteria.

The remaining 10% of the energy used is used for the heating, ventilating, air conditioning, (HVAC) and lighting of buildings at the treatment plants.

Energy Usage - Phoenix Water Treatment Plants

Energy usage for the Verde, Squaw Peak, Deer Valley and Val Vista water treatment plants, in terms of kilowatt hours (kwh) per year, is indicated in Table 1. Also indicated are the amounts of water treated as well as the yearly energy costs. As is shown, the total treatment plant energy costs for a period in 1981-82 were $1,472,346.

Table 2 provides a breakdown of the relative distribution of energy usage among the four energy intensive functions for each of the four treatment plants. As is shown, pumping is the primary energy user for each of the plants, followed by treatment processes, HVAC systems, and lighting respectively. The differences between Table 1 and Table 2 energy costs, are due to the unavoidable combined billing at the Deer Valley Plant and the extrapolation of figures in Table 2. to represent a "typical" years operation costs reflecting the also unavoidable "down" times of each plant. This "down" time is caused primarily by the Salt River Project's control of the flows of raw water that feed the Phoenix system.

Table 1 -- Energy Usage in the Phoenix Water Treatment Plants

	Plants			
	Verde	Squaw Peak	Deer Valley	Val Vista
Electric rate per KWH	(4.40¢)*	(4.26¢)*	(4.46¢)*	(4.63¢)*
Energy Usage				
KWH/yr.	2,628,800	6,518,800	17,592,000**	6,358,000
KWH/mo.-high	281,600 (Avg.)	1,228,800 (July)	2,384,000 (Avg.)	804,000 (Avg.)
-low	16,000 (Feb.)	79,000 (April)	528,000 (Nov.)	66,000 (Nov.)
Water Treated				
MM Gal./yr.	7,428	16,156	20,126	11,373
MM Gal./mon.				
-high	894	3,025	2,719	2,047
-average	612	1,329	1,650	930
Total Annual Energy Cost	$ 115,667	$ 277,701	$ 784,603	$ 294,375

* Present rates vary due to quantity plateaus.

** The figures included here are from billing invoices of the total plant consumption including raw water pumping, all processing equipment operation, HVAC and lighting systems, but do not include distribution (booster) pumping operations except in the case of Deer Valley which includes distribution pumping due to combined power metering. It is estimated that the distribution (booster) portion of this figure is approximately $450,000.

Table 2 -- Treatment Plant Energy Costs - Percentage Breakdown

	Plant Energy Costs*				
Function	Verde	Squaw Peak	Deer Valley	Val Vista	Total
Pumping	$110,252	$302,235	$ 97,029	$195,939	
Treatment Processes	9,606	39,493	60,394	90,020	
HVAC	5,541	5,168	8,033	10,277	
Lighting	4,423	12,519	23,751	29,699	
Total Annual Energy Cost	$129,822	$359,415	$189,207	$325,935	

Plant Energy Costs - Percentages (%)

Function	Verde	Squaw Peak	Deer Valley	Val Vista	Total
Pumping	85	84	51	60	70
Treatment Processes	7.3	11	32	28	20
HVAC	4.3	1.4	4.3	3	3
Lighting	3.4	3.6	12.7	9	7

* The figures indicated here are in current costs of $0.048 per KWH, $0.383 per therm and $0.72 per gal propane. The base periods for these functions vary due to available data, but have been extrapolated for comparison where necessary to represent a typical 12 month operating year during the 1981-82 period including an average scheduled "down" time of 45 days per year per plant. These figures have been used to determine and present cost savings comparisons in dollars and percentages in Chapter Seven.

CHAPTER 3:
ENERGY COST REDUCTION - PUMPING

Introduction

The raw water pumps were designed to lift the water from the canals or from the Verde or Salt Rivers and supply it to the inlet of the Process system. These pumps range in size from 75 HP to 500 HP. The most efficient lifting capacity has been analyzed and pump impeller and times of operation have been studied employing the manufacturers pump curves as shown in the case of Squaw Peak Pump #12.

Energy Usage

The following is a step by step procedure listing the pumping and treatment equipment and showing its consumption as analyzed from the operating data acquired at each plant.

The following tables 3-6, summarize total electrical consumption at each of the four plants by major pumping and process function, exclusive of booster pumping. Current cost per function is based on 4.8¢ per kwh:

Table 3 -- Verde Energy Analysis

Base Period: November 1980 - October 1981
Days of Operation in Base Period: 330
Average Cost of Electricity in Base Period: 4.40¢ per kwh

Function	NO. @HP	Consumption (kwh)	Base Period Cost ($)	Current Cost ($)
Raw Water Pumps	(see Table 7)	2,368,600	$104,266	$113,693
Backwash Pumps	1 @ 30 2 @ 25	37,342	1,643	1,792
Sample Pumps	3 @ 0.33	7,186	316	345
Air Compressors	2 @ 7.5	4,000	176	192
High Pressure Pumps	3 @ 20 1 @ 5	5,090	224	244
Grit Collectors	3 @ 3	1,231	54	59
Flocculator Drives	3 @ 7.5	142,432	6,270	6,837
Sludge Rakes	6 @ 5	3,980	175	191
Surface Rate Pump	1 @ 20	5,100	225	245
Total		2,574,961	$113,349	$123,598

Table 4 -- Squaw Peak Energy Analysis

Base Period: November 1980 - October 1981
Days of Operation in Base Period: 326
Average Cost of Electricity in Base Period: 4.26¢ per kwh

Function	NO. @HP	Consumption (kwh)	Base Period Cost ($)	Current Cost ($)
Raw Water Pumps	(see Table 8)	6,412,509	$273,365	$307,800
Clarifier	1 @ 5	7,816	333	375
Sludge Pumps	2 @ 20	60,369	2,574	2,898
Sump Pump	1 @ 2	670	29	32
Bar Screen	1 @ 1.5	853	36	41
Filter Agitator (Plant 1)	1 @ 20	2,165	96	104
Filter Agitator (Plant 2)	1 @ 50	11,609	495	557
Sample Pumps	18 @ 0.25	32,826	1,399	1,576
Air Compressors	various	13,395	571	643
Sludge Drive (Plant 1)	6 @ 1	2,591	110	124
Sludge Drive (Plant 2)	16 @ 1	6,911	295	332
Floc Drives (Plant 1)	6 @ 5	177,153	7,552	8,502
Floc Drives (Plant 2)	16 @ 5	472,397	20,138	22,675
Evaporator Circ. Pump 2	2 @ 1	6,613	282	317
Liquid Alum Pump	1 @ 2	557	24	27
Carbon Mixers (Plant 2)	2 @ 15	41,987	1,790	2,015
Total		7,250,421	$309,085	$348,019

Table 5 -- Deer Valley Energy Analysis

Base Period: January 1981 - December 1981
Days of Operation in Base Period: 221
Average Cost of Electricity in Base Period: 4.46¢ per kwh

Function	NO. @HP	Consumption (kwh)	Base Period Cost ($)	Current Cost ($)
Raw Water Pumps	(see Table 9)	1,396,042	$ 62,263	$ 67,010
Raw Water Agitation Pumps	2 @ 50	395,677	17,647	18,992
Rake Pumps	8 @ 5	893	40	43
Alum Flash Mixers	8 @ 27	659	29	32
Floc Drives	16 @ 5	339,153	15,126	16,279
Sample Pumps	13 @ 0.5	31,280	1,395	1,501
Air Compressors	3 @ 5	13,689	610	657
Carbon Pumps	2 @ 5	11,510	513	552
Carbon Mixers	6 @ 15	8,442	377	405
Pre-Mixer Pumps	4 @ 15	61,398	2,738	2,947
Floc Rakes	16 @ 1	6,247	279	300
Total		2,264,990	$101,107	$108,718

Table 6 -- Val Vista Energy Analysis

Base Period: September 1981 - August 1982
Days of Operation in Base Period: 326
Average Cost of Electricity in Base Period: 4.63¢ per kwh

Function	NO. @HP	Consumption (kwh)	Base Period Cost ($)	Current Cost ($)
Raw Water Pumps	(see Table 10)	4,157,228	$192,480	$199,547
Carbon Mixers	3 @ 15	4,276	198	205
Chlorine Evaporators	2 @ 20	106,798	4,945	5,126
Flocculation Transfer Pump	2 @ 1	7,004	324	336
Air Compressors	2 @ 20	10,692	495	513
Slurry Pump	1 @ 15	2,529	117	121
Filter Agitator	1 @ 100	18,930	876	908
Floc Mixers	various	617,736	28,601	29,651
Clarifier Drives	16 @ 1	9,339	432	448
Alum Pumps	2 @ 20	1,677	78	81
Sample Pumps	5 @ 0.75	26,620	1,233	1,278
Pre-Sedimentation Clarifier Drives	4 @ 1.5	3,411	158	164
Pre-Sedimentation Mixer	1 @ 20	9,504	440	456
Pre-Sedimentation Flash Mix Pump	1 @ 20	107,341	4,970	5,152
Grit Pumps	2 @ 20	30,190	1,398	1,449
Grit Basin Clar.	2 @ 3	4,864	225	233
Bar Screen Equip.	various	4,745	220	228
Plant Water Pumps	3 @ 50	204,285	9,458	9,806
Backwash	2 @ 400	26,307	1,218	1,263
Raw Water Agitator	1 @ 125	713,700	33,044	34,257
Total		6,067,176	$280,910	$291,222

Altogether, almost 80% of the energy consumed at the four plants (exclusive of booster pumping) is attributable to the raw water pumps. The following tables (7-10) summarize the operation of these pumps during the base periods.

Table 7 -- Verde Raw Water Pump Summary

No.	Avg. Flow (GPM)	Avg. TDH	Effi- ciency	Avg. BHP	Nom- inal Horse power	Assumed Mtr. Eff.**	Hrs.	kwh	Base Period Cost ($)
1,2	6,750	68	88.0	131.7	150	0.92	6,649	710,137	$ 31,260
3,4*	13,450	68	87.0	265.5	350	0.935	7,830	1,658,463	73,006
							14,479	2,368,600	$104,266

*Old pumps which have been replaced
**All raw water pump motors at all plants are standard vertical motors.

Table 8 -- Squaw Peak Raw Water Pump Summary

No.	Avg. Flow (GPM)	Avg. TDH	Effi- ciency	Avg. BHP	Nom- inal Horse power	Assumed Mtr. Eff.**	Hrs.	kwh	Base Period Cost ($)
1	8,000	66]	90.0	149.2	150	0.925	1,211	145,761	$ 6,214
2	8,000	66]	89.8	149.6	150	0.925	817	98,588	4,203
3	12,300	66]	87.5	236.1	250	0.935	2,054	386,881	16,493
4	13,000	66]	90.0	242.5	250	0.935	0	0	0
5	13,650	69	86.8	274.0	300	0.940	1,487	323,384	13,786
6	13,500	69	87.0	270.4	300	0.940	6,741	1,446,403	61,660
7	13,500	69	86.5	272.0	300	0.940	4,913	1,060,396	45,205
8	6,350	69	80.5	137.4	150	0.925	1,898	210,376	8,968
9	6,350	69	81.6	135.6	150	0.925	4,386	479,507	20,440
10	3,225	69	85.3	65.9	75	0.910	3,048	164,669	7,020
11	3,250	69	85.8	66.0	75	0.910	405	21,911	934
12	14,600	69	84.5	301.1	300	0.940	8,683	2,074,634	88,442
						Totals	35,643	6,412,509	$273,365

The MGD plant built in 1954 is known as Plant 1 and is served by raw water pumps 1 through 4. Pumps 5 through 12 serve the 80 MGD Plant 2. These plants are completely separate until reaching the storage reservoirs.

Table 9 -- Deer Valley Raw Water Pump Summary

No.	Avg. Flow (GPM)	Avg. TDH	Effi-ciency	Avg. BHP	Nom-inal Horse power	Assumed Mtr. Eff.**	Hrs.	kwh	Base Period Cost ($)
1	3,220	25	83.4	24.37	30	89.0	351	7,171	$ 320
2	6,450	25	85.3	47.74	60	90.5	1,921	75,588	3,372
3	13,350	25	84.0	100.34	125	92.0	1,794	145,949	6,509
4	13,500	25	84.5	100.86	125	92.0	4,667	381,695	17,023
5	13,425	25	86.2	98.32	125	92.0	4,272	340,591	15,191
6	13,500	25	84.8	100.50	125	92.0	1,209	98,528	4,394
7	13,475	25	84.9	100.20	125	92.0	2,402	195,159	8,704
8	13,450	25	84.2	100.85	125	92.0	1,851	151,360	6,751
						Totals		1,396,042	$62,263

Table 10 -- Val Vista Raw Water Pump Summary

No.	Avg. Flow (GPM)	Avg. TDH	Effi-ciency	Avg. BHP	Nom-inal Horse power	Assumed Mtr. Eff.**	Hrs.	kwh	Base Period Cost ($)
1	6,625	57	86.5	110.3	150	0.92	2,161.5	193,248	$ 8,948
2	14,000	57	87.0	231.7	300	0.93	3,822	710,212	32,882
3	26,500	57	86.7	440.0	500	0.94	4,425	1,545,129	71,540
4	26,500	57	86.7	440.0	500	0.94	4,533.5	1,583,015	73,293
5	26,500	57	86.7	440.0	500	0.94	363	126,753	5,869
6	6,500	57	86.7	440.0	500	0.94	0	0	0
					Totals		15,305	4,157,228	$192,480

Selection of on-line pumps in response to total production demand is done primarily on the basis of maintaining relative equality of running hours for like-sized pumps. Consideration is also given to obvious deficiencies such as the noticeable difference between the capabilities of No. 1 and No. 2 at Verde (No. 1 is currently not in use and is scheduled for replacement).

Low Cost - No Cost ECM's

All Savings are based upon a current cost of 4.8¢ over kwh.

1. Establish Pump Priorities

Tables (7-10) were developed by first comparing metered raw water flows with individual pump running times and rated capacities. Table 11 shows this comparison, using Squaw Peak as an example. The figures in the "Nominal Pumpage" column are derived by multiplying actual run times for each pump during each month of the base period by the pump's nominal design flow rate. For example, in November, 1980, pump number 5 ran for 303 hours, number 9 for 276 hours, number 10 for 10 hours, and number 12 for 276 hours. Therefore:

Pump 5: 303 Hours x 60 Min/Hour x 14,000 Gal/Min = 254.52 MG

Pump 6: 276 Hours x 60 Min/Hour x 7,000 Gal/Min = 115.92 MG

Pump 10: 10 Hours x 60 Min/Hour x 7,000 Gal/Min = 4.20 MG

Pump 12: 276 Hours x 60 Min/Hour x 14,000 Gal/Min = 231.84 MG

Total Nominal Pumpage for November, 1980 = 606.48 MG

Repeating this process for each month, and comparing to the metered flows, we have:

Table 11 -- Squaw Peak Nominal vs. Metered Flow

	A Nominal Pumpage (MG)	B Metered Flow (MG)	B/A Ratio (%)
Nov 80	606.48	553.20	91.2
Dec	626.64	601.214	95.9
Jan 81	1,076.88	(missing)	---
Feb	761.88	706.104	92.7
Mar	1,229.34	1,172.792	95.4
Apr	2,252.88	2,108.31	93.6
May	2,991.42	2,789.442	93.2
Jun	3,440.31	3,182.04	92.5
Jul	3,315.0	3,095.474	93.4
Aug	2,726.94	2,667.116	97.8
Sep	2,453.22	2,341.71	95.5
Oct	1,837.08	1,805.099	98.3
Total Excl. Jan:	22,241.19	21,022.501	94.5

* * *

Thus, the average pumping capability of the pumps is 94.5% of the rated capacity.

Next, the individual pump curves are examined in an iterative process to determine each operating point, such that the following conditions are met:

1) average flow rate is 94.5% of nominal;
2) total head is the same for all pumps in Plant 1 and for all pumps in Plant 2 at Squaw Peak.

This process locates a point on each set of pump curves. For example pump no. 12 at Squaw Peak is found to be operating at an average of 14,600 gpm at 69 feet TDH (see curve). Note that this particular pump produces more than its nominal rating, (which is 14,000 GPM at 75 feet TDH), whereas the other 20 MGD pumps at Squaw Peak produce less. However, the efficiency of no. 12 happens to be lower than that of the other 20 MGD pumps. This process of operating point identification is accomplished on the "family of curves" for the particular model of pump at its specific speed as exemplified by Figure No. 4, as opposed to the test curve supplied with the individual pump. This is because the flow versus head relationship for the pump changes as the impeller ages. In other words, a test curve supplied years ago for a pump which is no longer new no longer represents the characteristics of the pump.

The "family of curves" shows the interdependent relationship between head, flow, efficiency and brake horsepower for the entire range of possible conditions which the pump may encounter, regardless of the age of the pump or the condition of the impeller. Moreover, since the head conditions encountered by a pump rarely match the design head, it is imperative that this process be completed on the "family of curves."

Once the operating point is identified, the efficiency is known and the brake horsepower is calculated from: $BHP = \frac{QH}{3960E}$

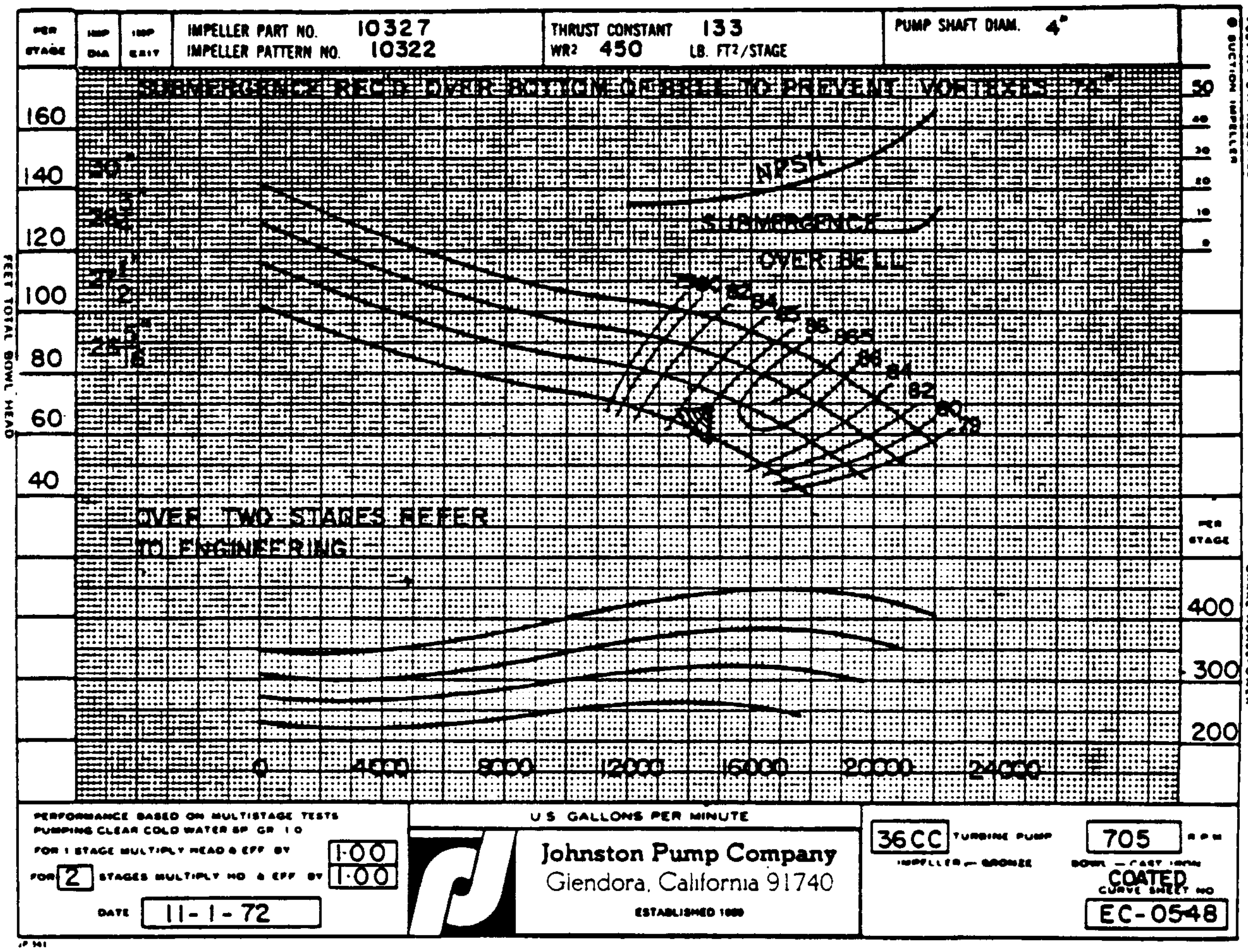
where Q = flow rate in gpm

H = total head in feet

E = pump efficiency

Once the pump summaries (Tables (7-10)) are completed, the cost per million gallons for each pump is calculated by dividing the cost (as presented in Tables 7-10) by the total pumpage (flow rate in gpm x 60 x pumping time, as shown above). The result of this is described in Table 12.

FIGURE — 4
SQUAW PEAK RAW WATER PUMP #12



Section 4E

March 10, 1975

Table 12 - Raw Water Pumping Costs per Million Gallons

Deer Valley Pump No.	Deer Valley Cost/MG	Squaw Peak Pump No.	Squaw Peak Cost/MG	Val Vista Pump No.	Val Vista Cost/MG	Verde Pump No.	Verde Cost/MG
1	$ 4.72	(Plant 1)		1	$10.42	1,2	$12.65
2	4.53	1	$10.69	2	10.24	3,4	12.61
3	4.53	2	10.72	3	10.16		
4	4.50	3	10.88	4	10.16		
5	4.41	4	10.57	5	10.16		
6	4.48	(Plant 2)		6	10.16		
7	4.48	5	11.32				
8	4.52	6	11.29				
		7	11.36				
		8	12.40				
		9	12.23				
		10	11.90				
		11	11.83				
		12	11.63				

The next step in establishing pump priorities is to examine the day-to-day pumping strategy at each plant to identify an optimum strategy for favoring the more efficient pumps as much as possible without altering daily total production. Table 12 quantifies this, again using Squaw Peak as an example. Only the often used pumps 10 mgd and above are considered for the base year.

Table 13 - Squaw Peak Raw Water Pump Optimization

Base Year Operation Pump	Hours	MG	Cost	Proposed Alternative Pump	Hours	MG	Cost
12	8,683	7,606.3	$ 88,442		Plant I		
6	6741	5,460.2	61,660	4	8,680	6,770.4	$ 71,587
7	4,913	3,979.5	45,205	1	8,680	4,166.4	44,539
3	2,054	1,515.85	16,493		Plant II		
5	1,487	1,217.85	13,786	9	8,200	3,124.2	38,209
4	0	0	0	6	5,040	4082.4	46,101
9	4,386	1,671.1	20,441	5	4,680	3,832.9	43,388
8	1,898	723.1	8,968	7	244	197.6	2,245
		22,173.9	$254,995			22,173.9	$246,069

* * *

Thus, the base year savings for Squaw Peak (at 4.263¢ per kwh) is $8,926, or $10,050 at 4.8¢ per kwh. Table 14 summarizes these savings for all four plants.

Table 14 - Savings Due to Preferential Pump Operation

Site	Base Period Days	Preferred Order	kwh Savings	Dollar Savings
Deer Valley	221	5, 7, 6, 4, 8, 3 (20 MGD pumps only)	4,172	$ 200
Squaw Peak	326	4, 3, 6, 5, 7, 12 (20 MGD pumps only)	209,375	10,050
Val Vista	326	5, 6, 3, 4, 2, 1	3,230	155
Verde		(keep #1 out of service until replaced)		
		Totals	216,777	$10,405

In the case of Squaw Peak, the savings is substantial because of the differing total head conditions between Plant 1 and Plant 2. From an energy standpoint, Plant 1 costs less to operate and should be operated at 30 MGD whenever Squaw Peak Plant is on line.

The most efficient way to operate Plant I at Squaw Peak is with Pump 4 and 1 (30 MGD total). When the required production is 40 MGD, as it was for 8,200 hours during the base year, run the most efficient 10 MGD Pump in Plant II to provide the remainder (Pump No. 9). Then to meet a demand of 60 MGD, add Pump No. 6 as shown, and so forth.

Should any pump be out of service for any reason, select like sized pump with the next lowest cost per MGD.

2. Bypass the Deer Valley Pre-Sedimentation Basins

Whenever influent quality permits, the Deer Valley Pre-Sedimentation Basins should be bypassed. The two-foot decrease in total head reduces pumping costs by over 8%. During the 221 days of operation in the base year, this would have saved 113,540 kwh, worth $5,450. On an 80 MGD day, the savings is 705 kwh, worth almost $34. In this mode, the preferred order of 20 MGD pumps mentioned in Table 14 (5, 7, 6, 4, 8, 3) should be changed to 8, 7, 6, 4, 3, 5.

3. Remove a Stage From the Val Vista Plant Water Pump

By removing one of the eight stages in the lead plant water pump at Val Vista, the full speed capacity would be reduced from 500 gpm to around 370 gpm. This reduces the full speed brake horsepower of the lead pump by over 9 BHP, while increasing the average variable speed drive efficiency of both the lead and second pump while reducing the volume of water being dumped back to the reservoir.

Assuming that 500 gpm meets the total demand 90% of the time and 370 gpm meets demand 60% of the time, the average input horsepower savings will be almost 13%, saving 26,050 kwh (worth $1,250) in a 326-day operating year.

Capital Cost Measures

All savings are based upon a current cost of 4.8¢ per kwh.

1. Replace Val Vista Raw Water Agitation Pump

The agitation of the Val Vista raw water suction well can be accomplished with low pressure air rather than high pressure water, by installing a 15 horsepower blower to deliver approximately 250 cfm at 9 psi through the existing distribution piping with appropriate revisions. This would replace the 125 horsepower pump currently in use.

During the 326-day base year, the agitation pump used 713,700 kwh, whereas the blower would use approximately 95,000 saving 618,700 kwh, worth $29,698.

Estimated installation costs are:

Blower with appurtenances	$16,500
15 x 10 blower house on slab	4,000
Piping and orifice revisions	3,300
TOTAL	$23,800

Simple payback would be 0.8 years.

2. Replace Deer Valley Raw Water Agitation Pumps

This measures is essentially the same as No. 1 above. In a 221-day operating year, the 15 horsepower low pressure air system would use 64,400 kwh, compared to 395,677 kwh currently consumed by the two 50 horsepower pumps. The 331,277 kwh savings would be worth $15,900, recovering the $23,800 investment in 1.5 years.

3. Replace the Impeller in Squaw Peak Raw Water Pump No. 12

Replacing the worn 27-1/2 inch impeller with a new 27-5/8-inch impeller would increase the flow capability from 14,600 gpm to 16,500 gpm at 69 feet TDH. Brake horsepower would increase from 301.1 to 334.3, utilizing the service factor of the motor to quite an extent (confirmation of the service factor is recommended). Base year savings would be 39,710 kwh, worth $1,906.

The estimated cost would be $8,000, with a simple payback of 4.2 years. Note: this measure is only cost-effective if Low Cost Measure No. 1 for Squaw Peak is not implemented.

4. Replace the Impeller in Squaw Peak Raw Water Pump No. 9

Replacing the 17-13/16 inch impeller with an 18-1/2 inch would increase the flow capability from 6,350 gpm to 7,500 gpm at 69 feet TDH. Brake horsepower would increase from 135.6 to 152.0, utilizing the service factor of the motor, and improving pump efficiency to approximately 86.0%. Base year savings would be 28,850 kwh, worth $1,385.

The estimated cost would be $6,000, with a simple payback of 4.3 years. Note: this measure is only cost-effective if Low Cost Measure No. 1 for Squaw Peak is not implemented.

5. Replace the Impeller in Squaw Peak Raw Water Pump No. 8

Replacing the 17-13/16 inch impeller with an 18-1/2 inch would increase the flow capability from 6,350 gpm to 7,500 gpm at 69 feet TDH. Brake horsepower would increase from 137.4 to 152.0, utilizing the service factor of the motor, and improving pump efficiency to approximately 86.0%. Base year savings would be 15,900 kwh, worth $763.

The estimated cost would be $6,000 with a simple payback of 7.9 years. Note: this measure is only cost-effective if Low Cost Measure No. 1 for Squaw Peak is not implemented.

6. Replace the Impeller in One Val Vista 40 MGD Raw Water Pump

Replacing the 22-1/16 inch impeller with a 23-9/16 inch in any of the 40 MGD pumps, and then using that pump as the lead pump would increase the flow capability from 26,500 gpm to 31,000 gpm at 57 feet TDH. Brake horsepower would increase from 440.0 to 505.9 utilizing the service factor of the motor. Base year savings would be 25,000 kwh, $1,200. The cost would be approximately $14,000 with a simple payback of 11.7 years.

Other Measures Considered

1. Raw Water Pump Variable Speed Drives

System-wide, there are a total of 30 raw water pumps providing 30 increments of pumping capacity. The function of variable speed drives is to provide capacity increments for a single pump. Because of the system increments available, variable speed drives would be misapplied, and are therefore not recommended.

2. Power Factor Correction

The Salt River Project electric rate schedule E-35 calls for power factor penalties when overall power factor falls below 85% lagging. Examination of the bills for the four plants during the base periods shows no month for which a penalty was imposed. Therefore, power factor is not a problem and no correction is needed.

3. Demand Charge Avoidance

The monthly demand charge at each plant is based upon the highest peak demand recorded during the billing period. It is therefore important to maintain an awareness of the demand meter read dates and, whenever possible, to avoid incurring unnecessary peak demands.

As an example, the Val Vista Plant was shut down continuously from October 1, 1981 to November 9, 1981. The billing history indicates that the meter was read on November 10, 1981 and that the peak demand in the period from October 9 to November 10 was 800 kw. Raw water pumps 1 and 3 were run on November 9 and 10, and presumably other equipment such as floc drives, etc., were run as well. If this startup could have been delayed until the 11th, most of the 800 kw peak demand for that period would have been avoided, saving 99 cents per kw, or almost $800.

This awareness is even more important in the period from May to October, when demand charge rates are doubled.

Total Energy Cost Reduction for Pumping

Total Energy Reduction for Pumping =	1,446,327 KWH/YR
Total Energy Cost Reduction @ 4.8¢/KWH =	$69,424/YR

CHAPTER 4:
ENERGY COST REDUCTION - TREATMENT PROCESS

Introduction

Water treatment plants basically are layed out per figure 5. Raw water is pumped from the river or canal to the inlet of grit chambers where larger particles are removed. From this point the water flows through the chemical feed area where alum, lime, chlorine and activated carbon are supplied in varying quantities depending on the pH, turbidity, taste and smell of the flow. Some plants also use copper sulfate as an algicide and polymero as coagulant aids for improving the turbidity removal process with alum.

Alum (insoluble aluminum hydroxide) is used as a coagulant to form floc. Slow agitation in the flocculation basins cause these floc particles to collect the turbidity particles which grow to a settleable size and precipitate out of the water in the sedimentation basins.

Lime is added to control pH (acidity or alkalinity) when the sample is taken and pH is found to be low, hydrated lime is added to increase the pH to a more alkaline condition, thus minimizing corrosion in the distribution system.

Chlorine is added for disinfection. This is one of the most important process in water treatment as it kills disease producing organisms which may be present in the raw water.

Activated Carbon is added to reduce unacceptable tastes and odors not controlled by chlorine. These tastes and odors are the result of decay and decomposition of vegetation and other organic compounds which occur after heavy rains wash the land surface.

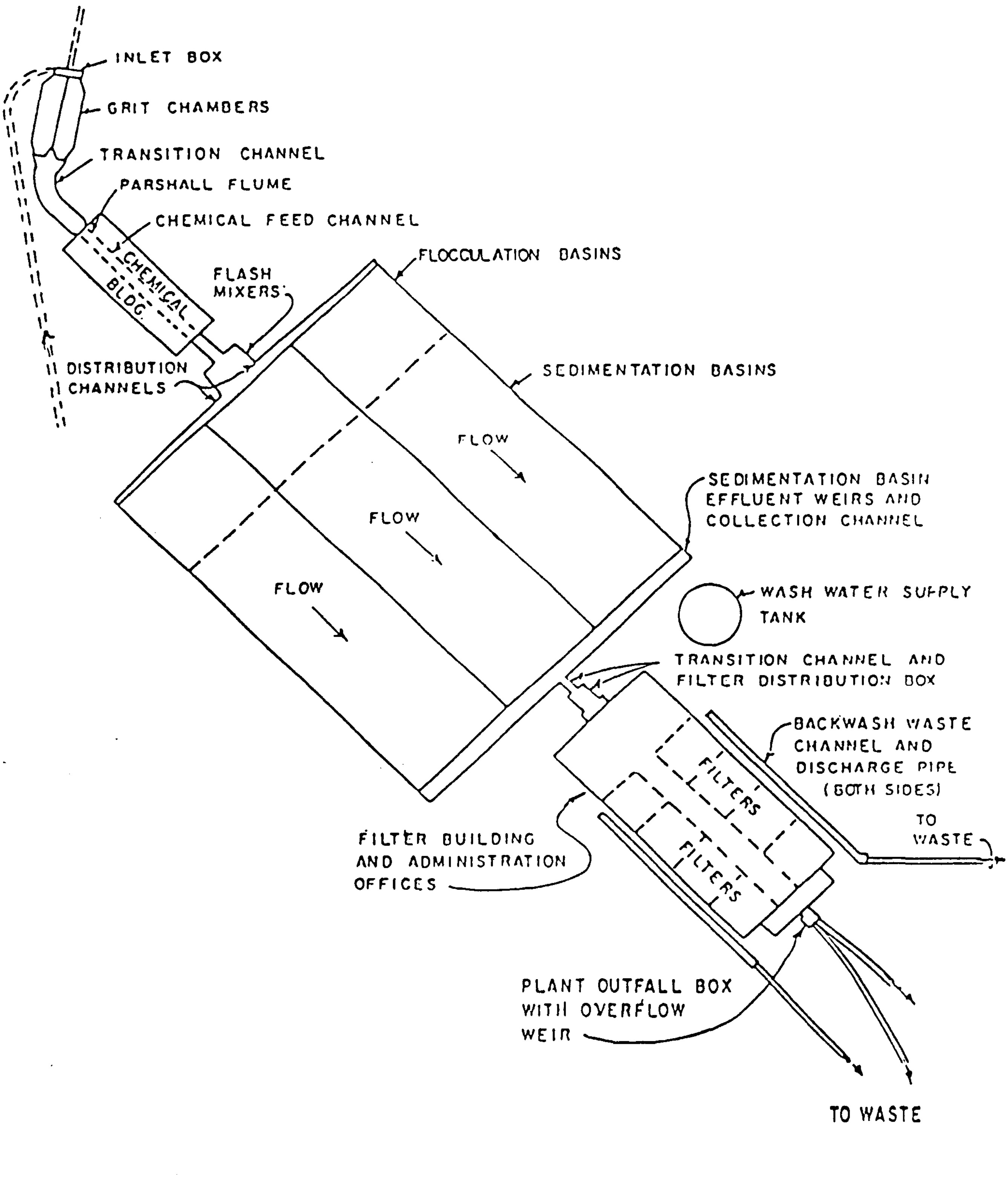


FIGURE — 5
BASIC LAYOUT OF A WATER TREATMENT PLANT

From the flash mixers and flocculation basins, the water flows to the sedimentation basins where the entrained suspended matter is allowed to settle by gravity. Detention time is about four hours. From here the water moves to the filter basins which remove those impurities that are not removed in the settling process. These filters are backwashed periodically to insure their effectiveness.

Both raw water and finished water are tested continuously by the lab chemists to assure a safe and potable water supply. The tests consist of chemical and bacteriological analysis.

The finished water then flows to reservoirs and from there to the distribution system either by gravity or booster pumps.

Typical Water Analysis

The City of Phoenix water supply is a combination of surface water from the Salt and Verde Rivers and Ground water developed by deep wells.

The primary source of supply is surface water from the Salt and Verde Rivers. This water is processed in the four water treatment plants operated by the City of Phoenix. The Deer Valley and Squaw Peak Plants are located on the Arizona Canal, the Val Vista Plant on the Southern Canal, while the Verde Plant is located at the confluence of the Salt and Verde Rivers. The additional sources of surface water are derived from the operation of an infiltration gallery and 14 shallow wells along the Verde River channel, and the 114 deep wells in Deer Valley, Paradise Valley and the Scottsdale area as mentioned.

The water chemistry data secured from representative sample points throughout the distribution grid is tabulated below. This data was secured from the 75 representative sampling points of the Phoenix water system grid. The range shown reflects the varying chemical make-up as influenced by the percentage of surface and ground water at various points in the grid and the varying chemical make-up of ground water aquifers. The actual analysis constantly varies depending on the ration of surface and ground water being utilized and seasonal variations of surface water chemistry.

Table 15 -- Annual Distribution System Chemical Analysis

Samples taken during 1981
Concentration in parts per million

	Average	Range	
pH	7.8	7.4	8.4
Chloride	72	11	445
Alkalinity (Total)	106	82	254
Hardness	158	72	450
Total Solids	333	199	1270
Fluoride*	0.30	0.23	0.58
Iron	0.02	0	0.14
Nitrate as (N)	0.82	0.01	12
Sodium	44	15	207
Sulfate	52	9	151

*Naturally occuring fluorides with no additional fluorides.

Energy Usage

The treatment system is analyzed here from the standpoint of chemical consumption as compared to energy consumption. Chemical consumption, although not specifically energy related, contributes greatly to the water treatment plants operational costs.

Table 16 -- Power Consumption and Chemical Costs for Water Plants

Water Plant	Power Consumption* (kwh)	Total Water Pumped in the System (MG)	Cost of Power Per MG Pumped	Total Chemical Cost**	Chemical Cost/ MG	Total Chemical and Power Cost MG
Deer Valley	2,264,990	13,878	$ 7.83	$206,600	$14.88	$22.71
Val-Vista	6,067,176	18,892	$15.41	$286,407	$15.16	$30.57
Verde	2,574,961	9,018	$13.71	$101,118	$11.21	$24.92
Squaw Peak	7,250,421	22,040	$15.79	$304,198	$13.80	$29.59
	18,157,548	63,828		$898,323		

* For base year
+ Based on 4.8¢/kwh power cost
**Chemical costs based on the following unit prices:

chlorine	$231.81/ton
alum	$144/ton
copper sulfate	$932/ton
activated carbon	$530/ton
lime	$67,59/ton
floc aid	$0.4492/lb
filter aid	$0.7615/lb

Low Cost/No Costs ECM's

1. Optimization of Alum Dosages Using Zeta Potential Meter

In 1981, the four water plants spent 74 precent of their chemical budget on alum amounting to $662,560. The average alum dosage was 17.3 ppm. Figure 6 shows a graphical summary of variations in average monthly alum dosages along with turbidity during 1981. At the present time all four plants are using jar tests for deciding alum dosages. Jar tests although quite popular in the water industry have certain limitations, namely:

a) Long set-up time and testing time (about 2 hours).
b) Coagulant dosage arrived at using jar tests is generally not optimal.

Zeta potential meter can provide a very fast response (5-10 minutes) to changing water conditions and also provides a much more optimal coagulant dosage. Experience at several plants has indicated that use of zeta potential meters for coagulant control could result in savings of 5 to 20 percent over the conventional jar tests. Thus there is potential for savings of $33,000 to $133,500.

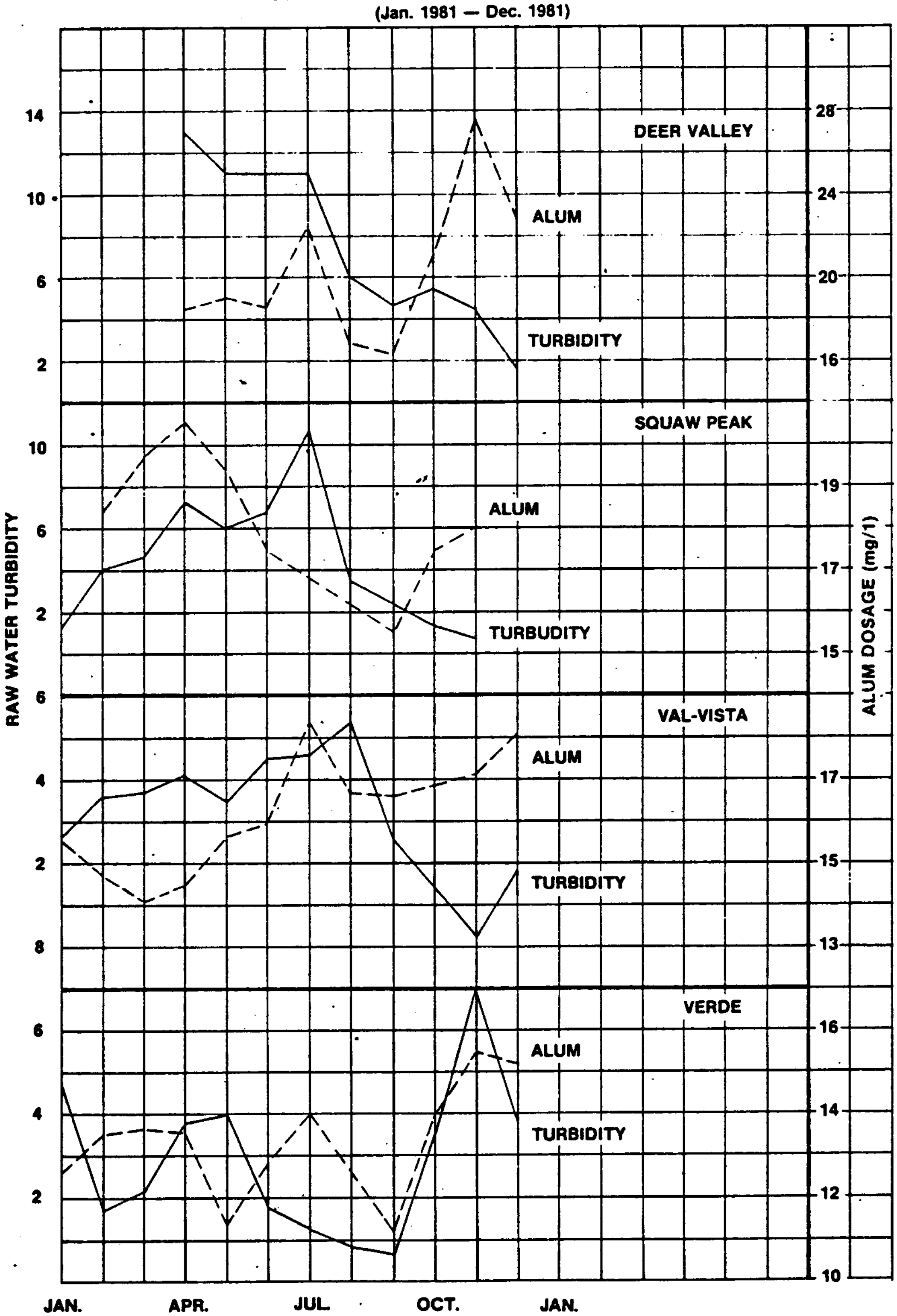
2. Optimize Energy Consumption for Flocculation

Table 17 summarizes total energy used for the flocculation process at the four water plants during the audit base year. It also summarizes optimum power requirements for flocculation based on G of 60 Sec^{-1}, detention time of 40 minutes and annual average water temperature of $70^{o}F$. The difference between the two numbers points out the potential

FIGURE — 6

SUMMARY OF TURBIDITY AND ALUM DOSAGE

(Jan. 1981 — Dec. 1981)



for energy conservation in the flocculation process. In order to achieve this potential saving, the following recommendations are made:

a) Vary the flocculation energy based on water temperature. As the water temperature goes up flocculation energy requirements decrease as shown by the following equation.

$$G = \sqrt{P/\mu V}$$

$$G60^{o}F = \sqrt{P60/\mu_{60}V}$$

$$G80^{o}F = \sqrt{P80/\mu_{80}V} \qquad \text{For Constant G,}$$

$$P60/_{P80} = \mu 60/\mu 80 \qquad \text{or,}$$

$$P60 = P80 \times \mu_{60}/\mu_{80} \qquad \text{or } P60 = 1.31P80$$

b) Vary the number of flocculation basins on line based on the quantity of water being treated.

c) Use the relationship provided in Figure 7 as a guide reference for estimating optimum power requirements. As the raw water conditions vary, optimum G value can be calculated from the Jar-tests performed in the laboratory.

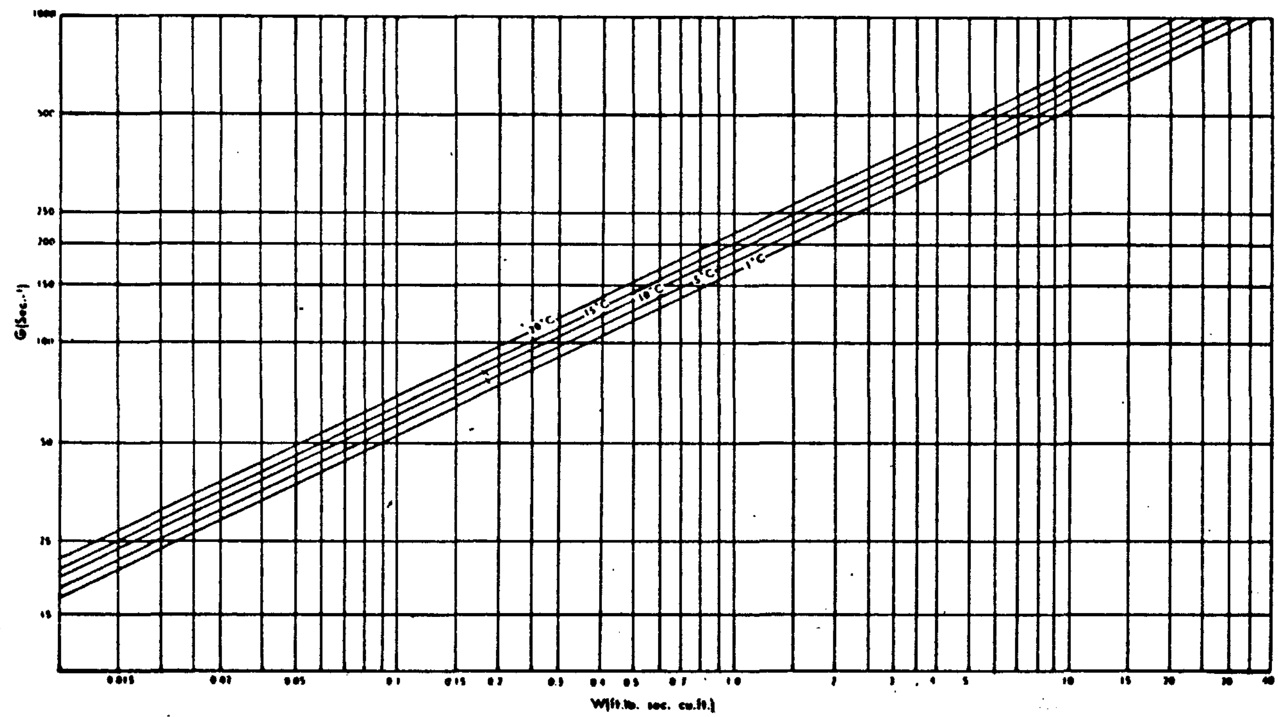
Table 17 -- Energy Consumption for Flocculation

Water Plant	Total Annual Water Pumped (MG)	Actual Power Consumption for Flocculation (kwh)	Optimum Power Reqd. for Flocculation (kwh)*	Potential Energy Savings (kwh)	Potential Annual Cost Savings+
Deer Valley	13,878	339,153	160,180	178,973	$ 8,590
Val Vista	18,892	617,736	218,088	399,648	$19,180
Verde	9,018	142,432	104,100	38,332	$ 1,840
Squaw Peak	22,040	649,550	254,430	395,120	$18,965
	63,828	1,748,871	736,798	1,012,073	$48,575

*Based on G of 60 Sec^{-1}, detention time of 40 minutes and annual average water temperature of 70°F.

+Potential savings based on power cost of 4.8¢/kwh

FIGURE — 7
G.V.S. POWER REQUIRED FOR FLOCCULATION



Abs. Viscosity of H_2O (M), lb-sec. sq. ft. at various temps.

TEMP °C	TEMP °F	VISCOSITY, μ
2	35.6	0.3473×10^{-4}
4	39.2	0.3273×10^{-4}
5	41.0	0.3171×10^{-4}
6	42.8	0.3075×10^{-4}
7	44.6	0.2983×10^{-4}
8	46.4	0.2894×10^{-4}
9	48.2	0.2811×10^{-4}
10	50.0	0.2730×10^{-4}
12	53.6	0.2581×10^{-4}
15	59.0	0.2361×10^{-4}
20	68.0	0.2098×10^{-4}
25	77.0	0.1866×10^{-4}
30	86.0	0.1672×10^{-4}

Procedure

1) Select G and flocculation tank volume required (cu. ft.)
2) Enter chart at G and water temperature involved, and find W.
3) Water H.P. = $\frac{W \times \text{Volume (cu. ft.)}}{550}$
4) Water H.P./1000 cu. ft. = 1.82 W

Note: Motor (brake) HP = $\frac{\text{Water HP}}{\text{Gear Eff.} \times \text{Bearing Eff.}}$

W = HP dissipated/unit vol. (ft. lb./sec./cu. ft.)

$= \frac{\text{Water HP} \times 550}{\text{Flocc. Vol. (cu. ft.)}}$

G = Velocity Gradient (fps/ft.), or (Sec.$^{-1}$)

$$= \sqrt{\frac{W}{\text{Abs. Vis. } H_2O}}$$

Useful relationships:

Increase power × 2 will increase G × 1.41

Increase power × 4 will increase G × 2

3. Preferential Operation of Water Plants in Relation to System Demand

Figure 8 shows the total system demand variations by month for 1981. Table 16 summarizes output of the various plants during the year. The monthly average demand varied from a low of 51.261 MGD for January to a high of 296.229 MGD for June of 1981. Table 17 summarizes power consumption and chemical costs for the four water plants. Power costs are for in-plant functions only and do not include any high service pumping costs. Total 1981 chemical and power costs per million gallon of water pumped for each of the four plants are:

Deer Valley (100 MGD)	$22.71/MG
Verde (30 MGD)	$26.05/MG
Squaw Peak (110 MGD)	$29.59/MG
Val-Vista (80 MGD)	$30.57/MG

In order to optimize the overall water system costs for the City of Phoenix, unit costs ($/MG) should also be developed for each of the four plants for high service pumping under various conditions of demand. Based on the cost information presented here, decisions should be made regarding preferential operation of water plants in relation to the system demand. This approach should result in considerable energy and cost savings. Under this approach as the system demand increased the plant with the next lowest marginal cost ($/MG) of production would be brought on-line. However, it is realized that plant production, with the execution of the Verde plant, is based on Salt River Project canal water flow schedules as they relate to SRP's canal maintenance during the annual "dry-up" periods.

Total Energy Cost Reduction - Treatment Process

Total Energy cost reduction for Treatment Process =	2,198,521 KWH/YR.
Total energy cost reduction @ 4.84/KWH =	$105,529/YR.
Plus chemical cost reduction	$ 83,250/YR.
Total cost reduction (energy + chemical)	$188,779/YR.

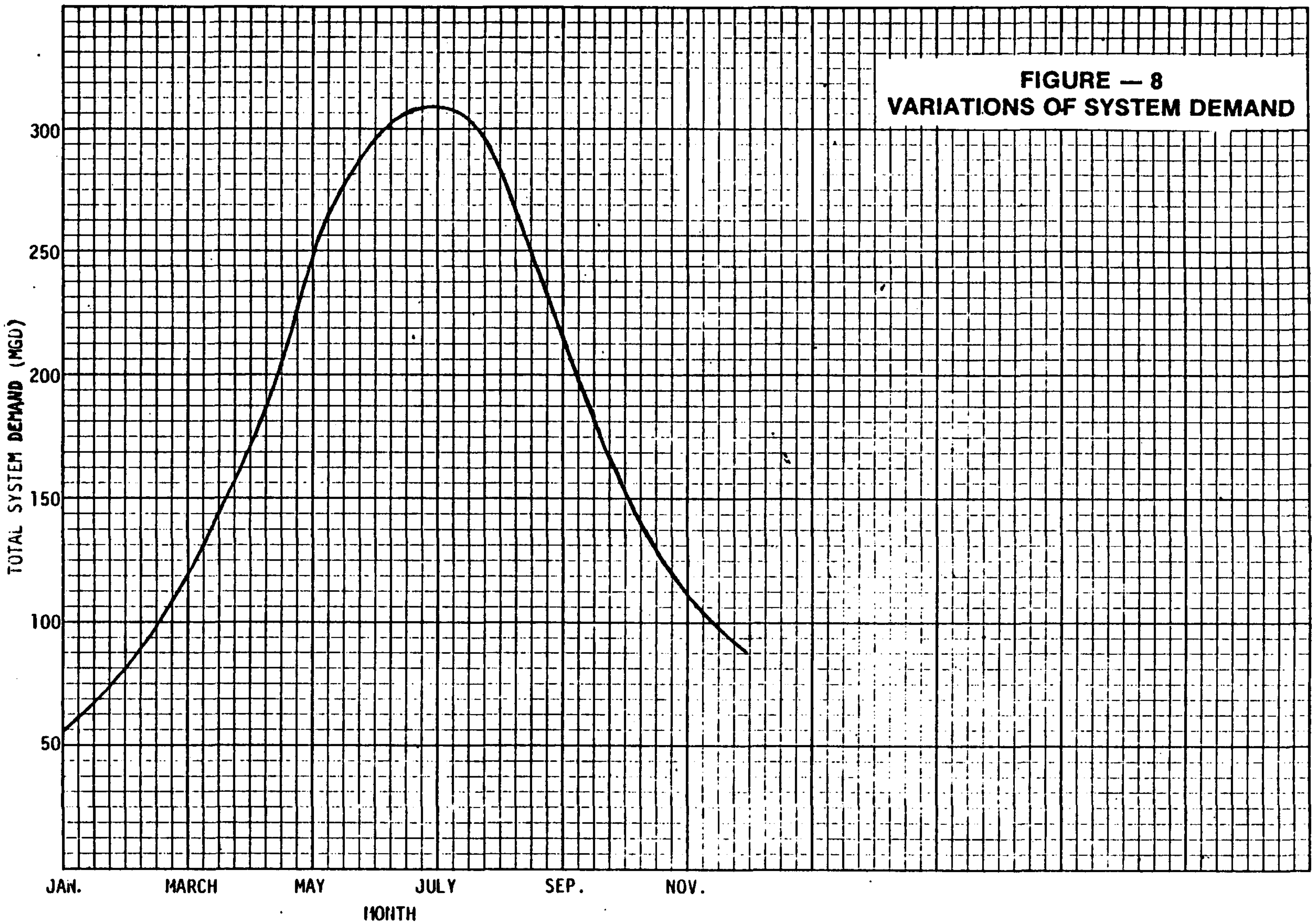


FIGURE — 8
VARIATIONS OF SYSTEM DEMAND

CHAPTER 5:
ENERGY COST REDUCTION - HVAC SYSTEMS

Introduction

The Heating, Ventilating and Air Conditioning System (HVAC) system provides controlled environment for the comfort and safety of the occupants of the facility. Air conditioning and heating systems are in operation in all the Administrative offices, conference and assembly rooms, break and restrooms and laboratory areas. Ventilation systems are in operation in all restrooms, break rooms, chlorine storage and feeder rooms, shop areas and areas where periodic or constant air flow is required for safety, comfort, or equipment operation. Special consideration using chemical hoods and exhausts are used in bacteriological and water sample laboratory areas. Evaporative cooling is employed in shop and break rooms and other areas where refrigerated air conditioning would not be critical. Heating is provided in chlorine feeder rooms to maintain efficient operation of this treatment function. Domestic hot water is produced by residential type heating equipment to provide service to shower areas and laboratories.

The HVAC equipment was initially installed to maintain 74^{o} to 76^{o}F in the air conditioned areas at maximum average outside ambient summer conditions of 108^{o}F dry bulb and 77^{o}F wet bulb. The heated areas design criteria was 72^{o}-74^{o} at ambient minimum temperatures of 34^{o}F. These conditions conform to the American Society of Heating & Refrigeration and Air Conditioning Engineers (ASHRAE) handbook of fundamentals. The evaporative cooled areas were sized to provide 80% dry bulb depression and one (1) minute air changes (i.e. 60 changes of the volume of air in a space every hour). Ventilation requirements of 20-25 CFM per person were originally set up. Hot water temperatures of 140^{o} to 145^{o}F were called for originally. The present designed operating criteria of the City of Phoenix facilities of this type are 78^{o}F indoor temperature and 50% R-H (relative humidity) in summer and 68^{o}F indoor temperature in winter. Ventilation requirements of 10 CFM per person are now required with domestic type hot water temperatures set at 105°F and 140°F in facilities equipped with domestic type dishwashers. The HVAC systems for all four plants are described in detail as follows:

Verde Water Treatment Plant

The Cooling System for this plant consists of packaged type equipment supplying air through an insulated sheet metal duct system in the Filter Building, and room and window type units in other areas.

The Office and Chemical Lab in the Filter Building, an area of 575 ft^2, is cooled by a Borg-Warner model #SW90-48 (5 ton nominal, water cooled) unit operating approximately 1,650 hours/year.

The Break Room of the Filter Building, an area of 570 ft^2, is cooled by a Carrier model #50CA004600 A/C unit (2 1/2 ton nominal, water cooled) operating an estimated 1650 hours/year, cooling.

The Chemical Building Break Room, an area or 235 ft^2, is served by a window type Carrier A/C unit model #500A002330 (3/4 ton nominal, air cooled) with an estimated operating time of 1650 hours/year.

The Filter Building filter area is served by 4 evaporative cooler units, 1 HP, 7500 CFM each with an estimated operating time of 3600 hours/year, each.

The Heating System for this plant consists of propane gas fired units and electric strip heaters.

The Office and Chemical Lab area is heated by a Heat Controller unit, in combination with the Borg-Warner unit, of 200,000 BTU input capacity operating approximately 810 hours/year.

The Filter Building Break Room is heated by a 3KW electric strip heater mounted in the Carrier unit operating for approximately 810-hours/year.

The Break Room of the Chemical Building is heated by a 5KW electric unit heater ceiling mounted operating approximately 810 hours/year.

The main Chlorine Room of the Chemical Building is heated by a York 200,000 BTU input propane gas fired furnace, serving an area of 250 ft^2, with an estimated operating time of 720 hours/year.

The Ventilation System consists of three exhaust fans of 1/4 HP each to exhaust the Chlorine Rooms. Estimated operating time of 500 hours/year, each.

The Hot Water System supplies the Filter Building Restrooms and consists of an AO Smith propane gas 30,000 BTU input water heater.

Squaw Peak Water Treatment Plant

The Cooling System for this plant consists of packaged water cooled units serving the Administrative Office, Assembly/Lunch and Conferences area and the Control Room/Feeder Room in Plant #2. This type of equipment is also used in the Lab and Office areas of Plant #1. Also an air cooled unit supplies the shop area of Plant #1. None of these systems have outside air capability.

The Control/Feeder Room (Plant #2), an area of 1924 ft^2, is served by an American Standard unit, model #1528 of 15 ton nominal capacity, operating for 1650 hours/year.

The Administrative Office (Plant #2), an area of 307 ft^2, is served by a 3 ton nominal American Standard unit #VWS318A, operating for approximately 1,650 hours/year.

The Assembly/Lunch and Conference Rooms (Plant #2), an area of 1,039 ft^2, is served by a 7 1/2 ton nominal American Standard unit #VW5818J, operating for approximately 1,650 hours/year.

The Lab area (Plant #1), an area of 1,240 ft^2, is served by a Carrier 7 1/2 ton nominal unit, operating for 1,320 hours/year.

The Shop area (Plant #1), an area of 740 ft^2, is served by a 3 ton nominal air cooled condensing A/C unit, operating for 1,650 hours/year.

Evaporative Cooling is provided to the Feeder Room of Plant #1 by a 1/2 HP, 4,500 CFM unit, operating approximately 3,960 hours/year.

The Heating System for this plant consists of three, gas fired furnaces and an electric strip heat unit.

The Control/Feeder Room (Plant #2), is heated by a 136,000 BTU gas fired Lennox furnace, operating for approximately 1,800 hours/year.

The Assembly/Lunch and Conference Room area (Plant #2), is heated by a 90,000 BTU gas fired furnace, operating for approximately 810 hours/year.

The Lab area (Plant #1), is heated by 7.4KW electric duct heater, operating for approximately 720 hours/year.

The Shop area (Plant #1), is heated by a 90,000 BTU Janitrol gas fired unit heater, operating for approximately 810 hours/year.

The Feeder Room (Plant #1), is heated by a Lennox gas fired furnace of 136,000 BTU input, operating for approximately 450 hours/year.

The Ventilating System consists of dome type exhaust fans at the Restrooms in Plant #2 (2) units of 1/4 HP each, wall-switch operated approximately 300 hours/year. Also a 1/4 HP utility set exhauster for the chemical hood in Plant #1, operating approximately 750 hours/year.

The Hot Water System consists of a gas fired Crane 120,000 BTU input unit with a 1/6 HP B&J circulating pump supplying domestic hot water to Plant #2. Also a 42,000 BTU input AO Smith 40 gal. gas fired water heater for Plant #1.

Deer Valley Treatment Plant

The Cooling System for this plant consists of air cooled and water cooled packaged equipment serving areas in the Administration Building and the Chemical Building through an insulated sheet metal duct system. The ducts serving the second floor Administration Building, Bio-Lab restrooms and foremans office and corridor are converted evaporative cooling ductwork with return air added.

The Administrative Offices, Lobby and Reception Office of the Administration Building are served by an American Standard model #VW5518J water cooled unit of 4 ton nominal capacity serving an area of 1800 ft^2, and operating for approximately 2,060 hours/year. This unit has no outside air capability.

The Conference Room on the second floor of the Administration Building, is served by a roof top mounted Carrier model 48B12-512 air cooled single zone unit of 10 ton nominal capacity serving an area of 665 ft^2. This unit is capable of 50% outside air tempered by the intake of this non-return air through the third floor tank room, thus allowing a 10 to 15 degree reduction in air temp in summer. This unit operates approximately 1,250 hours/year.

The Laboratory on the second floor of the Administration Building (to the north) is served by a Carrier model 48B-589 air cooled single zone unit of 7 1/2 ton nominal capacity serving an area of 1,350 ft^2. This unit is also capable of 50% outside air introduced similar to the Conference room unit. This unit operates approximately 1,650 hours/year.

The Bacteriological Lab, restrooms and foremans office and corridors on the second floor of the Administration Building, are served by a Rheem model RAWA-100-DAS condensing unit roof mounted split system, with the evaporator coil mounted in the ductwork in the tank room in combination with the heating unit and serving an area of 3,250 ft^2. The unit has 7 1/2 ton nominal capacity and has no outside air capability. It operates approximately 1,650 hours/year.

The Chief Chemists Office on the second floor of the Administration Building is served by a Fedders window type A/C unit, 1 ton nominal capacity mounted in the third floor tank room area where the condensing air is 10-15 degrees cooler in summer. The unit serves an area of 210 ft^2 and operates approximately 825 hours/year at reduced condensing temperatures.

The third floor Operators Lab in the Chemistry Building, is served by an American Standard A/C unit model #VWS818J water cooled, of 7 1/2 ton nominal capacity serving an ara of 3,100 ft^2, with no outside air capability. The unit operates approximately 1,980 hours/year.

The fourth floor Break Room and Restroom area in the Chemistry Building, is served by an American Standard A/C unit model #VWS818J water cooled, of 7 1/2 ton nominal capacity serving an area of 3,100 ft^2, with no outside air capability. The unit operates approximately 1,200 hours/year.

Evaporative Cooling is provided by (2) 6,500 CFM units serving the fourth floor of the Chemical Building. Also (2) 7,500 CFM units serving the second floor of the Chemical Building. The Administration Building first floor Chlorine room is served by (2) 7,500 CFM units. The 7,500 CFM unit on the roof of this building has been abandoned in favor of a retrofitted A/C unit for the second floor office areas. The Chlorine feeder room in the Administration Building is served by a 6,500 CFM unit. These units were intended to operate approximately 3,600 hours/year, each.

The Heating System for this plant consists of gas fired units mounted in combination with the A/C system and operated by summer/winter thermostats. (Clock type set back thermostats operate the two Carrier units serving the second floor of the Administration Building.) Some areas are heated by gas fired ceiling mounted United heaters without ductwork. The Office area of the Administration Building is heated by an 80,000 BTU input Lennox unit operating 810 hours/year.

The Conference Room unit and north Chemistry Lab of the Administration Building (i.e. the Carrier units) are served by a 150,000 BTU and a 250,000 BTU input heating sections of the roof mounted units. The Conference room units operate approximately 300 hours/year and the Lab unit approximately 810 hours/year.

The Bacteriological Lab, restroom, office and corridor areas are served by an 80,000 BTU input Lennox unit operating approximately 810 hours/year.

The Shop area of the Administration Building is served by three 50,000 BTU input gas fired units 1/3 HP circulating fans. These units operate approximately 810 hours/year, each.

The Operators Lab, third floor of the Chemistry Building is served by a Lennox 120,000 BTU input gas furnace operating approximately 1,200 hours/year.

The Break room, fourth floor of the Chemistry Building is served by a Lennox 80,000 BTU input gas furnace operating approximately 600 hours/year.

The Hot Water System consists of two 30 gal., 36,000 BTU input gas water heaters serving the Administration and the Chemical Building, lavatories and shower areas.

The Ventilation System consists of thru-wall type, dome type and fume hood type fans. Five 2 1/2 HP each propeller exhaust fans for the Chlorine room in the Administration Building are operated only by Chlorine detectors.

The Chlorinator room in the Administration Building has two 3/8 HP thru-wall exhaust fans operated intermittently.

Room 203 of the Chemical Building is exhausted by a 1/6 HP thru-wall fan operated intermittently.

Restrooms exhaust fans consist of 4 units of 1/4 HP each operating on wall switches for approximately 300 hours/year, each.

Val Vista Water Treatment Plant

The Cooling System for this plant consists of packaged roof mounted A/C - gas heat units air cooled, serving the following areas of the main building, a total area of 8,500 ft^2.

The offices, lobby hallways and break room areas (zone 1) 3,530 ft^2, are served by a single zone 20 ton Westinghouse roof mounted packaged air conditioning and gas heat unit model #IK240CRDP. This unit supplies cooled or heated air through a conventional insulated duct work systems with ceiling space return air and is operated by a conventional single stage thermostat located in the superintendents office. No outside air capability is available in this unit. The unit has air cooled condensing. Estimated operating time 1,650 hours/year cooling and 810 hours/year heating.

The Chem Lab area (zone 2) 1,600 ft^2, is served by a single zone 10 ton Westinghouse roof mounted unit #IK120CRDP similar to zone one, with ducted air and ceiling space return air. The thermostat is located in the main lab area. No outside air capability is available. Estimated operating time 1980 hours/year cooling and 970 hours/year heating.

The Operators Station and locker room areas (zone 3) 2,625 ft^2, are served by a single zone 20 ton Westinghouse unit #IK240CRDP similar to the above, with ducted air and ceiling space return air. The thermostat is located on the north wall adjacent to the chlorine room. No outside air capability is available. Estimated operating time is 1,320 hours/year cooling/year heating.

The Conference Room (zone 4) 750 ft^2, has a similar unit model #K090C3RR0L with 7 1/2 ton capability supplying air through ceiling space duct work with ceiling space return air. A conventional interior wall mounted thermostat controls this unit. The unit also has no outside air capability. Estimated operating is 825 hours/year cooling and 400 hours/year heating.

Evaporative Cooling is provided by seven, 4500 CFM units, 1/2 HP each, serving the Polyelectrolyte-carbon room, Time feeder room, Chlorine area, Chlorinator room, lower mens locker room and shop area, a total of 6,300 ft^2. Estimated operating time is 2,700 hours/year each.

The Heating System, in addition to the combinations units for the four main zones, which are 350,000 BTU input for each 20 ton unit and 250,000 BTU input for the 10 ton unit and 175,000 BTU for the 7 1/2 ton unit, consists of gas fired and electric unit heaters and baseboard electric heaters. Areas totaling 8,125 ft^2, are heated by (5) Peerlas gas fired unit heaters of 25,000 BTU (1/4 HP fans) and (2) 50,000 BTU units (1/2 HP fans). Estimated operating time of these units is 810 hours/year, each. This area also is served by (3) 5KW heaters at 720 hours/year, each and (5) baseboard heaters of 1.5KW operating 250 hours/year, each.

The Ventilation System consists of dome type and utility fan sets exhausting the restrooms, volatiles area, laboratory areas, shop and break rooms.

The restrooms (in zone 1) are exhausted by (2) Jenn-Aire 450 CFM, 1/4 HP and a small kitchen range fan in the break room, 1/12 HP. No other ventilation capability is present. The fans are operated by wall switches. Estimated operating time is 200 hours/year, each.

In the Chem Lab (zone 2), chemical hoods are exhausted by 800 CFM Bayley utility sets, 1 HP each. Also an 800 CFM Jenn-Aire exhauster serves the volatiles area. Two 800 CFM each Jenn-Aire exhausters serve the main lab and the Bacteriology area, 1/2 HP each. A total of 4,000 CFM exhaust is possible at any one time, with 1,600 CFM exhausting constantly. No outside air make up is evident in ths zone! The locker room area (in zone 3) is exhausted by a 450 CFM roof mounted exhaust fan, 1/4 HP. Estimated operating time is 200 hours/year.

Zone 4 has no exhaust or outside air capability. Estimated operating time of the Chem Lab fans is (1) 1/2 HP fan, 8,760 hours/year, (2) 1 HP fans, 500 hours/year, (2) 1/2 HP fans 750 hours/year.

The Raw Water Inlet Transformer Building has (3) 1 HP, thermostatically operated exhaust fans through the roof. Estimated operating time is 1,320 hours/year, each.

The Hot Water System consists of an A.O. Smith Glascote II electric water heater 10KW total, 66 gal. capacity.

Energy Usage

Yearly energy usage shown below by plant and equipment type.

Verde Water Treatment Plant

-- Air Conditioning Energy Consumption

AREA (SQ. FT.)	Installed Nominal Tonnage	Actual Maximum Tonnage Needed	Average Tonnage Used	Hours of Operation Per Year	Present Energy Use KWH/YR	
Office Chem Lab (575)	5.0	2.5	2.1	1,650	13,406	
Break room, F.B. (570)	2.5	1.7	1.2	1,650	5,156	
Break room, Chem. (235)	.75	1.3	.79	1,650	1,733	
Total A/C Usage					20,295	
Total A/C Cost (@ 4.8¢/KWH)						= $ 974

-- Gas Heating Energy Consumption (including hot water)
Total Heat cost (4,925 gal. @ 0.72¢/gal.) = $3,546

-- Electric Heating Energy Consumption

Break room, F.B.	3 KW heater @ 810 hrs/yr	= 2,430 KWH/YR
Break room, Chem.	5 KW heater @ 810 hrs/yr	= 4,050 KWY/YR
	Total Usage	6,480
	Total Cost (@ 4.8¢/KWH)	= $ 311

-- Ventilation Energy Consumption

3- 1/4HP fans operating 300 hrs/yr ea. = 450 KWH/YR
Total cost (@ 4.8¢/KWH) = $ 22

-- Evaporative Cooling Energy Consumption

4- 1 HP (7,500 CFM) operating 3,600 hrs/yr ea.
(4) (1 HP) (.746 KW/HR-HP) (3,600 HR)/.75 EFF =
14,323 KWH/YR
Total Cost (@ 4.8¢/KWH) = $ 688

TOTAL HVAC COST (gas and electric) $5,541

Squaw Peak Water Treatment Plant

-- Air Conditioning Energy Consumption

AREA (SQ. FT.)	Installed Nominal Tonnage	Actual Maximum Tonnage Needed	Average Tonnage Used	Hours of Operation Per Year	Present Energy Use KWH/YR
Admin. Office - $2(307)	3.0	1.2	1.0	1,650	8,044
Assembly, lunch, conf. rm. #2 (1040)	7.5	3.5	3.0	1,650	20,109
Control feeder, #2(1924)	15.0	3.6	3.1	1,650	40,219
Lab area #1(1240)	7.5	5.0	4.25	1,320	12,375
Shop area #1 (740)	3.0	2.2	1.9	1,650	6,930
Total A/C Usage					87,677

Total A/C Cost (@ 4.8¢/KWH) = $4,208

-- Evaporative Cooling Energy Consumption

1/2 HP (4,500 CFM) unit operating 3,960 hrs/yr
Total A/C Usage = 1979 KWH/YR
Total Cost (@ 4.8¢/KWH) = $ 95

-- Gas Heating Energy Consumption (including hot water)

Total Heat cost (1,541 therms) (@$ .383 per therm)= $ 590

-- Electric Heating Energy Consumption

Lab area #2 - 7.4 KW electric operating 720/hrs/yr 5,328 KWH/YR
Total Electric Heat cost (@4.8¢/KWH) = $ 256

-- Ventilation Energy Consumption

2- 1/4 HP units @ 300 HRS/YR
1- 1/4 HP unit @ 750 HRS/YR
(387 KWH/YR) (@4.8¢ KWH)
Total Usage = 387 KWH/YR
Total Cost @ 4.8¢/KWH/) = $ 19

TOTAL HVAC COST (gas and electric) $5,168

Deer Valley Water Treatment Plant

-- Air Conditioning Energy Consumption

AREA (SQ. FT.)	Installed Nominal Tonnage	Actual Maximum Tonnage Needed	Average Tonnage Used	Hours of Operation Per Year	Present Energy Use KWH/YR	
Admin. Bldg., Office (1800)	4.0	5.5	4.7	2,060 (825)	10,300	
Admin. Bldg., Conf. (665)	10.0	2.0	1.2	1,250	22,750	
Admin. Bldg., Lab (1350)	7.5	5.3	4.5	1,650	17,325	
Admin. Bldg., Bact., etc. (3250)	10.0	6.7	5.7	1,650	30,030	
Admin. Bldg., Chemist(210)	1.0	0.5	0.4	825	1,073	
Chem. Bldg., Oper., etc. (3100)	7.5	5.5	4.7	1,980	18,563	
Chem. Bldg., Break room (3100)	7.5	4.5	3.8	1,200	14,625	
Total A/C Usage					114,666	
Total A/C Cost (@ 4.8¢/KWH)						= $5,504

-- Evaporative Cooling Energy Consumption

8- 1 HP (65-7500 CFM) units operating 3600 hrs/yr, each
Total Usage = 28,645 KWH/YR
Total Cost (@ 4.8¢/KWH) = $1,375

-- Gas Heating Consumption (including hot water)

Total cost (2,880 therms @ $ .383 per therm) = $1,103

-- Ventilation Energy Consumption

Admin. Bldg.	(2) (1/3 HP) fans, (1) 1/2 HP and (1) 1/6 HP	
Chem. Bldg.	(1) (1/10 HP) fan, (1) 1/2 HP and (1) 1/6 HP	
Restroom, Chem. Bldg.	(4) (1/4 HP) for 300 hrs	
	Total Usage = 1065 KWH/YR	
	Total Cost @ 4.8¢/KWH	= $ 51
	TOTAL HVAC COST (gas and electric)	$8,033

Val Vista Water Treatment Plant

-- Air Conditioning Energy Consumption

AREA (SQ. FT.)	Installed Nominal Tonnage	Actual Maximum Tonnage Needed	Average Tonnage Used	Hours of Operation Per Year	Present Energy Use KWH/YR	
Office, lobby, etc. (3530)	20.0	7.0	6.2	1,650	60,060	
Chem. Lab, etc. (1600)	10.0	6.8	4.8	1,980	36,036	
Operators Station (2625)	20.0	6.1	5.2	1,320	48,048	
Conference room (750)	7.5	2.9	1.2	825	11,260	
Total A/C Usage					155,404	
Total A/C Cost (@ 4.8¢/KWH)						= $ 7,459

-- Evaporative Cooling Energy Consumption

7- 1/2 HP (4500 CFM) units operating 2700 hrs., each

Total Usage = 9400 KWH/YR

Total Cost =$ 451

-- Gas Heating Consumption

Total cost = 1950 therms @ $.383/Therm =$ 747

-- Electric Heating Consumption (including hot water)

3- 5 KW unit heaters @ 720 hrs/yr

5- 1.5 KW baseboard heaters @ 250 hrs/yr

10 KW water heater @ 1100 hrs/yr

Total cost = 23,675 KWH @ 4.8¢/KWH =$ 1,136

-- Ventilation Energy Consumption

Total cost = 10,080 KWH @ 4.8¢/KWH =$ 484

TOTAL HVAC COST (gas and electric) $10,277

Generic ECM's

The following is a list of generic energy conservation measures. The tabulation is comprehensive, but E.C.M.'s are not limited to this list.

Maintenance and Operation E.C.M.'s:

- Air filter and evaporator coil maintenance and replacement rescheduling.
- Evaluation of alternative fuel sources, either conventional or non-conventional.
- Improvement of environmental control for high traffic area openings.

- OFF peak operation (day, night, and seasonal), shutback or shutdown of power consuming equipment such as fan systems.
- Reduction of solar loading through fenestration areas.
- Improvements in preventive maintenance to reduce energy and consumption.
- Evaluation of optimizing water and air temperatures, quantities, control and distribution to optimize energy utilization, and to minimize simultaneous functions such as heating and cooling.
- Establish minimum outdoor and exhaust air requirements.
- Development of programs for employee energy cost conservation, awareness and incentive programs.
- Discontinue the use of unnecessary exhaust fan operation or restrict usage to identified timer.
- Initiate program of education of employees to keep doors and windows of air conditioned spaces closed.
- Evaluation of the air handling units.
- Evaluation of time-of-day rates.
- Close off unoccupied areas by blocking supply registers (non-dx systems only)
- Raise indoor cooling temperature to 78-80^{o}F.
- Close air dampers during morning warm-up.
- Evaluation of electrical demand load savings potential by reduction of equipment capacity needs.
- Identifying where HVAC system operation can be reduced to an acceptable level such as employing the most recent City of Phoenix criteria as stated above.
- Reduction of temperature setting on water heating equipment as applies to use and seasonal variations.

Capital Equipment E.C.M.'s:

- Investigate possibility for utilization and sources of waste heat such as preheating combustion air and condenser heat utilization.
- Installation of time clocks for exhaust/ventilation equipment.
- Installation of controlled or gravity dampers on exhaust ducts to prevent back flow.

- Installation of vestibule doors at major entrances to air conditioned spaces.
- Repair and replace insulation of space conditioning ductwork.
- Repair duct work air leaks.
- Utilize time clocks on water heaters to allow for vacation and weekend scheduling.
- Evaluation of weather stripping doors and windows in space conditioned area to reduce infiltration.
- Evaluation of increased use of insulation in building envelope structures (walls and roofs)
- Installations of automatic temperature set back and set up thermostats on HVAC equipment.
- Installation of manual switches for restroom exhaust fans to replace constant operation systems.
- Motor size matching to load and power factor, or efficiency improvement, or both.
- Evaluation of condenser pre-cooler systems in dry climate areas.
- Investigation of the feasibility of utilizing co-generation.
- Investigation of alternative cooling systems such as evaporative, roof spray.
- Evaluation of employing economy cycle operation through enthalpy sensing on HVAC units for moderate ambient condition operation.
- Evaluation of substituting water source heat pump system for HVAC where applicable.
- Evaluation of the installation of insulated and solar shade screens for energy reduction.

Energy Management Systems:

- Remote manual start/stop of equipment.
- Remote manual temperature reset.
- Automatic start/stop of equipment.
- Utilities consumption metering.
- Automatic optimization of operation based upon indoor and outdoor temperatures, traffic patterns, time of day and season.
- Maintenance scheduling program.

- Electrical load shedding and/or cycling.
- Electrical demand control - anticipatory or upon event.

Low Cost/No Cost Measures

1. Oversized Units - Capacity Reduction

A number of the air conditioning units at the Water Treatment Plants are oversized when comparing the nominal unit capacity @ 95^{o} ambient) to the maximum actual load at design conditions. It should be noted that air conditioning units with air-cooled condensers lose (on the average) 7% of their capacity for every 10^{o}F the outside ambient temperature rises above 95^{o}F.

On dual compressor units that are oversized by more than 125% (on an air-cooled unit) or 100% (on a water-cooled unit) some savings can be achieved by disconnecting one compressor and blocking the unused coil with sheet metal, or some other material. If the evaporator fan can be slowed by changing pulleys to reduce the supply air by 50% while maintaining the necessary static pressure then some savings can be achieved. On a direct drive motor or a motor where the speed cannot be reduced inlet or outlet dampers could be installed, so that the fan will ride the fan curve. Another option would be to install a smaller motor on the existing fan where feasible.

The majority of the savings would be fan horsepower savings. Compressor savings would be negligible. Also, humidity removal would be improved.

Before implementing any of these measures, consideration must be given to whether any additional equipment, light or people will be added to a zone in the future, that would add to the cooling load.

From the HVAC System Analysis (see appendix) it is apparent that the following three dual compressor units are significantly oversized.

- The two Westinghouse 20 ton units at the Val Vista plant.
- The 15 ton American Standard units at the Squaw Peak plant.

Disconnecting one compressor and midifying the fans has a potential to save 4,100 KWH/yr at Val Vista and 1,560 KWH/yr at Squaw Peak.

2. Hot Water Modification at Val Vista

Installation of gas fired water heater to replace the electric unit at normal replacement time at Val Vista can result in dollar savings as shown in Table 20. This is advantageous since natural gas service is already available at this facility, and is cheaper per BTU than electricity.

Dollar Savings = $282/yr.

Cost of implementation = $500

3. Duct Work

Repair ductwork leaks and duct insulation breaks where applicable at all installations and not limited to the following observed areas:

- Basement ductwork for office unit at Verde
- Tank Room ductwork for office area at Deer Valley

Energy savings and implementation dependent on scope of this effort.

4. Time Clocks/Programmable Thermostats

In areas that are usually not occupied all the time, a time clock or programmable thermostat can be installed to turn the heating or air conditioning units off during the unoccupied hours. In colder climates a night thermostat should be used for freeze protection.

The energy audits performed indicate that the following units can be controlled on a time-of-day schedule.

Deer Valley - the 10 ton unit serving the conference room and the 10 ton unit serving the Administration Building. Foremens Office hallway, etc.

Squaw Peak - the 7 1/2 ton unit serving the Assembly, lunch and locker rooms and the 3 ton unit serving the Administrative Offices.

Val Vista - the 20 ton unit serving the Offices hallway and lunch rooms and the 7 1/2 ton unit serving the Conference Room. (Note: the 20 ton unit should have a manual override timer in the lunch room in case this room is used after normal working hours.

Total Annual Energy Savings:

Deer Valley	9,600 KWH + 700 Therms
Squaw Peak	5,600 KWH + 200 Therms
Val Vista	13,000 KWH + 950 Therms

Cost of implementation = $1,500

Other Measures Considered

1. Overcapacity changeout

When the analysis indicated that an A/C unit was oversized by 50% or more consideration was given to replacing that unit with a smaller one in which the nominal capacity was 25% over the average load. However, it was shown that this was not cost effective in that the simple payback exceed- ed 15 years.

2. Economizer Cycle Equipment

Consideration was given to installing economizer cycles (with enthalpy control) on the A/C units to make use of outside air for "free" cooling when conditions permit. However, it was found that for these particular units the simple payback period was over 15 years. In most of these zones there are windows and doors that can be opened on mild days to maintain comfort conditions without using mechanical refrigeration.

TOTAL ENERGY COST REDUCTIONS FOR HVAC

Total Energy Reduction for HVAC	=	39,735 KWH/YR
		plus 1,850 THERM/YR
Total Energy Cost Reduction	=	$2,615/YR

CHAPTER 6:
ENERGY COST REDUCTION - LIGHTING

Introduction

The lighting systems of the four water treatment plants basically allow for fluorescent four tube fixtures in the office, lab and other suspended ceiling areas with incandescent, mercury vapor in other interior and exterior areas. Also fluorescent lighting is used in some exterior areas, along with high pressure sodium as indicated. The lighting systems for the interior areas of the water treatment plants are to provide general and task lighting in the office lab and work areas. Exterior lighting is to provide general illumination for work tasks and safety.

Table 18 -- D.O.E. Recommended Maximum Lighting Levels

Task or Area	Footcandle Levels	How Measured
Hallways or corridors	10 ± 5	Measured average, minimum 1 footcandle
Work and circulation areas surrounding work stations	30 ± 5	Measured average
Normal office work, such as reading and writing (on desk only), store shelves, and general display areas	50 ± 10	Measured at work station
Prolonged office work which is somewhat difficult visually (on task only)	75 ± 15	Measured at work station
Prolonged office work which is visually difficult and critical in nature (on task only)	100 ± 20	Measured at work station
Industrial tasks	ANSI-AII-1-1973	As maximum

Table 19 -- Relative Visual Task Difficulty For Common Office Tasks, From American National Standards Institute All, 1-73

Task Description	Visual Difficulty Rating
Large black object on white background	1
Book or magazine, printed matter, 8 point type and larger	2
Typed original	2
Ink writing (script)	3
Newspaper text	4
Shorthand notes, ink	4
Handwriting (script) in No. 2 pencil	5
Shorthand notes, No. 3 pencil	6
Washed-out copy from copying machine	7
Bookkeeping	8
Drafting	8
Telephone directory	12
Typed carbon, fifth copy	15

Energy Usage

Yearly energy usage shown below by plant and equipment type. The lighting systems of the four plants are described as follows, with lighting duration timer shown in appropriate hours:

Verde Water Treatment Plant

-- Interior areas without E.C..M.'s	KW	Hours of Operation	Consumption KWH Per Year
Florescent 4 ft. tube fixtures			
Office, lab.......Filter Bldg.	1.35	2,800	3,780
Break room........Filter Bldg.	1.2	6,260	7,512
Filter area.......Filter Bldg.	1.9	600	1,140
Basement area.....Filter Bldg.	1.7	8,760	14,892
1st floor.........Chem. Bldg.	1.85	3,650	34,070
-- Exterior areas without E.C.M.'s			
Sedimentation Basin area	5.4	4,380	23,652
Remaining area - lighting	7.2	4,380	31,536
High power flooe-filter & Chem. Bldg.	4.0	720	2,880
			58,068
TOTAL			92,138 KWH/YR

Squaw Peak Water Treatment Plant

-- Interior areas without E.C..M.'s	KW	Hours of Operation	Consumption KWH Per Year
Florescent 4 ft. tube fixtures, 2 tube and incandescent.			
Feeder room, Plant #2	5.9	2,600	15,340
Assembly, lunch, locker rooms Plant #2	2.1	2,600	5,460
Admin. Office, Plant #2	1.4	2,600	3,640
Shop area, Plant #1	.6	2,100	1,260
Lab, office area, Plant #1	3.2	2,600	8,320

Stairwell & additional lighting	32.3	350	11,305
Chain galley & Pipe galley areas	10.7	8,760	93,732
Coagulant pump area	4.4	8,760	38,544
			177,601

-- Exterior areas without E.C.M.'s

Sedimentation Basin area	12.0	4,380	52,560
Sedimentation Basin area(flore.)	7.7	2,190	16,863
Raw water pump area	2.3	2,190	5,037
Booster station and other area lighting (mercury vapor)	2.0	4,380	8,760
			83,220
TOTAL			260,821 KWH/YR

Deer Valley Water Treatment Plant

-- Interior areas without E.C..M.'s	KW	Hours of Operation	Consumption KWH Per Year
Florescent 4 ft. 2 tube fixtures			
Coagulant drive room and passageway	7.5	8,760	65,700
Equipment feeder room Chem. Bldg.	8.3	8,760	72,708
3rd Floor, Chem. Bldg.	12.4	8,760	108,624
4th Floor, Chem. Bldg.	3.9	4,380	17,082
5th and 6th Floor, Chem. Bldg.	4.1	150	615
7th Floor, Chem. Bldg.	1.1	150	165
Admin. Bldg., 1st Floor(+ 4 tube)	4.3	2,600	11,180
Admin. Bldg., 1st Floor (rear)	5.0	2,600	13,000
Admin. Bldg., 2nd Floor(+ 4 tube)	12.0	8,760	109,500
Admin. Bldg., 3rd Floor	1.3	2,600	3,380
			401,954

-- Exterior areas without E.C.M.'s

High press. sodium, florescent & incandescent

Sedimentation Basin area, mixer and filter areas	6.7	4,380	29,346
Parking area, raw water pump areas and surrounding areas	6.5	4,380	28,470
Sedimentation area lower lights	12.0	2,920	35,040
			92,856
TOTAL			494,810 KWH/YR

Val Vista Water Treatment Plant

-- Interior areas without E.C.M.'s	KW	Hours of Operation	Consumption KWH Per Year
Florescent 4 ft. 2 tube fixtures			
Office, lobby, hall and break room	6.9	2,600	17,940
Conference room	1.6	250	400
Laboratory	4.4	2,600	11,440
Operator area and locker room	5.6	8,760	49,056
All mechanical rooms north of air conditioned area (+ 4 tube)	9.6	4,200	40,320
Conveyor bin room	2.9	350	1,015
Entire lower work and equipment area	23.4	8,760	204,984
			325,155
-- Exterior areas without E.C.M.'s			
Mercury vapor and incandescent			
Sedimentation Basin area (excluding new basin area)	42.5	4,200	178,500
Area lighting (bldg., docks, passageways, etc.)	4.0	4,200	16,800
Parking lots, raw water pump area and adjoining areas	23.4	4,200	98,280
			293,580
TOTAL			618,735 KWH/YR

Generic E.C.M.'s

The following is a list of generic energy conservation measures. The tabulation is comprehensive, but E.C.M.'s are not limited to this list.

Low Cost/ No Cost E.C.M.'s.

- Lighting level reduction from the installed capacity to a sufficient level for safe, adequate operation in non-critical areas.
- Relamping the fluorescent fixtures as attrition dictates with 34 watt tubes.
- Where applicable, use single incandescent lamp of higher wattage rather than two or more smaller lamps of combined higher wattage.

- Disconnect ballasts which still use significant amounts of energy even though tubes have been removed.
- Lighting level reduction in four tube fluorescent fixtures to two tube and the disconnecting of appropriate ballasts.
- Lowering of fixture level where applicable to increase task area lighting level.
- Establish a regular inspection and cleaning schedule for lamps and fixtures.
- Replace hazy or yellowed lens shields with new acrylic lens where applicable.
- Replace exterior 150 watt flood lamps with 75 watt to reduce consumption while maintaining adequate illumination.
- Replace exterior incandescent lamps with more efficient types such as high pressure sodium or metal halide.
- Provide signs instructing occupants to turn off lights when leaving room.
- Rearrange task areas to eliminate unnecessary illumination.
- Utilize natural lighting where possible and clean walls or repaint with light reflective non-glossy colors.
- Eliminate outdoor lighting in areas where practical.

Capital Equipment E.C.M.'s

- Install time clocks for interior and exterior lighting in areas where applicable.
- Install photocell switching for exterior lighting to come on at dusk and off at dawn.
- Install override timers for special area lighting such as conference rooms and break rooms, etc.
- Install motion sensors to automatically control lighting in areas that are not constantly occupied.
- Install lighting dimming equipment which automatically compensates for varying natural lighting levels.
- Rewire switches so a single switch does not control all fixtures in multiple work spaces.

LOW/COST NO COST MEASURES

1. Reduction of Lighting Levels

Reduce lighting levels and switching off lighting (by personnel) when not in use in the following area.

- Break room at Verde -	6,103	KWH/YR
- Booster station area at Squaw Peak -	5,838	
- 3rd floor, Chem. Bldg. at Deer Valley -	73,146	
- 4th floor, Chem. Bldg. at Deer Valley -	10,978	
- 2nd floor, Admin. Bldg. at Deer Valley -	41,063	
- 3rd floor, Admin. Bldg. at Deer Valley -	3,185	
- Offices and lobby-hallways at Val Vista -	7,540	
- Operator area and locker room at Val Vista -	34,164	
- Treatment mech. equipment rooms at Val Vista -	20,160	
- Sedimentation basin area at Val Vista -	37,800	

Implementation Cost $496   Energy Savings 239,977 KWH/YR

2. Energy Savings Florescent Tubes

At time of replacement relamp fluorescent fixtures with 34 watt tubes

Implementation Cost $223.   Energy Savings 57,843 KWH/YR

3. Time Clocks

Installation of override timers and time clocks for selected areas such as, conference rooms and intermittent work areas.

Implementation Cost $300.   Energy Savings 38,416 KWH/YR

Capital Cost Measures

1. Motion Sensors

Installation of motion sensors in selected areas. (See Energy Analysis section) These devices will automatically control lighting in areas not constantly used. These sensors will turn lighting on when motion is detected and switch off at an adjustable time when motion is no longer detected.

Caution, area selection is critical and false triggering can occur with some equipment in "echoing" type areas.

Implementation Cost $10,700.	Energy Savings	294,190 KWH/YR

Total Energy Cost Reduction for Lighting

Total Energy Reduction for Lighting	=	630,426 KWH/YR
Total Energy Cost Reduction for Lighting	=	$30,261. /YR

CHAPTER 7:
IMPLEMENTATION PLANS

Summary of All Energy Conservation Measures

A Summary of all recommended E.C.M.'s for the four water treatment plants, including project costs and savings with applicable simple paybacks is presented in Table #20.

Simple payback is a convenient basis for assessing the economic viability of a prospective E.C.M. and for comparing the relative attractiveness of alternative E.C.M.'s. The simple payback is defined as the time required for the savings from an investment to equal the initial cost excluding such factors as the cost of money and inflation.

During the 12 month reference base period used in this report, the four water treatment plants consumed a total of 20,925,000 kilowatt hours of electricity for Raw Water pumping, Treatment System, HVAC and Lighting (exclusive of booster pumping). The cost of this power is $1,004,380. (At a current cost of 4.8¢ per KWH)

This report has identified energy conservation measures which, exclusive of the identified Chemical Cost Reduction E.C.M. ($83,250), would reduce this consumption by a minimum of 3,056,693 kilowatt hours/yr or 15%; a savings of $148,193 per year.

Table 20 -- Energy Conservations Measures

Low Cost - No Cost E.C.M.'s	Ann. Svgs. (KWH)	$ Savings	Cost ($)	Payback (Years)
Pumping Systems (Chapter 3)				
1. Pump Priorities	216,777	10,405	0	-
2. By-Pass Deer Valley Pre-Sched.[2]	72,703	3,490	0	-
3. Val Vista Plant Waterpump Mod.	25,542	1,226	0	-
Treatment Process (Chapter 4)				
1. Optimization of Alum Treatment	-	83,250	-	-
2. Optimize Flocculation Operations	1,012,073	48,580	0	-
3. Preferential Plant Operation	Not Known	-	0	-
HVAC Systems (Chapter 5)				
1. Capacity Reduction	5,660	272	600	2.2
2. Hot Water Mod. at Val Vista	5,875	282	500	1.8
3. Repair Ductwork	Not Known	Not Known	-	-
4. Time Clocks/Programmable T-stats	28,200[3]	2,06[3]	1,500	0.8
Lighting Systems (Chapter 6)				
1. Reduction of Lighting Levels	239,977	11,519	496	0.04
2. Energy Savings Florescent Tubes	57,843	2,777	223	0.08
3. Time Clocks	38,416	1,844	300	0.2
Totals for Low Cost-No Cost E.C.M.'s	1,703,066	$165,706	$3,619	

*Mid point in the range of $33,000 to $133,500

Capital Cost E.C.M.'s - Table 20 (continued)

Pumping Systems (Chapter 3)				
1. Val Vista Raw-water Agitation	618,700	29,698	23,800	0.8
2. Deer Valley Raw-water Agitation	331,277	15,900	23,800	1.5
3. Squaw Peak #12 impeller	39,710	1,906	8,000	4.2
4. Squaw Peak #9 impeller	28,850	1,385	6,000	4.3
5. Squaw Peak #8 impeller	15,900	763	6,000	7.9
6. Replace impeller in Val Vista R.W. pump	25,000	1,200	14,000	11.7
Lighting Systems (Chapter 6)				
1. Installation of Motion Sensors	294,190	14,121	10,700	0.8
Totals for Capital Cost E.C.M.'s	1,353,627	$65,737	$98,300	

Notes:

1. Some E.C.M.'s are difficult to quantify on an annual basis. Certain assumptions were made based on reasonable expectations to allow calculations of a typical annual energy consumption figure. (Exception is the cost savings of the Chemical treatment material such as Alum.)

2. Assume low turbidity for 5 months per year and 55 M.G.D.

3. Plus 1,850 therms at $0.383 per therm, $709.

Summary:

The measures presented here can be seen to represent savings in excess of:

a) 3,056,693 KWH per year (plus 1,850 therms).

b) $231,443 dollars per year (including chemicals and natural gas).

Steps to Implementation

Water & Sewer Department fundings are considered as enterprise funding distinguished from general purpose funding.

As soon as the energy conservation projects are identified along with the cost of implementation and payback these are subjected prioritization. This process is to place the implementation priority in line with other E-C projects in order of payback. The funds for each F.Y. are budgeted ahead of time before the start of the Fiscal Year. Normally, the projects identified during the current fiscal year finds its place for implementation in the next fiscal year. However, if a particular project has exceptionally high savings it could fit into current year's budget to replace other projects so the next step is to determine if this project could be done in current fiscal year as in the next one.

Before working on design and engineering or analysis the project concept and its schedule are discussed and concurrence obtained from the Water and Sewer Department providing the funds. Since the establishment of the Energy Conservation Office by the City of Phoenix, almost all of the energy conservation projects were funded by the City.

Once the schedule and engineering concept have been agreed to by the Water and Sewer Department the design and engineering task begins. Long delivery items identified during engineering process are ordered first so that they are delivered on time.

A division is made at this stage whether this task can be performed in house or it has to be contracted out.

On completion of the project it is essential to monitor the savings projected earlier.

This is done by connecting a recorder meter that records the energy consumption before and after the project implementation. In some cases difference of energy bills before and after the project completion is quite reliable to indicate the savings.

Although City of Phoenix does provide Finances for the energy Conservation projects on a limited bases yet other sources such as Government agencies, lease programs, private enterprise should also be considered.

CHAPTER 8:
SUMMARY AND SUGGESTIONS FOR APPLICATION

Suggestions for Application

It is very important that the personnel from the Water Production Division should be requested for participation throughout the project. This will ensure smooth progress of the project as well as positive response to various elements of the study. They should be encouraged to offer their ideas and suggestions for energy conservation to make full use of their experience and expertise in their areas. The data gathering task may be assigned to technicians.

At the time of conducting the Energy Audit through the plant a representative from the Water Treatment Plant should be encouraged to accompany.

The person conducting the study should refrain from discussing any adverse energy consuming observation.

The Project Director/Manager should hold periodic meetings to discuss and assess the progress on the project.

The Project Director should write adequate specifications for portion of the project let out to Consulting Engineer. The Consulting Engineer selected should have proven experience in similar studies.

The Project Study Team should have access to Water Treatment Plant plans, blueprints, utility bills, equipment operating logs and pump curves.

The information available from these records should be thoroughly analyzed and evaluated as part of the project study.

Lessons Learned

The first step towards the energy conservation effort is conducting an energy audit of the facility using as a guide the check list (and other factors) shown on pages 54 and 65. This activity reveals potential energy savings in the operation and maintenance of the systems, low cost and no cost measures and retrofit projects that require capital investment. Other lessons learned from the study of the water treatment plants include:

- o The need to employ consulting engineering personnel with a more focused expertise in the pumping and treatment functions of water production to compliment in-house engineering expertise in these and other areas of the study.
- o The need to educate and inform the departments involved in the study as to the areas and scope of material to be addressed. This is required so as not to give the impression that this work will duplicate other conservation study efforts underway in other areas of water production, distribution, and treatment.
- o Ultrasonic motion sensors were installed in the Coagulant drive room and passageway of the Deer Valley Plant. However, due to excessive false triggering, they were removed. The false triggering was caused by noise, especially metal-to-metal noise, and the construction of the room (all concrete and block-nothing to absorb sound, created an echo chamber effect. Care must be taken in the effective installation of this equipment.

Conclusions

This report shows that significant Energy Consumption in Water Treatment Plants in Phoenix can be realized in the areas of raw water pumping, processing equipment operations (including selective plant on-line optimization), and lighting reduction. Also modest reduction in HVAC operation costs can be realized.

The following are the percentages of the total energy conservation that can be realized (in KWH & Therms) attributable to each function;

o	raw water pumping	29%
o	process equipment & plant optimization	57%
o	lighting	13%
o	HVAC	1%

Also, chemical treatment savings, although ancillary to the main effort of the study, were however shown to be significant; (36% of the total dollar savings) and should be considered in any study of optimizating operational costs in municipal water treatment systems.

To summarize; 3,056,693 KWH/YR representing 15% of the total energy consumption for the reference period can be saved resulting in approximately $231,443 total reduction in operational costs.

APPENDIX A--TERMS, REFERENCES AND SUPPLIERS

Glossary of Terms

ASHRAE	American Society of Heating Refrigeration and Air-Conditioning Engineers
BHP	Brake Horsepower
BTU	British Termal Unit (measure of heat energy)
CCF	100 cubic feet (gas)
CFM	Cubic feet per minute
DB	Dry bulb (temperature)
E.C.M.	Energy Conservation Measure
Eff.	Efficiency (referenced to pump performance)
F	Degree Fahrenheit
Footcandle	Standard measure of lighting illumination
GPM	Gallons per minute (flow)
G	Velocity Gradient (fps./fr.), or (sect)
HR	Hour (60 minutes)
HP	Horsepower
HVAC	Heating Ventilating and Air Conditioning
KW	Kilowatt (1000 watts)
KWH	Kilowatt - hour
MB	Million gallon(s)
MGD	Million gallons per day
nom	Nominal as referred to standard capacity of equipment
pH	Hydrogen ion concentration in solution as referenced to a standard electrods
psi	Pounds per square foot (pressure)
sq.ft.(ft^2)	Square feet (area)

APPENDIX A CONT'D.

Glossary of Terms (cont'd.)

TDH	Total dynamic head (feet)
therm	Unit of measure of natural gas (103,000 BTU/therm)
ton	12,000 BTU/HR measure of capacity of HVAC equipment also 2,000 pounds in weight
WB	Web bulb (temperature)

References

City of Phoenix, Arizona, Water and Sewers Department Annual Report, Fiscal Year ending June 30, 1981.

Federal Energy Administration, Lighting and Thermal Operations: Energy Conservation Principles Applied to Office Lighting, Paper Number 18 Reduced Lighting Levels Table 1 and Table 2 Washington D.C. April 15, 1975.

ASHRAE - American Society of Heating Refrigeration and Air Conditioning Engineers;

- Fundamentals Handbook - 1977
- "Energy Conservation in New Building Design"

Arizona Energy Audit Workbook - 1978 Governors Office of Economic Planning and Development as funded by the U.S. Department of Energy.

Manufacturers and Suppliers

Motion Sensors	Novitas, California Kesser Electronic, Inc.
34 Watt Florescent Tubes	All Lighting Manufacturers
Time Clocks/Programmable Thermostats	Paragon, Intermatic, Honeywell, Robertshaw and others.
Economy Cycle Controls	Robertshaw Controls, Inc. Johnson Controls, Inc. Honeywell, Inc. and others.

APPENDIX B

HVAC DATA SHEET

VERDE WATER TREATMENT PLANT

Filter Building (Office and Chem Lab - 575 ft^2)

A/C Unit - Borg-Warner model #SW90-48 water cooled

Nominal Cooling Capacity: 5.0 ton

-- Cooling Load Analysis (maximum summer gain BTU/hr)

Transmission	1,570	BTU/Hr
Solar	550	BTU/Hr
Ventilation/Infiltration	6,800	BTU/Hr
People	1,530	BTU/Hr
Lights	4,607	BTU/Hr
Special Equipment	14,435	BTU/Hr
Maximum sensible cooling load	29,492	(2.5 ton)
Average cooling load 85%		2.1 ton

Heating Unit - Heat Controller propane gas unit in combination with

the A/C Unit	200,000	BTU input
Nominal Heating Capacity:	160,000	BTU/Hr

-- Heating Load Analysis: (maximum winter loss BTU/Hr)

Transmission	2,600	BTU/Hr
Ventilation/Infiltration	7,500	
Maximum Heating Load	10,100	BTU/Hr

HVAC DATA SHEET

VERDE WATER TREATMENT PLANT

Filter Building (Break room area - 570 ft^2)

A/C Unit - Carrier #50CA004600 water cooled

Nominal Cooling Capacity: 2.5 ton

-- Cooling Load Analysis (maximum summer gain BTU/hr)

Transmission	1,800	BTU/Hr
Solar	1,200	BTU/Hr
Ventilation/Infiltration	6,500	BTU/Hr
People (periodic)	5,100	BTU/Hr
Lights	4,100	BTU/Hr
Special Equipment	2,050	BTU/Hr
Maximum Sensible cooling load	20,750	(1.7 ton)
Average cooling load 70%		1.2 ton

Heating Unit - 3KW electric strip heater in Carrier Unit

Nominal Heating Capacity	10,240	BTU/Hr

-- Heating Load Analysis: (maximum winter loss BTU/Hr)

Transmission	2,200	BTU/Hr
Ventilation/infiltration	7,000	
Maximum Heating Load	9,200	BTU/Hr

HVAC DATA SHEET

VERDE WATER TREATMENT PLANT

Chemical Building (Break room - 235 ft^2)

A/C Unit - Carrier model #500A002330 air cooled

Nominal Cooling Capacity: .75 ton

-- Cooling Load Analysis (maximum summer gain BTU/hr)

Transmission	1,000	BTU/Hr
Solar	400	BTU/Hr
Ventilation/Infiltration	6,000	BTU/Hr
People (periodic)	2,500	BTU/Hr
Lights	4,100	BTU/Hr
Special Equipment	2,050	BTU/Hr
Maximum sensible cooling load	16,150	(1.3 ton)
Average cooling load 60%		.79 ton)

Heating Unit - 5KW electric unit heater

Nominal Heating Capacity: 17,065 BTU/Hr

-- Heating Load Analysis: (maximum winter loss BTU/Hr)

Transmission	1,400	BTU/Hr
Ventilation/Infiltration	7,500	
Maximum Heating Load	8,900	BTU/Hr

HVAC DATA SHEET

SQUAW PEAK WATER TREATMENT PLANT

Plant #2 (Administrative Office - 307 ft^2)

A/C Unit - American Standard #WS318A water cooled

Nominal Cooling Capacity: 3.0 ton

-- Cooling Load Analysis (maximum summer gain BTU/Hr)

Transmission	3,040	BTU/Hr
Solar	1,180	BTU/Hr
Ventilation/Infiltration	3,000	BTU/Hr
People	2,040	BTU/Hr
Lights	4,780	BTU/Hr
Special Equipment	170	BTU/Hr
Maximum sensible cooling load	14,210	(1.2 ton)
Average cooling load 85%		1.0 ton

Heating Unit - Gas fired furnace 90,000 BTU/HR input

Nominal Heating Capacity: 72,000 BTU/Hr

-- Heating Load Analysis: (maximum winter loss BTU/Hr)

Transmission	3,600	BTU/Hr
Ventilation/Infiltration	3,200	
Maximum Heating Load	6,800	BTU/Hr

HVAC DATA SHEET

SQUAW PEAK WATER TREATMENT PLANT

Plant #2 (Assembly/lunch room, Conference room - 1040 ft^2/)

A/C Unit - American Standard #VW818J water cooled

Nominal Cooling Capacity: 7.5 ton

-- Cooling Load Analysis (maximum summer gain BTU/Hr)

Transmission	10,130	BTU/Hr
Solar	3,990	BTU/Hr
Ventilation/Infiltration	7,500	BTU/Hr
People (periodic)	9,200	BTU/Hr
Lights	7,170	BTU/Hr
Special Equipment	4,130	BTU/Hr
Maximum sensible cooling load	42,120	(3.5 ton)
Average cooling load 85%		3.0 ton

Heating Unit - Gas fired furnace 90,000 BTU/HR input

Nominal Heating Capacity: 72,000 BTU/Hr

-- Heating Load Analysis: (maximum winter loss BTU/Hr)

Transmission	13,000	BTU/Hr
Ventilation/Infiltration	11,000	
Maximum Heating Load	24,000	BTU/Hr

HVAC DATA SHEET

SQUAW PEAK WATER TREATMENT PLANT

Plant #2 (Control feeder room - 1924 ft^2)

A/C Unit - American Standard model #1528 water cooled

Nominal Cooling Capacity: 15.0 ton

-- Cooling Load Analysis (maximum summer gain BTU/Hr)

Transmission	7,230	BTU/Hr
Solar	400	BTU/Hr
Ventilation/Infiltration	9,500	BTU/Hr
People	2,040	BTU/Hr
Lights	20,140	BTU/Hr
Special Equipment	3,820	BTU/Hr
Maximum sensible cooling load	43,130	(3.6 ton)
Average cooling load 85%		3.1 ton

Heating Unit - Lennox gas fired furnace 136,000 BTU/Hr input

Nominal Heating Capacity: 109,000 BTU/Hr

-- Heating Load Analysis: (maximum winter loss BTU/Hr)

Transmission	6,500	BTU/Hr
Ventilation/Infiltration	10,500	
Maximum Heating Load	17,000	BTU/Hr

HVAC DATA SHEET

SQUAW PEAK WATER TREATMENT PLANT

Plant #1 (Laboratory area - 1,240 ft^2)

A/C Unit - Carrier water cooled unit

Nominal Cooling Capacity: 7.5 ton

-- Cooling Load Analysis (maximum summer gain BTU/Hr)

Transmission	18,560	BTU/Hr
Solar	5,250	BTU/Hr
Ventilation/Infiltration	13,640	BTU/Hr
People	2,550	BTU/Hr
Lights	10,920	BTU/Hr
Special Equipment	11,960	BTU/Hr
Maximum sensible cooling load	59,890	(5.0 ton)
Average cooling load 85%		4.25 ton

Heating Unit - 7.4KW electric strip heater in ducts

Nominal Heating Capacity: 25,250 BTU/Hr

-- Heating Load Analysis: (maximum winter loss BTU/Hr)

Transmission	26,000	BTU/Hr
Ventilation/Infiltration	7,500	
Maximum Heating Load	33,500	BTU/Hr

HVAC DATA SHEET

SQUAW PEAK WATER TREATMENT PLANT

Plant #1 (Shop area - 740 ft^2

A/C Unit - Air cooled

Nominal Cooling Capacity: 3.0 ton

-- Cooling Load Analysis (maximum summer gain BTU/Hr)

Transmission	14,220	BTU/Hr
Solar	2,500	BTU/Hr
Ventilation/Infiltration	4,500	BTU/Hr
People	1,530	BTU/Hr
Lights	2,050	BTU/Hr
Special Equipment	1,500	BTU/Hr
Maximum sensible cooling load	26,300	(2.2 ton)
Average cooling load 85%		1.9 ton

Heating Unit - Janitorial gas fired unit heater 90,000 BTU/Hr input

Nominal Heating Capacity: 72,000 BTU/Hr

-- Heating Load Analysis: (maximum winter loss BTU/Hr)

Transmission	18,000	BTU/Hr
Ventilation/Infiltration	17,500	
Maximum Heating Load	35,500	BTU/Hr

HVAC DATA SHEET

DEER VALLEY WATER TREATMENT PLANT

Administration Building (Office, Lobby and Reception area - 1,800 ft^2)

A/C Unit - American Standard #VW5518J water cooled

Nominal Cooling Capacity: 4.0 ton

-- Cooling Load Analysis (maximum summer gain BTU/Hr)

Transmission	36,000	BTU/Hr
Solar	12,300	BTU/Hr
Ventilation/Infiltration	4,000	BTU/Hr
People	2,550	BTU/Hr
Lights	9,600	BTU/Hr
Special Equipment	1,950	BTU/Hr
Maximum sensible cooling load	26,300	(2.2 ton)
Average cooling load 85%		4.7 ton

Heating Unit - Rheem Furnace 80,000 BTU input gas

Nominal Heating Capacity: 64,000 BTU/Hr

-- Heating Load Analysis: (maximum winter loss BTU/Hr)

Transmission	50,000	BTU/Hr
Ventilation/Infiltration	4,000	
Maximum Heating Load	54,000	BTU/Hr

HVAC DATA SHEET

DEER VALLEY WATER TREATMENT PLANT

Administration Building (Conference room - 665 ft^2)

A/C Unit - Carrier Model 48B12-512 air cooled

Nominal Cooling Capacity: 10.0 ton

-- Cooling Load Analysis (maximum summer gain BTU/Hr)

Transmission	1,670	BTU/Hr
Solar	450	BTU/Hr
Ventilation/Infiltration	7,700	BTU/Hr
People	10,200	BTU/Hr
Lights	4,100	BTU/Hr
Special Equipment	-0-	BTU/Hr
Maximum sensible cooling load	24,120	(2.0 ton)
Average cooling load 60%		1.2 ton

Heating Unit - (combined in Carrier unit) 250,000 BTU input gas

Nominal Heating Capacity: 200,000 BTU/Hr

-- Heating Load Analysis: (maximum winter loss BTU/Hr)

Transmission	9,000	BTU/Hr
Ventilation/Infiltration	7,000	
Maximum Heating Load	16,000	BTU/Hr

HVAC DATA SHEET

DEER VALLEY WATER TREATMENT PLANT

Administration Building (Laboratory area on second floor, north-1350 ft^2)

A/C Unit - Carrier Model 48B-589 air cooled

Nominal Cooling Capacity: 7.5 ton

-- Cooling Load Analysis (maximum summer gain BTU/Hr)

Transmission	13,600	BTU/Hr
Solar	1,300	BTU/Hr
Ventilation/Infiltration	9,200	BTU/Hr
People	2,600	BTU/Hr
Lights	19,100	BTU/Hr
Special Equipment	17,300	BTU/Hr
Maximum sensible cooling load	63,100	(5.25 ton)
Average cooling load 85%		4.5 ton

Heating Unit - (combined in Carrier unit) 200,000 BTU input gas

Nominal Heating Capacity: 160,000 BTU/Hr

-- Heating Load Analysis: (maximum winter loss BTU/Hr)

Transmission	17,000	BTU/Hr
Ventilation/Infiltration	8,000	
Maximum Heating Load	25,000	BTU/Hr

HVAC DATA SHEET

DEER VALLEY WATER TREATMENT PLANT

Administration Building (Bacteriological Lab, Restrooms, Office, etc.-3250 ft^2)

A/C Unit - Rheem model RAWA-100-DAS air cooled

Nominal Cooling Capacity: 10.0 ton

-- Cooling Load Analysis (maximum summer gain BTU/Hr)

Transmission	6,900	BTU/Hr
Solar	850	BTU/Hr
Ventilation/Infiltration	53,900	BTU/Hr
People	4,000	BTU/Hr
Lights	13,200	BTU/Hr
Special Equipment	2,200	BTU/Hr
Maximum sensible cooling load	81,050	(6.7 ton)
Average cooling load 85%		5.7 ton

Heating Unit - Lennox furnace 80,000 BTU/Hr input gas

Nominal Heating Capacity: 64,000 BTU/Hr

-- Heating Load Analysis: (maximum winter loss BTU/Hr)

Transmission	17,000	BTU/Hr
Ventilation/Infiltration	45,000	
Maximum Heating Load	55,000	BTU/Hr

HVAC DATA SHEET

DEER VALLEY WATER TREATMENT PLANT

Administration Building (Chief Chemists Office, 2nd floor - 210 ft^2)

A/C Unit - Fedders window type, air cooled

Nominal Cooling Capacity: 1.0 ton

-- Cooling Load Analysis (maximum summer gain BTU/Hr)

Transmission	1,900	BTU/Hr
Solar	500	BTU/Hr
Ventilation/Infiltration	-0-	BTU/Hr
People	1,050	BTU/Hr
Lights	2,050	BTU/Hr
Special Equipment	-0-	BTU/Hr
Maximum sensible cooling load	5,500	(0.5 ton)
Average cooling load 85%		0.43 ton

Heating Unit - (Heat obtained from adjacent units by connection)

Nominal Heating Capacity:	-0-	BTU/Hr

-- Heating Load Analysis: (maximum winter loss BTU/Hr)

Transmission	2,400	BTU/Hr
Ventilation/Infiltration	800	
Maximum Heating Load	3,200	BTU/Hr

HVAC DATA SHEET

DEER VALLEY WATER TREATMENT PLANT

Chemistry Building (Operators Lab, 3rd floor, area 3,100 ft^2)

A/C Unit - American Standard #VWS818J water cooled

Nominal Cooling Capacity: 7.5 ton

-- Cooling Load Analysis (maximum summer gain BTU/Hr)

Transmission	37,000	BTU/Hr
Solar	6,600	BTU/Hr
Ventilation/Infiltration	6,000	BTU/Hr
People	1,550	BTU/Hr
Lights	13,850	BTU/Hr
Special Equipment	1,700	BTU/Hr
Maximum sensible cooling load	66,700	(5.5 ton)
Average cooling load 85%		4.7 ton

Heating Unit - Lennox furnace 120,000 BTU/Hr input gas

Nominal Heating Capacity: 96,000 BTU/Hr

-- Heating Load Analysis: (maximum winter loss BTU/Hr)

Transmission	37,000	BTU/Hr
Ventilation/Infiltration	13,000	
Maximum Heating Load	50,000	BTU/Hr

HVAC DATA SHEET

DEER VALLEY WATER TREATMENT PLANT

Chemistry Building (Break room and Restrooms, 4th floor - 3,100 ft^2)

A/C Unit - American Standard #VWS818J water cooled

Nominal Cooling Capacity: 7.5 ton

-- Cooling Load Analysis (maximum summer gain BTU/Hr)

Transmission	17,050	BTU/Hr
Solar	2,200	BTU/Hr
Ventilation/Infiltration	16,500	BTU/Hr
People	3,060	BTU/Hr
Lights	7,700	BTU/Hr
Special Equipment	7,200	BTU/Hr
Maximum sensible cooling load	53,710	(4.5 ton)
Average cooling load 85%		3.8 ton

Heating Unit - Lennox furnace 80,000 BTU/Hr input gas

Nominal Heating Capacity: 64,000 BTU/Hr

-- Heating Load Analysis: (maximum winter loss BTU/Hr)

Transmission	23,000	BTU/Hr
Ventilation/Infiltration	19,250	
Maximum Heating Load	42,250	BTU/Hr

HVAC DATA SHEET

VAL VISTA WATER TREATMENT PLANT

Chemistry Building (Offices, Lobby-hallways, Break room - 3,530 ft^2)

A/C Unit - Westinghouse model #IK240 CRDP packaged roof top single zone unit with gas fired furnace air cooled

Nominal Cooling Capacity: 20.0 ton

-- Cooling Load Analysis (maximum summer gain BTU/Hr)

Transmission	26,700	BTU/Hr
Solar	8,200	BTU/Hr
Ventilation/Infiltration	8,000	BTU/Hr
People	6,120	BTU/Hr
Lights	23,550	BTU/Hr
Special Equipment	10,050	BTU/Hr
Maximum sensible cooling load	82,620	(7.0 ton)
Average cooling load 89%		6.2 ton

Heating Unit - (combined unit) 350,000 BTU/Hr input

Nominal Heating Capacity: 280,000 BTU/Hr

-- Heating Load Analysis: (maximum winter loss BTU/Hr)

Transmission	37,000	BTU/Hr
Ventilation/Infiltration	7,500	
Maximum Heating Load	44,500	BTU/Hr

HVAC DATA SHEET

VAL VISTA WATER TREATMENT PLANT

Main Building (Chem. Lab are - 1,600 ft^2)

A/C Unit - Westinghouse model #IK120 CRDP packaged roof top single zone unit with gas fired furnace air cooled

Nominal Cooling Capacity: 10.0 ton

-- Cooling Load Analysis (maximum summer gain BTU/Hr)

Transmission	16,225	BTU/Hr
Solar	6,620	BTU/Hr
Ventilation/Infiltration	22,680	BTU/Hr
People	2,550	BTU/Hr
Lights	20,135	BTU/Hr
Special Equipment	13,700	BTU/Hr
Maximum sensible cooling load	81,910	(6.8 ton)
Average cooling load 70%		4.8 ton

Heating Unit - (combined unit) 250,000 BTU/Hr input

Nominal Heating Capacity: 280,000 BTU/Hr

-- Heating Load Analysis: (maximum winter loss BTU/Hr)

Transmission	16,225	BTU/Hr
Ventilation/Infiltration	22,680	
Maximum Heating Load	38,905	BTU/Hr

HVAC DATA SHEET

VAL VISTA WATER TREATMENT PLANT

Main Building (Operators Station, Locker rooms - 2,625 ft^2)

A/C Unit - Westinghouse model #IK240 CRDP packaged roof top single zone unit with gas fired furnace air cooled

Nominal Cooling Capacity: 20.0 ton

-- Cooling Load Analysis (maximum summer gain BTU/Hr)

Transmission	26,510	BTU/Hr
Solar	10,120	BTU/Hr
Ventilation/Infiltration	13,650	BTU/Hr
People	2,550	BTU/Hr
Lights	19,115	BTU/Hr
Special Equipment	1,700	BTU/Hr
Maximum sensible cooling load	73,645	(6.1 ton)
Average cooling load 85%		5.2 ton

Heating Unit - (combined unit) 350,000 BTU/Hr input

Nominal Heating Capacity: 280,000 BTU/Hr

-- Heating Load Analysis: (maximum winter loss BTU/Hr)

Transmission	26,510	BTU/Hr
Ventilation/Infiltration	13,650	
Maximum Heating Load	40,160	BTU/Hr

HVAC DATA SHEET

VAL VISTA WATER TREATMENT PLANT

Main Building (Conference room - 750 ft^2)

A/C Unit - Westinghouse model #K090C#RR0L packaged roof top single zone unit air cooled with gas fired furnace

Nominal Cooling Capacity: 7.5 ton

-- Cooling Load Analysis (maximum summer gain BTU/Hr)

Transmission	13,200	BTU/Hr
Solar	2,800	BTU/Hr
Ventilation/Infiltration	500	BTU/Hr
People	12,240	BTU/Hr
Lights	5,460	BTU/Hr
Special Equipment	-0-	BTU/Hr
Maximum sensible cooling load	34,200	(2.9 ton)
Average cooling load 42%		1.2 ton

Heating Unit - (combined unit) 175,000 BTU/Hr input

Nominal Heating Capacity: 140,000 BTU/Hr

-- Heating Load Analysis: (maximum winter loss BTU/Hr)

Transmission	13,500	BTU/Hr
Ventilation/Infiltration	500	
Maximum Heating Load	14,000	BTU/Hr

LIGHTING DATA SHEET

Verde Water Treatment Plant

-- Interior and Exterior areas with E.C.M.'s
Break room - (employ E.C.M.'s of lighting reduction and)
(switching of lights when not in use)
.9 KW 1,565 HRS/YR 1,409

Reduction with all florescents
to 34 watt tubes (3,066) (6,103)

TOTAL WITH E.C.M.'s (92,138-9,169) 82,969 KWH/YR

SQUAW PEAK WATER TREATMENT PLANT

-- Interior and Exterior areas with E.C.M.'s
Chain galley and pipe
galley area - (employ E.C.M. of motion sensor)
(installation to energize lighting)
(only when periodic walk through)
(of the area is done by operating)
(personnel. Caution; with motion)
(sensors, false triggering may)
(occur.)
10.7 KW 10 min./hr. - 1,460 15,622
(78,110)

Coagulant pump area - (employ ECM of motion sensors)
(same as above)
4.4 KW 1,460 HRS/YR 6,424
(32,120)

Booster station and other
area lighting - (employ ECM of reducing)
(lighting operating time)
(and quantity)
1.3 2,190 2,922
(5,838)
Reduction with all florescents to 34 watt tubes (5,383)

TOTAL WITH E.C.M.'s (260,821 - 121,451) 139,370 KWH/YR

LIGHTING DATA SHEET

Deer Valley Water Treatment Plant

-- Interior and Exterior areas with E.C.M.'s
Coagulant drive room and
equipment feeder room - (employ E.C.M. of motion sensor)
(installation; caution the area)
(is susceptible to false trigger-)
(ing of this advice.)

		(54,750)
7.5 KW	1,460 HRS/YR	10,950
8.3 KW	1,460 HRS/YR	12,118
		(60,590)

3rd Floor - Chem. Bldg. - (employ E.C.M. of lighting)
(reduction and reduced hrs.)
(of operation. Note: Some)
(lighting reduction has al-)
(ready been implemented by)
(plant superintendent)

8.1 KW	4,380 HRS/YR	35,478
		(73,146)

4th Floor - Chem. Bldg. - (employ E.C.M. of education)
(of personnel to switch off)
(lights when leaving area)

3.9 KW	1,565 HRS/YR	6,104
		(10,978)

2nd Floor - Admin. Bldg. - (employ E.C.M. of lighting)
(reduction and reduced hrs.)
(of operation. Note: Some)
(lighting reduction has al-)
(ready been implemented by)
(plant superintendent.)
Install override timer for conference
room lights

12.5 KW	4,380 HRS/YR	54,750
		(54,750)

3rd Floor - Admin. Bldg. - (employ E.C.M. of education)
(of personnel to switch off)
(lights when leaving area)

1.3 KW	150 HRS/YR	190
		(3,185)

Reduction with all florescents to 34 watt tubes (25,725)

TOTAL WITH E.C.M.'s (494,810-283,124) 211,686 KWH/YR

LIGHTING DATA SHEET

<u>Val Vista Water Treatment Plant</u>

-- Interior and Exterior areas with E.C.M.'s

Office, lobby, hall and break room - (employ E.C.M. of lighting) (reduction and reduced hrs.) (of operation. Note: These) (lighting reduction have al-) (ready been implemented by) (the plant superintendent.)

4.0 KW 1,600 HRS/YR 10,400

(7,540)

Operators area and locker room - (employ E.C.M. of lighting) (reduction and reduced hrs.) (of operation. Note: These) (lighting reduction have al-) (ready been implemented by) (the plant superintendent.)

1.7 KW 8,760 HRS/YR 14,892 (34,164)

Mechanical rooms - (employ the E.C.M. of re-) (hours of operation)

9.6 KW 2,100 HRS/YR 20,160 (20,160)

Lower work and equipment - (employ E.C.M. of lighting) (reduction and reduced hrs.) (of operation and personnel) (education to turn off lights) (when not in use. Note: Some) (of these E.C..M.'s have al-) (ready been implemented by) 75,044 (plant superintendent.)

Install override timers on designated lights in this area.

(61,820)

Install motion sensors on remaining lights this area. (68,620)

Sedimentation Basin area - (employ E.C.M. of reducing) (lighting level. Note: This) (E.C.M. has already been) (implemented by plant) (superintendent.)

33.5 KW 4,200 HRS/YR 104,700 (37,800)

reduction with all florescents to 34 watt tubes (17,569)

TOTAL WITH E.C.M.'s (618,735-247,173) 371,562 KWH/YR

REPORT AND INFORMATION SOURCES

Additional copies of this report, "Energy Conservation in Water Treatment: A Study of Four Water Treatment Plants in Phoenix, Arizona," are available from:

Publications and Distribution
Public Technology, Inc.
1301 Pennsylvania Avenue, NW
Washington, DC 20004

Further information on the techniques and procedures described in this report and additional information about ongoing implementation of energy cost reduction practices in the City of Phoenix are available from:

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