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Design of a Water Resources Training Program for Operation, Maintenance and Management

by

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The D.C. Water Resources

Research Center

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Management Administration

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October 1983

PREFACE

Rapid scientific and technological advances such as automation, computerization and improved techniques in operating water and wastewater systems have increased the need to train new workers and retrain existing employees so that they may perform their duties efficiently. In addition to water and sewer services, the D.C. Department of Environmental Services (DES) also operates the wastewater treatment facility at Blue Plains, which is one of the largest and most sophisticated in the world. Training of operating staff who man these environmental systems should include the most up to date technical information and methods in order to complement the huge dollar investment in equipment provided, and to assure optimum performance and meet compliance requirements.

This training project consisted of the analysis of the agency structure, a survey of the employees, a survey of job and task requirements, a survey of needs for training from both the workers and supervisors points of view, the analysis of job and performance functions, the development and design of the curriculum, and finally a pilot program.

Contents of this publication do not necessarily reflect the views and policies of the DES nor does mention of trade names or commercial products constitute their endorsement or recommendation for use by the DES.

DESIGN OF THE LONG-TERM TRAINING PROGRAM

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CHAPTER I

BACKGROUND

1. HISTORY OF TRAINING PROGRAMS CONDUCTED FOR THE WATER RESOURCES MANAGEMENT ADMINISTRATION (WRMA)

1.1 Introduction

The performance of the functions of a municipal organization such as the D.C. DES requires workers who are proficient at their duties and tasks. Although many factors contribute to job performance, it is true to say that the levels of training and motivation are basic to workers proficiency which may be improved through a training program adequately sequenced for experienced and new workers where natural turn-over causes a continuous flow of personnel. Furthermore the technology of water resources and wastewater treatment is changing at a very rapid rate. This increases the need for training which is not seen any more as a secondary objective but one of the primary objectives for increasing the efficiency of managing water systems. The forgoing observation led to consideration of inputs to the design and implementation of a long-term training program for the D.C. DES employees. Design strategies necessitated, among other tasks, the undertaking of a pilot program aimed at providing information about the training level of workers, trainees and supervisors acceptance, selections of training methods,

facilities and other factors relating to a long-term training program. Prior to getting into the details of this project, it is worthwhile to consider the WRMA'S past training experiences.

Over the years various departments at the WRMA have attempted to develop training programs. For instance, the Bureau of Sewer Services developed a training program geared mainly towards their crew chiefs. This program was at a fairly high engineering level. Mention was also made of attempts to develop management and safety programs, but due to lack of participation these mo programs were discontinued. However, there have not been, long term consistent and sustained training programs for any of the WRMA bureaus. Employees recruited are normally trained on the job to perform their functions. Management, however, has realized the need for long-term training and in the case of the Bureau of Wastewater Treatment (Blue Plains), acquired a large number of training materials for this purpose.

The primary building at Blue Plains houses two classrooms, an electrical maintenance lab and a storage room. A number of training materials (i.e., books and audiovisual aids) can be found in the media resource center. The strength of the center is in video programs development. A few of their short-term training programs are videotaped. A detailed description of the Blue Plains training facility is provided in Appendix A.

1.1.1 Program Prior to Ye r],927, Blue Plains

A two-year training program was conducted by the Blue Plains Training Office. The courses taught were basic mathematics and basic wastewater treatment. Mr. Bill Faw, a staff member at Blue Plains, was in charge of the program.

1.1.2 Program Years 1977 to 1979. University of D.C,.

A two-year training program was conducted by the University of D.C. comprising courses in wastewater treatment, associated mathematics, electrical and mechanical maintenance taught by Messrs. Howard Davis, Bill Faw and Ted Poliakoff, respectively. Approximately 120 students were-enrolled in the program; 60 students in wastewater treatment, and 60 in the electrical and mechanical maintenance course. The program which was scheduled for 20 hours a week of classroom instruction and an equal period of on the job training was to train operators and mechanics. The duration of the program was approximately 800 hours, and grants for its funding were provided by the Environmental Protection Agency under Title 109(B).

1.1.3 Program in Year 1979, Training Metcalf and Eddy Inc.

The program comprised start-up courses for the nitrification and multimedia filtration process and was conducted by Metcalf and Eddy, Inc. The program was designed for the training of operators and maintenance personnel. About 50 to 60 persons

participated. The instruction focused on teaching the operation rather than the repair of equipment.

1.1.4 Program Year 1979. Training by General Electric Co.

A six-week training program was conducted by the General Electric Co. for electricians at Blue Plains. Staff members of the General Electric Company served as instructors. About 30 to 40 trainees were enrolled in the program, which cost about $90,000.

1.2 OUTLOOK FOR FUTURE TRAINING PROGRAMS

The Department of Environmental Services is currently assessing its training objectives for the next five years. The training needs, during that period, include past start-up training for the Multimedia Filtration facilities at the Blue Plains Wastewater Treatment Plant, refresher courses in secondary process control, and. courses for maintenance personnel. However, emphasis needs to be placed on training workers in the bureaus of water and sewer services also.

1.3 SYNOPSIS OF TRAINING PROGRAMS IN WATER QUALITY OFFERED IN COLLEGES AND INSTITUTIONS IN THE WASHINGTON AREA

Description of Program	College of Institution
In- house on-the –job training, start-up training by facilities contractors or consultants; mechanics, electricians and industrial electronics courses; three credit hours of a college course in mathematics, chemistry, microbiology, physics and wastewater operations. Objective: Virginia Operator's License	Arlington County Water Pollution Control Plant, Virginia
Three-year apprenticeship program; 450 hours of classroom training, 6,000 hours of on-the-job training Objective: To recruit and develop personnel	Back River Waste Water Treatment Plant, Maryland
One year pollution abatement technology certificate; 30 class credit hours and 4 credit hours of on-the-job training; special topic courses in process control, safety, electrical and mechanical maintenance Objective: Maryland State Operator's Certificate	Maryland State Water Quality Training Center, Charles County Community College
Two-year Water Quality Program, A.A.S. Degree; 76 credit hours of technology lecture lab courses comprising of: chemical analysis of water quality, wastewater technology, wastewater systems and design, general chemistry and physics. Objective: Technician training	University of D.C.
B.S. and M.S. degree programs in Environmental and Water Resources Engineering Objective: Professional training	Howard University Washington, DC

2. BACKGROUND INFORMATION

The Task I Background Research and Information Gathering states that "Background research would be conducted into available training programs through library research and personnel interviews with people involved in training programs with EPA and other agencies. The information obtained would be compiled, analyzed and incorporated into the program as it developed." Because of start-up difficulties this task was delayed and was started about one and a half months late. This caused the interviews to be scheduled towards the end of the calendar year. Most of the agencies were functioning at a slower pace and some of the key people were already on vacation. However, it was possible to obtain a few interviews with relevant agencies and to start an intensive literature review.

There already exist a large number of publications on training programs. Both for academic and in-plant training. The literature survey was conducted in libraries in the Washington Metropolitan area, i.e., EPA Library, Washington Water Pollution Control Federation Library, Library of Congress, Department of the Interior Library, Water Resources Research Center Library and others. The findings on the literature survey are given below.

Interviews were conducted with agencies of various interests with respect to water resources training programs. Overall the cooperation of the agencies was positive and informative to the development of the program. The agencies interviewed were the EPA Headquarters at M Street, S.W., the Arlington Water Pollution Division of the Arlington County Department of Public Works in Alexandria, the Fairfax Water Authority, the Washington Suburban Sanitary commission, and some training specialists at the University of D.C. and elsewhere. It was felt that the first agencies to be interviewed besides EPA were to be agencies similar to the Department of Environmental Services. The summaries of the interviews conducted with these agencies and excerpts are given in the following paragraphs.

2.2 Library Research

Regarding the library research, a large number of articles, magazines, books, scientific and technical reports were reviewed. These reference documents were found mainly at the Library of Congress, the UDC Library, the Water Pollution Control Federation Library, the EPA Library, the Howard University Library and other related libraries. The Library of Congress has a large number of reports on vocational, technical and occupational education. Of the 180 references examined, 25 documents were found to contain material directly relevant to the project. EPA has published a large number of documents (including ERIC/ IRIS material) on

training programs relating to water and wastewater. The University of Ohio serves as a clearinghouse for the ERIC-IRIS material.

The Water Resources Research Center Library as well as the University of D.C. have few documents on *training* programs. However, the University of D.C.'s training books are on general science and technology with little focus on water resources or wastewater problems. The WRRC Report No. 23 already contains a list of the documents and audio-visual materials available at the University of D.C. Library.

The first result from the library search provided a tabulation of relevant documents to the program and an in-depth review of the literature concerning training programs. However,-a secondary benefit derived from the documents was the identification of further contacts that became useful as the project progressed. The literature survey was not exhausted. Periodic reviews and visits were made as needed. Most of the material found were on the planning and designing of training programs. Some actually addressed curriculum materials for training programs. However, there were very few concerned with remedial training programs in the water resources field. There are such programs as remedial math and remedial English, but they are mostly located in the respective departments.

2.3 Interview Summaries

About half a dozen agencies were interviewed during the course of the background information acquisition. The agencies interviewed were as mentioned earlier, the U.S. EPA, the Arlington Public Works, the Fairfax Water Authority, the Washington Suburban Sanitary Commission and some individuals with expertise in water resources and in technical training. All the interviews have been summarized and the contact summaries contain the basic information on the organizations, the individuals contacted, the date of contact, the telephone number, and a summary of the comments and recommendations or actions suggested. Appendix B provides names and addresses of contacts**.**

EPA is the lead agency in developing training programs. Through the University of Ohio and with ERIC/IRIS programs, EPA has developed numerous training programs on all facets of water and wastewater treatment. These materials are available through the ERIC System or can be purchased directly through the University of Ohio which acts as a clearinghouse.

Key recommendations from EPA included, a) to condier certification as a goal because it does not necessarily determine an operator's skill, and b) to consider the Dave Sullivan (Berkeley, California) computer simulation programs for operator training, as well as the Detroit Offices of Camp, Dresser and McKee for remedial training in basic math and English.

HISTORY OR TRAINING PROGRAMS

The contact at the Arlington Public Works was David Timbie. Mr Timbie started working at the Arlington Public Works in 1978. He passed from the rank of training officer to training coordinator. Mr Timbie talked about several valuable observations in his experience in developing a training program. First, the commitment of top management to have a training program and to maintain it throughout the years was considered as the most important factor for the success of any training program.

Second, once the commitment is made, a training coordinator is needed and he/she must devote at least 50% of his/her time to the training program itself. The training coordinator must be interested in the training and must have good oral and written skills as well as strong influencing skills. His/her role would involve data collection analysis, designing, planning, scheduling, supervising, evaluating, etc. He/she can build up his/her skills through “train the trainer” courses available everywhere. The third need is a plan. After an in-depth analysis of the needs of the organization, a plan must be developed, coordinated and have support of the management. Evaluation must be built into the plan and taken seriously. Anywhere up to 5% of the personnel budget should be devoted to the training program. There are two kinds of in-house training at the Arlington Public Works. There is contract training, which is training done by the contractors

at the end of the installation of new equipment or a new facility, and the other is regular training of new recruits. The attrition rate is between 20 to 25%. Usually it takes six months for a new recruit to decide if he/she wants to stay at the plant or not. The new operators go through a two to three month training program which includes both on the job and classroom training. All the new trainees must take the Water Pollution Control Federation beginner's course. The plant trains between two to twelve people at any one time. The Northern Virginia and the Charles County Community Colleges are the two institutions through which training activities are coordinated.

There is also an opportunity to take a state examination towards certification, but promotion is based more on performance on the job because the state exams tend to be too general and do not determine the actual on the job skill. As water distribution, wastewater treatment, sewer collection and maintenance techniques increase in sophistication, the emphasis on training would become more essential. New recruits might therefore be required to go through a two to four-year program to be able to function efficiently on the job. The increasing tendency to automate and computerize water and wastewater systems implies that operators who would be working with these systems must be able to read graphs, charts, and interpret output data and the like. Such

activities would require recruits with a higher level of technical competency.

The Fairfax Water Authority training program comprises on the job training for eight hours a day for fifty-two weeks for new employees where they spend the first six months with the senior operators. There is also a training program taken at the Virginia Polytechnic Institute which consists of a course, and a second program which consists of an advance course (one week) at the Virginia Military Institute. When recruiting for new employees, emphasis is placed on the willingness to work on shift hours and good aptitude in basic math. The Fairfax Water Authority encourages its employees to upgrade their background by taking the State Certification Examinations.

The WSSC training program includes an instructor, homestudy slides, video tapes, etc. To build up the employees' basic skills in math the modumath series developed by the New York state University is also used. Video tapes are highly recommended because they provide consistency and are transferable to all plants. However, the video tapes or any other media material should be complemented by a qualified instructor who can relate very well to the trainees. A positive environment conductive to learning must be created and incentives provided through a certificate of competion. The courses offered by the WSSC are

divided into three levels: entry, intermediate, and advanced.

Refresher courses are also offered and courses for veterans have been designed. Initially the length of the courses was two weeks for eight hours, but was reduced to one week for eight hours. Attendance ranged from ten to twelve people per class. Training was done once a month, but the shift hours did create some problems at the agency.

The Comprehensive Instructional Support Center (CISC) of the University of D.C. is an academic support unit for beginners, freshmen and sophomores in the University College. Through its comprehensive instructional support services, the system provides reinforcement to UDC students enrolled in freshmen level courses. The CISC program comprises tutorial, workshop and seminars that encompass a broad spectrum of subject matter including English grammar, writing skills development, various levels of mathematical computation and analysis, reading comprehension, study skills comprehension, and so forth.

The center's activities include the use of computer-assisted instruction of the Control Data Plato System. The Plato system is versatile, can be used individually, and has been proven to be an effective learning tool. The software contains comprehensive programs in basic math, English, sciences, etc. The rationale

for the background information gathering was to examine agencies similar at least in training needs to the WRMA in order to learn about their experience, difficulties and the successes they had in developing their programs. The literature survey provided additional information about training programs. From this background information gathering a clearer picture began to emerge, i..e., the need for management commitment, the need for effective coordination, and of great importance, the need for both short- and long-term plans to carry out the training programs.

2.4 New Project Emphasis

Following the meeting with Mr Sonnie Mason, Training Officer (DES) and subsequent acknowledgement of a letter from Messrs. Wallace White and Sonnie Mason, it appeared necessary to address different objectives. It was suggested that the training efforts should be focused only on water distribution and sewer collection systems. From that point of view, meetings were scheduled between the bureau chiefs of the Water Distribution and Sewer Services. The following sections describe the results of the meeting with Messrs Carl Johnson, Bureau Chief of the Water Services, Jim Dennis, Chief of the Meter Division, and Otto James, Chief (Investigation Branch) of the Bureau of Sewer Services. From the meeting the training needs were expressed as basic English, basic science and math, and basic hydrology.

worker's schedule posed a problem, the best time available for employees to take classes was considered to be either at the beginning or towards the end of shift hours. The supervisors stated that an English course would assist workers in writing their reports after the field assignments; the basic science and math would enable them to acquire a better understanding of the scientific principles and processes involved in water resources and the hydrology course would increase the technicians' understanding of the basic principles of hydrology and some basic fluid mechanics. Therefore the recommended new project directions were to provide an experimental program based on the following courses: basic English, basic math/science, and basic hydrology. All employees, both regular and lead workers, would be required to take basic math and English but the basic course in hydrology would be specifically targeted to the technicians, crew and foremen, although other interested workers would be encouraged to sit in on the course.

The courses would be made short (two weeks duration) and the methods of teaching would include the use of audio-visual aids, computer-assisted instruction, etc. It would be important to evaluate the experimental courses so that adequate recommendations could be made towards the end of this program. The final recommendations of the course content would depend on the analy-

sis of the tasks and functions 'performed at the two bureaus and also the identification of the level of the workers. The preparation of the class course content, schedule, and selection of teachers would be done prior to May.

The new objectives were to:

0 Select courses for the experimental program.

0 Select instructors.

0 Select and prepare course materials and location.

0 Perform job analyses and identification of long-term training needs.

0 Prepare program schedule.

0 Organize the experimental program.

- Orientation and Pre Test
- Evaluation
- Post test and recommendations

0 Design a long-term program

- Selection of courses and curriculum development
- Program management.
- Proposals for Certification and Apprenticeship

0 Prepare Final

General Remarks

Many of the agencies contacted have developed experience in designing training programs. Although the WRMA is bigger than most of these agencies, the information obtained was pertinent

because water resource training programs are fairly similar regardless of the size of the plant. It is recommended that strong contacts be maintained with these agencies for further advice on program development.

All the departments interviewed at the University of D.C. responded very positively. The Departments of Environmental Sciences, Mathematics, English and the CISC expressed their willingness to cooperate and participate in such a program. For these departments, an opportunity to participate and assist in this training project meant fulfilling one of the major functions of the University, which is, reaching out and using their knowledge, expertise and other resources to improve and upgrade the standards of the community in general. While it is not recommended to integrate the DES workers into the University system at this moment, it is advisable to use the University's resources to the greatest extent and to rely on the experience developed to strengthen the WRMA training program.

CHAPTER II

THE DEPARTMENT OF ENVIRONMENTAL SERVICES: ORGANIZATIONS, FUNCTIONS AND DUTIES

1.DEPARTMENT OF ENVIORNMENTAL SEARVICES

1.1 INTRODUCTION

The Department of Environmental Services is the primary agency within the District government with responsibility and oversight functions for water supply, sewer collection and waste water treatment. The Department was established to provide for "more timely response and cost effective utilization of existing resources directed to improving the environment of the Nation's Capital" (Ref: 6A).

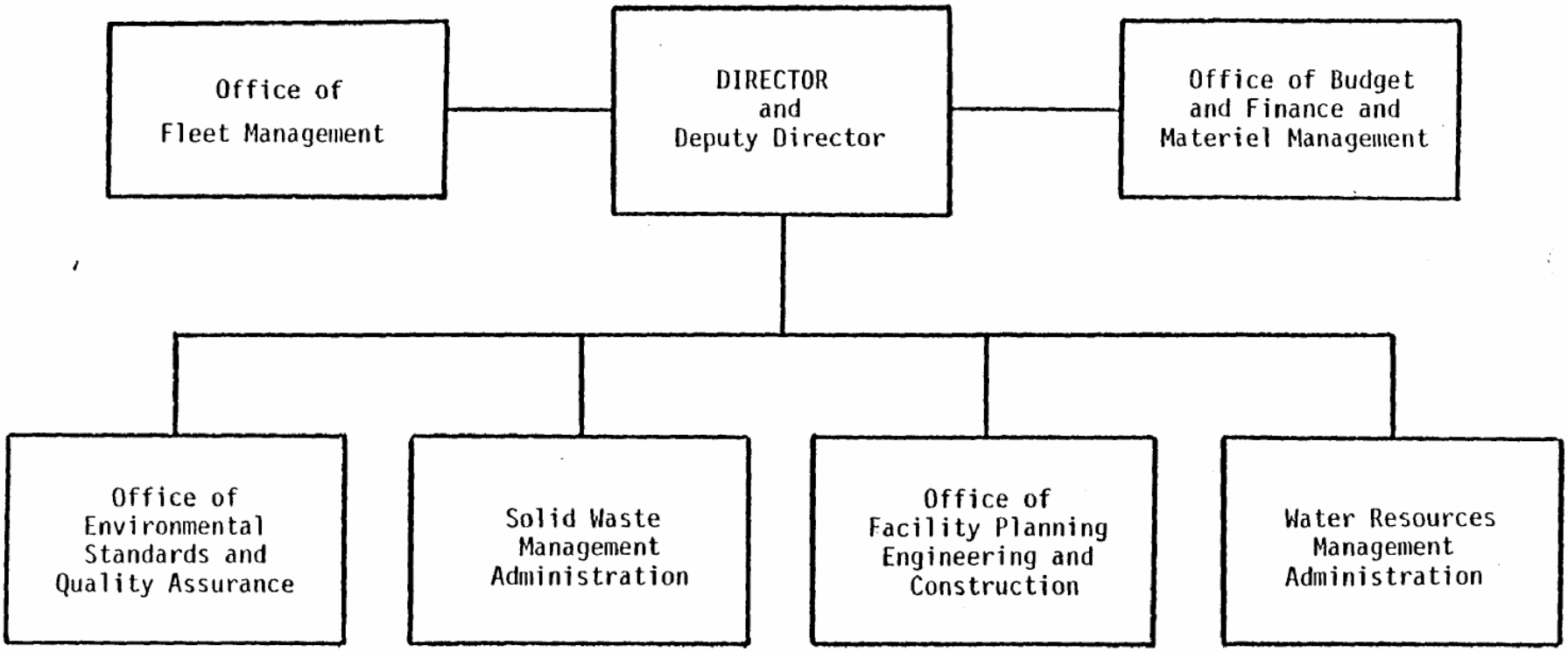
Prior to the establishment of the DES, environmental management in the District was shared by a number of agencies including:

- Department of Sanitary Engineering (water and sewer systems and solid waste programs)
- Department of Human Resources (environmental health programs, air and water quality programs, industrial hygiene and noise abatement)
- Department of Transportation (beautification program)
- Department of Licenses, Inspections and Investigations (issuance of licenses and permits and enforcement actions)

Figure 1 presents an organization chart for the DES. DES has four programmatic operating agencies as shown: the Office

FIGURE 1

Organizational Chart for the Department of Environmental Services



Source: District of Columbia, Budget and Resource Development Office, Justifications for the FY1982 Budget, (Washington: District of Columbia, 1981), p. 396.

of Environmental Standards and Quality Assurance; the Solid Waste Management Administration; the Office of Facility Planning; Engineering and Construction, and the Water Resources Management Administration. There are two primary staff offices which assist the Director of DES; they are the office of Fleet Management and the office of Budget and Finance and Material Management. The functions of these organizations are outlined below:

- Office of Budget and Finance and Material Management is responsible for providing an appropriate level of financial resources, insofar as possible, to support the responsibilities of the Department and to insure that such funds are expended in a fiscally responsible manner.

- Office of Fleet Management insures that mobile equipment essential to support the functional responsibilities of the Department is available when needed and that it is operated, maintained and repaired in an efficient and cost effective manner.

- Office of Environmental Standards and Quality Assurance Services represents a major part of the District's efforts to promote health, comfort, convenience and esthetics for residents and visitors through programs in consumer health, occupational and institutional hygiene, community hygiene, and air and water quality control.

- Solid Waste Management Administration collects all residential refuse from residential buildings having three dwellings units or less, disposes of-all refuse generated in the District and maintains the public areas.

- Water Resources Management Administration is responsible for the operation and maintenance of systems and facilities for the distribution of water, the control and disposal of stormwater and collection, treatment and disposal of sewage.

- Offices of Facilities Planning, Engineering and Construction is responsible for all matters relating to environmental engineering systems and facility planning, design and construction.

1.2 Water Resources Management Administration

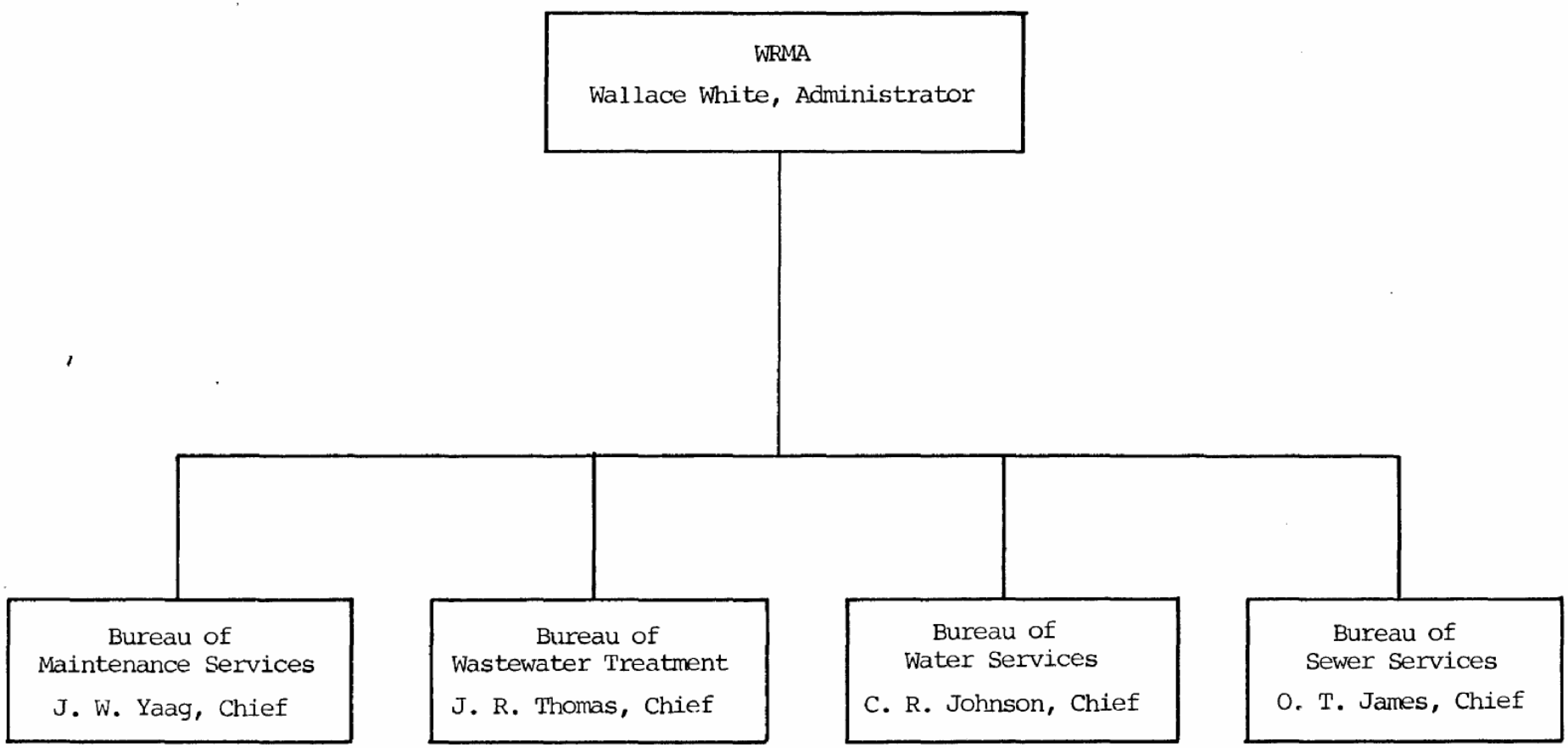
This project dealt with the Water Resources Management Administration (WRMA).

The WRMA is the major organization in the District government with responsibility for water supply, sewer collection and wastewater treatment. Figure 2 shows the organizational chart for the WRMA. The WRMA has a broad responsibility which includes operation and maintenance of:

- The District's water distribution system consisting of 1,400 miles (2240 km) of water mains, 130,000 water service connections, 30,000 water meters, 10,000 fire hydrants, 27,500 valves, 8 water reservoirs and elevated storage tanks;
- The district's sanitary, storm water and combined system consisting of 1,800 miles (2880 km) of sewers, 28,000 catch basins and 100,000 manholes;
- The Potomac Interceptor Sewer consisting of 45 miles (72 km)of sewer located in Maryland and Virginia;
- The D.C. Regional Wastewater Treatment plant with an average treatment capacity of 309 MGD.
- 26 water and sewage dumping stations, and 25 support buildings.

FIGURE 2

THE WATER RESOURCES MANAGEMENT ADMINISTRATION (WRMA)



The District has three open raw water reservoirs to handle water supplies; these facilities have a combined capacity of 200 mgd (0.7 million cu. meters). The reservois are Dalecarlia-50 mgd (0.19 million cu meters), Georgetown-50 mgd (0.19 million cu meters), and McMillan-100 mgd (0.38 million cu meters).

The WRMA employs approximately 800 workers in four main bureaus: the bureau of water services, the bureau of sewer services, the bureau of wastewater tr.eatment and the bureau of maintenance services.

1.2.1 Bureau of Water Services

The bureau of water services is responsible for the water distribution facilities including pumping stations, reservoirs, tanks, truck mains and service mains. It is also responsible for the efficient functioning of the thousands of valves and fire hydrants in the city, in addition to the servicing of connections and meters.

The bureau employs 200 workers in its divisions as follows: 86 workers in the division of water distribution; 87 in the meter division; and 25 in the pumping division.

Types of Positions

Some of the typical positions identified in the three divisions are listed as follows:

Distribution Division

Water Services General Foreman

Supervisory Consumer Services Representative Laborer

Consumer Services Respresentative

Water Services Worker (Field Engineering Section-Valve Unit) Water Services Worker (Hydrants, Chlorination and Test Unit) Water Services Worker (Investigation Unit)

Water Services Worker (Service Repair Section-Tap Removal Unit) Water and Sewer Services Worker (Field Engineering-Main Repair Unit)

Meter Division

Plumber

Electrical Equipment Helper Meter Installer Helper Instrument Mechanic Worker Instrument Mechanic Tapping Machine Operator Laborer

Meter Installer

Meter Repairer and Tester

Pumping Division

Boiler Plant Operators

Fixed Industrial Equipment Operators

Fixed Industrial equipment Operator Foreman

Buildings and Grounds Maintenance Personnel

Buildings and Grounds Maintenance Foreman

Duties and Working Conditions

Samples of typical duties and working conditions in the distribution, meter and pumping divisions are given as follows:

Water Services Worker – 8

Duties:

Incumbent, under supervision of Crew Chief, serves as member of an emergency crew involved in the investigation of consumer complaints concerning water and sewer service;

assists in the location of water leaks on watermains and service lines; assists in determining whether a leak on a service is on public space or on private property; assists in the emergency repair of broken watermains; in the absence of the Crew Chief, the incumbent may have to act in his capacity; assists in shutting off watermains; assists in the excavation of ditches and the erection of proper shoring and the blocking of other exposed utility lines; during inclement weather, assists in relieving obstructed catch basins; assists in determining whether an obstruction is in the private plumbing system or in the public sewer line; operates a 21,000 GVW special body truck and/or light truck equipped with a two-way radio; makes sure that the compressor assigned to the crew is kept clean and maintained with gasoline, oil & water, if applicable; maintains the tools and small equipment. Notifies crew chief when tools or equipment needed to be repaired or replaced; in the absence of the crew chief, incumbent is required to submit a daily report for each job; performs other related duties as assigned.

Working Conditions

Works outside in all kinds of weather. Works in open trenches which are usually muddy or filled with slush. In emergency situations (e.g. broken mains) must work at top speed under handicap of crowds and traffic. In using handtools is subject to cuts, bruises and abrasions. Repairs valves below ground in manholes 26" in diameter requiring increased physical stamina and manual dexterity. Subject to acrid fumes and burns when handling burning equipment. When using tapping or cutting machine, is subject to the dangers inherent in the sudden release of watermain pressure to tapping or cutting machine.

Subject to 24-hour emergency call and may be required to work overtime during emergencies.

Requires D.C. Employees Motor Vehicle Operator's Permit to operate light trucks up to 3-tons.

List of Equipment

Some of the general equipment used by workers in the bureau include such items as:

Air concrete breakers
Backhoes
Dump trucks
Pick-up trucks
Shovels
Hammers
Wrenches
Pliers
Gauges

Meter testing Equipment
Radios
Computers
Pumps
Valves
Pressure reducers and regulators
Flow meters
Steam Boilers
Vans

1.2.2 Bureau of Sewer Services

The Sewer Collection System-consists of two separate collection systems. The older parts of the city are served by combined sewer systems and the newer sections by separate lines which carry sanitary and storm sewage. The sewage system is basically a gravity flow system but due to topographic conditions there are pumping stations at a few points of the city to boost the flow.

The bureau has 127 employees working in four main divisions as follows:

Maintenance and Inspection Division	- 57
Pumping Division	- 33
Repair Division	- 32
Potomac Interceptor Division	- 1

The remaining employees work in the Consumer Services branch and in the administration, repectively.

Types of Positions

Typical positions identified in the bureau are as follows:

Tools and Parts Attendant
Oiler
Plumber Helper
Sewer Services Worker
Sewer Services Worker Leader
Foreman (Minor Repair Unit)
Fixed Industrial Equipment Operator Foreman
Sewer Maintenance General Foreman
Laborer
Masonry Worker
Masonry Helper
Plumbing Worker

Motor Vehicle Operator
Garage Taps Inspector
Electrical Equipment Repairer
Crane Operator
Plumber
Utilities Systems Operator

Duties, Working Conditions, and Equipment

Sewer Services Foreman - 10

Typical duties and working conditions include the following: Serves as head of minor repair branch which is responsible for inspecting, maintaining and repairing sanitary, stormwater and combined sewers; constructing and repairing catch basins; installing manhole frames, covers, etc.

Coordinates work of crews, truck drivers, and special equipment throughout the day. Inspects work for safety and adequacy. Review field note reports for accuracy and clarity. Responsible for training of subordinates. Explains purpose and use of tool's, equipment and safety devices.

Requires a complete knowledge of map and plat interpretations; the sewerage system; the interaction of other utility systems and the vehicles, tools, equipment processes and procedures used in the branch's operation, etc.

Working Conditions

Spends approximately 75% of time outside or in sewers. Subject to gas collection, lack of oxygen, falling, infections,

etc., while working. Climbs manhole ladders as much as 65-feet. Subject to rats, roaches and other vermin. Subject to 24-hour emergency call; required to work overtime during emergencies and must drive a light truck.

List of Equipment

Generally attempts to obtain brochures or detailed inventories of equipment used by workers in the various bureaus was difficult. However, documentation on some of the equipment used was compiled based on interviews with the workers. Most of the equipment falls into the category of hand tools and mobile equipment. The list of hand tools and other equipment includes items such as:

Wrenches
Pick forks
Shovels
3 ft. connecting rods
Bucket
Vise grips
Screw drivers
Hammers
Socket Pliers, etc.
Trl. Pump
Trk Swr. Cleaner
Bucket Machines
Trk. Jet Cleaners
Trk. Vacs
Trl. Sewer Rodders
Loader Fe. Bhoe
Pickup - 3/4 ton, etc.

1.2.3. Bureau of Wastewater Treatment

The Blue Plains Wastewater Treatment Facility is based on a modified aeration activated sludge process for secondary treatment followed by biological nitrification. The processes involved in the waste-water treatment plant at Blue Plains include: screening, pumping, grit removal, primary treatment, secondary treatment, chemical additions, secondary sedimentation, biological nitrification, mixed media filtration, disinfection, sludge thickening, sludge digestion, sludge "washing," vacuum filtration and composting. At the end of these processes, 95 to 98% removal of BOD and suspended solids is attained.

The bureau of wastewater treatment has two divisions, namely the wastewater and solids processing divisions, respectively. The bureau employs approximately 200 people working in the following branches as follows:

Management and Supervisors - 37

Operators - 133

Clerical Staff - 5

Maintenance Crew (buildings and grounds) - 12

Other plant workers - 33.

Typical positions identified in the bureau include the following:

Laborer	
Sewage Disposal Plant Operator	(Wastewater Division)
Sewage Disposal Plant Operator	(Secondary Treatment Section)
Sewage Disposal Plant Operator	(Solids Processing Division - Thickening and Digestion)

Sewage Disposal Plant Operator (Solids Processing Division Dewatering Branch)

Sewage Disposal Plant Operator (Wastewater Division - Primary Treatment)

Fixed Industrial Equipment Operator Utilities Systems Repairer/Operator

Sewage Disposal Plant Operator Helper (Sludge Processing and Disposal Branch)

Sewage Disposal Plant Operator - 05
(Primary Treatment)

Duties:

Performs a series of supporting operations related to the operation of a primary treatment process; insures compliance with correct procedures through operation of equipment within area as directed; assists in removing bar screenings, grit, sand and sludge by manual methods; assists in connecting chlorine tank cars to chlorination equipment; performs general cleaning and painting in work areas; lubricates or assists in lubricating and adjusting equipment.

Working Conditions:

Works both indoors and outdoors in all weather conditions. There is danger from falls into open tanks and channels, particularly at night, :and from infection when in contact with sewage. Facilities are poorly heated in winter and hot and humid in the summer. Dangerous foul odors are always present. Hours and days of work are varied according to a rotating shift schedule.

List of Typical Equipment

Some of the typical equipment used in the bureau include the following:

Screening and Grinding Equipment

Metal bars (screens)
Cleaning mechanisms (automated) - scrapper
Dumping mechanism
Hopper
Grinder (Comminutors)

Grit Removal

Grit chambers
Conveyor system
Hopper
Air compressors
Pressure indicators
Blow-off valves
Check valves

Pumping Equipment

Pumps (Centrifugal)
Electric motors (for driving pumps)
Flow measuring devices (meters)

Primary Sedimentation

Primary sedimentation tanks
Sludge scrapers
Scum remover
Hopper

Activated Sludge – Aeration and Sedimentation

Flow measuring devices

Parshall Flume
Flow meters
Orifice Plates

Aeration Tanks

Valve controls for air flow Diffusers
Center-feed clarifiers with skimming device, hydraulic sludge collectors and V-notch overflow weirs

Centrifugal varispeed pump; control panel for return activated sludge, wasting and blower control; etc.

1.2.4 Bureau of Maintenance Services

The bureau of maintenance services maintains and repairs both fixed and mobile equipment for the D.E.S.

The bureau is divided into the Mechanical and Electrical Maintenance Divisions respectively. About 143 people work for the bureau as follows:

Office Crew - 5

Production Control Group - 3 Metal

Section - 7

Process Mechanical Branch (Blue Plains) - 36 Process Mechanical

Branch (Uptown, SE) - 22 Facilities Maintenance Branch - 1

Carpentry - 5

Utilities - 11

Paint Section - 3

Scheduled Electrical Section - 13

Unscheduled Electrical Section - 14

Uptown - 12

Switchgear - 1

Instrumentation and Telemetering - 8

Mechanical Maintenance

Typical Positions include the following:

Mechanics

Welders

Machinists

Duties

General duties include the maintenance and repair of the following equipment: pumps, cranes, rigs, tanks, bore springs, valves, clarifiers, vacuum filters, sludge collection equipment, etc.

Working Conditions

Working conditions depend on the type of equipment used and its location.

Equipment Used

General equipment used include hand tools and items such as:

16 inch vertical bore mills
Lathes
Impact Wrenches
Grinders Presses

Welding Machines
Saws
Drills
30 ton Mobile crane Mobile
Pumps

Electrical Maintenance

Typical positions include the following:
Electrical Mechanics

Duties

Typical duties include:
Maintenance of switch gear, cleaning, calibration, adjusting, checking and repair of electrical equipment, installation of pumps, motors and controls; station service as well as sending and receiving signals by the telemetering branch.

Equipment

Equipment used include basic hand tools and items such as: welding equipment, electrical test equipment, vibration meters, bearing test instruments, alignment tools, etc.

CHAPTER III

JOB ANALYSIS AND TRAINING NEEDS

1. JOB ANALYSIS

1.1 General Description of the Need-To-Know (NTK) Objectives from the Analysis of Work Requirements

The design of an effective training program requires a thorough job analysis. The purpose of the job analysis is to identify and analyze the duties required for job performance, such as operations, *maintenance, construction, installation,* start-up and shut-down procedures, work conditions and safety, etc., thereby serving as a basis for designing a comprehensive training program. The job analysis allows to clearly address the needs of the three WRMA bureaus (namely the bureaus of Water Services, Sewer Services and Wastewater Treatment) for making the *training* more relevant to the needs of the administration. Since this analysis focuses only on what the employee needs to know to perform his/her job, it helps eliminate irrelevant curriculum objectives. The training objectives are related to the need-toknow tasks. The need-to-know tasks for all the bureaus involved are addressed to the extent possible. Classroom curriculum and on the job training are then designed to address these objectives.

Furthermore, the training objectives relating to the need-to-know tasks provide a valid basis for preparing a test or a certification program and for evaluating employee performance.

It is important to note that the NTK job analysis is intended to give an idea of the relationship between the job performance requirements and the training objectives. It is there fore not a comprehensive set of job requirements of any one plant. It is for an average plant.

The objectives address the equipment, tools and operations required in the three bureaus; therefore, the analysis is not as exhaustive because it does not address some of the routine tasks such as responding to emergencies or doing other intermediary tasks. However, it is comprehensive enough and each task statement considers factors already stated (i.e., operating and maintenance procedures, etc.). For the $WRMA_I$, bureaus under consideration, the job analysis addresses the general knowledge and skills required, the support systems, the unit and system control, as well as the technical management and supervision functions. The duties or tasks needed to know for the three bureaus mentioned above are discussed in this section. However, the tasks needed to know for the bureau of maintenance services are included in the three other bureaus. There is therefore no section for the bureau of maintenance services.

1.2 Detailed Analysis of Work Requirements

1.2.1 Bureau of Water Services

- Develop Skills and knowledge in water sources; water characteristics; water distributing processes; basic and applied math; safety; common parameters; and hydraulics.
- Perform operations and corrective maintenance procedures in switch gears; transformers; battery banks; pipes; joints; fittings; cathode protection devices; signal generators; signal transmitters; signal receivers; meters; alarms; HVAC (heating/ ventilation/air conditioning).
- Perform operating procedures in traffic control.
- Perform operations and preventive and corrective maintenance procedures in: motors; drives, pumps, blowers and compressors; generators; engines; valves, hydrants; and chemical feeders.
- Perform operations, construction and installation procedures in cross connection control devices; metering; leak detection and repair; visual leak detection; etc.
- Perform operations, start-up/shut-down, construction and installation procedures in: valves; service connections; hydrants; booster pumps; regulators and gauges; storage tanks; flushing systems; well operation; disinfection; water sampling/ monitoring.

- Perform management/supervision functions to develop a master plan to include: objectives; strategies; financial support and presentation to key personnel; prepare detailed management systems to implement the objectives and strategies; implement the systems to accomplish master plan objectives to organize, coordinate, direct and control; and to evaluate the effectiveness of the master plan-and management systems.

1.2.2 Bureau of Wastewater Treatment

- Develop skills and knowledge in sources of wastewater; wastewater characteristics; wastewater treatment processes; basic and applied math; safety; laboratory skills; common parameters; basic electrical concepts; and basic hydraulic concepts.

Perform the following tasks (where most applicable): (a) operating procedures associated with normal and abnormal conditions; (b) preventive and corrective maintenance procedures; and (c) start-up/shut-down procedures regarding the following support systems: battery banks; motors; drives; pumps; blowers and compressors; generators; engines; piping; pipe joints; valves; pipe fittings; signal generators; signal transmitters; signal receivers; meters; alarms; control systems; chemical feeders; and heating/ventilation/air conditioning.

- Perform operating and start-up/shut down procedures (where applicable) in the following unit process/process-control operations: Flow Equalization; Screening; Grinding; Grit Removal; Preparation; Primary Clarifiers; Activated Sludge and Secondary Clarifiers; Rotating Biological Contactors; Disinfection; Tertiary Filtration; Microscreens; Ammonia Stripping; Phosphorus Removal; Dechlorination; Effluent Discharge; Chemical Sludge Conditioning; Elutriation of Sludge; Sludge Thickening; Aerobic Sludge Digestion; Anaerobic Sludge Digestion; Sludge Drying Bed; Sludge Vacuum Filters; Sludge Filter Press; Sludge Centrifuges; Composting of Sludge; Flow Measurement.

- Perform sampling procedures; testing procedures and analysis (where applicable) in: Alkalinity; Ammonia; Arsenic; BOD; Cadmium; Calcium;. Centrifuge; Chlorinated organics; Chloride; Chlorine; Chromium (+3); Chromium (+6); COD; Color; Conductance; Copper; Cyanide; D.O.; Fecal Coliform; Iron; Kjeldahl Nitrogen; Manganese; Mercury; Microexam; Nickel; Oil and Grease; Orthophosphorus; Pesticides; pH; Phenol; Potassium; Selenium; Settleable Solids; Settleability; Silver; Sodium; Sulfate; Sulfide; Sulfite; Surfactants; Suspended Solids; Temperature; Total Coliform; Total Dissolved Solids; Total Organic Carbon; Total Phosphorus; Total Solids; Turbidity; Volatile Acids; Volatile Suspended Solids; and Zinc.

- Perform technical management/supervision (see bureau of water services page 38.

1.2.3. Bureau of Sewer Services

- Develop skills and knowledge in: wastewater sources, characteristics and collection processes; basic and applied math; safety; chemical skills; laboratory skills; common parameters; basic electrical concepts; basic hydraulic concepts; public health; maps and plans.

- Perform operating, preventive and corrective maintenance procedures in: sewer equipment components; pump station structure; service vehicles; personal protection gear; safety equipment (blowers); traffic control/public safety; hazard detection equipment; safety equipment (first aid/hygiene); chemical feeders; telemetry; measurement devices; sampling and recording devices.

- Perform preventive and corrective maintenance in: sewer maintenance equipment; portable pumps; generators.

- Perform operating procedures associated with collection (including gravity 'sewers, pressure sewers, etc.); perform operating procedures to correct abnormal conditions; perform construction and installation tasks.

- Perform operating procedures associated with normal conditions as well as procedures to correct abnormal conditions

in the following: flow measurement; other monitoring tasks such as power consumption; equipment efficiency; equipment run time; visual observations to detect violations of sewer use; etc.

- Perform operating procedures associated with normal conditions in chemical addition/aeration (including chlorination corrosion control, rodent control; etc.)
- Perform operating procedures to correct abnormal conditions in infiltration/inflow detection.
- Perform the following tasks with regard to lift station operating procedures associated with normal conditions; operating procedures to correct abnormal conditions; start-up/shut-down procedures; construction and installation.
- Perform quality control/surveillance for: physical/ chemical/biological characteristics such as temperature, suspend solids (grease, flammable solvents, floating oil), pH, qualitative tests of hydrogen sulfide, and *inspection* for vermin in manholes and pump stations.
- Perform technical management/supervision (see bureau of water services page 38).

In addition to the above analysis, field observations of typical work performance were conducted in the bureaus of wastewater treatment and sewer services respectively.

The analysis of these observations are presented in tables

TABLE 1

ANALYSIS #1 BUREAU OF WASTEWATER TREATMENT, SOLIDS PROCESSOR WG9 OPERATOR

Process: Slugde to thickened sludge (digesters)
thickened sludge (secondary)
thickened sludge (raw tank)

Purpose: Rag removal

TASKS - 3 HOURS

OPERATIONS	Frequency Operation Appears	1 Determine Load Rate of Polymer, Air & Water	2 Make Adjustment of Polymer Addition	3 Take Composite Sample of Influent and Effluent	4 Determine Air in Vessels	5 Adjust Effluent
Set Control Switch to Hand/Off Auto	2	X	X			
Measure Sludge with Ruler	1	X				
Position Equipment & Set Control Nozzel	1			X		
Adjust Controls for Air in Vessels	1				X	
Adjust Controls for Effluent	1					X

Rank Order: Order of importance of operation in the tasks of the position

ANALYSIS #1 BUREAU OF WASTEWATER TREATMENT, SOLIDS PROCESSOR WG9 OPERATOR

TASKS - 3 HOURS

OPERATIONS	Frequency Operation Appears	6 Adjust Flowmeter	7 Determine Available Space In Tank	8 Determine Quantity of Polymer Received Or Exist	9 Identify Defective Bearing In Pump	10 Correct Or Repair Leaky Pump
Adjust Flowmeter & Settings	1	X				
Measure Height of Liquid in Tank with Chain & Float	2		X	X		
Check Vibrations in Bearing	1				X	
Replace Packing in Pump	2				X	X

TABLE 2

ANALYSIS #2 BUREAU OF SEWER SERVICES, SEWER SERVICES WORKER GRADE 7

TASKS - 3 HOURS

Process: Dragging crew

Purpose: Clear roots & debris from sewer lines

OPERATIONS	Frequency Operation Appears	1	2	3	4	5
		Drive & Position Truck To Sewer Manhole	Install Equipment To Perform Dragging			
Drive Truck	1	X				
Position Truck To Manhole	1	X				
Set Up Sewer Bucket Machine	1		X			
Set Up Safety Cones	1		X			
Guide Cable Through Sewer	1		X			
Connect Rod To Cable	1		X			
Attach U-Bolt	1		X			
Install Rod Base Guard	1		X			

Rank Order: Order of importance of operation in the tasks of the position

2. Types and Processes/Methods of Training

Any training program is supported by an appropriate selection of delivery mechanisms and methods with adequate training materials. Numerous training systems are available and have been tried in various water and wastewater operating programs. Various institutions including universities, community colleges, training-centers, etc., have used, evaluated and testified to the effectiveness of a number of these methods and materials..
(Figure 3.) A brief description of these methods is given as follows:

2.1 Training Delivery Mechanisms

2.1.1 On the Job Training (OJT)

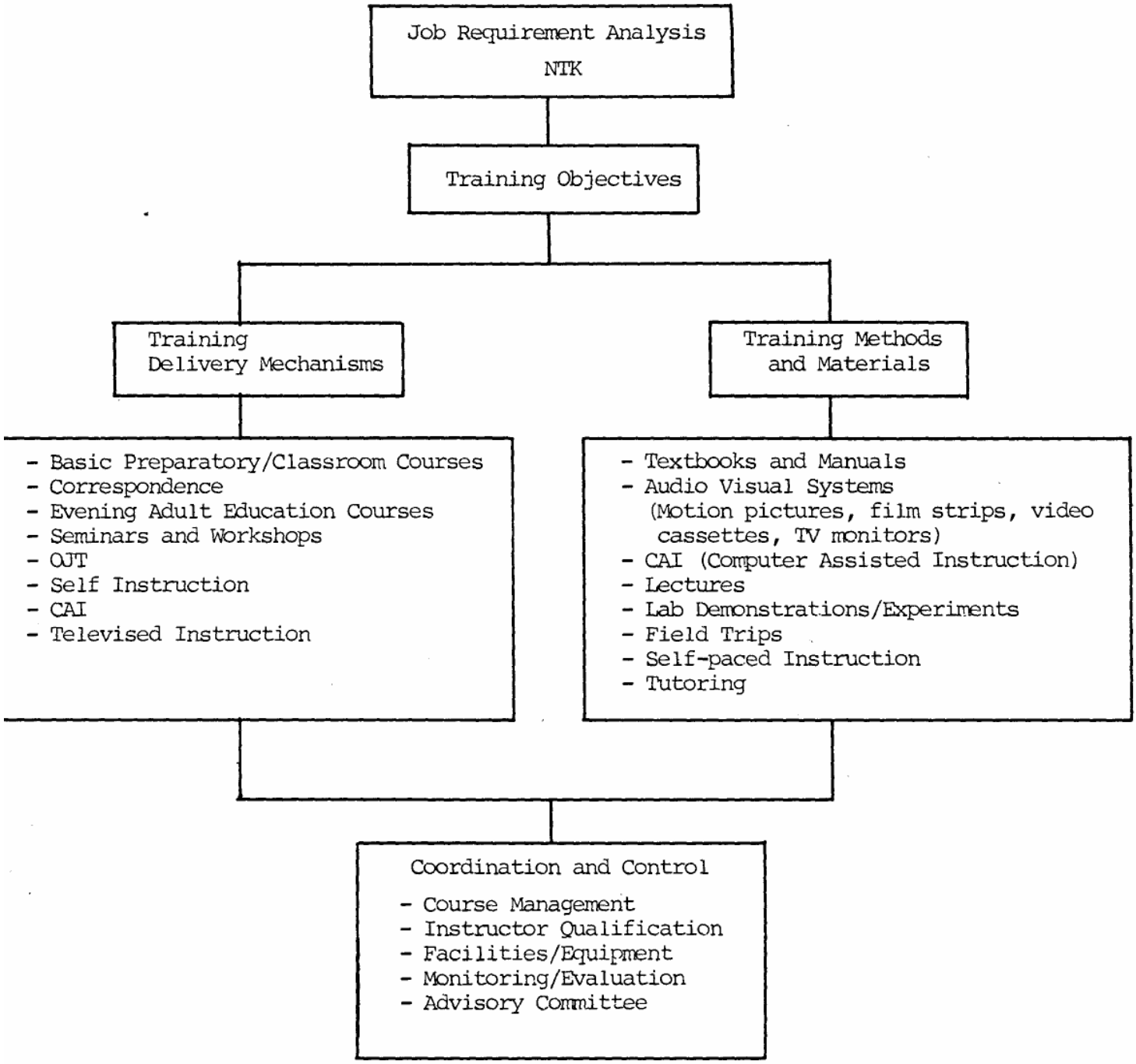
OJT is probably one of the oldest training methods. OJT 'is usually conducted under the supervision of a skilled and seasoned worker who trains the student to learn a craft and adjust to technological changes and work environment. Usually the trainee earns a living while learning a craft. This form of training is predominant in apprenticeship programs and in reality completes all the other forms of instruction.

2.1.2 Correspondence Courses

Under this program courses are designed for individual study. The courses, together with tests and other evaluation forms, are mailed regularly to the trainee. This type of

FIGURE 3

TRAINING MECHANISMS



training does not need any specific delivery techniques except studying the brochures and books and passing the exam. It is most suitable for people who cannot attend other forms of training because 'of distance or other impediments.

2.1.3 Seminars and Workshops

1-5 day short courses or seminars on special subjects are offered during a given day to a limited number of participants, usually with a paid fee.

2.1.4 Computer Assisted Instruction (CAI)

This is a new and fast growing field especially with the introduction of microprocessors. The courses are programmed in a software to be used with a given computer system. Tests are also programmed along with the courses. Students interact with a video terminal to learn the objectives presented. The CAI system is especially suited for basic courses such as English, writing, and reading, math and sciences, etc.

2.1.5 Self Instruction

These are programmed to be used individually at the learner's pace with built-in progress tests.

2.1.6 Evening Adult Education Courses

The evening programs are offered through community colleges, universities, and other teaching organizations. The programs can be a part of a curriculum or instruction and cover specific

subject areas. Evening programs are most suitable for trainees on regular (9 A.M. to 5 P.M.) jobs but might not be suitable for shift workers. These programs have built in credit units that are accepted by the college or the training organization offering the program.

2.1.7 Televised Instruction

This is a relatively new but a fast growing type of training method. Training objectives are developed and produced by specialists and delivered through a local TV network. This type of instruction can reach a broad segment of the population and can be programmed on any hour of the day or weekend. However, there might be high start-up costs associated with writing the script, finding an actor and producing the teaching materials.

2.1.8 Basic Preparatory/Classroom Courses

This is provided through universities, private educational institutions, community colleges, etc. It is designed for entry level personnel. It can be adapted to build up the learning and educational skills of employees who have been out of school for a long time or who did not complete basic high school requirements. This basic program is to prepare the worker towards a higher level of training. In the basic program items proposed for the WRMA, such as learning techniques, orientation, English, math and water resources are provided as initial courses.

2. 2 Materials and Methods

A number of methods are available and have been used in the field of water resources. However, in introducing a method or materials in a new environment it is essential to first try them and then evaluate their usefulness in the framework of the agency that needs the training. The list of training methods and materials is provided below:

- Textbook and manuals
- Audiovisual systems (film strips, video cassettes, motion pictures, video tapes, TV monitors, slides, overhead transparencies, etc.)
- Computer Assisted Instruction (CAI)
- Lecture provided by instructor
- Laboratory demonstrations/experiments
- Field Trips
- Self-paced instructions
- Tutoring by peer or a more qualified person

All the different aspects involved in preparing a training program such as job analysis, training needs analysis, delivery systems, *training* methods and materials, require proper coordi nation to provide for effective implementation. Coordination is also required in order to control, evaluate and establish criteria for training programs, manage the classroom and courses,

select the best instructors available, evaluate the training methods and delivery systems, acquire the equipment needed for the training facility, maintain and organize the facilities for the training, and provide for the monitoring of student progress toward meeting the program goals. An advisory committee must be formed to advise the coordinating team/committee regularly on the training program developments.

2.3 Matching Training to Needs

2.3.1 The Nature of the Trainees

The potential trainees can be divided into two categories the existing employees and newly hired personnel. Of the approximately 800 WRMA employees it is estimated that less than 50% have a high school education. Generally people are recruited at varying degrees of experience and training. The experience of employees already on the job may vary from a few months to several years. Although such employees are well versed in their day to day operations, their upward mobility is very limited due to lack of training. Interviews with the supervisors overwhelmingly pointed to the need to first train their employees in basic skills such as English, report-writing, elementary math, good working habits and an understanding of the work environment. Messrs. Carl Johnson, Otto James (chiefs of the bureaus of

water and sewer services, respectively) *and James* Dennis (chiefmeter division of the water services bureau) indicated that good penmanship, grammar and composition were needed by some of the employees to enable them to perform more effectively. Mr. Otto James further indicated the need for training in courses such as measurements, metric system, blue print and map reading, etc. Thus the development and introduction of any training program for these bureaus must have as a prerequisite the building and upgrading of workers' basic skills to a level that would enable them to effectively tackle the courses proposed for the long-term program. In the case of new employees who have been away from school for many years or did not complete high school, the preparatory/basic courses are necessary to prepare them to participate more effectively in a long-term training program and ultimately in their jobs. Such preliminary training instills confidence and self respect. As adults who have probably been away from the classroom environment for years, traditional teaching methods must be carefully examined and made adaptable to their needs. For instance self paced or individualized instruction can be started in addition to the utilization of computers to provide the discretion and the effectiveness required in having employees truly master basic skills.

2.4 Training Requirements

The following approximations provide the number of workers who may benefit from training. These assessments were based on interviews with bureau/division chiefs during the early phase of the project.

Title of Bureau	Number of Workers Employed	Number of Workers To Be Trained
Sewer Services	127	30-40
Water Services	200	60
Wastewater Treatment	200	60

In addition to the preliminary/basic water resources program that strengthens their English, writing abilities, math skills and general science knowledge, the workers are required to participate in an OJT program. The OJT must supplement the classroom training. As part of the overall program all trainees must undergo some counseling to prepare and orient them to the appropriate level. Their progress should be monitored throughout the program and the goal should be the award of a certificate which would attest to their mastering of the skills required for the particular job. Because of the different bureaus involved the training paths would not be the same.

Items such as enrollment procedures, registration, attendance, credits, grading system, records management, scheduling,

etc. would come under the control of the coordinating team. Care must be taken to ensure that the trainees accomplish the goals of the program. There should be built-in flexibility to take into account time constraints such as rotating shift hours. The location of classrooms, instruction sites and equipment involve problems that must be carefully addressed.

2.5 Program Management

2.5.1 Program Coordination

One of the most difficult aspects in developing a sound training program is management and coordination. Even though a plan can be thorough and comprehensive, there must be effective coordination, implementation, and supervision in order for the program to survive over a long period. Coordination between the WRMA, its personnel office and supervisors, is absolutely necessary to ensure that both new and existing employees can be channeled through the program without unnecessary impediments and have their work and credits recognized by the agency. Details involving the purchasing and installation of equipment, classroom and library organization, development of record forms and other logistical support should be handled by the coordination team. Proper coordination is also needed in developing relationships with other training centers to learn and exchange ideas

about developments. The coordination of the program should be scheduled very carefully to take into account workers' needs, their availability, etc.

2.5.2 Admission

The enrollment procedures would be as follows:

1. Schedule a counseling interview with the employee and his/her supervisor;

2. Submit a complete application for admission;

3. Take a test in basic English, grammar, reading, math, and basic sciences (for new employees); for existing employees, in addition to the math and English, a more advanced test could be administered to place them at the appropriate level;

4. Determine the beginning date and set program limits; 5. Provide the training program schedule (including the sequence of courses to be taken);

6. Provide text books and materials.

2.5.3 Attendance

Emphasis on regular class attendance is necessary because attending classes should not be used as an excuse to miss work. Absence and tardiness should be recorded and placed on a student's record.

2.5.4 Grading System

Grading should be based on either the pass/fail system, the

A, B, C, D, F system or any other system that would not hamper the student's self confidence and desire to pursue their studies. However, the level of learning must be evaluated throughout the program.

2.5.5 Academic Records

The coordinating office maintains a permanent record of the progress of all students regarding courses taken, credits and grades obtained. Due recognition of trainees accomplishments is made at the end of the program.

2.5.6 Graduation Requirements

New and continuing employees who are properly enrolled in the training program would after successful completion of the required courses receive:

1) A certificate, and
2) A letter of attendance citing the courses taken and the grades obtained.

2.5.7 Employment

In programs such as apprenticeship where a student is employed, class schedules should be made flexible to accommodate work hours. It is therefore suggested that in the proposed apprenticeship program, the first six months be taken as a probationary period during which a student would learn the basic

skills, in addition to driver-education (if a student does not possess a driver's license) and basic safety techniques. This probationary period would still be useful even if a student were to drop out of the program.

2.5.8 Library Facilities

A library where technical *books,* magazines, audio cassettes, computer learning systems, reference books, video systems, etc., are accessible should be made available to students at all times. In the case of workers on evening shift hours, such a library would be very useful in enhancing their learning capabilities. Trainees should also be encouraged to use the UDC library, other university libraries as well as the public libraries=located in or close to their neighborhoods.

2.5.9 Quality Assurance

All courses must be taught by qualified instructors. Instructors must not only be proficient in their respective specialities but must also be experienced in teaching adults and in the utilization of various instructional methods. The selected instructors should periodically be evaluated by the coordinating team as well as by the students.

The selection of the instructors must also be based on their personal qualities such as persevereance, enthusiasm, dedication, interest, and the ability to relate to the workers.

Management support, in terms of funds, personnel, release time, respect and recognition, is cruical for the success of such a program. Incentives must be provided to trainees as an encouragement to learn and progress. It is recommended that periodically, other training centers (for example, the Maryland State Water Quality Training Center in Charles County) be consulted for an exchange of ideas. Additionally, to keep abreast of new developments, membership in national related professional associations such as the National Environmental Training Association (NETA) is advised. Finally, the establishment of a local chapter of the Association of Water and Wastewater Plant Operators (if not already present in the area) would give the workers a professional status and enhance their image.

After completing important phases of the project, such as background information gathering, agency structure, and training needs, it was important to conduct a pilot program to try out a few of the ideas mentioned earlier. Furthermore, the response of the trainees to various types of instruction, different schedules, and instructional materials, was an essential input to the final recommendations in the design of the long-term program. The next chapter deals with these aspects.

CHAPTER IV

DESIGN OF THE LONG-TERM TRAINING PROGRAM

1. THE PILOT PROGRAM

1.1 Introduction

The pilot program was conducted from June 1st to June 15th for a group of workers from THE WRMA. Participation in the pilot program was on a voluntary basis (see Appendix C). The workers who volunteered to participate had a diversity of backgrounds and came from three bureaus within the WRMA. These were the bureaus of Water Services, Sewer Services and Wastewater Treatment respectively. Their ages ranged from 29-59 years. The number of years they had spent on the job varied from a minimum of 11 months to a maximum of 25 years.

The highest level of education attained by the group ranged from the 7th grade to the 12th grade with one worker having completed one year of college studies. The training program activities were held at three locations; these being the UDC campus, the media resource center in the primary building at DES (Blue Plains) and specially selected sites within the District, primarily on the east and west sides (for field trips). difference of the content learned by the students between the pre and post tests administered during the program,

Proceedings, tasks and other activities which were conducted during the pilot program as well as the findings and recommendations are presented in this chapter.

1.2 Objectives of The Pilot Program

The program which consisted of pilot courses in basic water resources was the fourth phase of this training project. The selection of the courses to be implemented in the pilot program was based on input from the employees and supervisors. As mentioned earlier, the purpose of the pilot program was to provide information which could be used in designing and forecasting the outcomes of a long-term training program. To achieve this purpose, the following tasks were performed:

(1) Design courses of study in English, Math and Basic Hydrology,

(2) Utilize research design in conducting the performance and analysis of the pilot program, analyze the test data and statistically determine the significance of the difference of the content learned by the students between the pre and post tests administered during the program,

(3) Schedule the class activities at Blue Plains, UDC, and in various sites selected in the city for the field trips,

(4) Obtain students evaluation of the course content, training methods, physical arrangements and other aspects of the pilot program,

(5) obtain any additional information which could affect the proposed long-term program,

(6) Integrate the findings and recommendations of the pilot program in the main report.

1.3 Implementation of the Pilot Program

1.3.1 Preliminary Preparations:

Initial preparations for the implementation of the pilot program included the following:

(1) Selection of the three main courses to be taught, which were basic English, math and hydrology,

(2) Selection of the teaching methods to be used, which included the following: video systems, computer assisted instruction (CAI), classroom teaching by instructors, tutorials, laboratory experiments and demonstrations, field trips, etc;

(3) Selection of instructors

(4) Preparation of course outlines and class schedules

(5) Arrangements for the *installation* of the CAI/PLATO system;

(6) Selection of students by the WRMA;

(7) Inventory and organization of past WRMA training materials and preparation of classrooms;

(8) Transportation arrangements;

(9) Organization of courses and other teaching materials;

(10) Preparation of certificates of completion;

(11) Preparation of evaluation forms, pre test and post test materials;

(12) Organization and provision of refreshments at the beginning and at the end of the program.

1.3.2 Selection of Teachers, Instructional Methods and Teacher-Made Achievements Tests

1.3.2.1 Selection of Teachers:

The selection of the teachers to implement the pilot program was a crucial factor. For the success of the program it was felt that teachers experienced in teaching adults, utilizing new methods of teaching, and dedicated to the project were essential. The selection of the teachers was therefore based on the following criteria: experience in teaching adults, ability to use multiple teaching methods on a competency-based approach (including self paced instruction, CAI and video systems) salaries and other factors such as availability, usefulness, enthusiasm and good teacher-student relationships. The teachers prepared the

lecture notes, composed the achievement tests for each course, and overall accomplished the goals set for the program.

1.3.2.2 Instructional Methods:

While the traditional methods of teaching which comprised lecture-discussion and exercises in class and at home served as the instructional core of the pilot program, they were augmented by the use of other teaching methods. These were CAI, individual conferences between teachers and students, audio visual methods and field trips to various water resource sites within the District of Columbia. The CAI which is a new method of teaching basic math and science enhanced psychological effects because it provided opportunities for the students to monitor their progress privately. The system used was PLATO from the Control Data Corporation. The system is very flexible, interactive and easy for a beginner to use. The PLATO system was used for instruction in math and English only. The system had no course software in basic hydrology.

During the visits to UDC, the program was scheduled in such a way that while one group used the CAI, the other group used the water quality lab to perform various experiments and also view demonstrations in hydrology. The hands-on experience as well' as the demonstrations in the lab helped to reinforce previous theoretical concepts learned in class. Individual conferences also

served as tutoring periods for teachers to instruct trainees in difficult questions and problems.

The field trips, although difficult to organize and manage did provide a welcome supplement to the classroom instruction. Sites selected covered both the east and west sides of Washing ton, D.C. The itineraries are given in Appendix D. Both field trips were heavily oriented towards hydrology because of the practical nature of the course. Major activites included measurement of river flows, locating and measuring sewer pipe diameters, lectures on the history of sewer development in Washington, D.C., demonstration of infiltration rate, and introduction of the concept of storm water runoff and its relationship to design capacity of sewer systems. However, math and English were programmed into the schedule in such a way that the students were able to utilize math concepts they had learned in class to perform simple calculations using data collected on the field trips. Similarly, they were also given the opportunity to reinforce concepts they had studied in the English class by writing short reports of their observations on the trips. Apart from helping the students to relate theory to practice and thereby reinforce basic concepts in the various subjects, these trips helped to break the monotony in the classroom.

1.3.2.3. Teacher-made Achievement Tests:

In each course the teacher-made achievement tests were composed by the teacher from the contents of the course syllabi. In English, the questions on the pre test and the post test were

based on the following topics; grammar, subject, verbs, direct and indirect objects, prepositional phrases, spelling, dependent and independent clauses.

The pre test and post test in hydrology each consisted of two parts, a true/false section and a multiple choice section. Both tests featured questions on items such as river mechanisms, runoff, erosion and sediment transport, landforms and drainage patterns, ground water hydrology, precipitation patterns, etc. In math the pre test and post test covered the following topics; digits, whole numbers, addition, subtraction, division, multiplication, fractions, decimals, square and cube roots, graphing, algebraic manipulations and some simple geometry involving area and volume calculations. The pre test and post test for each course are given in Appendix E. The duration for a student to complete a test was one hour.

1.3.2.4 Instructional Schedule:

A period-of two weeks was selected to implement the pilot program. The decision to conduct the program over the two-week

period instead of a three-week period was made by the advisory committee which felt that a three-week period was too long for the employees who had been away from the classroom for many years. The students were divided into two teams, Team A and Team B (comprising 8 students in each team) respectively. Although they had similar schedules, the activities at any given moment were different for both teams. English and math courses were taught in the morning while hydrology including the lab were taught in the afternoon and vice versa.

Tables 3 and 4 show the class schedules. The beginning and the end of the pilot program were reserved for the pretest and post test respectively. In addition during the program, pre evaluation, mid point evaluation and a final evaluation were administered. Furthermore, all students were awarded certificates of completion (see appendix F).

1.3.2.5 Questionnaires:

Three sets of evaluation questionnaires were prepared. These served as the most important tools for evaluating the pilot program. At the beginning of the program the students were informed that the emphasis on the evaluations would be placed on items such as the teaching methods, the course material, and other aspects related to it rather than on their performance in the tests. The questionnaires were therefore designed to reflect those basic needs. The first questionnaire form, called the

TABLE 3

WRRC PILOT PROGRAM
6/1-6/15/83

CLASS SCHEDULE

TEAM A

Date	9:00-10:30 am	10:30-12:00 pm	12:00-1:00 pm	1:00-3:00 pm
6/1	English	Math	L/B	Hydrology
6/2	English	Math	L/B	Hydrology
6/3	English	Math	L/B	Hydrology
6/4	---------- Weekend ----------			
6/5	---------- Weekend----------			
6/6	CAI/Hydrology Lab			
6/7	-----Field Trip and Evaluation-----			

Date	9:30-11:30 am	11:30-12:30 pm	12:30-2:00 pm	2:00-3:30 pm
6/8	Hydrology	Lunch	English	Math
6/9	Hydrology	Lunch	English	Math
6/10	CAI/Hydrology Lab			
6/11	----------Weekend----------			
6/12	---------- Weekend----------			
6/13	CAI/Hydrology Lab			
6/14	----------Field Trip----------			
6/15	Testing and Evaluation			

TABLE 4

WRRC PILOT PROGRAM
6/1-6/15/83

CLASS SCHEDULE

TEAM B

Date	9:30-11:30 am	11:30-12:30 pm	12:30-2:00 pm	2:00-3:30 pm
6/1	Hydrology	Lunch	English	Math
6/2	Hydrology	Lunch	English	Math
6/3	Hydrology	Lunch	English	Math
6/4		---------- Weekend----------		
6/5		----------Weekend----------		
6/6		------CAI/PLATO/Hydrology Lab------		
6/7		------ Field Trip and Evaluation-----		

Date	9:00-10:30 am	10:30-12:00 pm	12:00-1:00 pm	1:00-3:00 pm
6/8	English	Math	Lunch	Hydrology
6/9	English	Math	Lunch	Hydrology
6/10		---------- CAI/Hydrology Lab---------		
6/11		----------Weekend----------		
6/12		---------- Weekend----------		
6/13		---------CAI/Hydrology Lab ---------		
6/14		----------Field Trip----------		
6/15		-------Testing and Evaluation-------		

"student-interest evaluation" form, contained statements which sought information about the students' background, job title, educational level and expectations about the program. The midcourse evaluation was designed specifically to guide the teachers on the improvement of their courses for meeting the needs of their students. The last evaluation form, the "overall program evaluation", was more comprehensive and addressed various aspects of the program regarding the course content, teaching methods, instructions, etc. The answers to the questionnaires were tabulated and provided in Tables 5, 6 and 7. Two important aspects of the final evaluation were the provision of an opportunity for the students to express their opinions about the program on such topics as the teaching methods, class and course schedules, teachers, field trips, etc., both in writing and orally. The latter approach was particularly important due to the realization that because of the background of most of the students (age, educational level, etc.) oral expression was easier than writing.

1.3.2.6 Classroom Instruction Equipment and Other Facilities:

Two classrooms located in the primary building at DES (Blue Plains) in addition to classrooms at UDC (computer and water quality labs) were used for instruction. The classrooms were generally adequate for the number of students involved in the

TABLE 5

RESULTS OF STUDENT INTEREST EVALUATION

	Statement	Response	% (Response)
1.	Information about program	A majority of the participants obtained information about the pilot program through a memorandum	100
2.	Participation in pilot program	To have more education To improve math and English competency To improve job performance	69 6 25
3.	Participation in previous programs	A majority had never participated in any program of this nature	62
4.	Expectations about program	A majority expected to gain more know ledge	88
5.	Time available for homework	A majority indicated an open time schedule	57

TABLE 6

RESULTS OF MID COURSE EVALUATION

Statement	Agreement
Meeting Objectives	77
Classtime Utilization	75
Orientation	94
Teacher Availability	100
Teacher Concern and Empathy	92
Student Comfort	92
Student Participation	83
Adequacy of Course Level	75
Pace of Instruction	63
Adequacy of Class Materials	100
Continuation of Program	100

TABLE 7

RESULTS OF OVERALL PROGRAM EVALUATION

Statement	% Agreement
Course Content	87
Presentation of Material	93
Teacher - Student Interaction	100
Course Organization	100
Class Schedule	80
Usefulness of Class Material	100
Usefulness of CAI	93
Usefulness of Audio Visual Materials	100
Usefulness of Field Trips	100
Usefulness of Lab	100
Classroom Atmosphere	87
Student Participation	73
Class Location	87
Learning Improvement	73
Lecture Presentation	97

project. However for a long term program better organization and a more comfortable location should be selected. Because of the diversity of the locations the equipment did not pose much of a problem. The DES (Blue Plains) is well endowed with audio visual cassettes and other teaching aids. Each student was provided with a well organized package at the beginning of the pilot program. This consisted of a folder, a notebook, a pencil, a class schedule and basic course materials arranged in chronological order for easy reference and study.

1.4 ANALYSIS OF THE TESTS

1.4.1 Design of Statistical Analysis:

Two aspects were of interest in this project. The first was whether or not learning had taken place during the two weeks of training. The second was whether the overall approach of con ducting the pilot program was feasible and repeatable in the future. If not, what would be the recommendations to make to the implementing agency to design a better or an improved version of a 2-week training program. The first aspect, that is, the testing of the students' progress in math, English and hydrology during those two weeks was analyzed through the pre test and post test grades of the students. The second was analyzed through the questionnaires (evaluation forms) given to the students at the beginning, the mid point, and the end of the program.

The problem pursued in this project may be stated as follows: What is the effect on the achievement of a group of students in each of the courses in English, hydrology and math? According to research in education this problem led to the null hypothesis stated as follows: There is no effect on a group of students--in each of the three courses in English, math and hydrology. In order to measure changes in achievement level, the students must be tested with the same test before and after the training period. Kerlinger in his text entitles, "Foundations of Behavioral Research", New York, 1964 identified this example as a one shot case study.

1.4.2 Method of Data Collection

The raw data comprises the test scores in English, math and hydrology obtained from the pre test and post test administered at the beginning and at the end of the program respectively. The questions on the pre test were the same questions that were administered on the post test. The students were however not aware that the two tests were going to be identical. Furthermore the answers were not provided after the pre test, therefore no biases were induced in the statistical analysis. The gains and achievements came solely from the learning experience during the two weeks. The pre test and post test scores obtained from the

teachers were subjected to statistical analysis. The following statistical parameters, the means, the deviations were computed. The findings learning had taken place, but the level of learning differed from course to course. It was observed that there were noticeable gains in the students' ability in math and hydrology, but very little improvement in the student's ability in English.

This phenomenon might be attributed to the following factors: first being technical in orientation the students might have more inclination for technical or mathematical topics rather than for English. Secondly, there is a more direct relationship between hydrology and math especially regarding those aspects where mathematical concepts are needed to compute hydrologic quantities in the classroom and on the field. Thirdly, being used to speaking less formal English, it became evident that the two weeks were certainly not enough time for a noticeable improvement in English. Thus background and work environment might have contributed significantly to this discrepancy in the achievement levels. Fourthly, it was observed that the students with clerical backgrounds scored significantly and consistently higher in English and in spelling than those with a more technical background. Thus in a long term program, emphasis, should be placed on designing a program where English should be given as many or even more hours than the other courses toL really improve students' reading and writing abilities.

DESIGN OF THE LONG-TERM TRAINING PROGRAM

1.5 ANALYSIS OF QUESTIONNAIRE:

The design of the questionnaire was made with the program requirements in mind; mainly the study of the students' background and attitude vis a vis the pilot program and the modification

of the students behavior one week later in the course as well as final views about the program. The final views included the program evaluation and recommendations.

The student interest evaluation form was designed using two main ideas. First the working background, that is position, age, bureau, the number of years on the job, and secondly the

students' expectations before and after the pilot program. The mid-course questionnaire dealt directly with the course content, teaching methods, and other basic program variables. The final questionnaire dealt with the evaluation of the overall program including the method of teaching, class schedules, the teaching locations and other relevant information. The students completed the questionnaires in the presence of the instructors. Samples of all three questionnaires are to be found in Appendix (G).

1.6 EVALUATION OF THE PILOT PROGRAM

This section pertains to the evaluation of various aspects of the pilot program. After a memo was circulated in their respective bureaus some of the workers voluntarily agreed to participate in the 2-week experimental *training* program. The first questionnaire evaluated their anticipation and expectation about the program. When asked why they decided to participate in the program, the large majority (69%) agreed that it was to have more education, and the others indicated that they volunteered

with the desire to improve their job performance (25%) and their math and English competencies (6%). The vast majority had never participated in any programs of this nature on or outside their jobs. More than just their desire to improve upon their job performance and hopefully their salaries, the overwhelming majority indicated that they expected to gain more knowledge. It is therefore important to note that the desire to get an education was the overriding factor in their volunteering for the experimental program. Table 8 provides the results of the first evaluation.

The mid course evaluation which was designed to obtain the students' input on the possible changes and modification of objectives revolved around the class content, schedule, organization, teaching methods and other program variables. It can be observed from Table 9 that by the end of one week, the students had overcome their early nervousness and had started feeling comfortable with the classroom setting, the schedule; the course objectives, the instructors and the course material presented. Since most of the students have been out of school for many years or did not pursue their education beyond a certain grade level the concern was to make sure that they would be comfortable and be able to keep up with the program. All the students agreed to continue the pilot program to the end except one student who was unable to continue due to health reasons.

The overall evaluation of the program was a determining factor in judging the experimental course. This overall program evaluation was given to the students at the end of the program and completed by everybody at the same time. This was followed by an oral evaluation. As indicated in Table 10, the over whelming majority found that they had benefited to a large degree from the experimental program. As indicated in the analysis of the pre test and post test, they had effectively learned or increased their knowledge in English, math and hydrology. The increase varied from individual to individual and depended to some extent on a students' background. All students interviewed agreed to the benefits brought on by the program. The concern about the students getting potentially bored and disinterested was eliminated because the variety of locations used, the variety of course material and of teachers provided a dynamic and constantly changing environment which facilitated their total participation and involvement in every phase of the program. Table 10 also indicates that the variety of teaching approaches such as the use of CAI, video systems, lectures, one-on-one tutorial, team teaching, audio visuals, field trips and labs were found to be effective learning tools, and theory provided that atmosphere conducive to learning

and enthusiastic student participation. In addition, the field trips were a welcome relief from the classroom instructions, and helped to reinforce the course material learned especially in hydrology and math. Being technical and used to field work, most of the students felt quite comfortable with the field trip

-- activities. The overall evaluation also addressed the future of the program. The students' input was required in the planning of the long term program on items such as the course duration, class schedules, course material, teaching location and other variables of importance to the long-term training program.

Table 7 clearly indicates the overwhelming positive response to the pilot program. The teacher student interaction, the class organization, the usefulness of the course material presented, the usefulness of the teaching methods and techniques n

were all in 100% agreement with what the students expected. The response regarding the classroom atmosphere was very positive. The students felt relatively at ease. The creation of a positive classroom atmosphere was based on a recommendation from the experiences of the training division of the Washington Suburban Sanitary Commission (WSSC) after an interview with their training officer. The planning and organization of the pilot program also utilized the inputs of the surrounding jurisdictions (i.e. Fairfax Water Authority, Arlington Water Pollution Control Plant,

Charles County Community College, Maryland). Although some degree of flexibility was allowed, the program schedule was strictly adhered to. The second part of the overall program evaluation consisted of questions which sought to obtain the students' opinion about how the long-term program should be conducted. A large majority (73%) indicated that a 2-week period was too short and that classes should be conducted during the day and taught preferably in groups of six to twelve. For a long-term program the majority (73%) indicated that the location at Blue Plains was adequate. There was strong approval of CAI as a learning method for English and math. The majority of students also preferred to have training materials located in their respective divisions. Of interest in the findings was the willingness of the students to further their own careers by improving their educational level. The enthusiasm of the students was evident in their willingness to retake a similar course if it were offered again.

The vast majority of the students responded that they would recommend the program to their other colleagues. The analysis of the questionnaires showed that although the students preferred the CAI, they also approved of the other *learning* methods. It was therefore apparent that they welcomed any type of supportive activities that would enhance the instructor's lectures.

The three main factors responsible for the success of the experimental program were: 1) the early and detailed planning of the program; 2) management support, and 3) the supervisors' and workers' input. The early programming allowed for the delivery of the long lead items. Because complicated logistics were involved where three facilities were used, proper coordination of all activities was essential.

Furthermore the installation and subsequent utilization of the computer system required a lot of planning and hard work. The WRMA management's commitment to the program allowed for the release of the students to participate in the program. During the background interviews the supervisors recommended specific types of elements they would like to see included in the program. .

Judging from the statistical analysis some learning took place in all the three courses taught in the pilot program. Such a basic program could be viewed as an introductory course to a

more generalized water resources curriculum; or should the WRMA management decide to implement an apprenticeship program this could be viewed as a pre-apprenticeship component that could serve two purposes. First it could be used to upgrade the basic skills of existing employees who desire to improve their education, and second it could be used to reinforce and strengthen certain basic concepts for newly employed apprentices.

It may also be concluded, based on the diversity of the students and their occupations, that the general worker at WRMA would find this program informative, challenging, interesting, and useful. The diversity of the locations may explain in part why the interest and enthusiasm were sustained throughout the program. For instance, the utilization of the UDC water resources and the CAI/labs in a college setting enhanced the self image of the students and sustained their motivation.

2. RECOMMENDATIONS

2.1 Pilot Program Recommendations

The pilot program was conducted to evaluate a few teaching methods and teaching environments. The results were to be used for the overall plan for the long-term training program. There were a number of recommendations. These concerned the courses, the schedules, and program variables.

The students' oral recommendations might be summed up as follows: 1) the 2-week duration was too short and that in the future a program of this nature should have a duration greater than 2 weeks; 2) they would prefer to have teaching materials located in their own bureaus if possible; 3) some of the students would like to commute to UDC to use the CAI system if time would permit; 4) Those who had difficulty with reading and writing would like to have one-on-one tutorial assistance to

improve their competency in these two skills.

The written recommendations from both students and teachers include the following: 1) creation of different levels of instruction (for English, math and hydrology) which would allow for self-paced instruction; 2) incorporation of an initial reading curriculum in the English portion of the program; 3) encourage the use of CAI, especially for basic math and English; 4) use three or more weeks for basic water resources courses; 5) conduct classes during the day time or evening taking into consideration the constraints of shift work; 6) teach classes in small groups (1 to 4) for slow learners or larger groups of (1-9) for fast learners; 7) teach classes at the WRMA (Blue Plains) with the possibility to take additional classes at UDC; 8) distribute training materials in various divisions; 9) provide diversity of training methods in basic courses - this would include CAI, labs, field trips, audio visual aids and textbooks, all of which would enhance the regular instruction from an instructor; 10) place more emphasis on 4nalysis and synthesis of course material; 11) allocate review time for each course to allow students to work and gain understanding of difficult concepts; 12) careful preparation of course material step by step so that students may quickly overcome past inadequacies, learn basic scientific methods quickly and efficiently, and retain them as a daily

routine practice; 13) reinforce the lecture content with visual activities on a 20-20 and 15-15 minute ratio for best results; 14) allocation of more time to the English program; 15) use of different locations is very conducive to learning since it breaks down boredom and monotony; 16) provide special tutorial concerning scientific methods, how to be a good student, note taking, initiation to measurements, practice in interpretation, plotting graphs, planning, organizing labs, sketching, library research, learning and time management methods, and taking tests, etc.; 17) early preparation of data tables for the field trips and the classes in an easy to fill-in form to enable students to practice as much as possible with basic skills and work out weekly programs for a problem in science and math; 18) have a course coordinator present at all times and ready to provide assistance and resolve any particular logistical difficulty; 19) create a very relaxed and easy atmosphere conducive to learning that allows the students to be relaxed and free to interact and exchange ideas at all times; and 20) utilize the materials already available at the WRMA in the most efficient manner and purchase new ones if needed.

2.1 Recommended Long Term Program

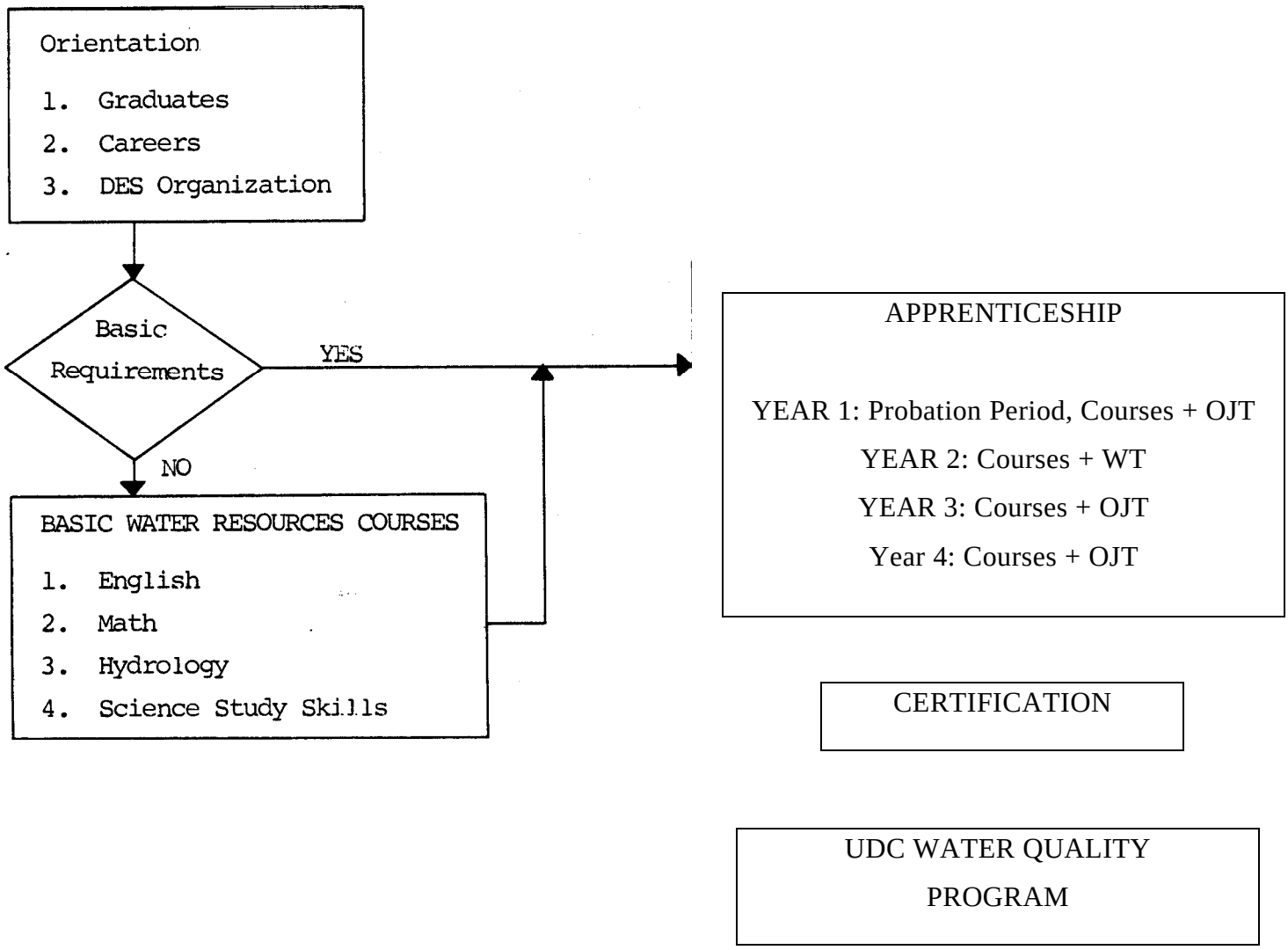
It has long been recognized that training and retraining o£ employees of public utilities is an important priority in

the management of such facilities. For this reason, the EPA has been mandated by Congress to assist States through Section 109B of the Clean Water Act to develop training centers for water and wastewater treatment operators. More than 20 states and the District of Columbia have been involved in this program. Between 1969 and 1977 more than 15,000 persons were trained.

Furthermore, the *findings* from the background research and the pilot program conducted for this project indicate the need for a continuous and sustained training program for the WRMA. Therefore, it is recommended to institute.a four-year training program for both new and existing employees. As indicated in' figure 4, this program would contain the following components: A preparatory phase; an apprenticeship phase; and certification. This program would: 1) enable a worker to learn his or her craft more thoroughly; 2) provide ample opportunities for a worker to progress along the career ladder; and 3) provide a solid foundation in theoretical and practical knowledge of water and wastewater concepts to employees so that persons interested in.pursuing studies in water and wastewater technology at UDC or elsewhere would be equipped with the requisite background. Appendices H and J describe proposed guidelines for apprenticeship and certif ication.

FIGURE 4

RECONMENDED LONG TERM TRAINING PROGRAM



The preparatory phase includes orientation for new employees and a basic/pre-apprenticeship water resources program. The orientation would consist of a review of career opportunities in water resources, description of the WRMA functions, explanation of the training program and advising, etc. As indicated in Tables 11 and 12, the core courses of the basic program are orientation (101), English (102), with emphasis on reading, math (103), with emphasis on conversions, word problems, hydrology (104) of the District of Columbia, general science study skills (105) to include taking notes and tests, interpretation and synthesis of scientific facts, and finally basic safety (108).

After the pre-apprenticeship program, which might coincide with the six-month probationary period, the students would start to specialize.

Appendix J provides a comprehensive list of all the courses deemed necessary for this program. The overall program would cover most of the NTK objectives cited earlier. However, all theoretical courses must be supplemented by OJT to enable particularly new employees to acquire hands-on experience.

Tables 11 and 12 provide the main courses and their sequencing for the four-year program for the WRMA bureaus considered.

TABLE 11

PROPOSED FOUR-YEAR PROGRAM

Bureau	Year 1	Year 2	Year 3	Year 4
Wastewater Treatment	Orientation (101) Basic WRC (102, 103, 104, 105) WPCF Basic Course (106) (Audio visual) Basic Safety (108)	English II (202) Math II (203) KK 1 (207) Advanced Safety (208) Hydraulics I (227)	Math III (M303) KK 2 (307) Computers (313) Lab Procedures (312) Instrumentation (314) Hydraulics II (327) English III (E303)	KK 3 (407) Mechanical Maintenance (415) Electrical Maintenance (416) Management/Supervision (417)
Sewer Services	Orientation (101) Basic WRC (102-105) Basic Safety (108)	Wastewater Collection Systems I (210) Advanced Safety (208) Map Reading (231) Hydraulics I (227) Math II (203) English II (202)	WW Collection Systems II (310) Computers (313) Instrumentation (314) Hydraulics II (327) Math III (M303) English III (E303)	Mechanical Maintenance (415) Electrical Maintenance (416) Management/Supervision (417)
Water Services	Orientation (101) Basic WRC (102-105) Basic Safety (108)	AWWA Int. Course II (211) Advanced Safety (208) Hydraulics I (227) Math II (203) English II (202)	AWWA Water Distribution Course III (309) Computer (313) Instrumentation (314) Hydraulics II (327) Math III (M303) English III (E303)	Mechanical Maintenance (415) Electrical Maintenance (416) Management/Supervision (417)

**Note: Course numbers are given in Appendix J

Key

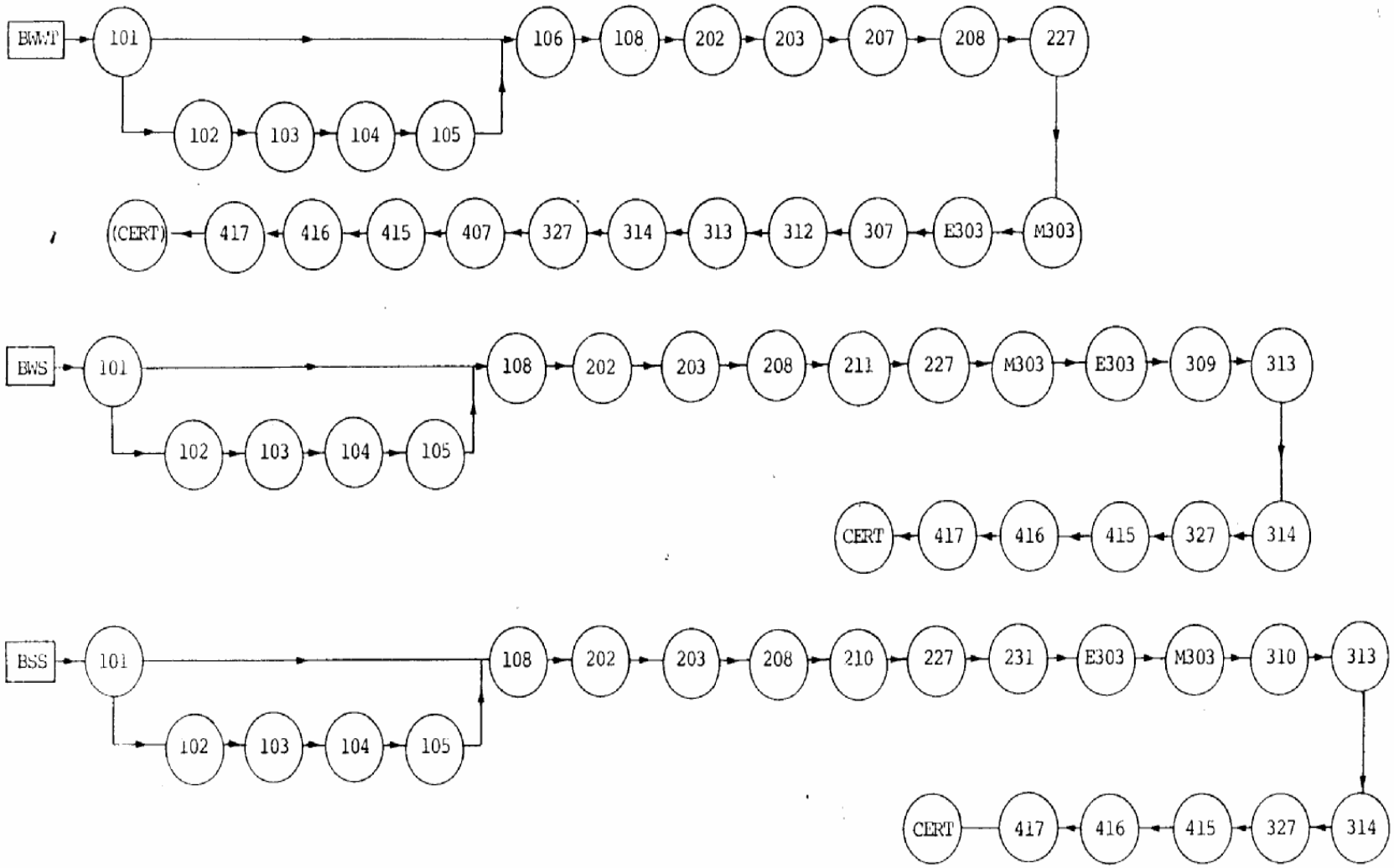
Basic WRC = Basic Water Resources Course
1. English I
2. Math I
3. Hydrology
4. Science Study Skills

AWWA = American Water Works Association
WPCF = Water Pollution Control Federation

KK = Kenneth Kerri

TABLE 12

PROPOSED COURSE SEQUENCE



Note: Course numbers are given in Appendix J

During the first year of the program, the three bureaus would generally have some identical courses already mentioned above; however, the wastewater treatment class would include the WPCF Basic Course (106). The first year would total between 186 to 218 classroom hours and 1290 hours of OJT. The second year courses would have 128 to 256 classroom hours and 1700 hours of OJT. The courses would include advanced mathematics (202) English (202). Safety (208) and Hydraulics I (227). but students in different bureaus would begin to specialize. The wastewater treatment classes would take the Ken Kerri course (207), the Sewer Services group would take map reading (231), and the water services group would be offered AWWA Intermediate Course II (211).

During the third and the fourth years the number of classroom hours would be 144 to 272 and 1700 hours of OJT, respectively. During the third year, computers (313), lab procedures(312), instrumentation (314) as well as advanced math (M 303), English composition (E 303) and Hydraulics II (327) would constitute the common courses; but the wastewater treatment group would be offered the Ken Kerri course Vol II (307), the Sewer Services Group would be offered the Wastewater Collection Systems II (310) course, and the water services group would be offered the AWWA Water Distribution Course III (309).

Finally, in the fourth year all groups from the three bureaus would be offered mechanical maintenance (415), Electrical Maintenance (416), Management and Supervision (417). These four years would have a total of 600 classroom hours and 6,400 hours of OJT. This number of hours meets the requirements set up by the D.C. Apprenticeship Council. The overall program management is summarized in table 13. Additionally, Appendix J has 500 level courses which include physics, chemistry, biology, electronics, pumps, sludge management, water quality analysis, microbiology, data analysis, etc. These are programmed for special future needs. Upon successful completion of the apprenticeship program, a journeyman's certificate would be awarded. At this point it must be clarified that the journeyman's certificate is different from the type of diploma envisaged for the certification program.

TABLE 13

PROGRAM MANAGEMENT

	YEAR 1	YEAR 2	YEAR 3	YEAR 4
Program Planning Development	→	→	→	→
Student Selection	→	→	→	→
Orientation	→	→	→	→
WRC-Basic Course	→	→	→	→
Main Course	→	→	→	—
Evaluation	→	→	→	—
Explanation:				
	o Develop Program	Same + 2nd	Same	Same
	o Select 1st yr. student	Yr. students	Students	Students
	o Orientation = DES plant description + organization, careers basic safety, etc.	Same + presentations from 2nd yr. students	Admission Instrumentation Computers	Admissi Compute
	o Basic/Preliminary Courses (E,M,H,S)	Advanced safety	Advanced safety	Basic Magn'
	o Main courses	Main courses	Main courses	Main Course
	o Evaluation			Mainte-nance
Total # of Class Hrs.	(186-218)	(128-256)	(144-272)	(144-27
Total Hrs. of OJT	1290	1700	1700	1700

GRAND TOTAL OF CLASS HOURS = 600

GRAND TOTAL OF HOURS OF OJT = 6,400

E = English H = Hydrology

M = Math S = Science Study Skills

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APPENDIX A

DES TRAINING FACILITIES

APPENDIX A

DES TRAINING FACILITIES

The DES has a media resource center at Blue Plains. The center is located on the second floor of the Primary building. Mr. Sonie Mason (Training officer) is in charge of the center and its activites. In addition to the center there is a large training room located on the same floor. This room can accommodate up to forty students. By means of a sliding partition or curtain, the room can be divided into two compartments to allow for lectures or demonstrations to take place simultaneously. The media resource center itself consists of a number of rooms, one of which is used as a classroom for instruction. This room can accommodate between fifteen ‘to twenty students at a time. Two storage rooms located on the first and second floors respectively house a large quantity of training materials ranging from books to glassware. The classrooms are fitted. With facilities such as sinks and side benches. Thus they may also be used for simple lab work. The media resource center also has a video production room with monitors, TV sets and cameras.

Training Aids

The media resource center is endowed with a large quantity of training materials. These include such items as

1) Overhead projectors
2) Video Tapes
3) Video Cassettes
4) TV Sets
5) Sony color video cameras
6) Slides and slide projectors

Some of the video tapes consist of a set of programmed instructions or modules on basic math. A partial inventory identified the following modumath series:

	1)	"Naming Whole Numbers":	Modumath	Text	1.1	23.05 min.
	2)	Multiplying Whole Numbers:	Modumath	Text	1.6	
A – 2	3)	Exponents	Modumath	Text	1.9	
	4)	Dividing Whole Nos. Part I	Modumath	Text	1.10	
	5)	Dividing Whole Nos. Part II	Modumath	Text	1.11	
	6)	Introducing Fractions	Modumath	Text	2.1	
	7)	Renaming Fractions	Modumath	Text	2.2	
	8)	Ratio and Proportion	Modumath	Text	2.8	
	9)	Percent	Modumath	Text	4.1	
	10)	Signed Numbers	Modumath	Text	5.1	
	11)	Adding Signed Nos.	Modumath	Text	5.2	
	12),	Subtracting Signed Nos.	Modumath	Text	5.3	
	13)	Multiplying Signed Nos.	Modumath	Text	5.4	

The slides deal with basic courses in wastewater operations and plant safety. Slides on the following courses are available at the center:

Wastewater Treatment Plant Operator – Basic Course

Unit	I	-	Introduction
Unit	II	-	Classes of Sewage
Unit	III	-	Natural Biological Treatment Process
Unit	IV	-	Wastewater Treatment Methods
Unit	V	-	Disinfection
Unit	VI	-	Test and Sampling
Unit	VII	-	Record Keeping
Unit	VIII	-	Maintenance and Safety

Slides on "Operation Controls" provide instruction on testing procedures for effective routine operational control of an activated sludge system.

There are also slides on Anaerobic Digestion, Dissolved Oxygen Analysis, Wastewater Chemistry, Polymer Feed Tanks and Flotation Thickening, Nitrification and Denitrification.

The slides on the Wastewater Operator Intermediate Course are on items such as:

- Clarification
- Activated Sludge
- Disinfection
  - Safety
  - Pumping

The media resource center has also produced its own tapes in such processes as:

- Primary Treatment
- Secondary Treatment
- Chlorination
- Sludge Disposal
- Chemical Laboratory
- Phosphorus Removal
- Nitrification Procedure Theory
- Nitrification Sludge Collection
- Solids Processing

Books and Other Reference Material

The Center has an assortment of books on skills training in the following areas: plant, power and pollution engineering. Most of the material was ordered around 1977 from the Technical Publishing Company (TPC) Training Systems in Barrington, Illinois. The Center has very few materials on basic English and sciences. There are also correspondence manuals (mostly from Texas and South Carolina) on wastewater programs geared towards operator certification. Other literature include programmed materials published by the DuPont Company on valves and valve systems.

The bureaus of water and sewer services have neither training programs nor the kind of facilities available at Blue Plains.

APPENDIX B

CONTACTS AND TRAINING CENTERS

AGENCIES VISITED AND CONTACT PERSONS

AGENCY	CONTACT	PHONE #
1. EPA 401 M Street, S.W. Rm. 1113C Washington, D.C.	John Samson	(202) 382-7382
2. DES 5000 Overlook Avenue, S.W. Washington, D.C.	William Johnson Director	(202) 767-8150
3. "	Wallace White Administrator, WRMA	(202) 767-7651
4. "	Sonnie Mason Training Officer	(202) 767-7369
5. "	Jim Hagen Assistant to Administrator	(202) 767-7651
6. "	Carl Johnson Bureau Chief	(202) 673-6552
7. "	H.I. Acar Deputy Chief	(202) 673-7374
8. "	Kazys A. Vasaitis Chief, Distribution Division	(202) 677-6584
9. "	James E. Dennis Chief, Meter Division	(202) 673-6577
10. "	William E. Warren Chief, Consumer Services Branch	(202) 673-6600
11. "	Otto James Chief, Investigation Branch	(202) 727-5696

12.	DES 5000 Overlook Avenue, S.W. Washington, D.C.	Pat Staten Secretary	(202) 727-5696
13.	UDC 4200 Connecticut Avenue, N.W. Washington, D.C. 20008	Georgette Hardy Director (CISC)	(202) 282-7470
14.	"	Myles Johnson Program Coordinator (CISC)	(202) 282-7790
15.	D.C. Apprenticeship Council Dept. of Employment Services 500 C Street, N.W. Rm. 241 Washington, D.C. 20001	Elizabeth G. Sarpy Director	(202) 639-1415
16.	Department of Labor Program Services Section	Cleveland Randall Specialist	

OUT-OF-TOWN AGENCIES

1.	Control Data Corporation 6003 Executive Blvd. Rockville, MD 20852	Talmadge T. Williams Marketing Specialist	(301) 468-8367
2.	Fairfax County Water Authority 8560 Arlington Blvd., P.O. Box 1500 Merrifield, VA 22116	Terry Buenzle Personnel Officer	(703) 698-5600 Ext. 270
3.	WSSC 4017 Hamilton Street Hyattsville, MD 20781	William Marlow Training	(301) 699-4000
4.	"	Bob Duddley Acting Training Officer	(301) 699-4431

5.	Back River Wastewater Treatment Plant 8201 Eastern Blvd. Baltimore, MD 21224	Gary J. Wagner Training Coordinator	(301) 288-1585
6.	State Water Quality Training Center Charles County Community College Box 910, Mitchell Road LaPlata, MD 20646	Jake Bair	(301) 934-2252 Ext. 338
7.	Arlington Public Works Water Pollution Control Plant Arlington County, VA	David P. Timbie Training Coordinator	(703) 684-6607

IMPORTANT TRAINING CENTERS/RESOURCE PERSONS

AGENCY	CONTACT	SPECIALTY	PHONE #
1. Ohio State University	Robert Howe	EPA	(614) 422-6717
2. Camp, Dresser and McKee Detroit		Remedial Program	
3. University of California Berkley	Dave Sullivan	Training Operators in the use of Computers	(415) 548-7970
4. National Environmental Training Association (NETA) 158 S. Napoleon St., Suite 102 P.O. Box 346 Valparaiso, Indiana 46383	George Kinias Executive Director		(219) 465-1744
5. Charles County Community College P.O. Box 910 LaPlata, MD 20646	William Engel		(301) 934-2251
6. EPA	Joe Bahnick	In charge of Career Opportunities	(202) 382-7912
7. Association of Boards of Certification (ABC)	Stephen Moehlmann	Operator Certification	(515) 232-3623
8. Fairfax Wastewater Treatment Plant Fairfax, VA	George Baird		(703) 550-9740
9. Environmental Training and Development Service, Texas	Debra Sober		(512) 258-7021
10. California State University Dept. of Civil Engineering	Kenneth Kerri		(916) 454-6142

APPENDIX C

PROGRAM PARTICIPANTS AND ADVISORY

APPENDIX C

PROGRAM PARTICIPANTS

LIST OF STUDENTS IN EXPERIMENTAL PROGRAM

Team A	Position	Highest Grade Completion	Bureau
1. Knight, Bridgett (Ms.)	Clerk	11	BWS
2. Dews, Phillip H.	Instrument Mechg Worker	10	BWS
3. Williams, Henry	Sewer Services Worker	12	BSS
4. Dunn, Charles Jr.	Sewer Services Worker	12	BSS
5. Johnson, James H.	Plumber	12	BSS
6. Williams, James	Sewer Services Worker	7	BSS
7. Butler, William	Plumber's Helper	12	BSS
8. Whitley, Carol (Ms.)	Clerk-Typist	Freshman College	BSS
9. Baiers, Paul F.	Instrument Mechanic	8	BWS
Team B			
10. Jennings, Jessie	Laborer	8	BWS
11. Haynesworth, Carlene	Wastewater Operator	12	BWWT
12. Jackson, Abraham	Sewage Disposal Plant Operator	10	BWW
13. Glenn,. Cora (Ms.)	Wastewater Operator	12	BWW
14. Washington, Lucille (Ms.)	Sewage Disposal Plant Operator	12	BWW
15. Mathis Howard	Plumbing Worker	10	BWWT
16. Rawl, Henry	Masonry Worker	8	BSS

BWS = Bureau of Water Services

BSS = Bureau of Sewer Services Bureau of

BWWT = Wastewater Treatment

Training Project Advisory Committee

1. Mr. Wallace White (DES)
2. Mr. Sonnie Mason (DES)
3. Mrs. Hope Etienne (DES)
4. Mr. James Hagen (DES)
5. Dr. James *Johnson*, Jr. (Howard University)
6. Mr. Santo P. Marzullo (UDC)
7. Dr. Jim Preer (UDC)

WRRC Staff

1. Dr. M. H. Watt

D. Dr. Arthur Bunyan

3. Dr. J. O'Connor
4. Mr. T.J. Karikari
5. Ms. Cora Griffiths
6. Mr. Mansour Mahbanoozadeh
7. Mr. Willie D. Marks
8. Mrs. Peggy Edler-Mack
9. Mr. William Mitchell

APPENDIX D

PILOT PROGRAM FIELD TRIPS

APPENDIX D

PILOT PROGRAM FIELD TRIPS

Field Exploration of Eastern D.C.

Objective 1: Observe the water regime in the Coastal Plain Province

2: Measure and evaluate flow in the field.

3: Study water behavior in a variety of different environments.

Depart Blue Plains: 9 a.m. via I-295 to East Capital View of the Anacostia Valley. Review the times for tides on the Anacostia today.

Stop 1: Watts Branch (East Capital at 61st Street, N.E.)

Site A: which stream is moving faster Sl, or S2? Calculate V1 = V2
Which stream (S_1 or $S_2$2) has the highest flow?
Q_1= Q_2 =
Why are the retaining walls in the location they are? Draw an energy flow diagram for this site.

Site B: Downstream bridge. calculate the discharge at this site? Q3= list the
A= and V= for this site. What would the total volume of water be for this channel if it were full and flowing at today's speed.

Site C: Bend in Watts Branch upstream. Calculate v for the beginning, middle and end of curve. Record your observations about material on both banks

On the northeast bank: what is the average diameter of 5 pieces of gravel:

Shape	1	+	w	+	h	=	T	T/3	=	Color
1										
2										
3										
4										
5										

Why is the bend in the stream here?

* Note the disappearing river as you proceed downstream near Woodson.

Stop 2: Watts Branch at 48th and Foote (old bridge) off Burroughs Avenue.

Task: Measure the flow on the east side and west side of bridge and compare values.

Measure the width o£ the bridge (stream direction) which side of the channel is the river flowing on? What % of the river bed is the river using? Which bank is the high-energy force? Calculate Q for upstream side of bridge and downstream side of bridge: What is the A total for the bridge opening.

Stop 3: Kenilworth Aquatic Gardens (N.P.S.)

What is an aquatic garden? Are these gardens: BOGS, swamps or marshes? Measure the temperature and pH (acidity - alkalinity) of the bog waters and the Anacostia waters. What tidal stage is the marsh at (time + stage)? How does the vegetation here differ from Watts Branch? Why are the green houses here an excellent transpiration laboratory?

Lunch and Potty Stop.

Stop 4: Peace Cross Flood Control Project - Anacostia Interceptor

Drive by of the old Bladensburg seaport View of the lever system
Confluence of the NE and NW branchs of the Anacostia River

Stop 5: Erosion Problems in Construction of Fort Lincoln.

View of Coastal Plain material and erosion capabilities
Impact of topography and.slope on water run off Observation of water and land use: design of .systems

Stop 6: Benning Road Power Plant (Pepco) - water siphon

Sediment sampling and turbidity measurement Calculation of tide cycle for today Temperature and pH
Calculation of channel depth and flow direction

<u>Field Exploration – Piedmont and Rock Creek in D.C.</u>

Stop 1: Confluence of Rock Creek and Potomac

Q - AV A=CxW V=dot

Time: Tide Cycle:

What history of water artifacts are still observable?

Stop 2: Taft Bridge Horse Stable

Q= A= V= S.L-.

Stop 3: Porter Street or Piney Branch Sewers (check on sewer map)

Stop 4: Pierce Mill (lunch and visit)

Calculate Flow over dam. Calculate Q for race to wheel calculate Infiltration Rate

Stop 5: Fall Zone

Q= A= V=

Describe how this area of the stream is different.

Stop 6: Sherrill Drive Gaging Station

- How does the U.S. Government monitor rivers?

Tools: D.C. Sewer Map, Washington West Topographic Map; stop watch, gold pan, meter sticks

APPENDIX H

PROPOSED GUIDELINES FOR APPRENTICESHIP

PROPOSED GUIDELINES FOR AN APPRENTICESHIP PROGRAM

1. Objectives of the Apprenticeship Program

Since the future of water and waste water facilities depends to a great degree on the training and development of their operators, the objectives of the proposed apprenticeship program would be as follows:

(a) To provide a mechanism for recruiting and developing personnel, and to retain at all times a pool of skilled personnel to minimize high turn-over rates;

(b) To implement a system for training personnel in the theoretical context and hands-on skills necessary for proper and efficient operation of water resource systems;

(c) To provide avenues for qualified apprentices and journeymen to pursue certification and ultimately college diplomas in water and waste water technology at U.D.C. or elsewhere.

2. Elements of the Apprenticeship Program

a) Entrance Requirements

Admission to the proposed apprenticeship program should be based on the following minimum requirements:

i) Age bracket (preferably between 17-26 years) with some flexibility for the upper age limits

iv) Possession of a high school diploma, GED, or equivalent diploma;

iii) Successfully pass a written aptitude test;

iv) Define special criteria to allow for the admission of existing employees into the program.

b) Program Duration

The duration of the program would be four years. Figure 4 shows the general elements of the program. A detailed list of all the courses including the sequencing is shown in tables 11 and 12.

c) Classroom Training

It is estimated that total classroom training would require 600 hours with the following breakdown:

1st year:	186 -	218 hrs.
2nd year:	128 -	256 hrs.
3rd year:	144 -	272 hrs.
4th year:	144 -	272 hrs.

The classroom courses would be taught by highly qualified and experienced instructors.

d) OJT

Total estimated on the job training (OJT) would be approximately 6400 hours with the breakdown as follows:

1st year: 1290 hours
2nd year: 1700 hours

3rd year: 1700 hours

4th year: 1700 hours

On-the-job or hands-on training would be taught by personnel selected by the WRMA in consultation with the WRRC and a duly constituted apprenticeship committee. The apprenticeship committee should include members of the D.C. Apprenticeship Council. The classroom training and on-the-job training would be articulated by the WRMA and WRRC and coordinated by the WRMA.

The theoretical courses would be prepared jointly by the WRRC and the selected instructors, while that aspect of the program dealing with on-the-job training would be prepared by personnel of the WRMA.

3. Apprenticeship for Existing Employees

All existing employees should be integrated into the program. Special criteria should be developed for employees who have no high school diploma or GED but have accumulated job experience to enter a pre-apprenticeship program. Successfully completing the pre-apprenticeship program would then enable such employees to enter the main apprenticeship program.

4. Benefits, Salary Scales, and Program Funding

These items would have to be decided by the WRMA management. However, for new apprentices, salaries and emoluments should perhaps be decided using the D.C. Apprenticeship Council guidelines.

5. Reciprocity

Reciprocity of the certificate of completion with those of other training programs should be established on the basis of their quality and comprehensiveness. Following are proposed major topics on which comparisons may be made:

- Courses of study (technical, related information content)
- Hours of study
- Processes of sewer collection, water and wastewater treatment covered
- Operational equipment (types, complexity)
- On-the-job training

6. Pre-apprenticeship Training

The long-term training program would include the training of all employees whose educational achievement needs to be improved to the level specified for admission to apprenticeship.

7. Types of positions

This proposal would recommend the identification of apprenticeable and non-apprenticeable positions of the bureaus in order to explore possibilities for other forms of training.

8. Apprenticeship Committee

In general, an apprenticeship committee embraces the performance of an apprenticeship program. Therefore, these guidelines recommend the formation of an apprenticeship committee to provide non-directive input, serve in the public interest and perform functions to which they may be designated.

9. State Apprenticeship Agencies

These guidelines point to the requirement that the State Apprenticeship Agency and Bureau of Apprenticeship and Training be contacted for registration of the apprenticeship training program and to obtain their input.

APPENDIX I

PROPOSED GUIDELINES FOR CERTIFICATION

PROPOSED GUIDELINES FOR CERTIFICATION

1. INTRODUCTION

The certification of workers has been pursued in the public interest. In the case for water distribution, wastewater treatment and sewer services, it's importance cannot be over emphasized, because certification tends to ensure adequate and uniform performance of tasks by operating personnel and reliability of products and services.

Historic trends in certification in the U.S. show that over the last decade the number of active certification programs in water supply increased from forty-two to fifty-six while the number of certified operators in the same field increased from 30,000 to 68,000. In wastewater the number of active programs increased from 49 to 61 while the number of certified operators increased from 26,000 to 74,000.

2. DEFINITION

Certification may be defined as the process of recognizing the abilities of an individual who satisfactorily performs pertinent requirements as laid down by an organization or a body. The process culminates with the award of a certificate or a license of recognition after successful completion of theoretical and practical examinations.

3. CERTIFICATION REQUIREMENTS

Suggested requirements for certification may be as follows:

i) Proof of a specific term of experience;

ii) Demonstration of applicants theoretical knowledge of the relevant processes in water distribution, water treatment, wastewater collection and wastewater treatment systems;

iii.) Demonstration of applicant's manipulative skills.

The proposed requirements for the DES are also shown.

4. FORMS OF CERTIFICATION

Certification of water and wastewater programs may fall in one of two categories:

a) Joint programs, where water and wastewater programs are administered jointly; and

b) Separate programs, where each program is administered separately.

Joint and separate programs may be administered either on a voluntary or a mandatory basis. A 1980 status report on operators certification in water and wastewater programs by the Association of the Boards of Certification (ABC) indicated that as of 1980 forty-one states had mandatory certification programs in water supply, while six states had voluntary programs. Two states had voluntary programs in water distribution while there

REQUIREMENTS

Certification Classification	
OIT*	No certification required at entry level, OIT optional
	Minimum of 1 year experience at entry level and pass the Class I exam.
	Minimum of 1 year experience at intermediate level and pass the Class II
	Minimum of two years experience at journeyman level and pass the Class
	OR
	Minimum of 2 years experience at leader level or 5 years related experience and pass the Class III exam.
	OR
	Associate Degree with 3 years experience, or Associate Degree plus 1 year additional related college level training with 2 years' experience, or Bachelor's Degree with 1 year experience and pass the Class III exam.
	Bachelors Degree with 2 years experience and pass the Class IV exam.

(* = Operator in Training)

DES GRADE STRUCTURE	CERTIFICATION CLASSIFICATION	REQUIREMENTS
WG-3	OIT*	No certification required at entry level, OIT optional.
WG5 WG7	I	Minimum of 1 year experience at entry level and pass the Class I exam.
WG9	II	Minimum of 1 year experience at intermediate level and pass the Class II exam.
WL	III	Minimum of 2 years' experience at journeyman level and pass the Class III exam. OR Minimum of 2 years' experience at leader level or 5 years' related experience and pass the Class III exam. OR
GS-11		Associate Degree with 3 years' experience, or Associate Degree plus one year additional related college level training with 2 years' experience, or Bachelor's Degree with 1 year experience and pass the Class III exam.
GS-12		Bachelor's Degree with 2 years' experience and pass the Class IV exam.

(* = Operator in .Training)

were no mandatory programs in water distribution. The total number of wastewater programs was 61. Thirty states administered joint programs for water and wastewater while 23 states administered separate programs.

5. AGENCIES

Certification programs may be operated:

1) through a certification board whose authority varies widely from an advisory role to active direction of the program;
2) by a State agency without a certification board or committee; and
3) by committees organized within the local American Water Works Association (AWWA) or the Water Pollution Control Federation (WPCF) member association.

6. THE PROPOSED DES BOARD OF CERTIFICATION

A board of Certification shall be appointed by the Mayor upon recommendations of the Department of Environmental Services. The function of the Board is to administer the certification program. The Board will consist of three members: one member who is currently certified as a wastewater operator-or who is eligible to be certified under this regulation; one member representing the Department of Environmental Services who shall be responsible for maintaining records; and one member-at-large.

Board members will serve three year terms which will be staggered so that the term of not more than one member will expire in any single year. The initial Board appointments will be one member each for one, two and three years respectively.

7. PROPOSED DES CERTIFICATION EXAMINATION GUIDELINES

The Board or its authorized designee shall prepare written examinations to be used in determining knowledge, ability and judgment of the operators.

Examinations shall be held at places and times set by the Board, with a suitable method of advance announcement made by the Board. Examinations shall be conducted at least semi-annually.

Except in such cases as the Board may decide otherwise, all examinations shall be written. All examinations will be graded by the Board, or by others designated by the Board, and the applicant notified of the outcome. Papers will not be returned to the applicant, but means will be provided to review the results with a member of the Board or the Bureau of Wastewater Treatment on request by the applicant.

Examinations are to be structured in accordance with operations of the Blue Plains Wastewater Treatment Plant.

Examinations are to address equally the wastewater treatment operations and the solids processing operations as practiced at the Blue Plains Plant. The passing grade shall be 70% with a

minimum of 50% being achieved in the section of the exam dealing with the Division in which the applicant is assigned.

8. CLASSES OF CERTIFICATION

Generally the certificates or licenses issued range from Grade D through Grade A. For states such as Texas the usual practice has been to make a grade A certificate or license permanent while grades B through D have to be renewed periodically.

9. THE NEED FOR CERTIFICATION

In the U.S. the increasing awareness of the public in the environmental movement, passage of more restrictive federal and state legislation, the increasing complexity of facilities and systems, and the desire of operation personnel to professionalize their occupation are among the forces that have driven some and other jurisdictions to establish certification programs. In short, certification is needed for the following reasons;

1) as a mechanism for selecting employees;
2) as a mechanism for promotion;
3) as an educational incentive;
4) as a mechanism to promote employee self confidence;
5) to provide the assurance of public safety by ensuring adequate and uniform performance of tasks, adherence to specifications and procedures, and reliability of products and services.

In an interview, Mr. James Hagen (Special Assistant - Engineering Liaison) of the WRMA at Blue Plains, indicated that DES is interested in certification and plans to that effect are under consideration. He indicated that any certification program by DES would be based on the agency's own special needs and circumstances. Mr. Hagan suggested that certification would provide an objective basis for judging employee promotions in addition to other considerations. It would also help define a number of things, such as the jobs operators and lab technicians or analysts would perform; perhaps the emoluments and salaries they would receive; and provision of a pool of qualified personnel from which leaders could be selected and trained to train other operators on the plant. Information on the proposed certification program regarding aspects such as examinations, the appointment of a certification board, certification requirements and classification was furnished by Mr. Hagan and is incorporated in these guidelines.

10. POSITIONS REQUIRING CERTIFICATION

The ABC Operator Certification 1980 status report indicates that at least the following personnel should be certified:

1) The Plant Superintendent or the top technical person on site, usually identified as the operator in direct responsible charge (DRC);

2) The head operator or foreman in charge of an operating shift;
3) The shift foreman;
4) Shift personnel;
5) Operating and maintenance specialists; and
6) Lab personnel.

However, lab personnel should not be made to take exams with the same course content as operators. This has been the usual practice in the past.

11. RECIPROCITY OF CERTIFICATION PROGRAMS

The increased mobility of operators, new job opportunities specifically requiring certification as a prerequisite, and greater exchange of information between operators and boards in different States and jurisdictions indicate the need for reciprocity in certification among the States. Reciprocity would allow for the transfer of equally/uniformly trained personnel.

12. RENEWAL REQUIREMENTS

The ABC status report also indicates that a majority of certification programs require a renewal of the licenses after a specific time period. The renewal may be based on criteria established by the certification body.

B. ADVISORY COMMITTEE

The role of advising and overseeing the whole certification program should be the responsibility of the Board of Certification proposed by the DES.

APPENDIX J.

PROPOSED COURSES FOR THE LONG-TERM TRAINING PROGRAM

APPENDIX J

PROPOSED COURSES FOR THE LONG-TERM TRAINING PROGRAM

101	Orientation
102,202,E303	English (I, II, III)
103,203,M303	Math (I, II, III)
104	Hydrology
105	Science.Study Skills
106	WPCF Basic Course
106A, 206, 306	WPCF Intermediate Course Vol. A, B, C
207,307, 407	KK Vol. I, II, III
108,208	Safety (I, II)
309	Water Distribution
210,310	Wastewater Collection Systems (I, II)
211	Water Sources and Transmission
227,327	Hydraulics (I, II)
231	Map Reading
312	Lab Procedures
313	Introduction to Computers
314	Instrumentation
415	Mechanical Maintenance
416	Electrical Maintenance
417	Supervision and Management
518	Sludge Management
519	Water Treatment
520	Biology
521	Physics
522	Chemistry
523	Basic Electricity
524	Basic Electronics
525	Industrial Electronics
526	Industrial Electricity 528 Pumps
529	Water Quality Analysis
530	Data Analysis
532	Microbiology

WPCF = Water Pollution Control Federation
KK = Kenneth Kerri

ORIENTATION (101)

- Training Program Organization and Goals
- The Department of Environmental Services/The Water Resources Management Administration
- Careers in Water Resources
- Historical Aspects of Water Resources Management in the District of Columbia
- Water Related Agencies and Institutions in the District of Columbia

ENGLISH FUNDAMENTALS COURSE OUTLINE

Ref. Eps, Mary, Carolyn Kirkpatrick, The Comp-Lab Exercises, Englewood Cliffs, N.J., Prentice Hall, Inc., 1980.

ENGLISHI (102)

Subject Content

o Functional Parts of Sentences

1. Recognize the complete verb and complete subject, including compounds.

2. Recognize direct objects and adjective or noun complements.

3. Write and correctly punctuate simple sentences and compound sentences composed of two simple sentences.

o The Structure of Sentences

1. Distinguish dependent from independent clauses in complex sentences.

2. Write and correctly punctuate sentences with adjective and noun clauses.

3. Write and correctly punctuate compound-complex sentences.

4. Recognize and correct fragment or run-on sentences.

o Subject-Verb Agreement

1. Distinguish singular nouns and pronouns from plural.

2. Choose correct present tense verb forms to agree with singular and plural subjects (both nouns and pronouns), especially in the third person singular.

o Verb Forms

1. Recognize and supply the forms and tenses of regular verbs and the past and past participle forms of common irregular verb.

2. Supply all forms of BE, DO, HAVE.

3. Choose and supply verb forms consistent with tense sequence in complex sentences (If..., then/ When..., then) and in longer prose passages.

o Pronoun Usage

1. Choose and supply correct pronoun forms in sentences, including sentences with comparative adverb clauses.

2. Recognize, choose, and supply correct reflexive and intensive pronoun forms and of who, both as interrogative and as relative.

3. Recognize and correct sentences and longer prose passages with pronoun shifts or with ambiguous and broad reference of pronoun to antecedent.

o Modifiers

1. Choose and supply correct form of adjective and adverb modifiers in sentences.

2. Recognize, choose, and supply adjective and adverb modifiers of all the degrees of comparison, especially of irregular and polysyllabic words.

o Mechanics and Punctuation

1. Choose and supply correct capitalization in sentences, longer prose passages, and quotations.

2. Supply correct comma and semicolon punctuation for compound or complex sentences, adjective clauses, introductory phrases or clauses, and sentences.

3. Distinguish between apostrophes of possession and contraction, especially with *pronouns.*

4. Recognize the main uses of the colon and quotation marks and supply these in longer prose passages, especially with *pronouns.*

5. Recognize the main uses of the colon and quotation marks and supply these in longer prose passages, especially lists, summaries, and dialogue.

o Reading

ENGLISH II (202)

- Writing and Proofreading

1. Write and correctly punctuate sentences of the type mentioned in objectives I-VII above.
2. Distinguish the topic sentence from other sentences in an expository prose paragraph.
3. Practice writing the following paragraph models: description, narration, process, example, cause and effect, comparison-contrast
4. Recognize and supply the most logical arrangement for sentences in an expository paragraph.
5. Recognize and supply logical paragraph divisions in a selection of expository prose with several paragraphs.
6. Practice proofreading for errors, both in exercises and. original compositions.

ENGLISH III (E 303)

- Composition

BASIC MATHEMATICS COURSE OUTLINE

MATH I (103)

1. Introduction to whole numbers
2. Whole numbers (subtraction & multiplication)
3. Whole numbers (division, exponents, word problems and solving equation)
4. Fractions (introduction to fractions, renaming fractions and addition of fractions)
5. Fractions (addition of fractions with different denominator and subtraction of fractions)

6'. Fractions (multiplication of fractions, division of fractions and ratio and proportion)

7. Decimal fractions (introduction to decimal fractions; addition and subtraction of decimal fractions)
8. Decimal fractions (rounding numbers and multiplication and division of decimal fractions)
9. Decimal fractions (changing fractions to decimals and decimals to fractions)
10. Percents (introduction to percents and various problems in percents)
11. Signed numbers (introduction to signed numbers and addition and subtraction of signed numbers)
12. Signed numbers (multiplication and division of signed numbers)
13. Negative exponents and measuring techniques
14. Unit conversions and metric system (unit conversions and introduction to the metric system)
15. Basic geometry and graphs
16. Areas (Rectangle, triangle, circle, trapezoid, paralellogram, combined shapes)
17. Perimeter
18. Volumes
19. Averages (arithmetic mean, median, mode, weighted averages)

MATH II (203)

(Ref: Johnston and Willis. 2nd Ed. Essential Algebra)

1. Exponents
2. General Rules of Exponents
3. Squares
4. Square Roots
5. Cubes
6. Cube Roots
7. Evaluating Formulas
8. Introduction to Algebraic Expressions
9. Simplifying Algebraic Expressions
10. Solving Simpell Algebraic Equations
11. Introduction to Polynomials
12. Factorization
13. Algebraic Fractions

MATH III (M 303)

(Ref: Kirkpatrick, Joanne. “Fundamental Mathematics For Water and Wastewater Treatment Plant Operators. 1973. Ann Arbor Science Publishers, Inc.)

1. Wastewater Collection
2. Preliminary Treatment
3. Primary Treatment
4. Secondary Treatment
5. Sludge Treatment and Disposal
6. Effluent Treatment and Disposal

7. Laboratory Calculations

BASIC HYDROLOGY (104)

- Precipitation & Climate

  a) USDA-SCS slide-tape on Rainfall-Runoff

  b) analysis of D.C. precipitation: by year, by month, by rank, by season

  c). % .of water in the hydrologic cycle

- Runoff = Behavior of Streams

  - analysis of weather maps for predicting D.C. weather
  - concepts and processes of streams (overheads) drainage systems and parts; channel systems and parts stream loads.
  - analysis of the Potomac Drainage Basin Map
  - math lecture and explanation of Discharge Equation: Q = Av

- Behavior of Ground Water Systems (UDC lab)

  - measurement of porosity in water-gravel column
  - briefing on processes and concepts in groundwater (hand-out)
  - How much does a plant drink? porosity - permeability calculations
  - evaporation of sea water to salt crystals demonstration lab on artesian wells, springs and head pressure
  - capturing evapo-transpiration through the greenhouse effect (model using same plants)
  - experiments with dry and wet landslides and the effects of rain, porosity and permeability

- Coastal Plain Hydrology Field Exploration

  1. Measure Q = Av in field at a variety of locations
  2. Relate vocabulary to areas in the field (parts of stream)
  3. Collect samples and analyze in lab: sediment, temperature, marsh, estuary, river, biology, geology along the Anacostia Basin
  4. Relate terrain and local history to disappearing rivers or drainage basins. (field guide)

o Fresh Water as Surface Water

- what is 1" of rain? (Handout leaflet)
- analysis of Rock Creek Discharge Records (compared to Potomac and Anacostia)
- understanding and use of flood recurrence equation (U.S.G.S. Cir 554)
R = B±l/m
- calculation of rank order and recurrence of peak floods of Rock Creek
- reading flood graphs
- review of D.C. water works form booklet by Broad Potomac's Shore: The Water and Sewarage Systems of D.C. (DES-WRMA-1979), compared to U.S.G.S. Cir. 752 lost rivers (p7)

o The Land and Ocean in D.C. over time

- reading topographic maps for slope and flow information
- activity to calculate % porosity from field data (area of a cylinder)
- The tidal cycles

o The D.C. Water Budget (UDC-Lab)

- orientation to the water balance, concepts, terms
- calculation of the water budget
- plot the graph of the D.C. water budget (handouts for the rules for calculations)

o Basic Hydraulics (UDC-Lab)

- review of water use in D.C. (U.S.G.S. cir. 1001)
- how to use graphs and why (demo)
- ways to measure and study water use (U.S.G.S. Cir. 601 I) 10-11
- collection of data from film (pg. 24)
- calculation of head, discharge, area and velocity (pg. 25)

o Piedmont Hydrology Field Exploration

1. Flow calculations for Potomac and Rock Creek

2. Measurement of trunk sewer potential flows

3. History of water at Pierce Mill Complex

4. Engineering problems along the Rock Creek Channel

5. Visit gaging stations (field guide)

Methods for Basic Hydrology Class

1. Slide-tape program
2. Physics Film Lecture
3. Overheads (streams)
4. Straight lecture
5. Slide lecture
6. Question - answer lecture
7. Problem solving lectures
8. Demonstrations
9. Team-teaching
10. Peer-group assistance

Lab and Field Methods

1. Collection of data - and analysis
2. Interpretation of data and graphs (already prepared)
3. Calculating and graphing from collected raw data
4. Use of basic lab equipment f or reading and note taking of student initiated measurements
5. Drawing and labeling of parts
6. Working individually or in teams
7. Plotting data correctly
8. Calculating conversions and recording proper units of measurements
9. Use of a calculator, equations, and tables to assist in getting the right answer
10. Ideas to know whether the answer is right or within the ball park - know where to look for an error
11. Bringing field samples back to lab for analysis

SCIENCE STUDY SKILLS (105)

- Basic First Aid
- How to be a good science student
- Time Management
- Interpretation of Scientific Information
- General laboratory instrumentation
- Blue Print Reading

BASIC COURSE FOR WASTEWATER TREATMENT PLANT OPERATORS AUDIOVISUALS (106)

o Introduction

- o Characteristics of Sewage
- o The Natural Biological Treatment Process
- o Waste Treatment Methods
- o Disinfection
- o Tests and Sampling
- o Record Keeping
- o Maintenance and Safety

Reference: Water Pollution Control Federation

INTERMEDIATE LEVEL TRAINING PROGRAM FOR WASTEWATER TREATMENT PLANT OPERATORS

AUDIOVISUAL 106A, 206, 206

VOL A

- Introduction
- The Community Wastewater System
- Pre-Treatment
- Clarification
- Activated Sludge

VOL B

Trickling Filter

- Single Thickening
- Anaerobic Digestion
- Aerobic Digestion

VOL C

- Wastewater Disinfection
- Safety
- Pumping

Reference: Water Pollution Control Federation

WASTEWATER TREATMENT (207, 307, 407)

References: K. Kerri, Sacramento Manual Also see WRRC Report #23

COURSE OUTLINE

VOLUME I, SECOND EDITION (207)

- The Treatment Plant Operator
- Why Treat Wastes?
- Wastewater Treatment Facilities
- Racks, Screens, Comminutors and Grit Removal
- Sedimentation and Flotation
- Trickling Filters
- Rotating Biological Contactors
- Activated Sludge (Package Plants and Oxidation Ditches)
- Waste Treatment Ponds
- Disinfection and Chlorination

COURSE OUTLINE

VOLUME II, SECOND EDITION (307)

Topic

Sludge Digestion and Solids Handling

- Effluent Disposal
- Plant Safety and Good Housekeeping o

Maintenance

- Laboratory Procedures and Chemistry
- Basic Arithmetic and Treatment Plant Problems
- Analysis and Presentation of Data
- Records and Report Writing

VOLUME III, SECOND EDITION (407)

- Odor Control
- Activated Sludge (Pure Oxygen and Operational Control Alternatives)
- Solids Handling and Disposal
- Solids Removal from Secondary Effluents
- Phosphorus Removal
- Wastewater Reclamation o Instrumentation o Industrial Waste Monitoring
- Industrial Waste Treatment
- Support Systems

PLANT SAFETY (108, 208)

- Making Safety Work
- Work Area Safety
- Safe Material Handling
- Tool and Equipment Safety
- Machinery Safeguards
- Electrical Safety
- Hazardous Materials and Operations
- Fire Prevention
- Understanding OSHA (Occupational Safety and Health Act of1970)

Reference: TPC Training Systems Manual

WASTEWATER COLLECTION SYSTEMS

WASTEWATER COLLECTION SYSTEM I (210)

1. The Wastewater Collection System Operator
2. Why Collection System Operation and Maintenance?
3. Wastewater Collection Systems
4. Safe Procedures
5. Inspecting and Testing Collection Systems
6. Pipeline Cleaning and Maintenance Methods

WASTEWATER COLLECTION SYSTEM II (310)

7. Underground Repair and New Construction
8. Left Stations
9. Equipment Maintenance
10. Safety Programs For Collection System Operators
11. Administration
12. Organization for System Operation and Maintenance

LABORATORY PROCEDURES (312)

- Sampling Techniques
- Tests and Measurements

    1. Measurement of pH
    2. Settling Test
    3. Measurement of Total Solids
    4. Measurement of Total Volatile Solids
    5. Measurement of Total Suspended Solids
    6. Measurement of Total Volatile Suspended Solids
    7. Measurement of Total Dissolved Solids
    8. Measurement of Total Residual Chlorine
    9. Sampling Mixed Liquor for the Dissolved Oxygen Test
    10. Dissolved Oxygen Test

11. BOD determination
12. Alkalinity Determination
13. Measurement of Volatile Acids

References: WPCF; D.C. WRRC Report #23

COURSE OUTLINE

WATER SOURCES AND TRANSMISSION (211)

- Sources and characteristics

  1. The Water Cycle
  2. Surface Water
  3. Ground Water
  4. Characteristics of Water
  5. Public Health Significance of Water Quality

- WATER USE

  1. How Water is Used
  2. Variations in Water Use

- DEVELOPING THE WATER SUPPLY

  1. Surface Water Development
  2. Ground-Water Development

- THE TRANSMISSION OF WATER

  1. Intake Structures
  2. Pipelines and Aqueducts
  3. Pipes and Couplings
  4. Valves
  5. Pumps
  6. Flow Measurement

(Reference: AWWA-A Basic/Intermediate Course for Water System Operators)

BASIC HYDRAULICS

HYDRAULICS I (227)

- Properties of Fluids
- Fluid Statistics
- Flow Concepts
- Fluid Flow Equations
- Dynamic Force in Fluids o Pumps
- Closed-Pipe Flow
- Open-Channel Flow
- Flow Measurement
    - Weirs
    - Venturi Meters
    - Parshall Flumes
    - Flow Meters

HYDRAULICS II (327)

- Hydraulic Fluids
- Strainers and Filters
- Reservoirs and Accumulators
- Hydraulic Pumps
- Piping, Tubing and Fittings
- Directional Control Vales o Pressure Control Valves
- Cylinders
- Hydraulic Motors

Ref: WRRC Report #23

TPC Training Systems

MAP READING (231)

- o Reading directions on Maps Definition of a Map.
  - The Four Principal Directions (N, S, E, W)
    - Using the Compass
    - Mariners Compass
    - Surveyons Compass
    - Azimuth Compass
    - Grids
- o Measuring Distances on Maps
  - Map Scales
    - Representative Fraction
    - Graphic Scale
    - Large Scale
    - Medium Scale
    - Small Scale
    - Coverting Scales
- o Area Study Through Maps
  - Parallels
    - Parallels North of the Equator
    - Parallels South of the Equator
    - Meridians
      - Prime Meridian
      - Greenwhich Meridian
- o Reading Physical Maps
  - Map Symbols/Legend Lines, Dots, Colors
  - Relief/Land Form Maps
    - Shaded Relief
    - Contour Lines
    - Contour Intervals
    - Choosing a Contour Interval
    - Bench Marks
    - Elevation
- o Reading Political and Economic Maps
- o Locating Places on maps

WATER DISTRIBUTION COURSE OUTLINE (309)

Reference: American Water Works Association

- Operating the Distribution System
- Pipe Installation and Maintenance
- Pumps and Pump Stations
- Motors
- Storage Tanks and Reservoirs
- Valves and Hydrants
- Meters and Services.
- Cross Connection Control
- Maps, Drawings and Plans

INTRODUCTION TO COMPUTERS (313)

- Features of a Computer
- What a Program Looks Like
- Data Types o Calculations
- Lists and Arrays
- Character Data
- Input/output
- Control Structures o Subroutines

Reference: Structured Fortran 77 Programming by Seymour V. Pollack. Boyd and Fraser Publishing Company. San Francisco

INSTRUMENTATION (314)

- Sensing Devices
- Sampling Devices
- Flow Measurement Primary Devices
- Head Measuring Devices
- Pneumatic Transmission-Systems
- Recorders and Indicators
- Elementary Calibration Procedures
- Electrical and Electronic Transmission Systems
- Control Systems For Valves and Motors
- Maintenance Records Keeping

MECHANICAL MAINTENANCE (415) or BASICS

Module	A:	Hand Tools
Module	B:	Measuring Instruments
Module	C:	General Shop Practices
Module	D:	Mechanical Print Reading

MECHANICAL EQUIPMENT MAINTENANCE

Modules 1	Rigging and Lifting
2	Mechanical Drives, Couplings, and Alignment
3	Packing and Seals
4	Bearings and Lubrication
5	Centrifugal Pumps
6	Specialized Centrifugal Pumps
7	Piping
8	Valves
9	Air Compressors
10	Boilers and Boiler Equipment
11	Coal and Ash Handling Equipment (Conveyors)
12	Diesel Engines
13	Vibration Analysis
14	Relief Valves
15	Advanced Alignment
16	Hydraulic Equipment
17	Advanced Pipefitting

Mechanical Maintenance for Water and Wastewater Plant Operators (See NETA)

ELECTRICAL MAINTENANCE (416)

Module A - AC/DC Theory (4 hrs)

Tape 1: Introduction to Electricity
Tape 2: AC/DC Circuits, Simple Print Reading
Tape 3: Magnetism and Electricity
Tape 4: 3-Phase Circuits, Motors, Transformers

Module B - Test Instruments (4 hrs)

Module C - Electrical Print Reading (2 hrs)

Module D - Safety Practices (1 hr)

Module E - Electrical Connections (4 hrs)

ELECTRICAL EQUIPMENT MAINTENANCE

Module 1: Control Equipment (6 hrs)

Module 2: Motors (5 hrs)

Module 3: Protective Relays

Module 4: Switchgear (2 hrs)

Module 5: Batteries and D.C. Equipment (2 hrs)

Module 6: Large Transformers (1 hr)

Module 7: Solid-State Devices

ITC = Industrial Training Corporation

NETA = National Environmental Training Association

Electricity for Water and Wastewater Plant operators. See NETA

or

See Electrical Maintenance Program (ITC) Electrical Maintenance Basics

SUPERVISION AND MANAGEMENT (417)

NATURE OF SUPERVISION AND MANAGEMENT

1. Significance of Work and Human Resource
2. Management Origins
3. Human Relations
4. Development and Interaction of Work Groups
5. Organization and Authority

RECRUITMENT

l. The Function of Personnel Administration
2. Recruitment and Selection Procedures
3. Testing and Interviewing

FUNCTIONAL SUPERVISION

1. Employee Induction, Orientation, and Training
2. Absenteeism, Lateness, and Turnover
3. Grievances and Discipline
4. Wage and Salary Administration
5. Administration of Employee Status Changes

MANAGEMENT COMPONENTS

1. Elements of Management
2. Communications
3. Management Development
4. Leadership
5. Evaluation and Appraisal of Performance
6. Public and Employee Relations
7. Decision Making

PRODUCTION ELEMENTS

1. Techniques of Work Measurement
2. Wage Incentives
3. Health and Safety
4. Productivity
5. Role of Unions and Labor Relations

SLUDGE MANAGEMENT (518)

- Occurrence of Sludges and Physical and Chemical Properties Relating to Processability
- Sludge Thickening
- Sludge Stabilization
- Sludge Conditioning
- Sludge De-Watering
- Sludge Reduction
- Final Disposal Processes
- Use of Chemicals in Excess Activated Sludge Processing
- Sludge Treatment By High Temperature and Pressure

Ref: EPA Manual for Sludge Treatment and Disposal EPA 62511-74-006

WATER TREATMENT (519)

Student Handbook - Modules 1-10

- Preliminary Treatment
  Aeration
- Coagulation/Flocculation
- Sedimentation
- Softening
- Filtration
- Absorption
- Fluoridation
- Stabilization
- Disinfection

(Ref: American Water Works Association)

BIOLOGY (520)

- Basic Concepts in Biology
- Characteristics of Living Things
- The Cell
- Animal Tissue
- Plant Tissue
- Diffusion and Osmosis
- How Living Things Reproduce
- How Living Things Get Food
- How Living Things Breathe
- A Taxonomy of Living Things
- Microorganisms
- Genetics – Fundamental Principles
- The Origin of Live
- Ecological Systems

(Ref: EPA – Course Guidelines for Instructors – Book 3, Wastewater Technology Program)

PHYSICS (521)

o Measurement

experimental error

Force

Properties of force

Torque

Motion

Velocity and accelleration

Newton's 2nd Law

Systems of Units

Energy Work Kinetic Energy Potential Energy Heat and the Conservation of Energy

Machines

Power and Efficiency Simple Machines Locomotion

Fluids

The Three States of Matter Pressure

Gravitational Effect on Fluids Buoyancy

Fluid Flow

Gases

Particle Density

Temperature

The Ideal Gas

The Kinetic Theory of Gases Real Gases

o Liquids

Head of Vaporization

Surface Tension

osmosis

Capillary Action

Negative Pressure

o Electricity

o Magnetism

Magnets

Currents and Magnet

Ferromagnetism Magnetic Forces Magnetic Induction

CHEMISTRY (522)

- Basic Terms in Chemistry
- The Scientific Method
- Properties of Metals
- Bonding Forces
- Chemical Compounds
- Organic Compounds
- Chemical Equations
- States of Matter
- Properties of Water and Aqueous Solutions
- Chemical Calculations
- Basic Laboratory Techniques
- Laboratory Experience

Ref: EPA Wastewater Technology Program - Book 2

I. BASIC ELECTRICITY (523)

Unit I.	Nature of Electricity and Direct Current Magnetism and
Unit II.	D-C Measuring Instruments Resistance Network
Unit III.	Analysis
Unit IV.	Inductance and Capacitance
Unit V.	Alternating Current

BASIC ELECTRICITY LAB EXPERIMENTS

Electronic Components and Their Symbols
The Schematic Diagram
Familiarization With Hand Tools Used in Electronics
Soldering Techniques
VTVM Familiarization
Resistor Color Code and Use of Ohmmeter
Dry Cells and Measurement of D-C Voltage
Direct-Current Measurement and Control of Current
Ohm's Law
The Series Circuit
Characteristics of a Parallel Circuit
Characteristics of Series-Parallel Circuits
Kirchoff's Laws For One Generator
Voltage-Divider Circuits (Unloaded)
Voltage-Divider Circuits (Loaded)
Defect Analysis by Voltage, Current, and Resistance
Nonlinear Resistors - Thermistors
Nonlinear Resistors - Varistors Characteristics of a D-C
Meter Movement Voltmeter Multipliers
Current-Meter Shunts The Series Ohmmeter Design
of a Volt-Ohm Milliammeter Use and Care of the
Vom Balanced-Bridge Circuit
Thevenin's Theorem
Norton's Theorem
Maximum Power Transfer
Oscilloscope Operation
Oscilloscope Voltage Calibration
Lissajous Patterns Characteristics of an Inductance
Inductances in Series and in Parallel
Capacitor Color Code and Testing Capacitors
RC Time Constants
Characteristics of a Capacitor

Total Capacitance of Capacitors in Series and in Parallel; The Capacitive Voltage Divider
Impedance of a Series RL Circuit
Characteristics of a Series RL Circuit
Impedance of a Series RC Circuit Characteristics of a Series RC Circuit Frequency Response of a Reactive Circuit
Characteristics of a Series RLC Circuit
Characteristics of Series-Resonant Circuits
Impedance of a Parallel RL and of a Parallel RC Circuit
Impedance of a Parallel RLC Circuit
Characteristics of Parallel Resonant Circuits
Transformer Characteristics
Phase-Shifting Networks

(Ref: Zbar P.B. Instructors Guide For Basic Electricity and Basic Electronics. 3rd Edition. McGraw-Hill Book Co.)

BASIC ELECTRONICS (524)

- Diodes
- Rectifiers and Power Supplies
- Transistor Triodes and Vacuum Tubes
- Tube and Transistor Amplifiers
- A-M Detectors, Oscillators and Signal Generators
- Other Semiconductor Devices qnd Applications

BASIC ELECTRONICS LAB

Semiconductor-Diode Characteristics
Zener-Diode Characteristics
Tunnel Diodes
Solid-State-Diode Logic Circuits
Vacuum Tubes: Diode Characteristics
The Diode Limiter
The Power Transformer
Half-Wave and Full-Wave Rectification Transformer Power Supply and Filter
Silicon and Selenium Half-Wave-Rectifier Power Supplies
The Voltage Doubler
The Bridge Rectifier Transistor Familiarization
Current Gain in Transistors
Transistor Characteristic Curves and Transistor Data
Triode-Vacuum-Tube Characteristics
The Triode As a D-C Amplifier
Characteristics of a Cathode-Ray Tube
Tube, Transistor, and Solid-State-Diode Testing
The A-C Amplifier
Triode-Tube Class A Voltage Amplifier
Cathode Bias and the Cathode Bypass Capacitor
Common-Emitter Amplifier
Common-Base Amplifier
Load-Line Analysis of a Transistor Amplifier
The Cathode-Follower and the Emitter-Follower (Grounded Collector) Amplifier
Cascaded Transistor Amplifiers Vacuum-
Tube Power Amplifier The Loudspeaker
Vacuum-Tube Phase Inverter Transistor Phase Inverter
Push-Pull Power Amplifier
Frequency Response of an Audio Amplifier

Resistance and Voltage Analysis of a Vacuum Tube Audio Amplifier
Resistance and Voltage Analysis of a Transistor Audio Amplifier
The Diode Detector and the T- R-F Receiver
The Hartley Oscillator
Transistor Phase-Shift Oscillator
Transistor Multivibrator
Transistor Sawtooth Generator
Transistor Voltage-Mode Trigger
The Silicon Controlled Rectifier
Integrated Circuits: The Linear Amplifier
Integrated Circuits: The Audio-Frequency Medium-Power Amplifier
Integrated Circuits: Resistor-Translator Logic (RTL) Circuits
Integrated Circuits: The Application or NOR logic to Multivibraton Action

Integrated Circuits: The One-Shot Multivibrator, Schmitt Trigger and Ramp-Function Generator
An Electronic System: A Transistorized cathode-Ray Oscilloscopy (CRO)

Ref: Zbar, Paul B. "Instructor's Guide for Basic Electricity and Basic Electronics." 3rd Edition. McGraw-Hill Book Co.

INDUSTRIAL ELECTRONICS (525)

Introduction
Gaseous and Vapor-filled Tubes
Control of Thyrations
Phototubes and Photoelectric Devices
Relays and-Time-delay Action
Semiconductors
Magnetic Devices
Polyphase Rectifiers and Inverters
Light and Heat Control.
Motor Control
Welding Control
R-F Heating
Miscellaneous Commercial Devices
Computers
Synchros, Selsyns, and Servomechanisms
Test Equipment Used in Industrial Electronics

INDUSTRIAL ELECTRONICS LABORATORY EXPERIMENTS

Characteristics of a Gaseous Rectifier
Thyratron Characteristics
Rectification Characteristics of a Thyratron
Phase-shift Bridge Circuit
Phase-shift Control of a Thyratron
Phase-shift and D-C Amplitude Control of a Thyratron
Control of Biphase Half-wave Thyratron Rectifier
Characteristics of Phototubes
Relays
Photoelectric Relay from an A-C Source
Timing Circuits
Time-delay Relay
Electronic Timer
Electronic Resistance-sensitive Relay
Transistor Time-delay Relay
Phototransistor as a Control Device
Characteristics of a Saturable Reactor Applicationss of a Saturable Reactor
The Peaking Transformer
Three-phase Half-wave Rectifier
Three-phase Full-wave Bridge Rectifier
D-C Shunt-motor Operation
Thyratron Control of the Speed of a D-C Motor
Automatic Control of Motor Speed
A Commercial Electronic Motor Control for Fractional-horsepower D-C Shunt Motors
Regulated Electronic Power Supplies
The Superheterodyne Receiver-Part I
The Superheterodyne Receiver-Part II

- o Radio Control System
- o Tone Signaling Control System
- o Computer Fundamentals
- o Logic Inverter
- o Binary Addition and Computer Adders o Triggers
- o Counters
- o Transistor Computer Circuits
- o The Synchro Generator and Motor
- o Differential Synchro

- The Synchro Control Transformer and Its Use in Servomechani

Ref: Zbar P.B. “Instructors Guide for Industrial Electronics.” McGraw-Hill Book Co.

INDUSTRIAL ELECTRICITY (526)

Electric Conductors

Electric Circuits

Electrical drafting

House Wiring

Magnetism and Electromagnetism

Direct-current Motors

Armature Winding

Commutators and Brushes

Direct-current Motor.Control

Direct-current Generators

Alternating Current and Induction

Single-phase Motors

Alternating-Current Motor Controls

Transformers

Making and Testing Electrical Coils

Power Wiring

Electrical Meters and Testing

Bearings and Lubrication

Ref: Adams, J.E. (1973), "Electrical Principles & Practice," 2nd ed., McGraw-Hill Book Co., Inc.

PUMPS (528)

- Operating Principles and Maintenance of Positive Displacement and Centrifugal Pumps
- Pump Selection
- Centrifugal Pumps
- Propeller and Turbine Pumps
- Rotary Pumps
- Reciprocating Pumps
- Metering Pumps
- Special Purpose Pumps
- Packing and Seals
- Pump Maintenance

Ref: TPC Training Systems Manual

COURSE OUTLINE

WATER QUALITY ANALYSIS (529)

- Drinking Water Standards
- Sample Collection, Preservation and Storage
- Use of Laboratory Equipment
- Microbiological Tests Standard Plate Count Multiple Tube Fermentation Membrane Filter

Physical/Chemical Tests Jar Test
Chlorine Demand and Residual Turbidity

pH Temperature
Hardness
Alkalinity Color
Taste and Odor
Algae Identification
Aluminum
Chloride
Copper
Fluoride
Iron
Manganese
Phosphate
Silica Sodium
Free Carbon Dioxide
Calcium Carbonate Stability
Total Dissolved Solids
Dissolved Oxygen

Ref: American Water Works Association

DATA ANALYSIS (530)

- Variation in Results
- Accuracy and Precision
- Averages
- Ranges
    - The Median
    - Ascending and Descending Order
- The Mode
- Geometric Mean
- Logarithms (common)
- Graphs
    - Kinds of Graphs
    - Normal Distribution
    - Skewed Distribution
    - Trends
    - Graphical Data Interpretation
- Variance
- Standard Deviation
- Calculating Variance
- Calculating Standard Deviation
- Percent Error

Ref : WRRC Report #23

MICROBIOLOGY (532)
Ref: EPA Wastewater Engineering Technology Program
Course Guides for Instructors - Book 3

- Types of Microorganisms
  - Procaryotes
  - Eucaryotes
- Characteristics of Microorganisms
  - Nutrition of Microorganisms
  - Autotrophs
  - Heterotrophs
  - Saprophytes
  - Parasites
- Sources of Microorganisms
  - Chemotrophs
  - Phototrophs
- Respiration of Microorganisms
  - Aerobic
  - Anaerobic
  - Facultative
- Biosynthesis in Microorganisms
  - Aerobic Oxidation of Glucose
  - Incomplete oxidation of ethyl alcohol
- Vectors of Microbiological Infection
  - Mechanical Vectors
  - Biological Vectors
- Microbiological Techniques
  - Use of Equipment
  - The Standard Plate Count
  - Culture of a Bacterium
  - The Gram-Stain Procedure I
  - solation of a Microbe
  - Coliform Tests
  - The Membrane Filtration Technique