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Computerized Monthly Wastewater Treatment Plant Reporting

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Technical Report

COMPUTERIZED MONTHLY WASTEWATER TREATMENT PLANT REPORTING

by

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Submitted to the

Massachusetts Department of Environmental Quality Engineering
Division of Water Pollution Control
S. Russell Silva, Commissioner
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FOREWORD

This report is based on Ms. Loretta Ruh's Master's Project Report. That report was completed in January 1983. Since that time we have continued work on the DTECTR program and its implementation. This additional work is described briefly in Chapter VII, "Current and Future Work (1983-1985)". A full report of the DTECTR project, including a full-fledged user's manual will be submitted at the conclusion of the current project. In the meantime we have prepared this report, even though portions of it are no longer current. Nonetheless this interim report will give readers an understanding of the purposes, philosophy, and workings of DTECTR.

The work covered by this report was supported in part by a grant from the Massachusetts Division of Water Pollution Control, Research and Development Grant No. 80-32 (1980-1983). Current work on DTECTR is also supported in part by a grant from the Massachusetts Division of Water Pollution Control, Research and Development Grant No. 83-31 (1983-1985).

CHAPTER I

INTRODUCTION

There are innumerable occupational situations where detailed accounts of routine proceedings must be completed and reported to the proper authorities. Current inventory status and process control information play a vital role in almost every functioning industry. Public utilities, including municipal wastewater treatment plants are no exception.

Each wastewater treatment plant in Massachusetts must submit a report of operational data to the appropriate regional office of the Massachusetts Division of Water Pollution Control (MDWPC) each month. These reports are used for several purposes. The MDWPC checks the effluent data for compliance with the plant's National Pollutant Discharge Elimination System (NPDES) Permit. In addition, the monthly operating reports are reviewed by MDWPC engineers to evaluate plant performance and determine the degree of plant utilization. The problem is that this type of individual attention can only be given to a few plants each month due to the number of reports which must be reviewed and the limited staff available.

The current data management system begins with tabular monthly operating reports prepared by the treatment plant operator. The Division of Water Pollution Control provides a monthly operating report form for this purpose, but many treatment plant operators prefer to use their own forms. As a result, the Western Regional office of the MDWPC receives 80 operating reports with a variety of different formats each month. Report contents vary from the 81 parameters required by the MDWPC to more elaborate forms with additional parameters and diagnostic evaluations.

After a required check of regulatory performance requirements, the most important task of the Division engineers is to "troubleshoot" treatment plants which are operating poorly. Due to budget cutbacks, staff layoffs, and an ever increasing number of permit holders, Division Engineers find they do not have time to fully process all of the report forms. There are approximately 110 municipal treatment plants in the State. In addition the MDWPC receives approximately 300 monthly reports from non-municipal dischargers. These reports contain less information than the municipal one and are not addressed here. Each report takes about an hour to review. As a result, rapid feedback on plant performance to aid treatment plants performing poorly is often not forthcoming.

Statement of Objectives

The purpose of this report is to present the results of our work to develop a readily usable, straightforward computer program to aid the Massachusetts Division of Water Pollution Control in its management of monthly reports from municipal wastewater treatment plants in the state. The program must be suitable for checking whether the plants are in compliance with their discharge permits and be able to perform simple diagnostic evaluations of treatment performance. We believe that the implementation of this program will result in a more efficient management system at decreased cost to the MDWPC.

This project report provides a detailed description of the program along with information on its usage. This report can function as a users' manual or simply provide information for future modifications of the program. The final section of the report describes current pilot implementation activities.

CHAPTER II

STATE OF THE ART IN MONTHLY PERFORMANCE REPORTING

A national survey conducted by the U.S. Environmental Protection Agency (Evans, 1979) cited improper technical guidance as the fifth most frequent cause of poor plant performance based on comprehensive evaluations of 103 treatment plants. (See Table 1.) This category included misinformation from authoritative sources including design engineers, state and federal regulatory agency personnel, equipment suppliers, operator training staff, and other plant operators. Incorrect advice from officials could result from their limited field experience, inaccurate operator reporting, or simply from a lack of good supporting data.

A similar survey by Roberts et al. (1978) cited three potential sources of monitoring data by which the performance of a treatment plant might be evaluated. One source is the data contained in plant operating reports. Another source is the sampling and analysis information maintained by state regulatory agencies. The third source is results of analyses performed on the samples collected during an on-site investigation. This survey also ranked factors contributing adversely to plant performance. Misinformation, once again, was listed as a primary concern.

Passage of the Federal Water Pollution Control Act Amendments of 1972 prompted Tinsley and Andrews (1978) to reevaluate South Carolina's method of processing monthly reports. They commented that state and federal authorities often request extraneous data and information on the operation of each wastewater treatment facility. Officials have failed to realize that extensive data collection requires both increased time and resource expenditures. Review of this data by regulatory personnel is not carried to its fullest extent simply because of the large quantities processed. Once the parameters have been reviewed for compliance and non-compliance, the data is placed in files, and generally is never accessed again. Multiple utilization of this data could result in the savings of many person-hours. They conclude that computer processing techniques utilizing only essential data would streamline the reporting system and render it more useful.

Survey of State Practices

To determine what monthly reporting methods were currently used, a telephone survey of state water pollution control agencies was conducted in the fall of 1982. Thirteen states were chosen as the most likely to have instituted some form of computerized monthly reporting because of their active concern and involvement in environmental controls. The survey results are summarized in Table 2.

The state of New Hampshire has no computerized aids for checking monthly operating report forms. A state official scans each discharge report monthly. Colorado, Illinois, Minnesota, Oregon, Washington and Massachusetts have divided their states into regions to ease the monthly reporting review process. They do not use computerized monthly reporting.

Table 1

Top Ten Causes of Poor Wastewater Treatment Plant Performance (from Evans [1979])

1. Operator application of concepts and testing to process control
2. Process control test procedures
3. Infiltration/inflow
4. Inadequate understanding of wastewater treatment
5. Improper technical guidance
6. Sludge wasting capability
7. Process control ability
8. Process flexibility
9. Ineffective O & M manual instructions
10. Aerator design

Table 2

Results of Telephone Survey of State Monthly
Wastewater Reporting Practices - November 1982

State	Computerized Form Generation?	Computerized Compliance Checking?	Computerized Performance Evaluation?	Comments
New Hampshire	no	no	no	--
Colorado	no	no	no	--
Illinois	no	no	no	--
Minnesota	no	no	no	--
Oregon	no	no	no	--
Washington	no	no	no	--
Wisconsin	yes	no	no	--
Virginia	yes	no	no	--
Texas	yes	no	no	--
Maine	no	yes	no	--
New York	no	yes	no	pending
California	no	yes	no	pilot
North Carolina	no	yes	no	--
Massachusetts	no	yes	yes	planned w/DTECTR

The Wisconsin Department of Natural Resources uses the computer to print out the required monthly forms rather than for data review. Permit information for each treatment facility has been keyed into the computer and is retrieved each month for compliance monitoring. Some information is available for design referral. Operating forms are filled out by the operator and checked for compliance by department personnel.

The Commonwealth of Virginia has adopted a computer system to print out monthly operating reports. As was the case in Wisconsin, the computer is keyed with parameters specific to each discharger. Virginia appears to do a more thorough monitoring for heavy metals and other priority pollutants. Forms completed by the operator are checked at the Virginia State Water Control Board Offices.

The Texas Department of Water Resources requires all dischargers to submit reports showing monthly averages and permit violations. If their NPDES permit requests sampling for a specific parameter, the Department also requires this data. All information is entered into the computer manually. Stored data is available for problem analysis but is not used for compliance checking.

The Department of Environmental Protection in the state of Maine has adopted a two form plan. The first sheet requires the operator to list all monthly operational parameters. Data on flow, sludge processing, secondary treatment and chlorination are required. Since the form checks for NPDES compliance, a section for analyzed parameters such as pH, temperature, BOD and suspended solids must be completed. Space is provided to give the minimum and maximum monthly values. The second form is a parameter "worksheet". The operator lists minimum, maximum and average values for a given parameter. Frequency of analysis and number of times permit levels were exceeded must also be included. This form provides valuable data on ailing treatment plants because it gives the Department of Environmental Protection a preliminary diagnosis to work from without traveling to the facility. The values from both forms are entered by hand into the computer and a monthly compliance report is printed out for all treatment plants in the state and used in the State office for reference.

New York State and California are both in the infant stages of computerized compliance monitoring. The New York State Department of Environmental Conservation is in the process of revising a previously abandoned monitoring system. Use of the program had been discontinued due to errors in the data base. Following implementation of the system, data will be entered into the computer by hand.

California's State Water Resources Control Board has recently launched a pilot program to monitor dischargers entitled "The Automated Compliance Checking System". The system is designed to test the percent removal and effluent concentration requirements against the facility's discharge permit. California has about 10,000 wastewater facilities in the state. This system is being implemented on a pilot basis with three of California's nine Regional Boards taking part. Up to this time each region had been responsible for its own facilities' compliance.

The state of North Carolina has, by far, the most extensive computer data management and review system. A consulting engineer was hired to develop the program and an engineer, a chemist, and three programmers were hired specifically to implement the system. It is expected to take three years to complete the project. In addition to compliance monitoring, the system prints out non-compliance letters, checks on lab-technician and operator certification, and prints out the latitude and longitude of the discharger. North Carolina hopes that the program will eventually identify river dischargers by their location relative to numbered dissolved oxygen monitoring stations.

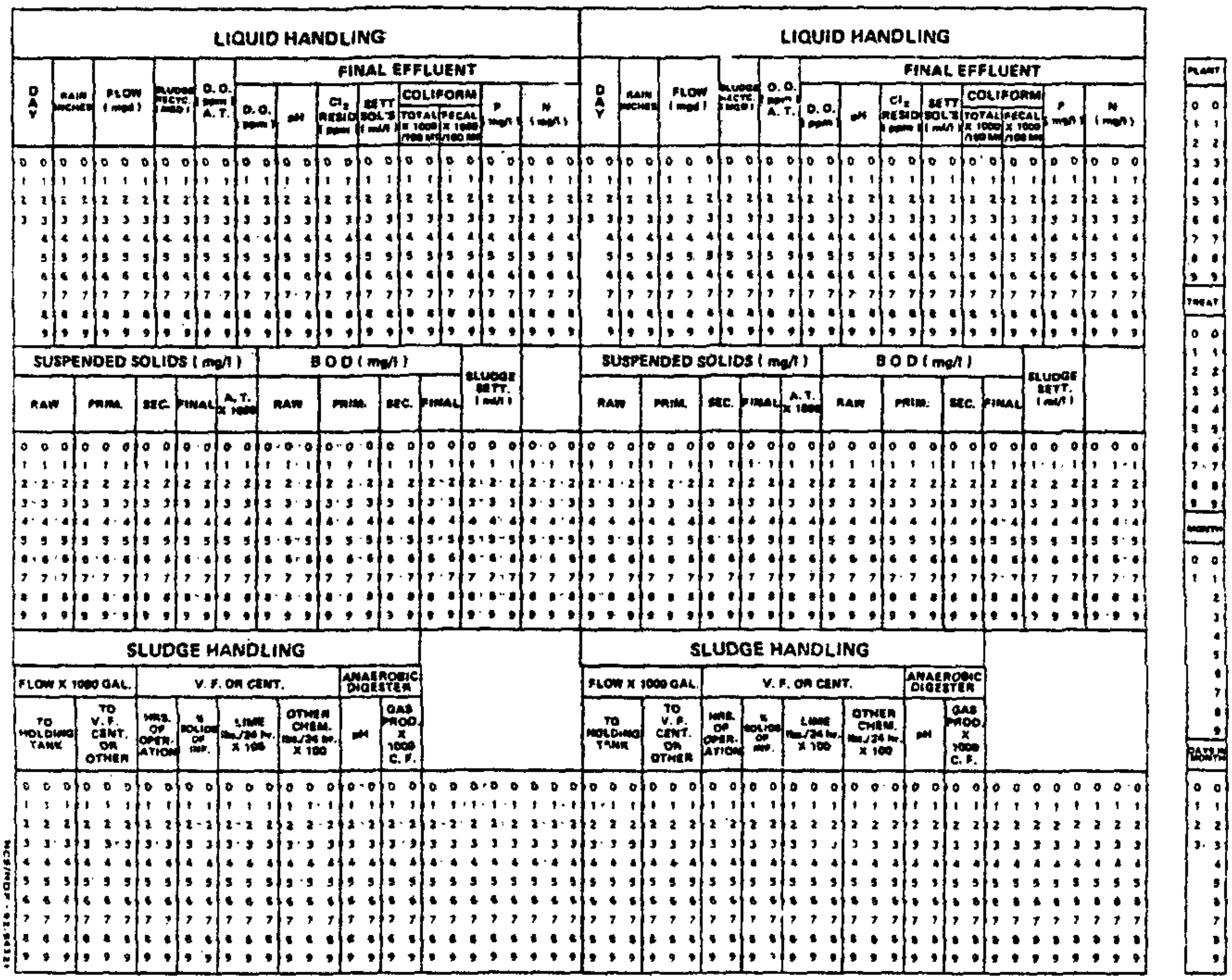
The U.S. EPA has paid little attention to computerization of monthly operating reports. A memorandum dated August 5, 1977 was sent to all EPA Regional Enforcement Directors detailing a form to be used in computerizing the monthly monitoring process. Most responses were against the implementation of such a system. Regional Enforcement Directors thought that a form of this type would be too complicated for a permittee to understand. The optical scanning form was seen as a valuable asset for some applications, but the monthly monitoring reports would not adapt easily to a computerized approach. Final evaluation of the system indicated overwhelmingly that the Agency was not ready for either the form or its related automated data entry process.

Previous Work Done at the University of Massachusetts

Research began in June 1974 by DiGiano et al. on a computer program to analyze treatment plant data ("Diagnostic Testing of Efficiency by Computerization of Treatment Reports" [DTECTR]). An optical scanning form was developed to aid data processing. A pilot scale study of implementation of the optical scanning form/DTECTR program system was conducted. Three wastewater treatment plants were involved in the study: Amherst, Massachusetts (at the time a primary treatment plant), Westfield, Massachusetts (an activated sludge plant), and Greenfield, Massachusetts (a trickling filter plant).

The old optical scanning form handled four days of data per sheet for a limited number of parameters. (See Figure 1) Two days of data were tightly fit onto each side. No decimal points were present to help the operator place significant figures. Instead of a circle response or bubble sheet, the form used fill-in bar responses. This type of optical scanning form is now obsolete and cannot be processed.

Plant operators from the treatment plants involved in the study completed the forms for processing and were then asked to comment on the format of the forms. They were also asked their opinions of the feasibility of implementing the op-scan forms system statewide. The Amherst primary treatment plant operator was not particularly impressed with the project. He thought that data tabulation with the op-scan forms was a less convenient system than the present system. The operator did comment that the optical scan data report sheet was a more convenient permanent data record. He also felt that small facilities with no ability to manipulate process parameters were not highly served by the project.



LIQUID HANDLING

DAY | RAIN INCHES | FLOW (mgd) | SLUDGE RECYC. (MGD) | D.O. ppm A.T. | FINAL EFFLUENT: D.O. ppm | pH | Cl_2 RESID (ppm) | SETT SOL'S (ml/l) | COLIFORM: TOTAL X 1000 /100 ml | FECAL X 1000 /100 ml | P mg/l | N (mg/l)

SUSPENDED SOLIDS (mg/l): RAW | PRIM. | SEC. | FINAL | A.T. X 1000

B O D (mg/l): RAW | PRIM. | SEC. | FINAL

SLUDGE SETT. (ml/l)

SLUDGE HANDLING

FLOW X 1000 GAL.: TO HOLDING TANK | TO V.F. CENT. OR OTHER

V. F. OR CENT.: HRS. OF OPERATION | % SOLIDS OF INF. | LIME lbs./24 hr. X 100 | OTHER CHEM. lbs./24 hr. X 100

ANAEROBIC DIGESTER: pH | GAS PROD. X 1000 C.F.

PLANT | TREAT | MONTH | DAYS IN MONTH

Figure 1. Original Optical Scanning Form.

The Westfield, Massachusetts treatment plant operator was more enthusiastic about the value of the project. He was convinced that the project would be a valuable tool in the administration and operation of his facility.

The Greenfield, Massachusetts treatment plant operator did not feel that the data compilation method was more convenient than that currently used. She concluded that the computer report was not extensive enough to substitute completely for their Monthly Monitoring Report. She felt that space must be provided for the operator to explain certain conditions, request assistance, etc., if the op-scan reports were to take the place of written monthly monitoring reports.

Greenfield's operator felt that the computer form was not particularly valuable for administration/operation of a small plant such as theirs because the benefits gained were outweighed by the time necessary to complete it. She did recognize the value of the program to regulatory agencies. She concluded that she would not object to participating in the program since the long range benefits for the wastewater field in general would justify the inconvenience to individual operators.

Unfortunately, the work begun in 1974 was not maintained and, as of 1981, both the program and the optical scanning form were out of date, leading to the initiation of the work described in this report.

CHAPTER III

THE DTECTR PROGRAM

The acronym DTECTR stands for Diagnostic Testing of Efficiency by Computerization of Treatment Reports. It is the name first assigned to the 1975 version of the treatment plant compliance checking program. A flowchart of the current DTECTR program is presented in Figure 2.

The flowchart pictured in Figure 2 includes the implementation of an optical scanning form for data entry. With this form, the computer is capable of transferring treatment plant data from the optical scanning sheets (as entered by the operator) directly into specific signals the computer can interpret. Use of this form eliminates the need for manual data processing.

Data entered on the optical scanning form is read and stored in four separate files. The computer also reads the number of days in the month and the total number of plants being processed.

Once data is stored in the proper files, the DTECTR program can be executed. The first of six subroutines in the program reads data for the plant being processed. The next subroutine reprints, in tabular form, parameters which are sampled daily and performs some simple diagnostic calculations. The third subroutine prints BOD and suspended solids data for the specific days such analyses were run. A table of sludge treatment parameters is printed out by the fourth subroutine. The fifth subroutine checks for and reports on NPDES permit compliance while the final subroutine graphs some design and permit parameters vs. time. The graphs are included to facilitate trend identification and spot inspections of performance.

Program Description

At the present time, the DTECTR program is stored on the VAX computer system located in the School of Engineering at the University of Massachusetts. The FORTRAN-77 version of the program is structured as a main program with six separate subroutines for data manipulation. This program structure will facilitate understanding of the program and future modification. The program is designed to be easily adaptable to most other computer systems.

Data from each treatment plant scheme is coded by three numbers: a treatment code, a sludge processing code and a treatment plant ultimate sludge disposal code. These numbers control what sections of each subroutine are applicable to each treatment facility. They are re-entered into the computer each month. There are five wastewater treatment, five sludge treatment, and seven ultimate sludge disposal options available in the program. Table 3 presents a summary of available treatment processes included in the program.

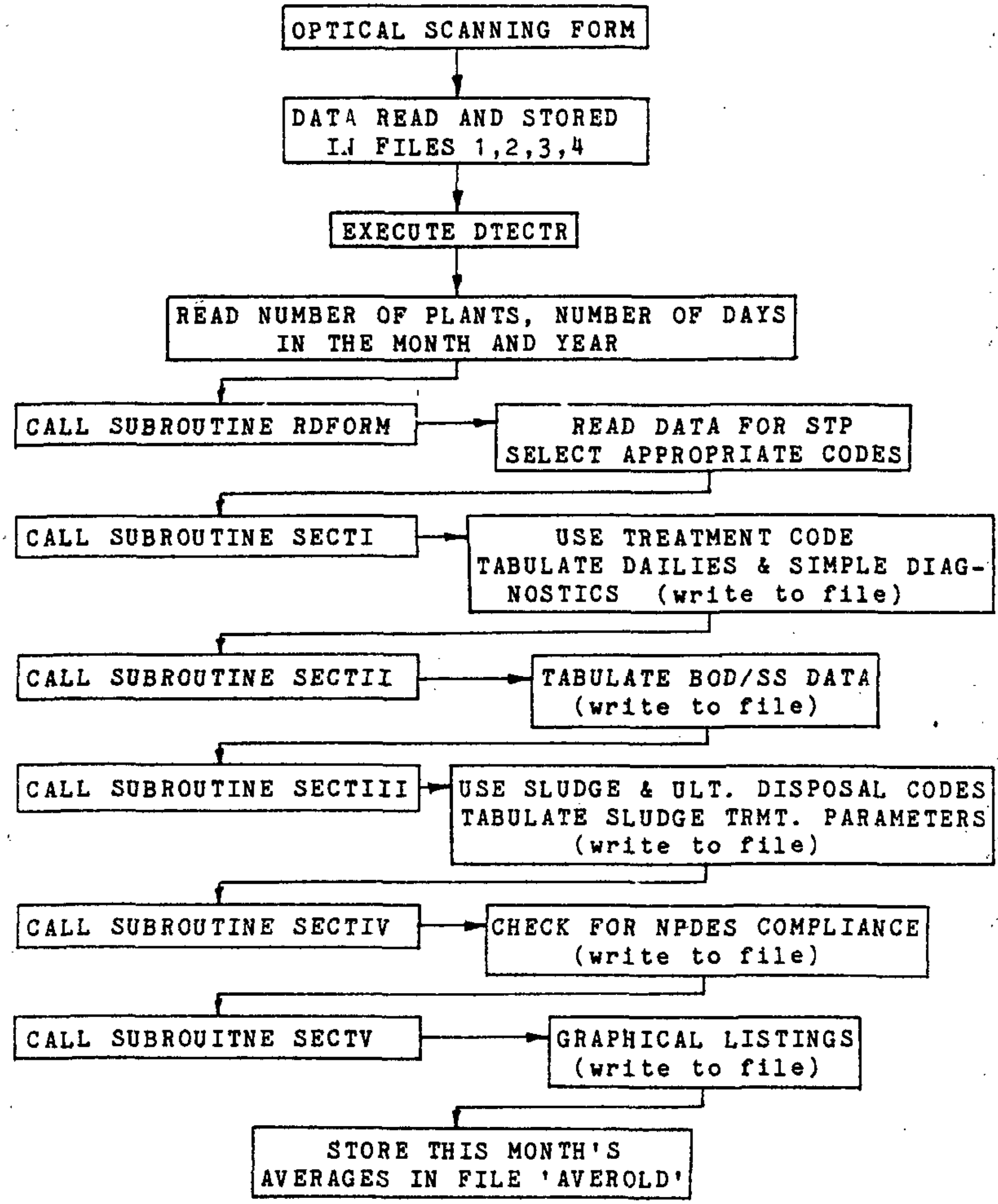


Figure 2. Idealized DTECTR Flow Diagram.

Table 3

Summary of Available Treatment Processes

WASTEWATER TREATMENT PROCESSES

- primary treatment
- activated sludge
- modified activated sludge
- trickling filter
- extended aeration

SLUDGE TREATMENT PROCESSES

- thickening, digestion and mechanical dewatering
- digestion and bed drying
- thickening and mechanical dewatering
- digestion and mechanical dewatering
- digestion

METHOD OF ULTIMATE DISPOSAL

- incineration
- landfill
- land application
- reclamation
- reuse
- ocean disposal

Description of Files

Four input files and three permanent files are called by the program for data manipulation. The first file, "date.dat", tells the computer how many plants are to be processed. This is an indication of how many iterations must be completed to process all plants. Numerical assignments are given to the month, year, and number of days in that month.

The second file, "dailies.dat", contains all values for data collected daily. The day of the month, daily rainfall, and minimum, maximum, and average wastewater flows are included in this section. Other parameters for which file space is provided for daily monitoring results are: recycle flows, dissolved oxygen, ammonia, residual chlorine, mixed liquor suspended solids, total and fecal coliform, phosphorus, nitrogen, and settleable solids. Zeros must be entered for dates on which daily data are not available in order to retain file continuity.

The third file, "BODSS.dat", first states the number of days on which BOD and suspended solids (SS) were analyzed. This number keys the computer to read influent, intermediate, and effluent BOD and SS data for the specified number of days. BOD and SS are input according to the date of the month on which tests were done.

The "sludge.dat" file contains data taken on the sludge processing operations. Information on unit flows, solids concentration, gas production (in the case of anaerobic digestion), pH, and time of operation are all included. As with the BOD and SS file, parameters are identified by the day of the month data was taken. The file is also preceeded by an integer indicating the frequency of sludge processing data collection.

The first permanent file, "limits.dat", holds any existing NPDES permit requirements for the treatment facility with space provided additionally for plant specific requirements. This file is set up so that any number not equal to the integer zero is considered a current permit value.

The final permanent permit file "averold.dat" has been created for internal use in Section V of the computer program and output: the graphing section. Using this file, the subroutine presents a graph of recent BOD and SS data. A maximum of 24 months will be displayed. When the "averold.dat" file contains 24 months of BOD and SS monthly averages, the computer drops the earliest twelve values. This provides file space for the upcoming year's data.

Description of Subroutines

The DTECTR main program consists of a series of commands calling the various subroutines. It has been written so that each subroutine creates one section of output. The five subroutines are described in the following paragraphs.

Subroutine "rdform" reads files 1 through 4. For each plant, data is read and brought up for active use. Parameters are transferred consistently throughout the program via 'common' statements to maintain their original variable name assignment.

Subroutine "SectI" produces Section I of the output: "Tabulation of Daily Operational Data." All parameters applicable to the waste treatment code given are printed out in tabular form for each day of the month. (See Figure 3) Numerical averages, or totals in the case of rainfall, are calculated and printed at the bottom of each column. The categories of treatment that can be handled by Section I include:

-primary treatment
-activated sludge
-modified activated sludge
-trickling filter
-extended aeration

It is hoped that the Section I listing can take the place of the current monthly operating report form. Section I also calculates two simple diagnostic indicators: the sludge volume index and the food/microorganism (f/m) ratio for the case where secondary treatment is activated sludge.

Subroutine "SectII" produces Section II of the output: "Daily BOD, SS Loading and Percent Removals". This section lists influent, effluent, and percent removals for BOD and suspended solids in terms of milligrams/liter and pounds/day for the days on which these tests were run. Arithmetic averages are listed at the bottom of each column. (See Figure 4.)

Section III, "Tabulation of Sludge Treatment Parameters," is keyed from subroutine "SectIII". This section lists data for days when sludge processing units were operated. Arithmetic averages are listed at the bottom of the table. (See Figure 5) Sludge treatment processes that can be handled are:

-thickening, digestion, and mechanical dewatering
-digestion and bed drying
-thickening and mechanical dewatering
-digestion and mechanical dewatering
-digestion

Generic treatment processes rather than specific treatment methods are used so that five choices might encompass as many sludge treatment schemes as possible. For a case where a treatment scheme cannot be matched to one of the five choices, zeros can be substituted for inappropriate parameters. Section III also prints out a treatment facility's method of ultimate sludge disposal. Options included in the program are:

-incineration
-landfill
-land application
-reclamation
-reuse
-ocean disposal

SECTION I :

TABULATION OF DAILY OPERATIONAL DATA

PLANT NUMBER 1 : MODIFIED ACTIVATED SLUDGE

DAY	RAINFALL (inches)	AVE. FLOW (mgd)	PEAK FLOW (mgd)	RECYC FLOW (mgd)	DO: AER TANK (mg/l)	MLSS (ml/l)	SVI (ml/g)	F/M RATIO (/days)	CHLORINE RESIDUAL (mg/l)	TOTAL COLIFORM (/100 ml)	FECAL COLIFORM (/100 ml)	PHOS (mg/l)	AMM NIT (mg/l)	NO3 NIT (mg/l)
1	0.00	3.06	4.10	0.00	0.0	2240.0	0.00	0.00	0.60	95.0	0.0	2.4	7.8	0.51
2	0.02	3.14	4.40	0.00	14.4	2235.0	0.00	0.00	1.40	0.0	0.0	0.0	0.0	0.00
3	0.06	3.10	4.40	0.00	0.0	0.0	0.00	0.00	1.30	0.0	0.0	0.0	0.0	0.00
4	0.01	3.03	4.20	0.00	0.0	0.0	0.00	0.00	0.30	0.0	0.0	0.0	0.0	0.00
5	1.14	3.54	6.80	0.00	0.0	0.0	0.00	0.00	0.40	0.0	0.0	0.0	0.0	0.00
6	0.35	3.16	4.70	0.00	0.0	2160.0	0.00	0.00	0.35	0.0	0.0	0.0	0.0	0.00
7	0.00	2.74	4.50	0.00	0.0	0.0	0.00	0.00	1.10	150.0	0.0	0.0	0.0	0.00
8	0.00	3.23	5.00	0.00	0.0	1710.0	0.00	0.00	0.87	0.0	0.0	1.8	12.6	0.00
9	0.00	3.16	4.40	0.00	31.8	1755.0	0.00	0.00	0.50	1000.0	0.0	0.0	0.0	0.00
10	0.00	3.36	4.50	0.00	0.0	1210.0	0.00	0.00	1.07	0.0	0.0	0.0	0.0	0.00
11	0.00	2.89	4.50	0.00	0.0	0.0	0.00	0.00	0.55	0.0	0.0	0.0	0.0	0.00
12	0.00	2.96	4.10	0.00	0.0	0.0	0.00	0.00	0.45	0.0	0.0	0.0	0.0	0.00
13	0.01	2.97	4.50	0.00	0.0	1620.0	0.00	0.00	0.50	0.0	0.0	0.0	0.0	0.00
14	0.00	2.13	4.40	0.00	0.0	1350.0	0.00	0.00	1.60	68.0	0.0	0.0	0.0	0.00
15	0.00	2.35	5.00	0.00	0.0	1615.0	0.00	0.00	1.80	0.0	0.0	2.4	9.5	0.29
16	0.00	2.85	4.70	0.00	0.0	1695.0	0.00	0.00	1.10	32.0	0.0	0.0	0.0	0.00
17	0.00	2.77	5.00	0.00	0.0	1410.0	0.00	0.00	1.50	0.0	0.0	0.0	0.0	0.00
18	0.00	2.46	5.00	0.00	0.0	0.0	0.00	0.00	1.10	0.0	0.0	0.0	0.0	0.00
19	0.03	2.45	4.50	0.00	0.0	0.0	0.00	0.00	1.20	0.0	0.0	0.0	0.0	0.00
20	0.28	3.30	5.00	0.00	0.0	1175.0	0.00	0.00	1.25	0.0	0.0	0.0	0.0	0.00
21	0.63	3.33	4.90	0.00	0.0	1415.0	0.00	0.00	1.45	28.0	0.0	0.0	0.0	0.00
22	0.02	2.91	4.50	0.00	0.0	1600.0	0.00	0.00	1.40	0.0	0.0	2.9	0.0	0.24
23	0.00	3.21	4.50	0.00	0.0	1635.0	0.00	0.00	0.85	170.0	0.0	0.0	0.0	0.00
24	0.00	3.07	4.50	0.00	0.0	1365.0	0.00	0.00	1.30	0.0	0.0	0.0	0.0	0.00
25	0.00	2.66	4.50	0.00	0.0	0.0	0.00	0.00	0.65	0.0	0.0	0.0	0.0	0.00
26	0.00	2.14	4.90	0.00	0.0	0.0	0.00	0.00	1.30	0.0	0.0	0.0	0.0	0.00
27	0.14	3.00	4.50	0.00	0.0	1475.0	0.00	0.00	0.60	0.0	0.0	0.0	0.0	0.00
28	0.00	2.86	5.80	0.00	0.0	1655.0	0.00	0.00	1.30	69.0	0.0	0.0	0.0	0.00
29	0.42	2.63	0.00	0.00	0.0	1735.0	0.00	0.00	1.15	0.0	0.0	4.0	15.4	0.19
30	0.00	2.96	0.00	0.00	0.0	2030.0	0.00	0.00	1.05	110.0	0.0	0.0	0.0	0.00
31	0.00	3.60	4.50	0.00	0.0	1620.0	0.00	0.00	1.10	0.0	0.0	0.0	0.0	0.00
AVE.	3.11	2.94	4.40	0.00	23.10	1652.62	0.00	0.00	1.00	191.2	0.0	2.7	11.3	0.31

Figure 3. Section I Output

SECTION II:

DAILY BOD, SS LOADINGS, AND PERCENT REMOVALS

DAY	DAILY BOD (mg/l)		DAILY SS (mg/l)		BOD LOADING (PPD)		SS LOADING (PPD)		PERCENT REMOVALS	
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	BOD	SS
1	85.50	2.80	133.30	2.30	2181.99	71.46	3401.87	71.46	.97	.98
6	91.50	6.60	101.30	6.00	2411.43	173.94	2669.70	158.13	.93	.94
8	99.00	4.50	133.30	5.10	2666.88	121.22	3590.86	145.47	.95	.96
10	73.50	2.62	105.40	9.00	2059.65	73.42	2953.56	252.20	.96	.91
13	166.50	4.30	170.70	2.50	4124.17	106.51	4228.21	61.92	.97	.99
15	114.50	3.10	138.70	5.00	2322.48	60.76	2718.38	98.00	.97	.96
17	136.50	2.50	143.50	6.50	3153.40	57.75	3315.11	150.16	.98	.95
20	162.00	6.20	153.40	7.50	4458.56	170.64	4221.87	206.42	.96	.95
22	121.50	5.30	144.00	8.50	2948.73	128.63	3494.79	206.29	.96	.94
24	108.00	4.60	130.70	1.30	2765.21	117.78	3346.42	33.28	.96	.99
27	138.00	3.20	139.40	11.30	3452.76	80.06	3487.79	282.73	.98	.92
29	118.50	2.30	145.30	2.50	2599.20	50.45	3187.04	54.84	.98	.98
31	100.50	2.40	130.70	6.50	3017.41	72.06	3924.14	195.16	.98	.95
AVE.	116.88	3.88	136.13	5.75	2935.53	98.82	3426.13	147.39	.97	.96

Figure 4. Section II Output

SECTION III:

TABULATION OF SLUDGE TREATMENT PARAMETERS

METHOD: Digestion

DAY	FLOW TO DIGESTOR (100 gal)	INFL. PERCENT SOLIDS (mg/l)	GAS PRODUCED (ft-3)	DETENTION TIME (min)	PH	VOL. SLUDGE PRODUCED (yd-3)	% SOLIDS SLUDGE
1	15.300	0.0	0.0	60	5.2	20.0	27.0
6	15.800	0.0	0.0	70	4.9	30.0	25.0
8	16.500	0.0	0.0	75	5.0	25.0	30.0
13	14.850	0.0	0.0	90	4.7	27.0	29.0
15	11.750	0.0	0.0	95	4.8	30.0	32.0
17	13.950	0.0	0.0	90	5.1	15.0	33.0
20	16.500	0.0	0.0	93	4.7	17.0	28.0
22	14.550	0.0	0.0	95	4.9	19.0	33.5
24	15.350	0.0	0.0	96	5.1	25.0	35.1
27	15.000	0.0	0.0	87	5.2	19.0	29.7
29	13.150	0.0	0.0	90	4.9	28.0	29.1
AVE.	14.782	0.0	0.0	83.	5.0	23.2	30.1

METHOD OF DISPOSAL: Incineration

Figure 5. Section III Output

Subroutine "SectIV" checks for compliance with NPDES permit requirements. Each NPDES permit parameter is printed out in the first column, the plant's monthly maximum in the second, and the permit level in the third. (See Figure 6.) The final column lists the number of times the permit was exceeded. Dates of the violations are not printed out since these are easily identified in the graphs presented in Section V and in the tabular listings of Sections I and II. Permit parameters not specified for a particular facility are shown as "0.0."

This section also compares overall plant flow to 80% of design capacity. Anything over 80% is flagged as a "violation". This is included as an indicator that problems requiring remedial action such as increased capacity needs or excessive infiltration/inflow may be occurring.

parameters included in this section are:

- -daily and monthly effluent BOD
- -daily and monthly effluent suspended solids
- -daily and monthly percent removal BOD
- -daily and monthly percent removal suspended solids
- -daily and monthly effluent phosphorus
- -daily and monthly effluent ammonia
- -daily and monthly effluent nitrate
- -daily and monthly total coliform
- -daily and monthly fecal coliform
- -daily and monthly settleable solids

Storage space has been provided in the program for two additional permit parameters as well. They are listed on the output as Other Parameter I and Other Parameter II. These parameter categories may be used on a plant specific basis where the plant operator and the DWPC agree upon the parameters to include. The program heading must read Other Parameter I and Other Parameter II since they cannot be distinguished on a plant by plant basis.

The fifth and final subroutine produces Section V of the output: "Graphical Representation of Performance Data and NPDES and Design Parameters." It gives graphical representations of important parameters. (See Figure 7.) There are five graphs in this section. The first two graphs show daily effluent BOD and SS concentrations for the current month. Data points are printed out only for days when samples were tested.

The third graph in Section V shows daily average plant flow and rainfall data as a function of time. Plant flow values can be read from the lefthand side of the graph and rainfall from the right side. Daily total rainfall amounts are represented in bar graph fashion by rising vertical sets of points for easier interpretation. This superposition is often useful in identifying the effect of infiltration/inflow.

The first three graphs are positioned one under the other so that a given day of the month can be read along the same vertical line. In all

SECTION IV :

COMPARISON OF OPERATING PERFORMANCES
WITH PERMIT AND DESIGN LIMITS

	MAXIMUM VALUE	PERMIT LEVEL	NO. TIMES PERMIT EXCEEDED
Daily BOD (mg/l)	2.40	0.00	0
Monthly BOD (mg/l)	3.88	30.00	0
Daily SS (mg/l)	6.50	0.00	0
Monthly SS (mg/l)	5.75	30.00	0
Daily Percent Removal: BOD	0.98	0.00	0
Monthly Percent Removal: BOD	0.97	0.00	0
Daily Percent Removal SS	0.98	0.00	0
Monthly Percent Removal: SS	0.96	0.00	0
Daily Effl. Phosphorus (mg/l)	4.00	0.00	0
Monthly Effl. Phosphorus (mg/l)	2.70	0.00	0
Daily Effl. Ammonia (mg/l)	15.40	0.00	0
Monthly Effl. Ammonia (mg/l)	11.33	0.00	0

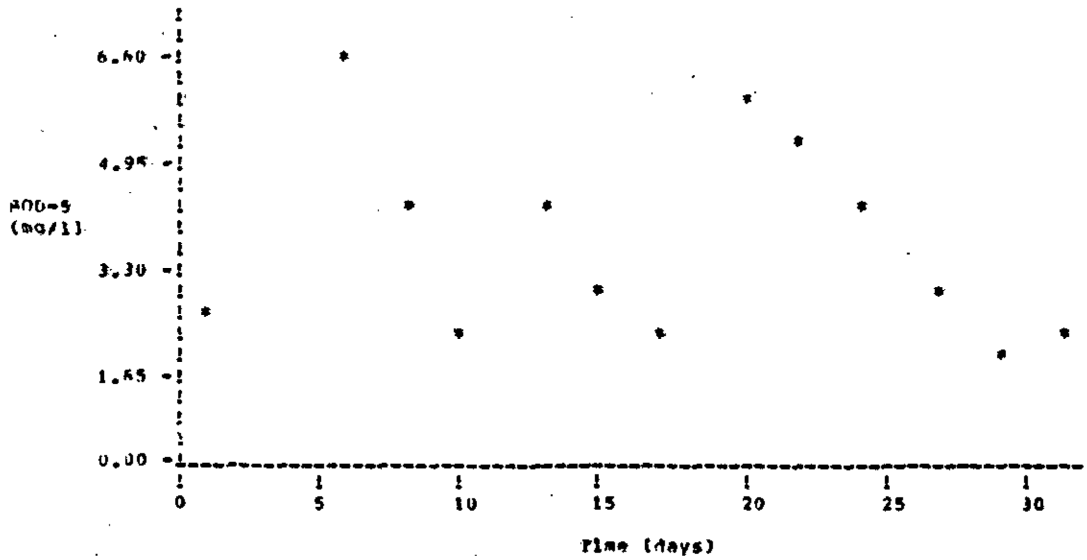
Figure 6. Section IV Output

Daily Effl. Nitrate (mg/l)	0.19	0.00	0
Monthly Effl. Nitrate (mg/l)	0.31	0.00	0
Daily Flow (mgd)	3.60	0.00	0
Monthly Design Flow (mgd)	2.94	7.00	0
Daily Total Coliform (/100 ml)	110.0	0.0	0
Monthly Total Coliform (/100 ml)	191.2	1000.0	0
Daily Fecal Coliform (/100 ml)	0.0	0.0	0
Monthly Fecal Coliform (/100 ml)	0.0	200.0	0
Daily Settleable Solids (ml/l)	0.000	0.000	0
Monthly Settleable Solids (ml/l)	0.000	0.100	0
Other Parameter I (units)	0.000	0.000	0
Monthly Other Parameter I (units)	0.000	0.000	0
Other Parameter II (units)	0.000	0.000	0
Monthly Other Parameter I (units)	0.000	0.000	0

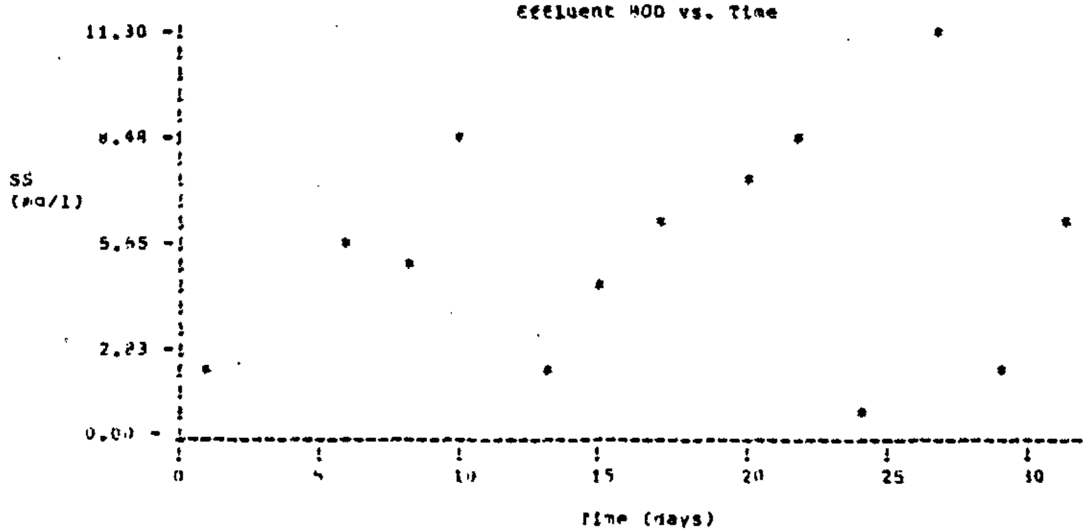
Figure 6. Section IV Output, continued

SECTION V :

GRAPHIC REPRESENTATION OF NPDES & DESIGN PARAMETERS



Effluent BOD vs. Time



Effluent SS .vs. Time

Figure 7. Section V Output

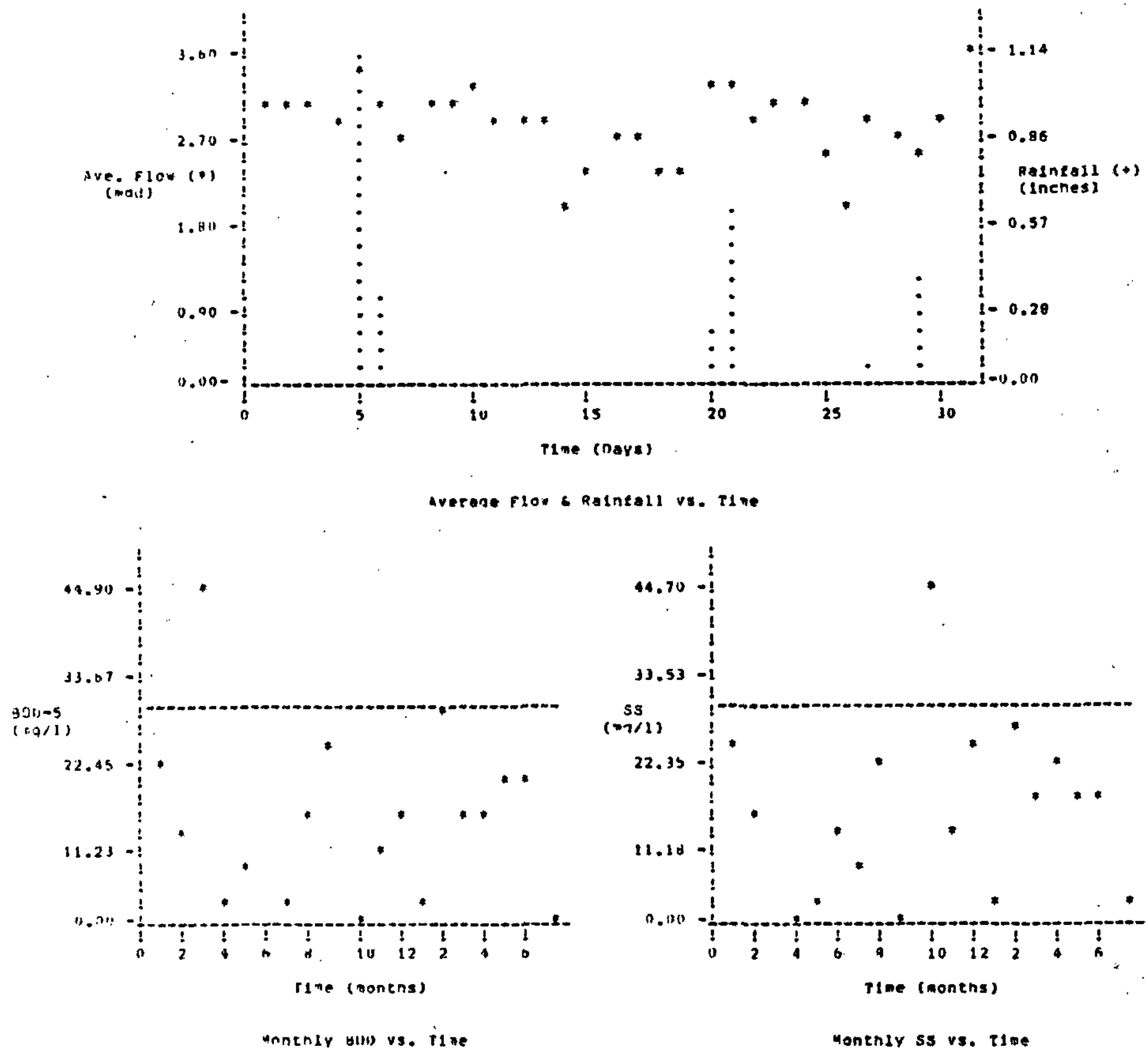


Figure 7. Section V Output, continued

three cases, the maximum value for the graph has been identified by searching for that month's maximum value. Values on the y-axis are also printed for three-fourths, one-half, and one-fourth of this monthly maximum value.

The same method was used to identify the maximum value for the fourth and fifth graphs in Section V; except that this maximum value is compared to the existing permit level. If the permit value is greater, it becomes the maximum value.

Graphs four and five use calculated average monthly BOD and SS values for the current year and the year past. At the end of every year, the previous year's data is dropped from storage to make room for the new year's data. Thus, between 13 and 24 monthly averages are shown on each graph.

Specific Discussion of Output

Figures 3 through 7 give examples of each section of printout. The format of Section II, IV, and V remain the same regardless of a change in treatment or sludge code. The printout from Sections I and III differs depending on the treatment code give.

The following parameters are included in all treatment choices for Section I:

- -day of the month
- -rainfall
- -average flow
- -peak flow
- -chlorine residual
- -total coliform
- -fecal coliform
- -effluent phosphorus
- -effluent ammonia nitrogen
- -effluent nitrate nitrogen.

The above parameters are printed out when primary treatment is coded in. Additional parameters included when a trickling filter scheme has been coded are:

- -recycle flow
- -effluent dissolved oxygen.

For conventional activated sludge, extended aeration, and modifications of activated sludge (e.g., step aeration) the following parameters are added:

- -mixed liquor suspended solids
- -sludge volume index
- -food/microorganism ratio
- -volatile suspended solids.

The Sludge Volume Index and Food to Microorganism ratio are calculated within the program. Mixed liquor suspended solids, volatile suspended solids and F/M ratio give indications of the state of the activated sludge process (e.g., microorganism age, need for detention time change). The sludge volume index indicates whether the microbial sludge is settling well enough to be properly dewatered in later treatment steps.

Additional simple diagnostics and process performance parameters could be added to DTECTR as a separate section. Currently, the primary purposes of DTECTR are to make monthly reporting and NPDES compliance checking more efficient so these diagnostics have not been included in this version.

The parameters included in Section I are similar to those required by the 1974 DTECTR Program. The Western Massachusetts Office of the State Division of Water Pollution Control and the Department of Environmental Quality Engineering were consulted and recommended no major changes. All parameters required here are already included in most individual monthly operating reports. It should be noted that file space has not been created for inclusion of effluents from each unit process since this information is not intrinsic to the monthly compliance checking process.

Since coding of specific treatment types has not been included in Section II, the computer must determine what value represents the final effluent BOD and SS concentrations. If there is no value for the BOD from tertiary treatment, the BOD from secondary treatment is considered the final effluent BOD and so on through primary wastewater treatment. Chlorination is not considered tertiary treatment.

CHAPTER IV

USE OF DTECTR

As it exists now, the DTECTR program is workable for manual data input. With the use of cards or a CRT terminal for keypunching, plant parameters can be entered into their proper files and stored indefinitely. The entire month's data from each plant must be entered together in chronological order. However, the order of plant arrangement need not be sequenced because the computer arranges them in a prespecified alphanumeric sequence. The plant number given at the beginning of Section I is another code number that can be referenced back to the name of the region or municipality where the treatment plant is located. This information is printed at the beginning of the program.

Logical abbreviations of standard names have been used for all variables, including those internal to the program, wherever possible. For example, the daily rainfall parameter is RAIN(M), with 'M' being a particular day of the month. A list of variables along with their usage in the program is included as an Appendix to this report.

Implementation Costs

The most significant implementation action would involve entering treatment plant data and NPDES permit requirements into permanent files. In addition to programming costs during implementation, there are consulting and printing fees associated with the optical scanning form.

Minimal effort would be required to put DTECTR up on the Division's computer system. This discussion assumes that the Division would have the optical scanning forms read at the University of Massachusetts, Amherst rather than purchasing its own hardware.

Once implemented, considerable cost savings will be realized by the Massachusetts Division of Water Pollution Control. An actual cost comparison between conventional compliance report review and computerized systems is not available because a full scale computerized system with an optical scanning form has not as yet been implemented. A cost comparison, including required person-hours and computer costs was arrived at in 1975 by the Western Regional Office of the MDWPC. This branch processes approximately 100 treatment plant reports per month. The costs for computerized compliance checking in 1975 figures are as follows:

Computation Costs (0.028 hr at $1000/hr)	= $ 28
Printing and Storage Costs	= 30
Person-power Costs (0.25 hr per review X 100 review X $6/hr)	= 150
Optical Scanner Rental Cost $400/month shared among three regional offices	= 133
Total Monthly Cost for DTECTR	$341

It should be noted that this cost estimate included the rental of an optical scanner and this is no longer necessary because reports are processed at the University of Massachusetts, Amherst.

Personnel at the Western Regional Office currently spend about one hour checking each treatment plant per month. At the salary rate given above, a simple calculation for 100 plants yields a monthly cost of $600. The figures indicate that the cost of using the DTECTR system is approximately half of the currently used method. In addition, person-hours are reduced and more time is available for the engineers to use these monthly report results to improve treatment plant efficiency.

Benefits of Computerized Monthly Reports

The State would benefit in many ways from changing to an automated reporting system. In time saved processing municipal reports alone, 110 person-hours can be gained per month. The substitute computer processing costs are much lower. Since computerized compliance checking decreases processing time, the efficiency of the overall review process is increased and the State will be able to respond more quickly to ailing treatment plants. Since the Regional Engineers will have more time available for performance evaluation and meetings with operators, publicly owned wastewater treatment plants will run more efficiently and unnecessary operating expenditures may be avoided.

The computer program can be expanded to include additional permit holders or expanded treatment diagnostics. Comparisons between similar treatment plant schemes could be routinely performed by the program.

Computerized reporting will probably improve the accuracy of the monthly reports. The operator may be more conscientious in preparing reports knowing that each individual parameter is checked each month for compliance. Double checking data in the reports will be easier. The computer printout scheme is set up so that gross operator errors can be detected with just a quick glance. For example, an effluent BOD of 300 (mg/1) will appear unusual when compared to the month's values ranging between 20 and 30 (mg/1). In fact the computer could be programmed to do routine statistical analyses of the data in order to identify or eliminate extraneous data points.

At the present time, there is no uniform monthly report form in Massachusetts. Furthermore, the current forms request up to 81 pieces of information each day (see Appendix I). Much more information is requested than is necessary for compliance checking. A computer printout containing only relevant information presented in tabular form would be much easier to read.

CHAPTER V

A LOOK FORWARD

Several extensions of the current DTECTR program are possible. These include: (1) optical scanning, (2) distributed data processing, (3) an expanded evaluation system, (4) non-municipal permit reporting and compliance checking, and (5) cost assessment evaluation.

Optical Scanning

Optical scanning is the process of reading information from a document using an optical mark or character reader. Common examples are score sheets for computer graded tests. The process involves changing the information on the document into specific electronic signals which can be stored on computer magnetic tapes.

Optical scanning has many advantages over the conventional means of data input. The marks entered on the scanning form are read directly by the scanner onto computer files. This eliminates a major source of error on data transcription: keypunching oversight. Data files will therefore be more accurate and the processing time will be greatly reduced. Data collection costs are reduced because only paper and pencil are required to complete the process.

The primary purpose of an optical scanning form is to translate data into information a computer can understand. A number of steps are necessary before the scanning form system can be used. First, an optical scanning form must be designed to suit both the operator and the programmer. Secondly, a computer program must be written and tested to read the data from the optical scanning form. The documents are read by the scanner and the resulting information is processed by a computer program and organized into an input file suitable for use with the DTECTR program.

At the present time, optical scanning forms utilize a bubble or response circle format. Each circle on the form corresponds to a point that can be read by a single photocell in the scanner. There are 2961 possible points on the optical scanning form. It is important that the form be designed so that space is utilized efficiently, but not to the point of clutter. The instructions must be clear and compatible with the scanner model being used.

An optical scanning form adaptable to the DTECTR Program should be arranged according to the program's input files. Wastewater treatment daily values, BOD and suspended solids data (filled in only on applicable days) and sludge treatment parameters should be placed in separate sections of the form. Separation of the daily and non-daily parameters should help minimize operator error. Also, both sides of the form should be used with 1 days' values on each side. A preliminary mock-up of an optical scanning form is presented in Figure 8.

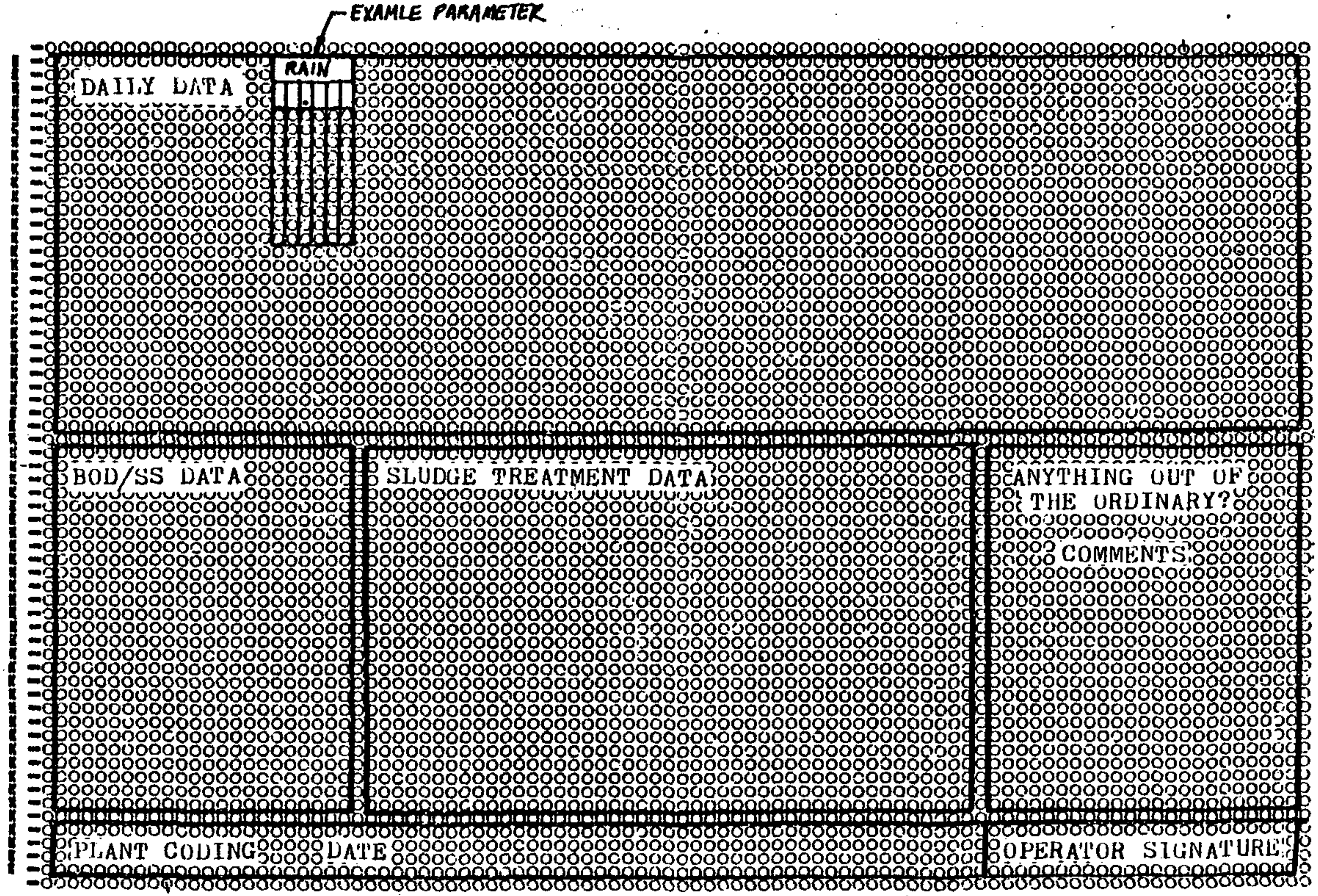


Figure 8. Revised Optical Scanning Form

Space should be provided for the operator's signature to certify that all entries have been entered correctly. A box for operator comments should also be included. Program identifier codes, plant number, treatment scheme, and sludge handling, must be entered each month for the plant. A header form might be necessary to inform the computer of information contained in file 1; the total number of plants and the number of days in the month. Since the DTECTR program will be run from a CRT terminal, this information could be entered at the time of programming by a series of interactive input commands.

Optical scanning forms are usually 8-1/2 X 11 inches in area, however, the optical scanner at the University can process optical scanning forms up to 11 X 17 inches in size. The larger size might be preferable because the additional space can be used for directions, comments and boxes in which the data values can be written above the form's "bubble" marks.

It should be noted that the minimum number of optical scanning forms printed by UMASS'S contractor, National Computer Systems, Inc. is 5,000 at a cost of approximately $87.00 per 1,000. Initial cost of the optical scanning form design is about $500.00. The designer must allow 7 weeks from the time the first draft of the form is sent in until the completed optical scanning forms are delivered.

Distributed Data Processing

We have assumed that monthly operating reports and permit compliance checking would continue to be handled by the DWPC (i e., centralized). An alternate arrangement would be to have each treatment plant prepare the monthly reports on their own micro-computer with their own DTECTR program. They could then send the computer generated reports to the DWPC each month.

A centralized system is more economical than a distributed system. Perhaps most importantly, a centralized system allows the DWPC to maintain maximum control over the reporting/compliance process.

There are also a number of disadvantages. Mistakes can be made either in completing the optical scanning forms or in keypunching data files. There is a cost involved in processing the scanning forms in operator and computer time. If the keypunch option is chosen, data processing personnel must be hired to transcribe data to files. Both choices of data transcription for a central processing system can be inconvenient because all the forms have to be present before the program is run.

Distributed monthly processing, while having a higher implementation cost, has many advantages. A small micro-computer could be equipped with a dynamic or interactive program written to ask the operator for daily data. The computer would then file this data onto a disk for storage. If required, the disk also could be sent to the State along with the program output for review each month.

The DTECTR Program could be modified to fit individual plant schemes. An "APPLE" micro-computer can have a memory capacity of up to 256,000 bytes.

As it exists now, the FORTRAN DTECTR program could be run on a micro-computer. The DTECTR program without the interactive files is contained in 58,000 bytes. The executable version of the program requires approximately 39,500 bytes and the input/output files, about 3,000 bytes. If the program is too large for a specific micro-computer, it could easily be broken down into several smaller programs and executed separately.

The operator would be able to enter more cost information into the computer for report purposes or for testing plant modification feasibility. The operator would be able to enter data into files every day instead of completing the monthly compliance report form. The main disadvantage of a distributed system, however, is the high capital cost involved in investing in micro-computers for each treatment plant. A significant investment in operator training may also be required to teach the operators to use and be comfortable with the micro-computers. On the other hand, once the operators are "computer literate", the micro-computer could be used to perform a host of other functions for the staff (automatic recording of process parameters, inventory, maintenance records, real time evaluation of plant performance, technical assistance and referencing, etc.) Substantial programming time and costs would be incurred if modified programs for each individual plant were implemented.

Expanded Evaluation System

An expanded evaluation system could be developed for plants not meeting their permit requirements. Additional subroutines would be called to describe and analyze the nature and probable cause of the non-compliance incident. The computer could determine whether the situation is unique or recurring and make recommendations to help alleviate the problem.

Non-Municipal Permit Reporting and Compliance Checking

The DTECTR program could be used to check industrial waste discharge permits. This would, of course, encompass a much larger range of permit values and diagnostics, but the basic programming ideas are the same.

Cost Assessment

The DTECTR program could be expanded to be used to compile and assess overall treatment plant operation and maintenance costs, broken down for each operating unit if desired. This would enable the MDWPC to draw comparisons between similar plants and prepare practical operational recommendations for saving time and energy.

CHAPTER VI

CONCLUSIONS

An optical scanning form for data reporting and computer program for report generation and compliance monitoring are a feasible alternative to the conventional method of monthly report checking. Benefits over the current checking method include time savings, cost reduction, increased accuracy, more complete and legible reporting, and easier interpretation of data and trends. In addition, the DTECTR computer program can be expanded to include more complicated diagnostics or cost information. This would make the time spent checking reports each month even shorter.

An optical scanning form designed with the operator in mind, once implemented, will be easy to complete each month. Operator feedback during the trial period will help minimize problems farther down the line.

As computerized technology takes on more and more filing and reporting tasks, it is inevitable that some type of computerized system be implemented to complete the monthly compliance checking of wastewater treatment plant report forms. The DTECTR/Optical Scanning form system is a practical, feasible method to meet current objectives and to provide a basis for future expansion.

CHAPTER VII

CURRENT AND FUTURE WORK (1983-1985)

It was originally proposed to continue development work on DTECTR with a pilot field implementation of the op-scan forms at the 41 publicly owned treatment works in the DWPC's Western Region. The treatment plant operators would fill in the data values on the form and then fill in a circle corresponding to the number in each column. These forms would then be read by an optical scanner at a rate of 1,500 forms per hour. This approach would be cheaper than using keypunch operators to transcribe the data, and the DTECTR system with the optical scanning forms was estimated to be 35% less expensive than the current system, when the value of engineers' time is taken into account. This cost savings to the Division is achieved at the expense of the operators, however, who must spend more time filling out the optical scanning forms and coloring the circles than they presently spend filling out the Division's monthly operating report forms. In addition, the op-scan forms system would result in a tremendous amount of paper, to be handled on an ongoing basis. Operator resentment to the additional workload would probably require special hand-holding during the implementation period.

As a result of our continued work and discussions on DTECTR, we came to believe that a system based on micro-computers in each treatment plant offered many advantages to the MDWPC.

The decentralized micro-computer approach to data entry solves many of the aforementioned problems, while retaining all of the benefits of computerized monthly operating reports, and then some. Operators would use their own micro-computers on a daily or weekly basis to enter the data into a data file maintained in the memory of their computer. This data would be input via a software program that was "user friendly". At the end of each month, the operators would use another software program, also "user friendly", to transfer one month's data to the division's computer via a telephone hook-up with a modem. The Division would then run the DTECTR program using the data file sent by the operator to generate the monthly operating report in-house. "User friendly" software is used here to mean an interactive program which guides the operator through the procedures step-by-step and is "intelligent" enough to recognize and correct operator errors. Such software would not require any special training in order to use it, and would be written interactively to allay any fears or anxieties the operators may have about having to use a computer. Full-scale implementation of this approach would require the acquisition of micro-computers for those treatment plants which do not already have them (namely most of them) although this could be phased in at a speed determined by the Division.

There are many, many benefits associated with having micro-computers in sewage treatment plants. Once available, these computers could be used for other routine tasks such as inventory, maintenance, payroll, billing, etc. A large portion of the Division's operator training programs could be built around software designed for use by the operators in their own plants at their convenience. Computer programs are available for trouble-shooting plant operations and for guiding routine operations and more will no doubt become available. A likely spin-off of the incorporation of micro-computers into their daily routine will be enhanced perceptions by the operators of themselves as professionals.

Accordingly, a scope of work covering five major work elements was agreed upon:

1. the development of software necessary for implementing DTECTR with decentralized micro-computers,

2. trial implementation of the DTECTR system at six sewage treatment plants (which already possess micro-computers),

3. continuing modification and revision of the DTECTR Program and other software and outputs from them in response to experience gained in the trial implementation and suggestions from the Division,

4. presentation and resolution of administrative, and procedural issues associated with the adoption of a full-scale decentralized DTECTR system, and

5. recommendations for a plan of action to implement the DTECTR system state-wide, including estimates of the costs involved.

These work elements are described in more detail below.

Software Development

Three major pieces of software will be developed in order to achieve the objectives of this project. First, an interactive program is being written to guide the operators in the entering of the operating data into the data file. This program is being written in a way which makes it easy for the operators to follow instructions. It will also be able to recognize when the operator has done something incorrectly. The second program, also interactive, will guide the operator through the steps necessary to transfer the monthly data file to the Division's computer via the telephone line and modem. For this project the files will be transferred to the School of Engineering VAX computer at the University of Massachusetts (where the DTECTR program is currently up and running). Modifications can be made at a later time to make the program appropriate for transferring data to a computer of the Division's choice. A third program which will be necessary is one for use by the Division to call up the individual data files and run them with DTECTR in order to generate the monthly operating reports and other outputs. It too will be interactive. A User's Manual or set of instructions will be prepared for each of these programs.

Pilot Implementation of the DTECTR System with Decentralized Micro-computers

The software described above is being field tested at six wastewater treatment plants which already have micro-computers. We are training the operators in the use of the programs. When we receive the monthly data files from them we will generate monthly reports using the DTECTR program for the months of September, October and November, 1984. This pilot implementation will allow us to de-bug the software under realistic conditions and will allow us to modify the software in response to feedback from the operators and Division personnel. The pilot implementation will also allow us to demonstrate the feasibility of this approach and will give us experience upon which to base our recommendations for full-scale implementation of the system. Since none of the sources contacted to date have been able to identify which treatment plants already have micro-computers, we are in the process of conducting a survey to obtain comprehensive, accurate information on micro-computers in Massachusetts POTW's. We are tentatively putting the software up at treatment plants in N. Andover, Adams, Southbridge, Fitchburg and Salem. Four of these are IBM PC's and the fifth is an Apple IIe. We are supplying the modem for the duration of the trial implementation.

Modify Software

The programs developed to implement the DTECTR system for monthly operating reports will undergo continuous revisions and improvements through the course of the work period. Changes may be recognized in response to operator feedback and suggestions from the Division. Improvements in the program will become apparent as we gain experience with using them. It is important to recognize that computer programs are not stagnant entities. The advantage of a computer program is that it can easily be modified to incorporate new information or to produce new results as such changes suggest themselves. One definite task to be accomplished will be the rewriting of the output sections so that a dash will appear when no data has been collected. Thus, any zeros which appear in the output will be truly values measured to be zero. We will also be rewriting DTECTR in BASIC so that it can be run on a micro-computer.

Personnel Training

We are working closely with members of the newly formed Technical Assistance Group. Several members of this group will be trained in the use of DTECTR and other software in order to form an in-house cadre to guide the ultimate full-scale implementation of the DTECTR system.

Recommendations for Implementation

After the trial implementation of the DTECTR system is completed and evaluated, we will prepare recommendations for a plan of action to implement the DTECTR system state-wide. The plan presented will include a discussion of alternatives to our recommendations, a timetable of recommended actions, and estimates of the cost involved. This recommended plan of action will be forwarded to the Division well in advance of the final report to allow the Division time to react to our recommendations and for interaction to take place before a recommended plan of action is set forth in the final report.

Institutional, Administrative and Procedural Issues

In addition to undertaking the field evaluation of the DTECTR system and preparing a recommended plan of action for full-scale implementation, there will be numerous smaller questions and issues that must be addressed in order for the DTECTR system to be successfully adopted. These will be addressed throughout the course of the work as they arise. A coordinated discussion of them will be presented in the final report. For instance:

-How does one assure operators that they have fulfilled their legal obligations to submit monthly operating reports when electronic data transmission in involved?

-Should individual sewage treatment plants be given DTECTR?

-If the Division is involved in a program to provide micro-computers to each treatment plant, should such computers be standardized?

-Should the Division's monthly operating reports be generated in a central office or in the regions where they will be reviewed?

LIST OF REFERENCES

1. DiGiano, Francis A., Roland J. DuPuis, and Peter J. Williams, "Computerized Monthly Reports; Cost-effective Alternative?", Water and Sewage Works, Dec. 1975.

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APPENDIX I: CURRENT MONTHLY REPORT FORM

MONTHLY REPORT

WASTEWATER TREATMENT PLANT

2

City or Town ______________________

Month ______________________ 19 ____

Chief Operator ______________________

Date	pH				AIR SUPPLIED (CFM)	RECIRCULATION (MGD)		MIXED LIQUOR SETTLEABILITY (ml/L)	SAND FILTERS OR LAGOONS				Date
	Raw Sewage	Primary Effluent	Mixed Liquor	Final Effluent		To Trickling Filters	Return Activated Sludge		Total Acres Dosed	Unit Numbers	Total Dose (MGD)		
	37	38	39	40	41	42	43	44	45	46	47	48	
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30													30
31													31
TOTAL													
MEDIAN													

Date	5 DAY BOD (mg/L)									SUSPENDED SOLIDS (mg/L)									
										Raw		Effluent			Aeration Tank			Aerated Digester	
	Raw 49	Primary Effluent 50	% Removed 51	Secondary Effluent 52	% Removed 53	Final Effluent 54	% Removed 55	Downstream 56	Upstream 57	Total 58	Volatile 59	Primary Total 60	Secondary Total 61	Final Total 62	Total 63	Volatile 64	Return Sludge Total 65	Total 66	Volatile 67

Date	RAW SLUDGE		DIGESTER SLUDGE					SLUDGE BEDS				MPN or MF per 100 ml							
	Total Solids % 68	Volatile Solids % 69	pH 70	Alkalinity (mg/L) 71	Volatile Acids (mg/L) 72	Total Solids % 73	Volatile Solids % 74	Date Drawn 75	Volume (gal.) 76	Date Removed 77	Volume (cu. yds.) 78	Final Effluent 79	Downstream 80	Upstream 81	82	83	84	85	86

*Multiply Value By 1000

PLANT PERSONNEL

87

Name	Title	Class

88 **PLANT DESIGN DATA**

Type	Present Average Flow MGD
Design Capacity MGD	Population Served

89. COMPOSITE SAMPLE INFORMATION

1) Composite from ______ to ______

2) Number of samples in composite ______

3) Interval between samples ______

4) Composite made up from:

Samples of equal volume ☐ Proportion to flow ☐

90 GENERAL COMMENTS (Operating Problems or Assistance Desired)

'G' = Grab Samples (Note All other samples will be composited)

7200-2-78 Massachusetts Water Resources Commission / Division of Water Pollution Control

Date	DISSOLVED OXYGEN mg/L						SLUDGE														Date
										pH			Gas		Vacuum Filter or Centrifuge						
																	Chemicals		Filter Cake		
	Raw 17	Aeration Tank 18	Secondary Effluent 19	Final Effluent 20	Downstream 21	Upstream 22	Sludge to Digester (1000 gals) 23	Excess Activated Sludge (gals) 24	Digester Temp (°F) 25	Digester Sludge 26	Overflow to Primary Tank 27	Supernatant Wasted (1000 gals) 28	Produced (1000 cu ft) 29	Used (1000 cu ft) 30	1000 Gallons 31	% Solids 32	lbs./24 hrs 33	lbs./24 hrs 34	lbs./24 hrs 35	% Solids 36	
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TOTAL																					
MEDIAN																					

Please forward this report to the Regional Engineer at the address above by the 10th of each following month.

7200-2-78

MONTHLY REPORT

WASTEWATER TREATMENT PLANT

City or Town ____________________

Month ____________________ 19 ______

Chief Operator ____________________

Date	WEATHER		SEWAGE						CHLORINATION				SETTLEABLE SOLIDS ml/L				Date
				Flow (MGD)					Pre		Post						
	Rainfall (in.) 1	Temp °F 2	Temp. °F 3	Maximum 4	Minimum 5	Total 6	Bypass 7	Grit & Screening (cu. ft.) 8	Dosage lbs./24 hrs 9	Residual (mg/L) 10	Dosage lbs./24 hrs 11	Residual (mg/L) 12	Raw 13	Primary Effluent 14	Secondary Effluent 15	Final Effluent 16	
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TOTAL				Maximum	Minimum												
MEDIAN																	