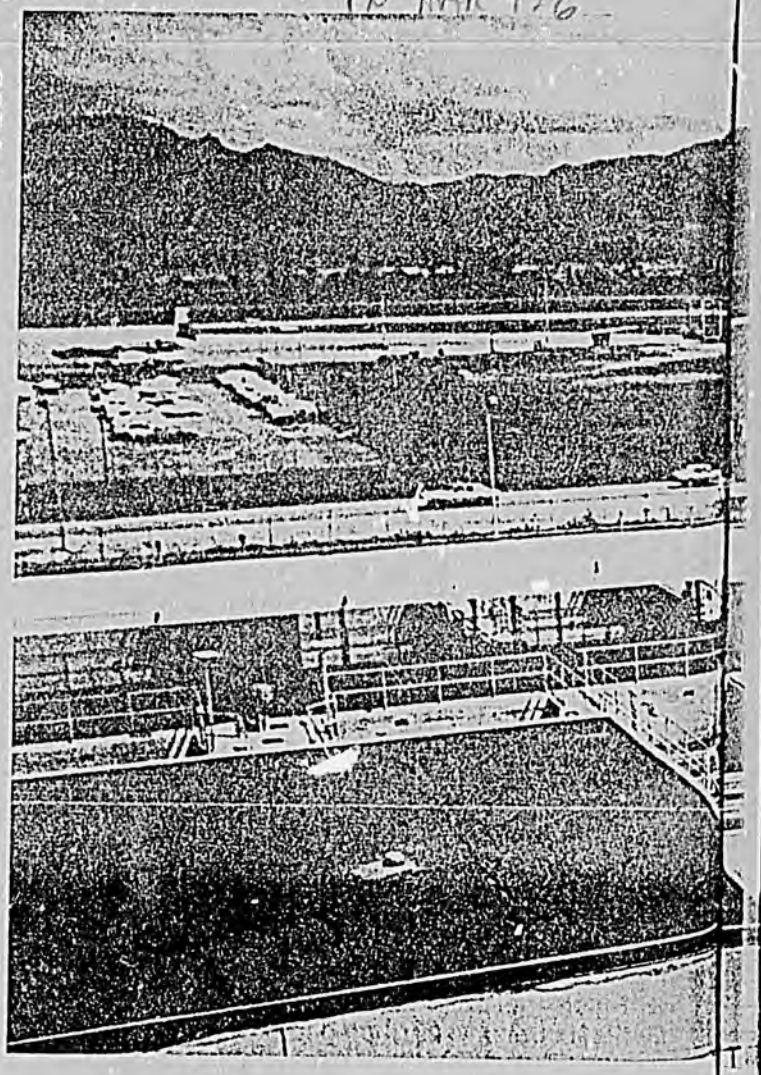

Caroni water treatment plant, with a 273 000 m³/d (60 imgd) capacity, is the largest treatment plant in Trinidad's program to double its potable and industrial water supplies, and it is the first landmark visitors see when entering Trinidad at Piarco International Airport.

#6 St

Staff training for water supply projects in the West Indies

Dale Batchelor, Fred E. Harem, and Merlevyn A. Sankeralli

An ongoing staff training program and a comprehensive maintenance management system are evolving as a result of recently constructed water treatment plants on the island of Trinidad. With approximately 130 trained technical staff needed to operate the treatment systems, an accelerated four-phase training program was initiated. Local water system engineer and superintendent trainees were sent to the United States for specialized classes and plant tours; a full-time operator trainer was employed; and, with guidance from outside consultants, operators and maintenance technicians are being trained in specializations by equipment manufacturers and suppliers.

The Water and Sewerage Authority (WASA) was established in September 1965 and charged with responsibility for the development of water resources in Trinidad and Tobago; the conservation and proper use of water supplies; and the collection, treatment, and disposal of wastewater. Water needs for the 1.1 million people of the two islands were estimated in 1970 to be 305 000 m³/d (67 imgd),* about 32 000 m³/d (7 imgd) in excess of the supply. These needs for a potable and industrial-use water supply have been projected to reach 523 000 m³/d (115 imgd) by 1985. Available groundwater reserves were recognized as inadequate to meet rapidly increasing demands, and the government turned to developing surface water resources.

A plan for water supply development was adopted, based on a comprehensive study of the available sources and anticipated demands. A system was needed to supply the entire island of Trinidad and to replace truckborne potable supplies to the less-populated, rural areas and to fringes of the existing systems. The objective was to link these areas in an integrated system that would also supply the industrial development resulting from the government's push for economic diversification. This water supply program has been a major undertaking for WASA, not only in constructing facilities but also in recruiting and training personnel to supervise, operate, and maintain the sophisticated system required.

Scope of project

During the early 1970s the government of Trinidad and Tobago contracted* to expand the existing Navet scheme in the south-central part of Trinidad and later to design, provide construction supervision, and train operating personnel for six new water treatment plants. In July 1971 a contract was let for expansion of the Navet system into the 55 000-m³/d (12-imgd) treatment

*Million imperial gallons per day

*With the joint-venture firm of Trintoplan Consultants Ltd., Trinidad, West Indies, and CH2M Hill, Corvallis, Ore.

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plant that was to supply 50 percent more water. A contract for the design of the Caroni–Arena water supply project followed in July 1973, and an additional contract for the Northern Range valleys and North Oropuche systems was awarded in late 1976.

The largest plant taps impounded storage released to the Caroni River for 273 000 m^3/d (60 imgd). Water from this river, the largest in Trinidad, carries high organic loadings and silt from runoff and aggregate mining operations upstream; it is also contaminated by wastewaters from agricultural pursuits, industrial uses, and human habitation within the watershed. As a result, the treatment processes are more sophisticated than those for the other sources and require a high degree of operator skill and judgment as well as a high level of preventive maintenance. They include a pumped storage complex; a raw water intake; metering, chemical mixing, and sterilization; sedimentation and flocculation; mechanical sludge removal; filtration with GAC; posttreatment conditioning; and treated-water pumping. In addition, the Caroni water treatment plant includes two secondary processes: sodium hypochlorite generation and carbon regeneration.

Four small plants have been constructed in the Northern Range valleys (Table 1). These plants are supplied from small streams originating in the relatively uninhabited areas of the Northern Range that are subject to varying degrees of contamination by silt and organic material during flash runoff and by some agricultural wastewater.

A larger plant of 91 000 m^3/d (20 imgd) is supplied from the North Oropuche River in the northeasterly sector of the island, which is approximately 105 km (65 mi) long by 72 km (45 mi) wide. Water from the North Oropuche is relatively uncontaminated except by natural silt and organic debris. This plant was constructed in two phases: the first, to produce 91 000 m^3/d (20 imgd) from natural stream flow and the second, to increase plant output to 273 000 m^3/d (60 imgd). The additional water is supplied from an impounding storage dam and reservoir, scheduled for construction within the next decade.

In late 1978 construction had proceeded to the point that startup operations were able to commence in the summer of 1979. In recognition of the greatly expanded need for skilled supervisory staff, the WASA developed and implemented a training program for personnel for these new plants. Staffing plans were developed for all personnel levels, including supervising engineers, superintendents, plant operators (Levels 1, 2, and 3,*) laboratory staff, maintenance technicians, and laborers.

*Level 1 is the entry level.

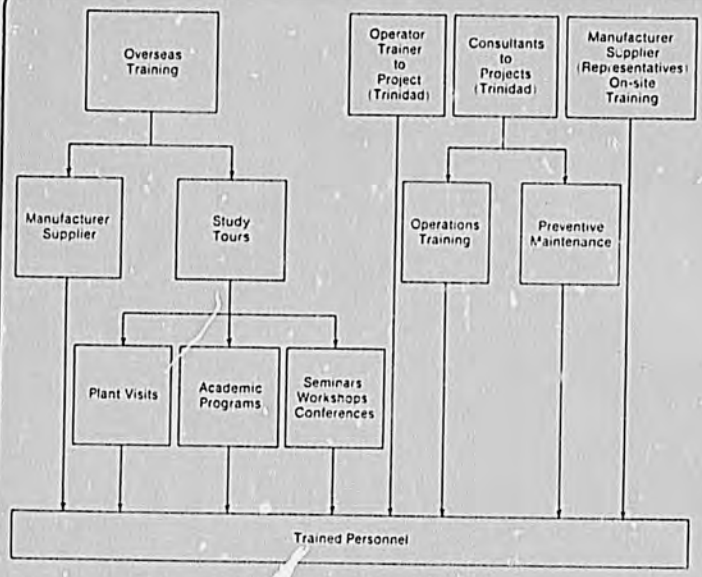


Figure 1. Training scheme

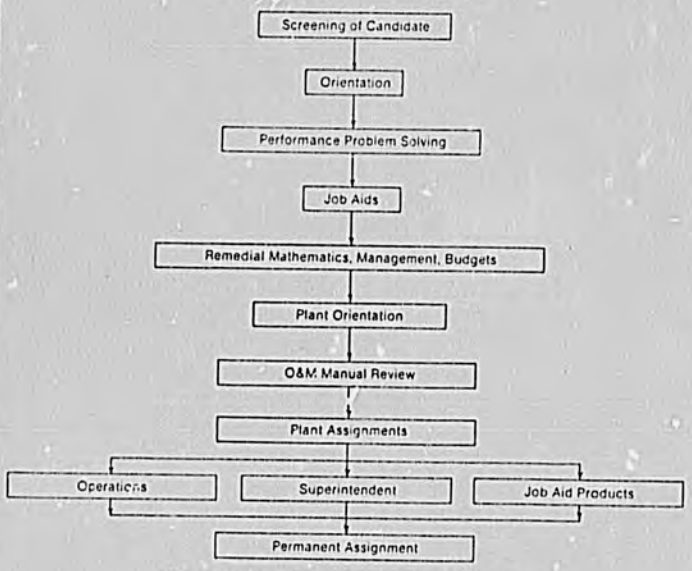


Figure 2. In-house operator training

TABLE 1
Projected plants in the Northern Range valleys

Location	Plant Size	
	m^3/d	imgd*
Acono	2250	0.5
Loango-Naranjo	4500	1.0
Aripo	11 400	2.5
Caura	11 400	2.5

*Million imperial gallons per day

TABLE 2
Job levels of water treatment personnel requiring training

Staff Category	
Title	Level
Engineer manager	3
Plant superintende	2
	3
	2
	1
Plant operator	3
	2
	1
Electrical engineer	3
	1
Electrical superintendent	
Electrical technician	
Electrical foreman	2
Mechanical equipment supervisor	2
	1
Mechanical equipment mechanic	
Process control equipment engineer	2
Digital electronics engineer	2
Radio communications superintendent	
Process control technician	
Digital electronics technician	
Radio communications technician	
Chemist	3
Systems analyst	
Scientific assistant	2

TABLE 3
Training provided by manufacturer or supplier

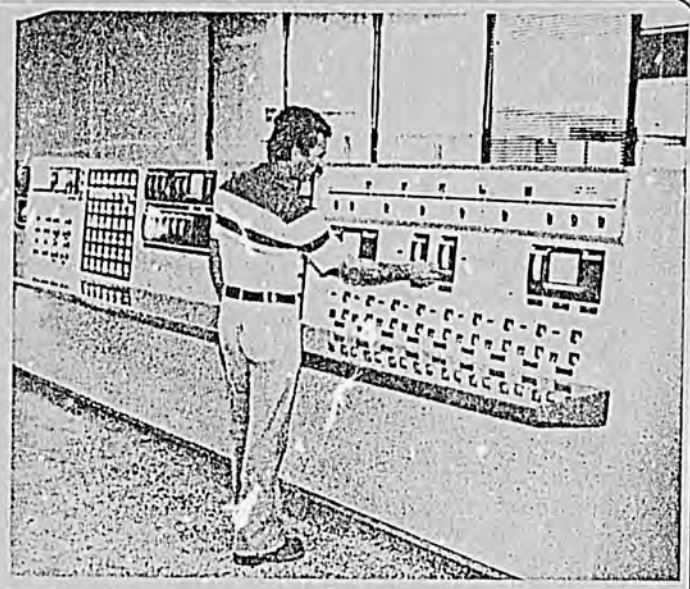
Staff Member Receiving Training	Manufacturer or Supplier	Type of Training
Systems engineer	Digital Equipment Corp.	programming and operating procedures for computers and peripherals; diagnosis of problems
	Systems Controls, Inc.	operations, programming, and diagnosis of hardware and software problems
Digital electronics engineer	Topax, Inc.	operation and maintenance of uninterruptable supply
	Vadic, Inc.	operation and maintenance of modems
	Fisher & Porter Co.	fundamentals of digital logic, process control, and industrial electronics
	Digital Equipment Corp.	introduction to minicomputers, digital computer logic, and PDP-11
	Modicon, Inc.	programming and maintenance of programmable controllers
Process control equipment engineer	Fisher & Porter Co.	fundamentals of process instrumentation, electronic instrument maintenance, pneumatic and mechanical instrument maintenance, and flow measurement
Process control equipment engineer	Hach Chemical Co.	repair and calibration of turbidimeters
	Monitex Corp.	operation, maintenance, and calibration of density meters
	Wallace & Tiernan, Inc.	operation, maintenance, and calibration of chlorination equipment

A central supervisory system (CSS) was constructed to monitor the Caroni–Arena water supply system, the status of certain features of the five smaller treatment plants, and many of the existing water supply and distribution facilities. This system will also facilitate operations and maintenance dispatching.

In addition to its primary purpose of expediting and optimizing system operation, the CSS has developed historical data acquisition and processing that will permit both long-range and short-range planning. The major components of the system include a voice communication system, primary elements (sensors for levels, flows, pipeline pressures, equipment status, turbidity, pH, and Cl_2 residual alarms), a data radio system, and a central computer.

Overall training requirements

The design features of the smaller plants are similar to existing surface water treatment plants in Trinidad. However, the Caroni plant, besides being by far the largest treatment facility in the country, also incorporates hypochlorite generation and carbon regeneration



The plant control panel provides the plant operator with the status and critical control of the raw water pump station, the sedimentation and filtration processes, the finished water pumps, and the water distribution system. The operator is adjusting the speed of one of the large finished water pumps to match system demand.

TABLE 4
Stuay tours in the United States

Category of Staff	Type of Training	Length of Training Period days
Engineer 2	tutorial assistance at Oregon State Univ. Corvallis, Ore., in carbon adsorption, stabilization softening, process control, water quality testing, troubleshooting	38
	development of performance-oriented operator training programs at Linn-Benton Community College, Albany, Ore.	2
	visits to water treatment plants at Hillsboro, Estacada, Lake Oswego, Dallas, and Eugene, Ore. and at Denver and Aurora, Colo.	10
	visit to CH2M Hill's corporate offices, Corvallis, Ore	1
	attendance at preventive maintenance workshop	2
	visit to Byron Jackson Pump Co.	2
Superintendent 3	visits to water treatment plants at Denver, Aurora, Breckenridge, and Dillon, Colo.; Corvallis, Lake Oswego, Dallas, Springfield, and Eugene, Ore.; Contra Costa, Sacramento, Truckee (wastewater plant), and South Lake Tahoe (wastewater plant), Calif.; Lower Potomac, Va. (wastewater plant); and Philadelphia, Pa.	34
	visit to AWWA headquarters, Denver, Colo.	1
	visit to CH2M Hill's corporate offices, Corvallis, Ore.	5
	visit to a sodium hypochlorite generation facility at Diamond Shamrock, Chardon, Ohio	1

systems, the operation of which is completely new to WASA personnel. Most of the features of the CSS and its maintenance are also new to the existing staff. Thus, an extensive recruitment and training program was necessary. The staff training scheme, depicted in Figure 1, consists of training through an overseas training program (specialized training and instruction in the United States), an operator trainer (a full-time employee in Trinidad), consultants (part-time staff in Trinidad), and manufacturers or suppliers (part-time staff in Trinidad).

Approximately 130 trained technical staff, including 70 plant operators, are required to operate the supply systems. A breakdown of the types of technical personnel needing training is shown in Table 2.

Overseas training

Manufacturers' courses. In several cases, contracts stipulated that specialized types of training would be furnished as a part of the work of the contractor or supplier. This was particularly true in the case of training required for CSS personnel. Selected personnel were sent to the United States for specialized training by the manufacturers of the equipment. Table 3 summarizes this type of training.

Study tours. Where specialized courses were not available or appropriate, study tours were arranged for selected personnel. These included visits to treatment plants or factories; training sessions at academic institutions; and attendance at seminars, workshops, or conferences. Table 4 summarizes this type of training.

Operator trainer

A full-time operator trainer with 30 years of experience provided continuous monitoring of, and assistance with, all training efforts. His involvement with all aspects of preparing the operational staff for their new positions is covered in the following paper, "Trainee Involvement in the Training Process."

Consultants

Special consultants periodically assisted with the training program, particularly in developing the operational training delivery system and the maintenance management system.

Training delivery system. J. H. Austin, vice president of the MAXIMA Corporation, was employed by the project consultant. Along with the authors, Austin provided direction for the operational training program that emerged. Resident and US-based consultants and technical specialists worked closely with WASA's training officer and staff to assess the levels of staff competency and specialized training required. The consultants were then able to provide expertise directly applicable to the project during their visits and at preselected times during the training period. Continuity was provided by the resident training staff. Major elements in the development of the training delivery system are shown in Figure 2.

Maintenance management system. Consultants are working with WASA in the initial stages of a comprehensive plan to upgrade the utility's maintenance procedures, which will be coordinated with the training program for plant operators and maintenance staff. The result will be an overall maintenance management system and an ongoing training program for all levels of WASA maintenance personnel.

The first phase of the plant maintenance program was development of a preventive maintenance system for use at the Northern Range valleys, North Oropuche, Caroni-Arena, and CSS facilities. This initial phase covers equipment only. Under this concept, the program will later be expanded to include maintenance of buildings and grounds; then, progressively, it will be applied at all WASA's existing facilities.

TABLE 5
Manufacturer or supplier on-site training for operators

Manufacturer or Supplier	Equipment
Envirex, Inc.	traveling band screens
	traveling bridge sludge collectors
	cross-screw sludge collector
Vibra Screw, Inc.	raw water pumps
	lime system
Diamond Shamrock, Inc.	sodium hypochlorite generation system
Worthington Pump, Inc.	backwash pumps
Hoffman Air, Inc.	air blowers and filter silencers
Miscellaneous suppliers	carbon regeneration system
	pump stations
Cleaver Brooks	boiler treatment equipment
Onan	diesel generator
Mud Cat	sludge dredge
Fisher & Porter Co.	instrumentation and control system
Industrial Marine, Inc.	rapid mixer
	backwash pump
	air blowers and silencers
	coagulation control center
	chemical feeders
	diesel generator
	hoisting and weighing equipment
	instrumentation and control system
Patterson Candy, Inc.	package water treatment plants

The goal of the preventive maintenance system is to extend the useful life of equipment and plant facilities, to reduce overall maintenance costs and service interruptions, and to minimize breakdowns and shutdowns that threaten the quality of the water supply.

A manual card-file system was proposed initially for record-keeping and for acquainting plant operating personnel with the system. The Aripo plant was selected as a pilot installation site, and the system was installed at the other treatment plants as they were placed in service. Refinements of the manual card system and the reports to be generated will be tailored to WASA's needs as this system is used during initial plant operation. The numbering system is composed of two parts: the identification numbering system and the equipment component list. The first part identifies the site by a three-digit code, the location or structure containing the piece of equipment, and the specific pieces of equipment. The second part identifies the components (e.g., the motor for a raw water pump and the referenced pump). Each facility uses the same system to identify all items requiring preventive maintenance.

The manual card system can be readily adapted for computerization when the preventive maintenance system is fully operational and when the savings to be realized in record-keeping justify this conversion. Microfiche will be considered for future use to reduce the volume of operations and maintenance manuals, job aids, and master files on manufacturers.

Plant operating and maintenance staff are expected to be responsible for all routine preventive maintenance tasks and corrective maintenance within their skill levels. Job descriptions and job aids are being developed to define responsibilities and to ensure that maintenance tasks are properly executed. The staff training program has been extended to include maintenance training.

Manufacturers and suppliers

In several cases contracts with contractors or suppliers required on-site startup and operational assistance for a period of time. This requirement was designed to give operational staff time to become familiar with the equipment and its operation and maintenance features under the guidance of the manufacturer's representative. Table 5 indicates activities in this area of training and lists the manufacturers and suppliers providing this service. Whenever possible, trainees were given hands-on experience as the equipment was placed in service and adjustments made.

Training schedule

Development of manpower information, preliminary work on the training delivery system, and planning for stateside training for the staff who would operate the CSS began in the last quarter of 1978 under the direction of J. H. Austin. Training activities during the first quarter of 1979 consisted primarily of a series of workshops for WASA staff on performance problem solving, basic instructional design, and preparation and use of job aids.

When the supervisor-operator trainer arrived in Trinidad to assume his duties in late March 1979, screening and selection of trainees began. Orientation of training staff continued through the second quarter. A nucleus of WASA staff members, including potential plant superintendents, was formed to assist in the training program.

Class work began for the first group of 20 trainees on Jul. 9, 1979. Four basic groups of trainees went through the program during the next eleven months. They took charge of the four Northern Range valleys plants as soon as these facilities were operational, and they are now operating the North Oropuche system, Phase 1, as planned. The results of the training program have been demonstrated since these trainees assumed their assignments in the initial operation of the Caroni plant in April 1981. Full operation of Phase 2 of the North Oropuche system occurred almost simultaneously with startup of the large Caroni plant.

Ongoing training

Operational training will not stop with completion of the new water supply facilities. The success of the present effort and continued support by WASA management mean that training replacement staff and continuing efforts toward staff improvement at WASA's existing plants will receive high priority.

Acknowledgments

The authors acknowledge Emile Warner, Frank Chu Cheong, and the staff at WASA for supporting this program. They also extend sincere appreciation to John H. Austin for his planning and guidance.

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