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MANAGER'S GUIDE

TO STORET

U.S. Environmental Protection Agency
Washington, D.C. 20460

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PROLOGUE

The Manager's Guide to STORET identifies applications of EPA's STORET system to the requirements of the water quality management program. It is intended to help the water quality manager to reduce time-consuming and manpower-intensive manipulations of raw data and to simplify preparation of reports and graphics.

The Guide describes data analysis techniques applicable to programs initiated under the Federal Water Pollution Control Act, as amended, with emphasis on Section 305(b). Many of the techniques described will also be applicable to programs initiated under the Toxic Substances Control Act (TSCA) and the Resource Conservation and Recovery Act (RCRA) and to the functions of the Office of Drinking Water and the Office of Solid Waste.

Separate chapters of the Guide are devoted to:

- Monitoring Programs
- Existing Water Quality and Historical Trends
- Pollution Sources and Control Programs
- Biological Monitoring
- Lake Water Quality

Each chapter begins with a brief narrative that provides background information and describes general STORET applications to water quality management problems. Following the narrative are individual descriptions of specific STORET data analysis techniques, including example outputs. A glossary of technical terms used throughout the Guide is appended, as are a bibliography and a listing of information sources pertinent to water quality data analysis.

Throughout the Guide, the technical perspective is that of the manager. No previous experience with STORET is assumed and no attempt is made to explain specific system language or syntax. Summary information on specific data analysis techniques is included to facilitate communication between managers and their analysts. For those who require more detailed information, cross-references are provided to the STORET User Handbook.

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INTRODUCTION

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INTRODUCTION

WHAT IS STORET?

STORET is a computerized data base utility maintained by EPA for the STOrage and RETrieval of parametric data pertaining to the quality of the waterways within and contiguous to the United States. Since its inception in the early 1960s, the original data base has evolved into a comprehensive system, capable of performing a broad range of reporting, statistical analysis and graphics functions, while continuing to serve in its original role as a repository of parametric water quality data. STORET is accessed by hundreds of users, utilizing computer terminals located throughout the country.

The system is comprised of several individual but related files, which contain various types of information, including:

- Geographic and other descriptive data about the sites where water quality data have been collected, referred to in STORET as "station" data
- Data related to the physical characteristics and chemical constituents of the water, fish tissue, or sediment sampled, referred to in STORET as "parametric" data
- Information on municipal waste sources and disposal systems
- Data on pollution-caused fish kills, and
- Daily stream flow data.

The data contained in STORET are collected, stored, and used by a variety of Federal, State, and local government agencies and their contractors, as depicted in Figure 1-1. Data and retrieval requests are usually entered at computer terminals, and users have the option of routing job output either to their own keyboard terminals or to a remote printer (the central printer or another specified remote printer). Output from the central printer is sent to the user through the mails. It is also possible to place job output on cards or microfilm and to store output on tape or disk.

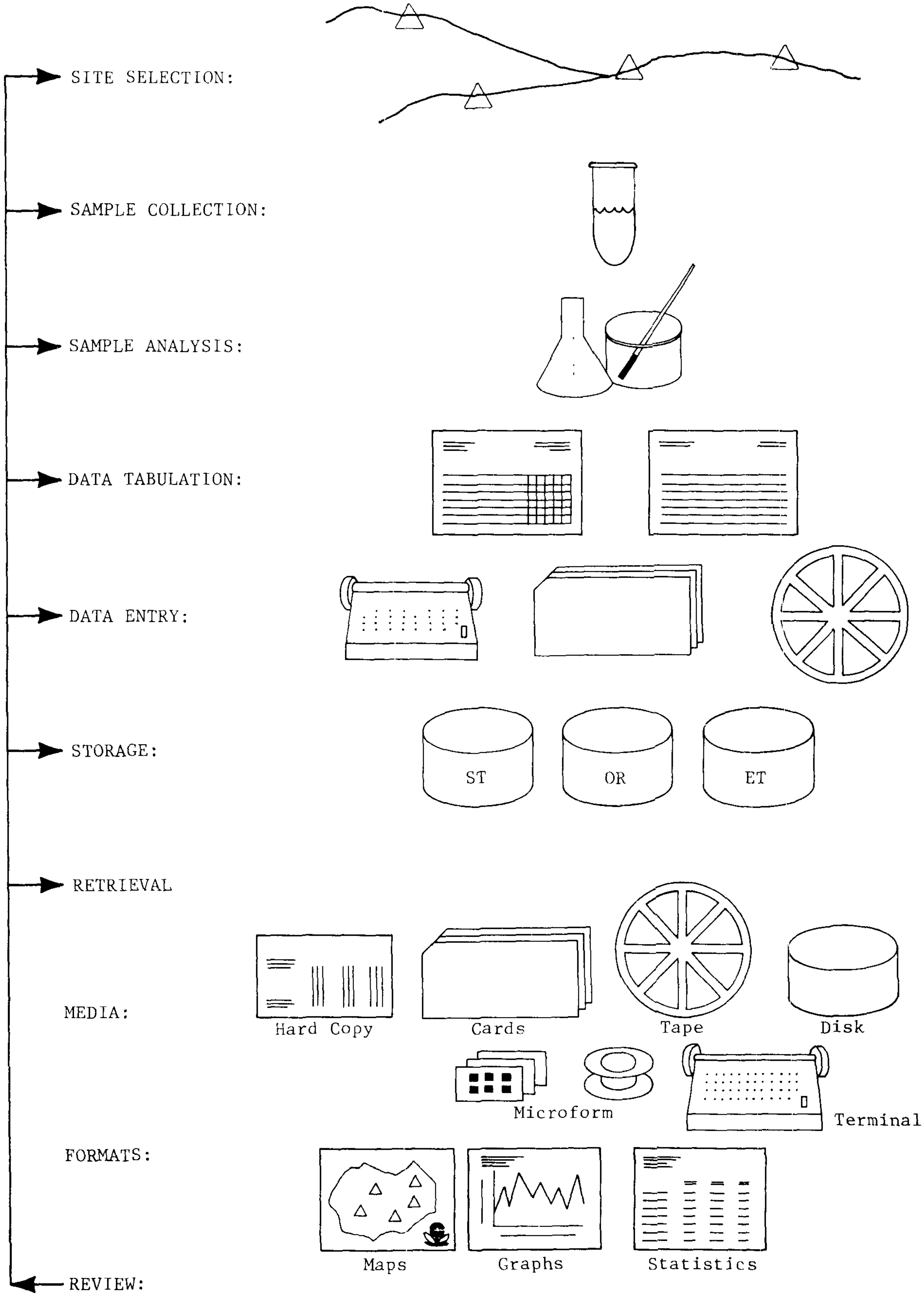

FIGURE 1-1
FROM DATA TO INFORMATION

PRACTICAL APPLICATIONS

When used efficiently, STORET's data analysis capabilities can greatly simplify the job of the water quality manager. Knowledgeable selection of data and output formats can help the manager fulfill reporting requirements and expedite decision-making processes. Among other things, STORET data can be used to:

- Fulfill 305(b) reporting requirements
- Update State and area-wide water quality management plans
- Provide background information for research studies
- Summarize compliance with standards and criteria
- Assess the availability of data on priority pollutants
- Evaluate the effectiveness of water pollution control programs, and
- Check on NPDES permit compliance.

The user must realize, however, that the data in STORET are only as useful as the monitoring plans that were used to collect these data. There may not be enough information available to answer every water quality question.

HOW DOES STORET WORK?

To store, retrieve, summarize and display STORET data, analysts make use of a collection of customized computer programs and keywords. Because the Water Quality File (WQF) is the largest and most widely used of the STORET files, its programs are generally the most flexible and the most sophisticated.

Using appropriate combinations of keywords, the user can easily determine what data are available in the Water Quality File to answer a given question. Flexible retrieval routines permit the user to restrict the data retrieved according to:

- Geographic area
- Type of collection site (stream, lake, groundwater, etc.)
- Time period
- Depth, and/or
- Parametric values.

If sufficient data are present, the user has a choice of formats in which to summarize and display the information. Output format is controlled by specifying the WQF program to be used. Alternative outputs include:

- Tabulations of raw parametric data, for specified parameters or for all parameters sampled at selected stations
- Listings of sampling station information
- Statistical summaries of parametric data
- Graphical plots of variations in parametric values over time or along a waterway
- Location maps of specified geographic areas showing sampling station locations
- Summaries of parametric values in violation of standards
- Contour, area-shaded, or trend maps showing variations in parametric values over a specified geographic area
- Linear regression plots and statistical calculations showing relationships between specified variables
- 80-column punched cards containing station codes and parametric data, and
- A disk or magnetic tape containing STORET data that have been reformatted to be compatible with other programs.

Program-specific keywords allow the user to further manipulate the output format in terms of scale, statistical functions, plotting symbols, and other variables. There are also program-specific keywords that limit the data retrieved to values meeting other user-specified criteria.

ARE STORET DATA RELIABLE?

STORET data are collected and entered into the system by a multitude of Federal, State, and local government agencies and their contractors, often over lengthy historical periods. To a large extent, the reliability of the data is dependent on the level of care employed by those agencies in the processes of sampling, laboratory analysis, and data entry. EPA has little, if any, control over those processes.

However, recognizing that the usefulness of the system hinges on the reliability of its data, the Agency has taken steps to enhance the data entry procedure such that only high quality data will be entered into STORET:

For the 187 most frequently used parameter codes, each value is automatically checked at the time of data entry against preestablished highest-acceptable and lowest-acceptable values for that parameter; values that fall outside those limits will not be stored without the use of an override code.

Agencies may supply their own upper and/or lower limits -- these user-supplied edit checks can be input at the time of data entry, or can be stored at individual stations or at special cross-reference stations.

Extreme values that may bias a statistical summary may be eliminated from a user's retrieval through the use of program-specific keywords that can establish maximum or minimum values for the parameters to be retrieved.

To clarify the circumstances surrounding sampling or analysis procedures, users may store an alphabetic "remark code" with any parameter value. (Remark codes may indicate, for example, that a stored value is known to be less than or greater than the actual value or that the value is estimated.)

Finally, another series of alphabetic codes is being developed, which will serve to indicate the level of quality assurance used in sampling and analysis; when this capability becomes available, users will be able to retrieve data based on the level of quality assurance used.

If, after all of these capabilities have been explored, a user retrieves a value that appears to be in error, STORET also provides a mechanism whereby the name, address, and telephone number of the agency that stored the data can be located and the reasons for an abnormally high or low value can be discussed. If necessary, the agency that stored the value can change it.

STORET AND THE ANALYST

STORET is not a substitute for the professional judgement of the analyst. Proper formulation of STORET retrieval requests and subsequent interpretation of the printed output can only be accomplished by an experienced water quality analyst. STORET is merely a tool. Its capabilities complement, but cannot be substituted for, professional judgement and experience.

STORET is a powerful utility. It can eliminate time-consuming and manpower-intensive manipulations of raw data and can produce sophisticated plots and maps that otherwise would require personnel with special graphics skills. In addition, STORET permits the sharing of data among users, thus minimizing the need for duplicate monitoring and record-keeping efforts.

None of these capabilities, however, can or should be used in a vacuum. Familiarity with local conditions and general knowledge of aquatic biology, chemistry, and physics are all essential to their appropriate application. In devising a STORET retrieval and evaluating its output, the analyst must be aware of the influence of a multitude of variables, including, but not limited to:

The physical and chemical characteristics of the parameters being measured

Local geographic and demographic features

Stream flow

Sampling and laboratory analysis methods used

Related point and nonpoint sources, and

Statistical methodology.

In each of the following chapters of this Guide, descriptions of specific STORET capabilities are prefaced with several pages of narrative delineating how these and other related considerations can affect water quality data analysis.

WHERE DOES THE MANAGER'S GUIDE FIT IN?

This Guide is designed to bridge a gap between Federally legislated water program requirements and the detailed descriptions of computer programs and keywords contained in the STORET User Handbook. (Figure 1-2 illustrates where the Guide fits into the flow of information.) In view of the trend toward consolidation of Federal water quality management reporting requirements in the States' biennial 305(b) reports, responsiveness to program guidance for 305(b) reporting has been emphasized. Individual chapters cover the subjects of monitoring programs, existing water quality and historical trends, pollution sources and control programs, biological monitoring, and lake water quality.

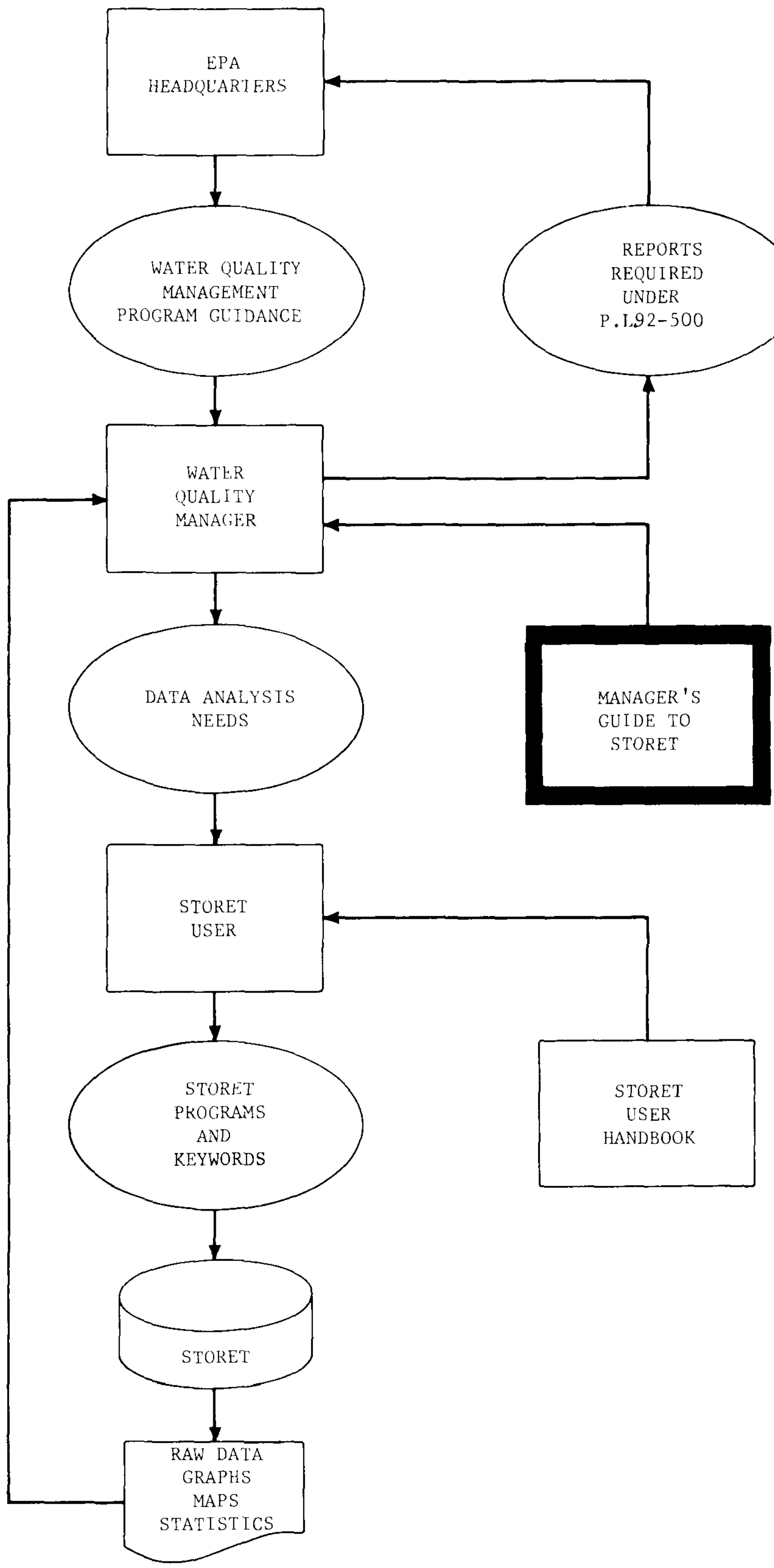

FIGURE 1-2
WHERE DOES THE MANAGER'S GUIDE FIT IN?

Each of the following chapters is comprised of several pages of narrative, followed by a series of one- or two-page descriptions of applicable STORET capabilities. The narrative portion addresses general data analysis questions pertinent to the problem area under consideration. Individual techniques are presented in a carefully structured outline format, and each is described on a separate page, allowing for selective reproduction and for insertion of updates reflecting changes in program requirements and/or STORET capabilities.

Throughout this Guide, the information provided is of a very general nature. The analysis techniques described represent only a sampling of the system's many potential applications in the area of water quality management. Adaptation or expansion of the methodologies outlined in order to meet individual needs is encouraged.

ADDITIONAL DETAILS

EPA Headquarters provides extensive operational support for the STORET user community, through the STORET User Assistance Section, Monitoring and Data Support Division. User Assistance personnel are available by telephone from 8 am to 5 pm eastern time, Monday through Friday, to answer user questions. During those hours, users may call toll free ((800) 424-9067). Local users may wish to call the Washington, D.C. number ((202) 426-7792).

The STORET User Handbook contains complete documentation on how to use the system. Copies of the Handbook are distributed to all new users. A current list of Handbook owners is used as a mailing list for updates, periodicals, memos, and other items that may be made available to STORET users.

User Assistance personnel also periodically conduct basic and advanced STORET training seminars. (Prerequisites for the advanced seminar are completion of the basic seminar and at least 6 months' experience as an active STORET user.) In addition, an annual 3-day users' meeting provides a forum for users from across the country to exchange ideas and share experiences with the use of the system.

Representatives of Federal, State, interstate and local government agencies all are eligible to become STORET users. Depending on the affiliation of the user, there are several methods of monetary compensation to EPA for the use of the system.

EPA supports its contracted hardware vendor by assigning each program office an ADP suballowance; one of these assignments is for State usage of STORET. Each year this suballowance is distributed among the States through their respective EPA

Regional Offices. A prospective State user should contact his or her Regional STORET representative for further details.

Federal agencies may compensate EPA for their STORET usage by means of an interagency agreement. These agreements may be negotiated by the appropriate Regional office or by EPA Headquarters in Washington, D.C. Agreements that cross EPA Regional boundaries, or are on a national level, should be negotiated through EPA Headquarters.

For further information on funding or on how STORET can help you fulfill your water quality data analysis needs, contact your Regional STORET representative. STORET User Assistance in Washington, D.C. ((800) 424-9067) can furnish you with the name and telephone number of your representative.

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CHAPTER
2

MONITORING PROGRAMS

CHAPTER 2

MONITORING PROGRAMS

Water quality monitoring activities conducted by the States, EPA Regions, and other agencies and organizations are an integral part of the water quality management program mandated by the Federal Water Pollution Control Act (P.L. 92-500). The data collected in the course of such efforts form the basis for all subsequent management planning and decision-making. In addition, retrospective evaluations of an agency's monitoring program can help provide a framework for later analysis of historical data. A monitoring program description is required as part of the States' biennial 305(b) reports, and related assessments can complement activities conducted under Sections 104(b), 201, 208, 303(e), and 314.

EPA's Basic Water Monitoring Program (1978) distinguishes four types of water quality monitoring:

- Ambient monitoring, the collection of uniform data on representative parameters for the assessment of long-term progress toward national water quality goals
- Intensive surveys, which provide greater volumes of data over shorter time spans, in order to answer specific water quality management questions
- Effluent monitoring, including both self-monitoring and compliance monitoring activities conducted in conjunction with the NPDES permit program, and
- Biological monitoring, a pilot program designed to assess the effects of water pollution on aquatic life.

Data collected in all four types of monitoring efforts are accommodated by the STORET system, and can be retrieved separately or in combination, using techniques described in this and subsequent chapters.

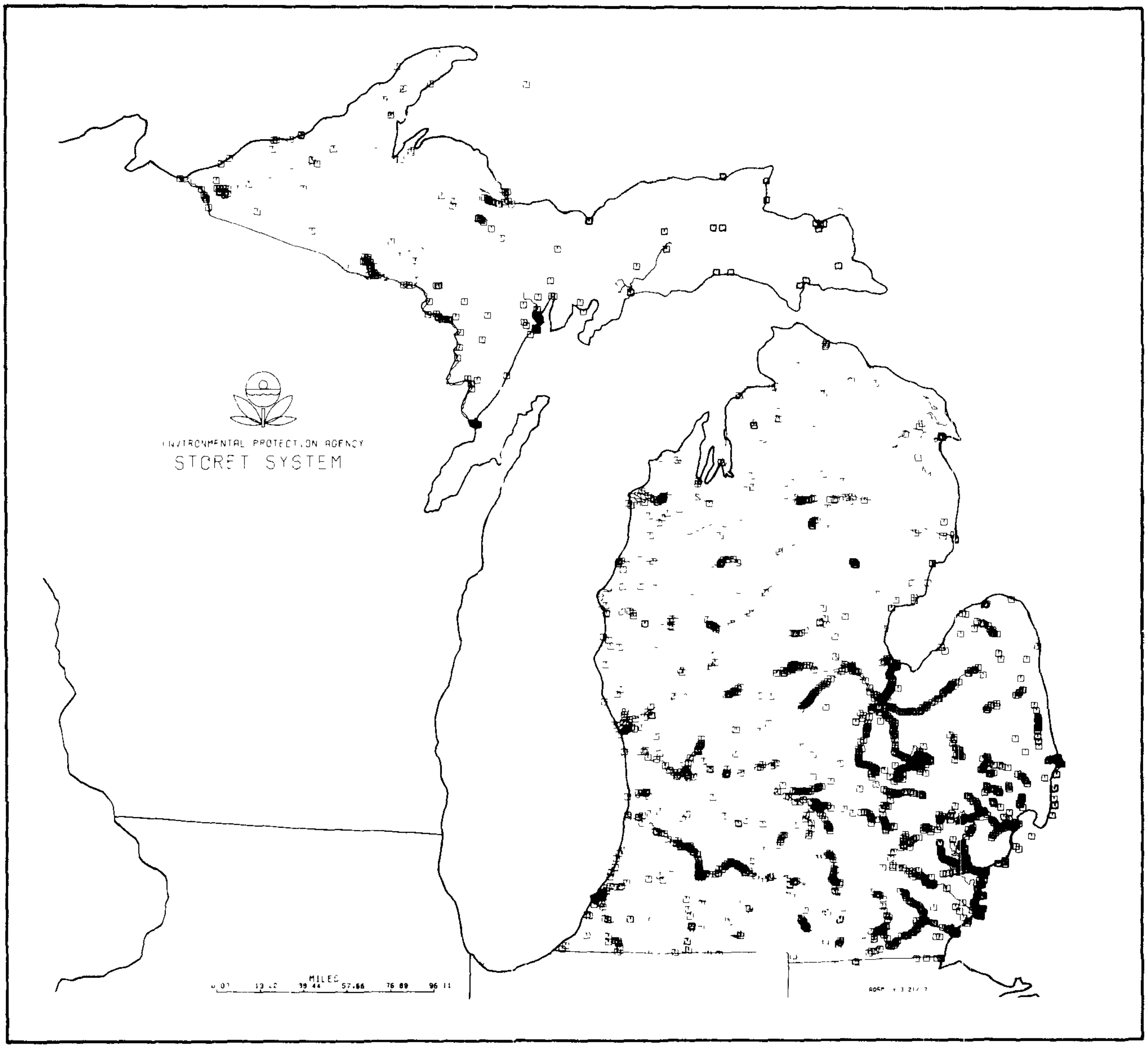

FIGURE 2-1
AMBIENT STREAM MONITORING NETWORK FOR THE STATE OF MICHIGAN

AMBIENT MONITORING PROGRAMS

In describing an ambient monitoring network the analyst should include, at a minimum, information on station siting, parameters sampled, and frequency of observations. Efforts of all agencies that monitor water quality in a particular geographic area should be reviewed, and quality assurance measures used in sampling and analysis should be considered, if that information is available. All of this data can be entered into and retrieved from STORET.

In defining monitoring stations to the Water Quality File, future retrieval requirements should be kept in mind. For example, if stations are numbered sequentially, it is possible to identify them at retrieval time using a range of either primary or secondary station codes, instead of individual agency and station code pairs. Sequential numbering in downstream order can further facilitate both retrieval submission and subsequent interpretation of analysis results. In naming a new station, its relationship to the existing network must be carefully considered, so that logical retrieval mechanisms can be maintained and duplicate naming avoided. For this purpose, a current listing of all station codes previously assigned by a given agency should be maintained and referred to when necessary.[1]

Stations for routine ambient monitoring should be sited to insure a representative sampling of both problem areas and clean water areas, as well as a variety of land use and water use types. To assess the spatial distribution of monitoring stations stored in STORET, the user may retrieve station descriptions or map station locations for a particular geographic area of interest.[2] Figure 2-1 shows the location of stations in the ambient monitoring network maintained by the State of Michigan.

Similar techniques can be used to identify sampling redundancies among stations maintained by different agencies in the same geographic area. Where overlaps are found, interagency agreements can be initiated to insure that the goals of all agencies involved can be met in a cost-effective manner.

One likely source of additional water quality data is the United States Geological Survey (USGS), which maintains an extensive water quality monitoring network, including stations sited to give a balanced picture of the quality and quantity of water in the Nation's streams. The USGS also maintains a benchmark system that assesses only those basins as yet undisturbed by man. New

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[1]Technique 2-1: Identification of Station Codes Used by a Specified Agency.

[2]Technique 2-2: Identification of Stations in a Specified Area and Technique 2-6: Plotting Locations of Monitoring Sites.

water quality data collected by the USGS are routinely entered into STORET, including the widely used flow data. Data collected at USGS stations can often be useful to other agencies and should be considered when reviewing regional monitoring efforts.

Once key stations have been identified, a complete monitoring program description also demands an assessment of the parameters sampled and the frequency of sampling.[3] Minimum sampling frequencies and parameter coverage specified by EPA in the Basic Water Monitoring Program (1978) may be used as a point of comparison to assess completeness of coverage and identify areas where sampling should be expanded or consolidated.

The effectiveness of quality assurance programs used in both sampling and laboratory analysis procedures should also be considered, so that data collected by agencies with inadequate quality control programs or values that have been stored with remark codes can be given the appropriate weight in analyses. The analyst should express his reservations, if any, concerning data collected by the monitoring network under review.

Since one of the goals of EPA's ambient monitoring program is uniformity of data collection, with a view to aggregation of data on a national scale, the location and number of routine monitoring stations are not likely to vary dramatically over time. Once the ambient network has been reviewed adequately, using appropriate STORET capabilities, subsequent reports need only describe modifications to that framework. Any expansion or alteration of the monitoring network or parameters sampled should be specified, and the impetus behind those changes explained. It may not be necessary, however, to reproduce State-wide maps or station descriptions in every review cycle.

INTENSIVE SURVEYS

Although routine ambient monitoring is still a critical part of any complete monitoring program, provisions of P.L. 92-500 have caused a shift in emphasis toward greater utilization of intensive surveys. The Basic Water Monitoring Program (1978) suggests that intensive surveys be conducted at least once every 5 years on every river, lake, estuary, bay or aquifer where waste loads are allocated or significant water quality changes have occurred or are probable. Adherence to these guidelines would result in the conduct of approximately 300 such surveys annually.

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[3]Technique 2-3: Identification of Parameters Sampled; Technique 2-4: Retrieval of Raw Data; and Technique 2-5: Determination of Sampling Patterns over Time.

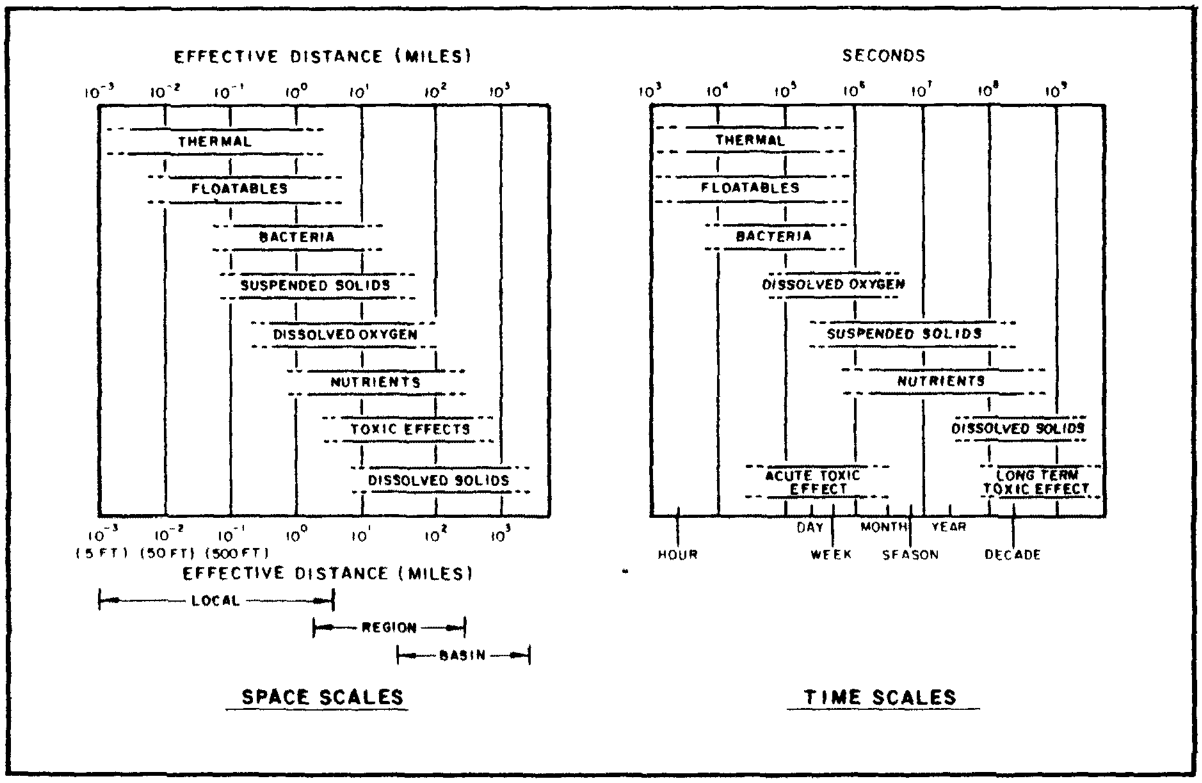

FIGURE 2-2
TIME AND SPACE SCALES FOR ASSESSMENT OF WATER QUALITY PROBLEMS

When intensive surveys have been conducted within an area and time period of interest, details must be reviewed in the State's biennial 305(b) report. The same data can be used in 201, 208, and 303(e) studies as a basis for interpreting ambient monitoring data, identifying areas of water quality degradation, and analyzing cause and effect relationships.

STORET has special capabilities for the storage and retrieval of intensive survey stations and data. These capabilities can be used in conjunction with the techniques mentioned under Ambient Monitoring Programs to characterize the purpose, methodologies, and conclusions of all intensive surveys conducted in a particular area and time period of interest.[4]

Because intensive survey data are often collected in order to answer specific water quality management questions, the analyst will ordinarily be attempting to reach some conclusion about the meaning of the data collected. Both the time and space scales used in the survey are critical to the validity of those conclusions. Whereas ambient monitoring is designed to provide uniform, representative water quality data, intensive survey sampling must be conducted where and when the data collected are most likely to provide conclusive evidence in support of decision-making processes.

For example, a station set up to monitor bacterial pollution should be sited relatively close to the source of the problem, because of the rapid bacterial die-away rate. Alternatively, the siting of stations sampling dissolved oxygen is more dependent on stream and waste characteristics. Temporally, the critical period for dissolved oxygen is likely to be during low-flow summer months and, if algae are present, the critical time of the day is near dawn. Figure 2-2 (Hydroscience, 1976a) summarizes the appropriate time and space scales for assessment of various types of water quality problems. Using this information, coupled with knowledge of chemical reaction rates and characteristics of the geographic area under investigation, the analyst can assess the appropriateness of the time and space scales used in the survey before attempting to interpret the data collected.

EFFLUENT AND BIOLOGICAL MONITORING PROGRAMS

Both effluent and biological monitoring programs were given impetus by the enactment of P.L. 92-500. The NPDES (National Pollutant Discharge Elimination System) program authorized by Section 402 calls for self-monitoring by dischargers as well as compliance monitoring by the States. Biological monitoring is mandated in Section 502, which calls for a "determination of the effects on aquatic life. . .in receiving waters due to the

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[4]Technique 2-7: Retrieval of Intensive Survey Information.

discharge of pollutants". Retrievals of effluent and biological data from STORET are discussed in Chapters 4 and 5 of this Guide, respectively.

WATER QUALITY DATA ANALYSIS
TECHNIQUE
2-1

IDENTIFICATION OF STATION CODES USED BY A SPECIFIED AGENCY

Water quality monitoring stations may be identified in STORET by a primary station code and up to three secondary station codes. This technique lists all of the primary and secondary station codes currently in use by a given agency. The output listing can be used to determine how many stations are maintained by that agency and to avoid duplication in station naming.

TECHNIQUE:	Use the Water Quality File retrieval program STA.
DATA REQUIREMENTS:	Enter the agency code for the agency of interest.
OUTPUT:	A listing of all primary and secondary station codes associated with the specified agency code will be printed, including an indication as to whether the parametric data associated with those stations are available on-line or have been archived. Station codes are listed in alphabetical order, reading left to right and top to bottom.
DOCUMENTATION:	Part WQ, Chapter RET, Section 6.
NOTES:	The agency code is the only valid station identification keyword for the STA program; no data selection keywords are valid. More than one agency code may be specified, if desired.

EXAMPLE:

This example shows the first page of output from program STA. The retrieval was restricted to stations maintained by the State of Michigan (agency code 21MICH). In this case, the characters "00S" preceding each station code indicate that these are secondary station codes (S) that are available on-line (00).

21MICH

00S AC00504.1	00S AC00505.0	00S AC00505.1	00S AC00506.0	00S AC00508.0	00S AC00513.0
00S AC00524.0	00S AC00525.0	00S AC00527.0	00S AC00530.0	00S AC00530.1	00S AC00540.0
00S AC00540.1	00S AC00540.2	00S AC00545.0	00S AC00545.1	00S AC00551.0	00S AC00560.0
00S AC00571.0	00S AC00575.0	00S AC00580.0	00S AC00584.0	00S AC00600.0	00S AC00600.1
00S AC00601.0	00S AC00602.0	00S AC00617.0	00S AC00629.0	00S AC00630.0	00S AC00644.0
00S AC00644.1	00S AC00665.0	00S AC00670.0	00S AC00670.1	00S AC00670.2	00S AC00677.0
00S AC00690.0	00S AC00695.0	00S AC00695.1	00S AC00696.0	00S AC00724.0	00S AC00724.1
00S AC00735.0	00S AC00735.1	00S AC00735.2	00S AC00748.0	00S AC00758.0	00S AC00780.0
00S AC00780.1	00S AC00781.0	00S AC00781.1	00S AC00785.0	00S AC00785.1	00S AC00785.2
00S AC00786.0	00S AC00788.1	00S AC00788.2	00S AC00790.0	00S AC00790.1	00S AC00791.0
00S AC00791.1	00S AC00825.0	00S AC00830.0	00S AC00830.1	00S AC00836.0	00S AC00845.0
00S AC00846.0	00S AC00857.0	00S AC00857.1	00S AC00890.0	00S AC00912.0	00S AC00930.0
00S AC00974.0	00S AC00975.1	00S AC00975.2	00S AC00975.3	00S AC00994.0	00S AC01000.0
00S AC01001.0	00S AC01001.1	00S AC01020.0	00S AC01020.1	00S AC01020.3	00S AC01020.4
00S AC01047.0	00S AC01062.0	00S AC01075.0	00S AC01090.0	00S AC01100.0	00S AC01125.0
00S AC01146.0	00S AC01150.0	00S AC01200.1	00S AC01270.0	00S AC01281.1	00S AC01281.2
00S AC01281.3	00S AC01281.4	00S AC01320.0	00S AC01327.0	00S AC01330.2	00S AC01330.3
00S AC01400.0	00S AC01438.0	00S AC01600.0	00S AC01610.0	00S AC01610.1	00S AC01610.2
00S AC01680.0	00S AC01722.0	00S AC01744.0	00S AC01775.0	00S AC01780.0	00S AC01780.1
00S AC01860.0	00S AC01880.0	00S AC01900.0	00S AC01920.0	00S AC01920.1	00S AC01920.2
00S AC01930.0	00S AC01930.1	00S AC01930.2	00S AC01956.0	00S AC01972.0	00S AC02000.1
00S AC02000.2	00S AC02030.0	00S AC02030.1	00S AC02030.2	00S AC02110.0	00S AC02110.1
00S AC02300.0	00S AC02400.0	00S AC02500.0	00S AC02500.1	00S AC02516.0	00S AC02516.1
00S AC02516.2	00S AC02560.0	00S AC02571.0	00S AC02580.0	00S AC02680.1	00S AC02680.2
00S AC02680.3	00S AC02680.4	00S AC02860.0	00S AC02860.1	00S AC02860.2	00S AC029[illegible].0
00S AC03395.0	00S AC04001.0	00S AC04150.0	00S AC04230.0	00S AC04260.0	00S AC04260.1
00S AC04260.2	00S AC04320.0	00S AC04320.1	00S AC04865.0	00S AC04990.1	00S AC04990.2
00S AC04990.3	00S AC05220.0	00S AC05220.1	00S AC05370.0	00S AC05370.1	00S AC05652.0
00S AC05660.0	00S AC05660.1	00S AC07730.0	00S AC07730.1	00S AC07730.2	00S AC08659.0
00S AC08659.1	00S AC08850.0	00S AC08970.0	00S AC09600.0	00S AC09600.1	00S AC09600.2
00S AC09600.3	00S AC09711.0	00S AC10130.0	00S AC10131.0	00S AC12800.0	00S AC17120.0
00S AC17260.1	00S AC17260.2	00S AC17260.3	00S AC17360.0	00S AC18770.0	00S AC18770.1
00S AC20044.0	00S AC20044.1	00S AC20044.2	00S AL0023	00S AL0045	00S AUS001
00S AUS002	00S AUS003	00S AUS004	00S AUS005	00S AUS006	00S AUS007
00S AUS008	00S AUS009	00S AUS010	00S BA0001	00S BA0004	00S BA0005
00S BA0010	00S BA0011	00S BA0013	00S BA0014	00S BA0015	00S BA0016
00S BA0017	00S BA0018	00S BA0019	00S BA0020	00S BA0021	00S BA0022
00S BA0023	00S BA0025	00S BA0027	00S BA0029	00S BA0030	00S BA0033
00S BA0035	00S BA0038	00S BA0039	00S BA0040	00S BA0041	00S BA004[illegible]
00S BA0047	00S BA0048	00S BA0052	00S BA0053	00S BA0056	00S BA0058
00S BA0059	00S BA0060	00S BA0062	00S BA0063	00S BA0065	00S BA0066
00S BA0067	00S BA0069	00S BA0070	00S BA0072	00S BA0074	00S BA0077
00S BA0080	00S BA0081	00S BA0087	00S BA0089	00S BA0090	00S BA0091
00S BA0100	00S BA0102	00S BA0104	00S BA0105	00S BA0106	00S BA0108
00S BA0109	00S BA0110	00S BA0113	00S BA0116	00S BA0117	00S BA0119
00S BA0122	00S BA0123	00S BA0124	00S BA0130	00S BA0132	00S BA0135
00S BA0139	00S BA0142	00S BA0143	00S BA0149	00S BA0150	00S BA0151
00S BC0013	00S B01450	00S B01460	00S B02500	00S B02740	00S B03[illegible]10
00S B03820	00S B03901	00S B04000	00S B04010	00S B04040	00S B04210
00S B04240	00S B04330	00S B04340	00S B04360	00S B04370	00S CCAP010
00S CCCP001	00S CCCP010	00S CCCP020	00S CCTE010	00S CCTE020	00S CPCN010
00S CPCN020	00S CPCS010	00S CWPP001	00S CWPP010	00S CWPP020	00S DCTP010
00S DECC001	00S DECC010	00S DECP001	00S DECP002	00S DECP010	00S DECP020
00S DEDP001	00S DEDP010	00S DERP001	00S DERP010	00S DERP020	00S DERP030
00S DETP001	00S DETP010	00S DEWN001	00S DEWN010	00S DEWN020	00S DEWS001
00S DEWS010	00S DI0001	00S DI0002	00S DI0003	00S DI0004	00S DI0005
00S DI0006	00S DI0007	00S DI0009	00S DI0010	00S DI0011	00S DI0012
00S DI0013	00S DI0014	00S DI0015	00S DI0016	00S DI0017	00S DI0018

WATER QUALITY DATA ANALYSIS
TECHNIQUE
2-2

IDENTIFICATION OF STATIONS IN A SPECIFIED AREA

This technique identifies stations maintained by an analyst's own agency and/or other agencies that sample water quality within a particular geographic area of interest. The station identification information retrieved can be useful in describing an overall monitoring program.

TECHNIQUE:	Use the Water Quality File retrieval program INDEX.
DATA REQUIREMENTS:	Enter station identification keywords to specify the geographic area of interest.
OUTPUT:	Modified station identification information for each station selected will be printed, including: State name; State and county codes; agency code; primary and secondary station codes; major, minor, and terminal basin codes; latitude and longitude coordinates; river mile index (if stored); and station type.
DOCUMENTATION:	Part WQ, Chapter RET, Section 6.
NOTES:	This program retrieves no parametric data. If necessary, the retrieval can be restricted to print information only on stations maintained by a specified agency or agencies.

EXAMPLE:

This example shows the first page of output from the Water Quality File retrieval program INDEX. In this case, the retrieval was restricted to stations located in Gogebic County, Michigan.

```
*****************************************************************************************************************
STATE           ST/CO #     LOCATION                                                BASIN CODE         STORAGE DATE
                STATION TYPE
                USER CODE     STATION       SECONDARY STATIONS                       MAJ/MIN/TERM
                     LAT/LONG                 MILESLV1       LV2      LV3      LV4     LV5   LV6   LV7   LV8   LV9   LV10   LV11

                           INDEX
*****************************************************************************************************************

MICHIGAN        26053 MONTREAL R. AT AURORA ST.                                                 2215
                /TYPA/AMBNT/STREAM
                21MICH          270009          IN0028                                  BASIN
                46 27 01.0 090 10 42.0
                           INDEX

MICHIGAN        26053 MONTREAL R. AT COUNTY RD.                                                 2215
                /TYPA/AMBNT/STREAM
                21MICH          270010          IN0089                                  BASIN
                46 26 23.5 090 10 00.0
                           INDEX

MICHIGAN        26053 MONTREAL R. AT COUNTY RD.                                                 2215
                /TYPA/AMBNT/STREAM
                21MICH          270011                                                  BASIN
                46 23 16.0 090 08 28.0
                           INDEX

MICHIGAN        26053 MID BR ONTONAGON R. AT US-45 BR                                           2215
                /TYPA/AMBNT/STREAM
                21MICH          270012          BA01.F                                  BASIN
                46 16 28.0 089 10 39.0
                           INDEX

MICHIGAN        26053 PRESQUE ISLE R. AT CO. RD. BR.                                            2214
                /TYPA/AMBNT/STREAM
                21MICH          270013                                                  BASIN
                46 22 36.0 089 41 20.0
                           INDEX

MICHIGAN        26053 JACKSON CR. AT M-28 BRIDGE                                                2214
                /TYPA/AMBNT/STREAM
                21MICH          270014                                                  BASIN
                46 30 57.0 089 52 50.0
                           INDEX

MICHIGAN        26053 MONTREAL RIVER NEAR IRONWOOD, MI                                          222391
                /TYPA/AMBNT/STREAM
                112WRD          04028100                                                BASIN
                46 30 26.0 090 13 47.0
                           INDEX
```

WATER QUALITY DATA ANALYSIS
TECHNIQUE
2-3

IDENTIFICATION OF PARAMETERS SAMPLED

Summary information is provided to help review parameter coverage in an analyst's own network and/or at stations maintained by other agencies in a specific area of interest.

TECHNIQUE: Use the Water Quality File retrieval program INVENT or INV120.

DATA REQUIREMENTS: Enter station identification and data selection keywords to define geographic area and time period of interest.

OUTPUT: For each station selected, station identification information and summary statistics on all parameters sampled will be printed. In addition, a gross summary that combines data from all stations retrieved will be produced.

DOCUMENTATION: Part WQ, Chapter RET, Section 6.

NOTES: Unless the retrieval is restricted to a manageable number of stations and/or parameters, this program could generate significant volumes of output. It is advisable to retrieve data for key stations only.

The example shows output from the program INVENT; if INV120 is used, the two columns listing the coefficients of variation and standard errors will be omitted.

It is also possible to suppress individual station summaries and to print only a single aggregation of data from all stations retrieved (refer to Technique 2-8: Summarizing Monitoring Activities).

EXAMPLE: This example shows INVENT output for station 070858, which is maintained by the U.S. Forest Service (agency code 14AGNFS9). The retrieval was limited to data collected in 1978 and 1979.

```
                                   070858          C90704089141 402010404141 PERCH RIV.
                                  46 31 10.0 CE8 39 45.0   3
                                                   10.9MI.079DEG. FROM M28EFH16N J.
                                  26013 MICHIGAN
                                  LAKE SUPERIOR           220800
                                  STURGEON RIVER-PERCH RIVERR
/TYPA/AMBNT/STREAM                14AGNFS9   781227
                                   0000  CLASS 00
```

PARAMETER				NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00004	STREAM	WIDTH	FEET	10	30.2000	52.0121	7.21194	.238806	2.28062	44.0000	22.0000	78/04/24	78/09/26
00010	WATER	TEMP	CENT	15	13.2667	67.0667	8.18942	.617293	2.11450	22.0000	.000000	78/03/08	79/04/11
00020	AIR	TEMP	CENT	15	14.3000	101.636	10.0815	.704997	2.60302	27.0000	-.100E+02	78/03/08	79/04/11
00025	BAROMTRC	PRESSURE	MM OF HG	15	29.9019	.038225	.195513	.006538	.050481	30.1600	29.3700	78/03/08	79/04/11
00036	WIND	DIR.FROM	NORTH-0	15	178.667	9108.82	95.4401	.534180	24.6425	360.000	.000000	78/03/08	79/04/11
00042	ALTITUDE	FEET	AB MSL	15	1332.67	49.1428	7.01020	.005260	1.81002	1350.00	1330.00	78/03/08	79/04/11
00043	CLOUD	TYPE	WMO CODE	15	3.53333	5.98096	2.44560	.692151	.631451	8.00000	.000000	78/03/08	79/04/11
00044	CLOUD	AMOUNT	WMO CODE	15	4.53333	8.55240	2.92445	.645099	.755089	9.00000	.000000	78/03/08	79/04/11
00045	PRECIP	TOT DAY	IN	13	.139231	.055008	.234537	1.68452	.065049	.730000	.000000	78/03/08	79/04/11
00052	RELATIVE	HUMIDITY	PERCENT	15	59.7333	562.640	23.7200	.397099	6.12449	95.0000	19.0000	78/03/08	79/04/11
00061	STREAM	FLOW,	INST-CFS	10	183.967	10951.5	104.649	.568849	33.0930	445.500	79.0900	78/04/24	78/09/26
00065	STREAM	STAGE	FEET	15	87.8200	.544643	.737999	.008404	.190551	88.9000	86.1000	78/03/08	79/04/11
00076	TURB	TRBIDMTR	HACH FTU	14	1.74285	.478037	.691402	.396707	.184785	3.70000	.900000	78/03/08	79/02/27
00080	COLOR	PT-CO	UNITS	13	103.846	1674.31	40.9184	.394029	11.3487	195.000	40.0000	78/03/08	78/09/26
00081	AP COLOR	PT-CO	UNITS	1	37.0000					37.0000	37.0000	79/02/27	79/02/27
00095	CNDUCTVY	AT 25C	MICROMHO	14	77.8571	465.827	21.5830	.277213	5.76830	131.000	48.0000	78/03/08	79/02/27
00300	DO		MG/L	15	10.1667	4.30814	2.07561	.204158	.535919	13.5000	8.10000	78/03/08	79/04/11
00301	DO	SATUR	PERCENT	15	98.2465	28.3214	5.32179	.054168	1.37408	109.600	89.7000	78/03/08	79/04/11
00403	LAB	PH	SU	14	7.27142	.092961	.304895	.041931	.081487	7.70000	6.80000	78/03/08	79/02/27
00410	T ALK	CACO3	MG/L	13	27.2461	69.2295	8.32043	.305380	2.30767	39.8000	11.5000	78/04/24	79/02/27
00600	TOTAL N	N	MG/L	3	1.00667	.484433	.696012	.691403	.401843	1.68000	.290000	78/05/09	79/02/27
00610	NH3-N	TOTAL	MG/L	3	.130000	.002100	.045826	.352506	.026458	.180000	.090000	78/05/09	79/02/27
00615	NO2-N	TOTAL	MG/L	1	.002000					.002000	.002000	79/02/27	79/02/27
00625	TOT KJEL	N	MG/L	3	.886666	.573033	.756989	.853748	.437048	1.61000	.100000	78/05/09	79/02/27
00630	NO2&NO3	N-TOTAL	MG/L	14	.096428	.004855	.069681	.722622	.018623	.270000	.020000	78/03/08	79/02/27
00650	T PO4	PO4	MG/L	14	.067500	.000479	.021894	.324357	.005851	.111000	.027000	78/03/08	79/02/27
00900	TOT HARD	CACO3	MG/L	4	45.6500	38.6237	6.21480	.136140	3.10740	54.0000	40.0000	78/04/24	79/02/27
01355	ICE	COVER	SEVERITY	1	6.00000					6.00000	6.00000	78/03/08	78/03/08

WATER QUALITY DATA ANALYSIS
TECHNIQUE
2-4

RETRIEVAL OF RAW DATA

This technique provides maximum detail about parametric data stored in the system. It is most useful if the geographic area and time frame under consideration are limited.

TECHNIQUE: Use the Water Quality File retrieval program ALLPARM.

DATA REQUIREMENTS: Enter appropriate station identification and data selection keywords to define the geographic area and time period of interest. Up to 2,000 parameter codes can be used if data on specific parameters are required.

OUTPUT: For each station retrieved, output will include station identification information and tabulations of all raw parametric data collected in the time period specified.

DOCUMENTATION: Part WQ, Chapter RET, Section 6.

NOTES: Unless stations and data to be retrieved are limited carefully, this type of retrieval can produce an unmanageable volume of data.

Not all general retrieval keywords are valid with the ALLPARM program; consult the STORET User Handbook for details.

EXAMPLE: This example shows the first page of ALLPARM output for station 070858. The retrieval was limited to data collected in 1978 and 1979.

```
070858          090704089141 402010404141 PERCH RIV.
46 31 10.0 088 39 45.0  3
               10.9MI.079DEG. F
26013 MICHIGAN
LAKE SUPERIOR              220800
STURGEON RIVER-PERCH RIVERR
14AGNFS9
       781227      DEPTH     0
/TYPA/AMBNT/STREAM
```

	INITIAL DATE			78/03/08	78/04/24	78/05/09	78/05/24	78/06/02	78/06/02	78/06/15	78/06/27
	INITIAL TIME-DEPTH-BOTTOM			1100 0000	1230 0000	1105 0000	1015 0000	1030 0000	1035 0000	0955 0000	1230 0000
00004	STREAM	WIDTH	FEET		44	34	22	40		26	33
00010	WATER	TEMP	CENT	0.0	6.0	9.0	22.0	14.0		14.0	21.0
00011	WATER	TEMP	FAHN	32.0	42 8	48 2	71 6	57 2		57.2	69.8
00020	AIR	TEMP	CENT	10.0-	10.0	7 0	23.0	11 0		16 0	24 0
00025	BAROMTRC	PRESSURE	MM OF HG	30	30	29	30	30		30	30
00036	WIND	DIR.FROM	NORTH-0	225	90	270	0	270		140	270
00042	ALTITUDE	FEET	AB MSL	1350	1350	1330	1330	1330		1330	1330
00043	CLOUD	TYPE	WMO CODE	1	3	5	1	4		2	6
00044	CLOUD	AMOUNT	WMO CODE	1	5	9	1	3		2	7
00045	PRECIP	TOT DAY	IN	0.00		0.17		0.05		0.03	0.00
00052	RELATIVE	HUMIDITY	PERCENT	19.0	49.0	95.0	33.0	51 0		60 0	57.0
00061	STREAM	FLOW,	INST-CFS		446	233	146	243		124	125
00065	STREAM	STAGE	FEET	87.0	88.6	87.5	87 5	88 5		88.0	87.0
00076	TURB	TRBIDMTR	HACH FTU	2.7	3 7	1 9	1.8		1.6	1 6	1.4
00080	COLOR	PT-CO	UNITS	40	75	80	85		160	150	96
00095	CNDUCTVY	AT 25C	MICROMHO	131	48	65	72		63	73	80
00300	DO		MG/L	13.5	2.5	10.2	8.7	9.3		10.8	8 8
00301	DO	SATUR	PERCENT	95.9	105 2	92.4	103.5	94.4		109.6	102.7
00403	LAB	PH	SU	7.7	7 5	7.6	7.5		6.9	7.3	7.3
00410	T ALK	CACO3	MG/L		12	26	35		21	27	29
00600	TOTAL N	N	MG/L			1.05 C	1.68 C				
00610	NH3-N	TOTAL	MG/L			0.180	0 120				
00625	TOT KJEL	N	MG/L			0.950	1 610				
00630	NO2&NO3	N-TOTAL	MG/L	0.2	0 3	0.0	0 1		0.1	0.0	0.1
00650	T PO4	PO4	MG/L	0.03	0.08	0.06	0.06		0.07	0.05	0.07
00900	TOT HARD	CACO3	MG/L		40	54	42				
01355	ICE	COVER	SEVERITY	6							
	INITIAL DATE			78/07/07	78/07/25	78/08/09	78/08/25	78/09/07	78/09/26	79/02/27	79/04/11
	INITIAL TIME-DEPTH-BOTTOM			1045 0000	1230 0000	1130 0000	1000 0000	1045 0000	0900 0000	1000 0000	0830 0000
00004	STREAM	WIDTH	FEET		27	25		26	26		
00010	WATER	TEMP	CENT	21.0	22.0	19.0	17 0	20 0	13.0	0.0	1.0
00011	WATER	TEMP	FAHN	69.8	71.6	66.2	62.6	68.0	55.4	32 0	33.8
00020	AIR	TEMP	CENT	23.0	27 0	19.0	20.5	20.0	16.0	8.0	0.0
00025	BAROMTRC	PRESSURE	MM OF HG	30	30	30	30	30	30	30	30
00036	WIND	DIR.FROM	NORTH-0	200	180	360	45	180	180	180	90
00042	ALTITUDE	FEET	AB MSL	1330	1330	1330	1330	1330	1330	1330	1330
00043	CLOUD	TYPE	WMO CODE	6	5	8	3	3	0	0	6
00044	CLOUD	AMOUNT	WMO CODE	6	7	4	9	2	6	0	6
00045	PRECIP	TOT DAY	IN	0.45	0.73	0.00	0 00	0.00	0.38	0.00	0.00
00052	RELATIVE	HUMIDITY	PERCENT	94.0	70.0	40.0	84.0	94.0	64.0	38.0	48 0
00061	STREAM	FLOW,	INST-CFS		164	79		158	123		
00065	STREAM	STAGE	FEET	87.5	88.0	86.1	88.9	88.2	88.0	88.0	88.5
00076	TURB	TRBIDMTR	HACH FTU	1.6	1.3	0.9	1.3	1.4	1 6	1.6	0 8
00080	COLOR	PT-CO	UNITS	74	115	104	195	120	76		
00081	AP COLOR	PT-CO	UNITS							37	74

(SAMPLE CONTINUED ON NEXT PAGE)

WATER QUALITY DATA ANALYSIS
TECHNIQUE
2-5

DETERMINATION OF SAMPLING PATTERNS OVER TIME

The frequency of sampling is important in any monitoring program description. This technique tabulates the number of observations in each season or defined time period for selected parameters.

TECHNIQUE: Use the Water Quality File retrieval program MEAN with the variable date group keyword to summarize data by season; use the statistical function "number of observations".

DATA REQUIREMENTS: Enter appropriate data selection and station identification keywords to define geographic area and time period of interest. Up to 10 parameter codes can be used per retrieval.

OUTPUT: For each station retrieved, the output will include station identification information, plus number of observations stored under specified parameter codes in each season. If specified, associated raw data and/or seasonal statistics can also be printed.

DOCUMENTATION: Part WQ, Chapter RET, Section 6.

NOTES: It is possible to define date groups other than season (e.g., month or quarter), if desired.

Outliers may be eliminated by using MEAN program-specific keywords.

EXAMPLE:

This example shows the number of observations for six different parameters collected at station 030009 in the four seasons of the year, from the winter of 1976-1977 to the fall of 1978. A yearly summary for 1977 also is included.

STORET RETRIEVAL DATE 79/08/27

030009
42 38 53.3 086 11 55.0 2
KALAMAZOO R AT OLD US-31 [illegible]
26005 ALLEGAN CO., MI
MAJ BASIN: LAKE MICHIGAN 033700
MIN BASIN: KALAMAZOO RIVER
21MICH
0000 FEET DEPTH CLASS 00

/TYPA/AMBNT/STREAM

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00076 TURB TRBIDMTR HACH FTU	00095 CNDUCTVY AT 25C MICROMHO	00060 STREAM FLOW CFS	00300 DO MG/L	00400 PH SU
76/12/21 VARIABLE 77/03/20	NUMBER		3.00000	3.00000	3.00000	3.00000	3.00000	3.00000
77/03/21 VARIABLE 77/06/20	NUMBER		3.00000	3.00000	3.00000	3.00000	3.00000	3.00000
77/06/21 VARIABLE 77/09/20	NUMBER		3.00000	3.00000	3.00000	3.00000	3.00000	3.00000
77/09/21 VARIABLE 77/12/20	NUMBER		3.00000	3.00000	3.00000	3.00000	3.00000	3.00000
77/01/01 YEAR 78/01/00	NUMBER		12.0000	12.0000	12.0000	12.0000	12.0000	12.0000
77/12/21 VARIABLE 78/03/20	NUMBER		3.00000	3.00000	3.00000	3.00000	3.00000	3.00000
78/03/21 VARIABLE 78/06/20	NUMBER		3.00000	3.00000	3.00000	3.00000	3.00000	3.00000
78/06/21 VARIABLE 78/09/20	NUMBER		2.00000	2.00000	2.00000	2.00000	2.00000	2.00000
78/09/21 VARIABLE 78/12/20	NUMBER		4.00000	4.00000	4.00000	1.00000	4.00000	4.00000

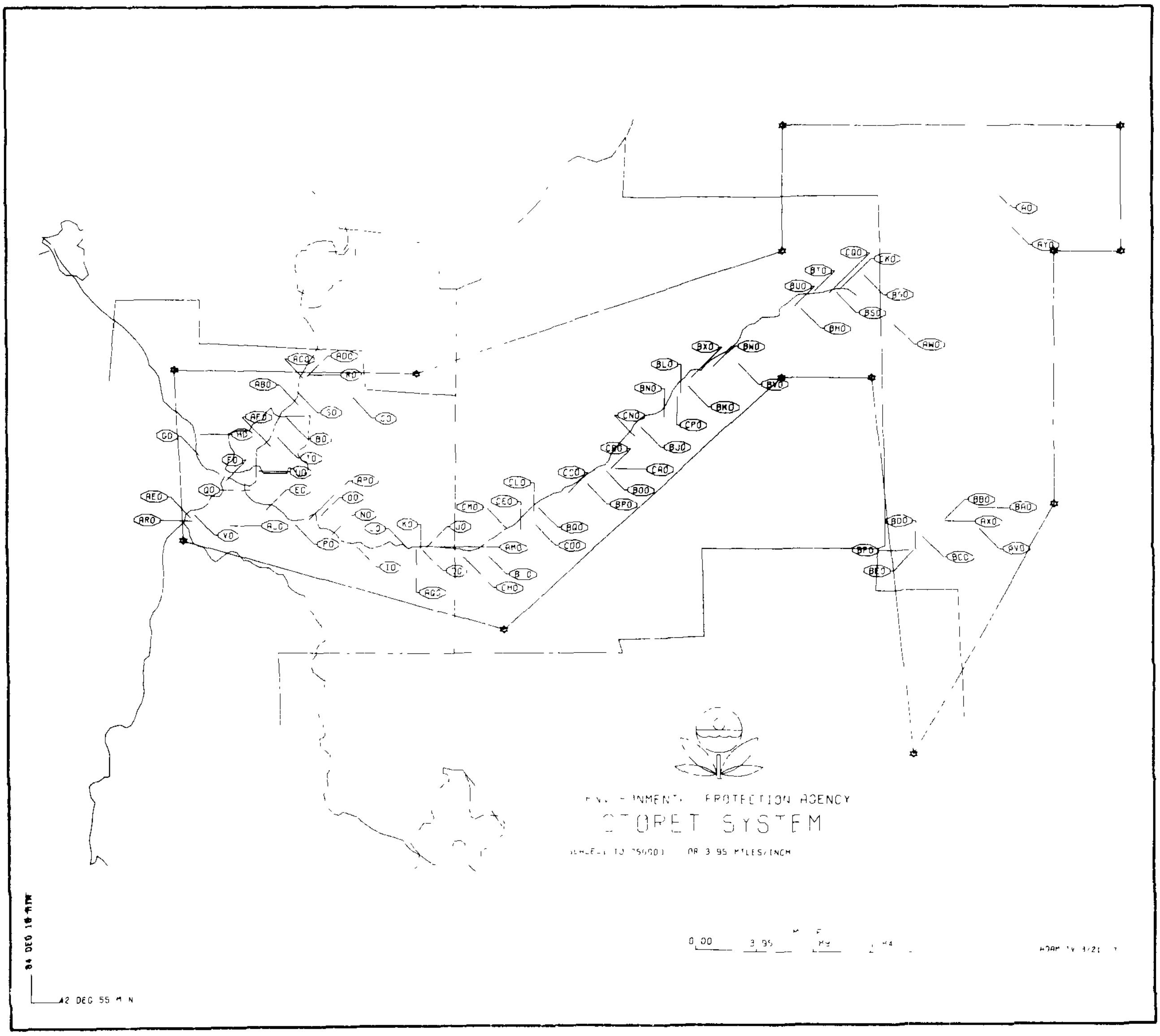
WATER QUALITY DATA ANALYSIS
TECHNIQUE
2-6

PLOTTING LOCATIONS OF MONITORING SITES

This technique produces a reference map of all STORET stations maintained by a given agency or in a specified geographic area. The output helps identify any gaps or redundancies in a monitoring network, and could be used to illustrate the monitoring program description normally provided in a State's 305(b) report.

TECHNIQUE:	Use the Water Quality File retrieval program LOC; specify labeling of stations with a cross-reference number.
DATA REQUIREMENTS:	Enter station identification keywords to define the geographic area and/or agency of interest.
OUTPUT:	A map of the area specified will be printed, with tags showing sampling station locations, and a listing of station information corresponding to those tags.
DOCUMENTATION:	Part WQ, Chapter RET, Sections 6 and 7.
NOTES:	In order to achieve sufficient resolution of station symbols, it may be necessary to make separate retrievals for portions of the area of interest. The NOPAR retrieval program may be used to screen stations before printing, based on user-specified sampling criteria.

EXAMPLE: This map shows the locations of monitoring stations maintained by the State of Michigan within a specified latitude/ longitude polygon. Tags on the map correspond to station descriptions listed by the LOC program, as shown on the next page.



This listing is the first page of station information corresponding to the map tags on the preceding page. For each station, the data provided includes agency code, station code, latitude and longitude, a brief location description, State and county codes, county name, and State name.

AO	21MICH	320051	43 41 15.0 082 57 32.0 2	0	N BR CASS R AT STANBAUGH RD	26063	HURON CO., MI	
BO	21MICH	730002	43 27 17.5 083 55 38.5 1	0	SAGINAW RIVER AT 6TH AVENUE	26145	SAGINAW CO., MI	
CO	21MICH	730003	43 28 32.5 083 50 16.0 2	0	CHEBOYGANING CR AT PORTSMOUTH RD	26145	SAGINAW CO., MI	
DO	21MICH	730018	43 19 37.5 083 44 19.0 2	0	WATER INTAKE FROM CASS RIVER	26145	SAGINAW CO., MI	
EO	21MICH	730024	43 21 54.0 083 57 17.0 2	0	CASS RIVER AT M-13 BRIDGE	26145	MICHIGAN	SAGINAW
FO	21MICH	730025	43 23 34.0 084 00 40.0 2	0	TITTABAWASSEE RIVER AT CENTER RD	26145	MICHIGAN	SAGINAW
GO	21MICH	730048	43 24 56.0 084 02 42.0 2	0	TITTABAWASSEE R AT GRATIOT RD.	26145	SAGINAW CO., MI	
HO	21MICH	730065	43 26 16.0 084 02 49.0 2	0	TITTABAWASSEE R. AT STATE ROAD	26145	SAGINAW CO., MI	
IO	21MICH	730071	43 19 48.0 083 49 49.0 2	0	CASS R AT DIXIE HWY BRIDGE	26145	SAGINAW CO., MI	
JO	21MICH	730097	43 19 50.0 083 43 58.0 4	0	CASS R. AT FRANKENM. BOAT LANDNG	26145	SAGINAW CO., MI	
KO	21MICH	730098	43 19 28.0 083 44 27.0 2	0	CASS RIVER AT M-83.	26145	SAGINAW CO., MI	
LO	21MICH	730099	43 19 41.0 083 45 27.0 2	0	CASS RIVER AT DEHMEL ROAD.	26145	SAGINAW CO., MI	
MO	21MICH	730100	43 19 44.0 083 46 36.0 2	0	CASS RIVER AT S. BEYER RD.	26145	SAGINAW CO., MI	
NO	21MICH	730103	43 20 28.0 083 51 52.0 2	0	CASS RIVER AT I-75 BRIDGE.	26145	SAGINAW CO., MI	
OO	21MICH	730104	43 21 29.0 083 52 57.0 2	0	CASS RIVER AT BRIDGEPORT BRIDGE.	26145	SAGINAW CO., MI	
PO	21MICH	730105	43 21 07.0 083 54 55.0 2	0	CASS RIVER AT STUDOR ROAD.	26145	SAGINAW CO., MI	
QO	21MICH	730134	43 23 03.0 083 58 31.0 2	0	TITABA. R NEAR SAGINAW R CONFL.	26145	SAGINAW CO., MI	
RO	21MICH	730147	43 29 54.0 083 53 55.0 2	0	SAGINAW R AT LIGHT BUOY 58	26145	SAGINAW CO., MI	
SO	21MICH	730148	43 28 52.0 083 54 48.0 2	0	SAGINAW RIVER OFF I-75 BRIDGE	26145	SAGINAW CO., MI	
TO	21MICH	730149	43 26 10.0 083 56 27.0 2	0	SAGINAW R OFF DAVENPORT AVE FR	26145	SAGINAW CO., MI	
UO	21MICH	730150	43 24 08.0 083 57 58.0 2	0	SAGINAW R OFF CENTER ST BRIDGE	26145	SAGINAW CO., MI	
VO	21MICH	730151	43 21 33.0 084 03 10.0 2	0	SHIAWASSEE R AT S RIVER RD	26145	SAGINAW CO., MI	
WO	21MICH	730152	43 24 39.0 083 57 58.0 2	0	SAGINAW RIVER AT RUST AVE BRIDGE	26145	SAGINAW CO., MI	
XO	21MICH	730153	43 24 56.0 083 57 42.0 2	0	SAGINAW RIVER AT COURT ST BRIDGE	26145	SAGINAW CO., MI	
YO	21MICH	730154	43 25 17.0 083 57 11.0 2	0	SAGINAW R AT BRISTOL ST BRIDGE	26145	SAGINAW CO., MI	
AAO	21MICH	730155	43 26 01.0 083 56 30.0 2	0	SAGINAW R AT GENESSEE AVE BRIDGE	26145	SAGINAW CO., MI	
ABO	21MICH	730156	43 28 03.0 083 54 36.0 2	0	SAGINAW R - 0.75 MI ABOVE I-75	26145	SAGINAW CO., MI	
ACO	21MICH	730157	43 29 36.0 083 54 13.0 2	0	SAGINAW R - 1.0 MI BELOW I-75	26145	SAGINAW CO., MI	
ADO	21MICH	730158	43 29 48.0 083 54 02.0 2	0	SAGINAW R AT LIGHT BUOYS 63-64	26145	SAGINAW CO., MI	
AEO	21MICH	730160	43 21 23.0 084 03 29.0 2	0	SHIAWASSEE R. 1/4 MI. BELOW SWAN	26145	SAGINAW CO., MI	
AFO	21MICH	730161	43 25 31.0 083 56 48.0 2	0	SAGINAW R. AT PENN CENT. RR BRID	26145	SAGINAW CO., MI	
AGO	21MICH	730163	43 26 35.0 083 56 00.0 2	0	SAGINAW R. OFF CARROLLTON WT	26145	SAGINAW CO., MI	
AHO	21MICH	730164	43 27 20.0 083 55 25.0 2	0	SAGINAW R. UPSTR. CARROLLTON BAR	26145	SAGINAW CO., MI	
AIO	21MICH	730165	43 27 46.0 083 54 15.0 2	0	SAG. R. OFF CHEV. NOD. WT	26145	SAGINAW CO., MI	
AJO	21MICH	730166	43 20 56.0 084 00 14.0 2	0	FLINT R-SPAULDING DRAIN	26145	SAGINAW CO., MI	
AKO	21MICH	730167	43 19 19.0 083 48 28.0 2	0	CASS R. 3.5 MILES W. OF FRANKENM	26145	SAGINAW CO., MI	
ALO	21MICH	730168	43 21 45.0 083 56 07.0 4	0	CASS RIVER AT SHERIDAN ROAD.	26145	SAGINAW CO., MI	
AMO	21MICH	730186	43 19 50.0 083 42 53.0 2	0	CASS R. AT RODAMMER RD.	26145	SAGINAW CO., MI	
ANO	21MICH	730187	43 19 18.0 083 47 38.0 2	0	DEAD CREEK AT CURTIS RD.	26145	SAGINAW CO., MI	
AOO	21MICH	730188	43 20 56.0 083 53 02.0 2	0	CASS R. AT FAYETTE STREET	26145	SAGINAW CO., MI	
APO	21MICH	730239	43 21 17.0 083 53 52.0 2	0	CASS R. DWNSTR BRIDGEPORT WWTP	26145	SAGINAW CO., MI	
AQO	21MICH	730240	43 19 42.0 083 44 51.0 2	0	CASS R. DWNSTR FRANKENMUTH WWTP	26145	SAGINAW CO., MI	
ARO	21MICH	730242	43 21 12.0 084 03 20.0 2	0	SHIAWASSEE R 100YD UPSTR FLINT R	26145	SAGINAW CO., MI	
ASO	21MICH	730243	43 21 30.0 084 00 05.0 2	0	FLINT RIVER AT FERGUSON BAYOU	26145	SAGINAW CO., MI	
ATO	21MICH	730244	43 23 39.0 083 57 51.0 2	0	SAGINAW RIVER AT WICKS PARK	26145	SAGINAW CO., MI	
AUO	21MICH	730245	43 25 55.0 084 01 30.0 2	0	TITTABAWASSEE R @ SAGINAW TWP PK	26145	SAGINAW CO., MI	
AVO	21MICH	760011	43 21 03.0 082 58 38.0 2	0	S.BR.CASS R. AT FRENCH LINE RD.	26151	SANILAC CO., MI	
AWO	21MICH	760012	43 33 08.0 083 05 42.0 2	0	CASS RIVER AT M-53 BRIDGE	26151	SANILAC CO., MI	
AXO	21MICH	760080	43 21 29.0 083 01 37.0 2	0	DUFF CREEK AT FRENCH LINE RD	26151	SANILAC CO., MI	
AYO	21MICH	760109	43 39 04.0 082 56 15.0 2	0	S FK CASS R AT M-19 BRIDGE	26151	SANILAC CO., MI	
BAO	21MICH	760123	43 22 17.5 082 58 47.5 2	0	DUFF CR. UPSTR SOUTH BR. CASS R.	26151	SANILAC CO., MI	
BBO	21MICH	760124	43 21 35.0 083 01 33.0 2	0	DUFF CREEK AT WOOD ROAD	26151	SANILAC CO., MI	
BCO	21MICH	760125	43 20 33.0 083 03 18.0 2	0	DUFF CREEK AT MAYVILLE ROAD	26151	SANILAC CO., MI	
BDO	21MICH	760126	43 19 47.0 083 03 52.0 2	0	DUFF CREEK AT BOYNE ROAD	26151	SANILAC CO., MI	
BEO	21MICH	760127	43 19 44.0 083 04 02.5 2	0	DUFF CR JUST UPSTR MARLETTE WWTP	26151	SANILAC CO., MI	
BFO	21MICH	760128	43 19 45.0 083 04 18.0 2	0	DUFF CR.400YD UPST MARLETTE WWTP	26151	SANILAC CO., MI	
BGO	21MICH	790001	43 36 06.0 083 08 12.5 2	0	N.BR. CASS R. AT M-81 BR.	26157	TUSCOLA CO., MI	
BHO	21MICH	790002	43 34 05.0 083 13 25.0 2	0	CASS R. AT HURDS CORNER ROAD.	26157	TUSCOLA CO., MI	
BIO	21MICH	790003	43 19 27.0 083 39 07.0 4	0	PERRY CREEK AT ORMES ROAD.	26157	TUSCOLA CO., MI	

WATER QUALITY DATA ANALYSIS
TECHNIQUE
2-7

RETRIEVAL OF INTENSIVE SURVEY INFORMATION

This technique permits the analyst to list all intensive surveys stored in the system that meet user-specified criteria for geographic location, date, parameters measured, and/or other important factors. It can provide a specific breakdown of intensive survey activity in a limited area of interest or a broad, nation-wide review.

TECHNIQUE: Use the Intensive Survey Directory File retrieval procedure ISFIND.

DATA REQUIREMENTS: In response to system queries, enter appropriate criteria to characterize the intensive surveys to be retrieved. Valid retrieval criteria include geographic location, date, parameters or groups of parameters measured, survey purpose, pollution source or problem evaluated, land and/or water use, water body type, sample type, and source of funding.

OUTPUT: For each survey that meets specified retrieval criteria, a list of intensive survey numbers will be printed; corresponding agency and station codes may also be listed, if desired. Intensive survey numbers are in the form yyssnn, where yy is the year in which the survey was begun, ss is the FIPS State code, and nn is a unique two-digit number within the State and year.

DOCUMENTATION: Part WQ, Appendix G.

NOTES: This technique retrieves only descriptive intensive survey information stored using the new storage procedure ISDESC. Parametric data for the stations identified using this procedure may be retrieved using standard Water Quality File retrieval programs.

Until this new capability has been fully implemented, data available for application of this technique may be limited.

EXAMPLE:

When this capability is operational, the analyst will be able to request, e.g., a listing of all intensive surveys conducted in the State of Michigan for the purpose of assessing eutrophication problems. Output would be a list of the unique numbers associated with surveys meeting those criteria, with or without agency and station codes.

WATER QUALITY DATA ANALYSIS
TECHNIQUE
2-8

SUMMARIZING MONITORING ACTIVITIES

This technique can be used to tabulate the number of stations added to and deleted from a monitoring network within a specified time frame, as well as the numbers of observations and numbers of samples collected during that time. In addition, summary information is provided about each parameter sampled. The output can be used to give a broad picture of an agency's sampling activities without necessitating the printing of information for each individual station.

TECHNIQUE: Use the Water Quality File retrieval program INVENT or INV120; request that individual station summaries be suppressed.

DATA REQUIREMENTS: Enter appropriate station identification and data selection keywords to define the geographic area and time period of interest.

OUTPUT: The number of stations added to and deleted from the monitoring network specified will be tabulated, as well as the number of observations and samples collected and the period of record for stations deleted during that time frame. A second table summarizing the parametric data collected will also print.

DOCUMENTATION: Part WQ, Chapter RET, Section 6.

NOTES: The example shows output from the program INVENT. If the INV120 program is used, the two columns listing the coefficients of variation and standard errors will not print.

EXAMPLE: These two computer printouts summarize the monitoring activities conducted by the State of Michigan over the entire period of record.

	STA BEG	STA END	# OF OBS	# OF SAMPLE	STA END-PERIOD OF RECD IN YRS =0	<.5	<3	>=3
<1960	58	11	4033	940	0	7	1	3
1960	24	4	2311	676	0	4	0	0
1961	11	0	1153	287	0	0	0	0
1962	11	7	1314	344	0	1	6	0
1963	24	2	7994	798	0	0	2	0
1964	31	13	8288	1130	0	13	0	0
1965	20	0	7830	1016	0	0	0	0
1966	204	44	12773	2166	0	40	4	0
1967	366	68	25453	3447	0	61	5	2
1968	557	52	31913	6135	0	32	17	3
1969	65	31	52073	5105	0	22	5	4
1970	145	124	58707	5625	0	24	27	73
1971	215	136	69899	6362	0	51	20	65
1972	168	406	79734	6726	0	101	25	280
1973	460	438	94247	7117	0	328	35	75
1974	481	757	138528	9579	0	360	63	334
1975	289	535	77327	5051	0	245	113	177
1976	230	326	63923	3485	0	216	12	98
1977	158	214	69375	4362	0	135	23	56
1978	102	332	55919	3047	0	98	42	192
1979	1	120	8706	455	0	1	5	114
TOTAL	3620	3620	871500	73853	0	1739	405	1476

PARAMETER				NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00001	[illegible]LOC	FT FROM	RT BANK	54	43.5926	2497.08	49.9707	1.14631	6.80016	200.000	1.00000	71/07/13	71/09/09
00004	STREAM	WIDTH	FEET	1	.000000					.000000	.000000	74/12/12	74/12/12
00008	LAB	IDENT.	NUMBER	165	3851.13	8790684	2964.91	.769880	230.818	16144.0	5.00000	69/08/12	76/09/22
00010	WATER	TEMP	CENT	54735	15.7314	74.4841	8.63042	.548611	.036889	396.000	.000000	20/06/25	79/05/08
00011	WATER	TEMP	FAHN	4	54.6250	366.896	19.1545	.350655	9.57726	74.0000	30.0000	74/05/50	74/05/50
00015	THERMAL	MILLION	BTU/HOUR	4	10.5300	178.604	13.3643	1.26916	6.68214	30.0000	.330000	74/05/50	74/05/50
00016	DT FROM	NATURAL	CENT	4	19.5750	80.9892	8.99940	.459739	4.49970	30.0000	9.00000	74/05/50	74/05/50
00020	AIR	TEMP	CENT	10242	22.7503	39.4470	6.28069	.276070	.062060	36.5000	-.500E+01	20/06/25	73/09/27
00023	WEIGHT		POUNDS	1125	3.33792	9.00248	3.00041	.898886	.089455	24.4000	.000000	74/02/06	75/12/05
00024	LENGTH		INCHES	1238	18.1457	44.2309	6.65063	.366513	.185313	43.6000	.000000	71/07/01	78/05/02
00030	INCDT LT	SURF	C/SQCM/D	125	95.7600	25879.2	160.870	1.67993	14.3887	1100.00	4.00000	66/04/15	68/12/10
00032	CLOUD	COVER	PERCENT	14066	46.6202	1589.28	39.8658	.855118	.336136	100.000	.000000	20/06/25	79/03/21
00035	WIND	VELOCITY	MPH	13417	7.64470	43.9578	6.63007	.867276	.057239	80.0000	.000000	20/06/25	76/07/29
00036	WIND	DIR.FROM	NORTH-0	12483	197.383	9474.07	97.3348	.493128	.871182	360.000	.000000	20/06/25	76/06/24
00037	WIND	FORCE	BEAUFORT	3	.900000	.003601	.060005	.066672	.034644	.960000	.840000	74/02/20	74/02/20
00045	PRECIP	TOT DAY	IN	4497	1568.07	.417E+10	64610.0	41.2034	963.470	4200000	.000000	66/04/25	78/09/30
00050	EVAP	TOT DAY	IN	1	13.0000					13.0000	13.0000	71/06/22	71/06/22
00060	STREAM	FLOW	CFS	16079	2634.53	.369E+09	19216.8	7.29421	151.548	239000	.000000	55/05/31	78/09/26
00061	STREAM	FLOW,	INST-CFS	799	857.615	1514482	1230.64	1.43496	43.5370	7360.00	1.40000	73/11/20	78/09/26
00070	TURB	JKS	JTU	6821	12.6819	520.153	22.8069	1.79838	.276148	680.000	.000000	67/07/10	74/11/19
00075	TURB	HELGE	PPM SIO2	760	10.7557	418.013	20.4454	1.90088	.741632	260.000	.110000	73/11/05	75/06/30
00076	TURB	TRBIDMTR	HACH FTU	10336	7.42669	240.192	15.4981	2.08681	.150276	410.000	.100000	73/09/26	79/04/17
00077	TRANSP	SECCHI	INCHES	903	90.0089	5150.96	71.7702	.797368	2.38836	720.000	6.00000	50/07/08	79/05/08
00080	COLOR	PT-CO	UNITS	3293	23.5612	911.913	30.1979	1.28168	.526236	400.000	.000000	67/07/10	79/04/16
00087	ODOR	THRSH NO	AT 40C	4	9.00000	14.6667	3.82971	.425523	1.91485	12.0000	4.00000	72/03/02	72/03/03
00095	CNDUCTVY	AT 25C	MICROMHO	24684	477.501	1705885	1306.10	2.73527	8.31318	200000	7.50000	61/08/14	79/04/17
00250	INVALID	PAR	NUMBER	1	700.000					700.000	700.000	75/07/23	75/07/23
00252	BOD 5-DA	SEDIMENT	MG/KG	23	7503.08	.485E+08	6965.45	.916134	1452.40	25800.0	71.0000	73/08/22	73/08/22
00300	DO		MG/L	35811	8.45967	9.37193	3.06136	.361877	.016177	30.0000	.000000	50/07/07	79/05/08
00304	BOD	2 DAY	MG/L	39	2.79743	2.60709	1.61465	.577190	.258551	6.20000	.500000	76/07/20	76/08/17
00305	BOD	3 DAY	MG/L	15	1.02667	.073525	.271154	.264111	.070012	1.70000	.700000	76/09/15	76/09/15
00310	BOD	5 DAY	MG/L	24463	18.7098	2707597	1663.61	88.9164	10.6364	260000	.000000	59/07/28	79/04/17
00320	BOD	ULT 1RST	MG/L	99	8.55997	23.2696	4.82386	.563537	.508479	25.0000	1.00000	73/07/02	74/09/04
00322	BOD	10 DAY	MG/L	8	4.63750	2.95413	1.71876	.370622	.607672	7.80000	2.30000	60/08/29	60/08/29
00324	BOD	20 DAY	MG/L	1011	9.28145	59.2751	7.69903	.829509	.242137	79.2000	.500000	74/07/08	78/08/23
00325	OXY [illegible]	BASE E	PER DAY	19	.137631	.035168	.187531	1.36256	.043023	.900000	.050000	67/12/20	70/09/17
[illegible]	BOD	12 DAY	MG/L	48	6.43456	30.7226	5.54280	.857413	.800034	25.0000	1.70000	76/07/20	76/09/15
[illegible]	BOD	13 DAY	MG/L	33	20.2454	12.8718	3.58773	.177212	.624544	24.5000	1 .6000	78/05/23	78/05/23
[illegible]	COD	LOWLEVEL	MG/L	6663	22.1889	2253.33	47.4692	2.13933	.581537	2800.00	.000000	63/03/11	79/04/17
[illegible]	COD	DRY WGT	MG/KG	260	52739.3	.120E+11	109787	2.08168	6808.67	660000	200.000	73/08/22	78/01/24

MANAGER'S GUIDE
TO
STORET

CHAPTER
3

EXISTING WATER QUALITY
AND
HISTORICAL TRENDS

CHAPTER 3

EXISTING WATER QUALITY AND HISTORICAL TRENDS

In 1972, the Federal Water Pollution Control Act set as national goals the achievement of "fishable/swimmable" water quality by 1983 and zero discharge of pollutants to U.S. waters by 1985. To assess progress toward these goals, Section 305(b) of the Act, as amended, requires that each State prepare a biennial report to the Congress that will include, among other things, a description of the current water quality within the State and an analysis of the extent to which pollution control programs have been successful and can be expected to facilitate the achievement of the 1983 and 1985 objectives.

This type of reporting requires quantitative assessments of both existing water quality and historical trends. STORET provides the planner with efficient mechanisms for both types of analyses. Projections of future water quality, while they will necessarily be more qualitative in nature, can also draw upon STORET data to a certain extent.

EXISTING WATER QUALITY

There is no uniform definition of the time period to be considered in evaluations of "existing" water quality. Analyses may be based on a minimum of one year's collection of data, so that seasonal variations will be taken into account, or only on data collected during critical time periods, so that worst-case conditions can be assessed. For the biennial 305(b) reports, conclusions are to be based on data collected over the previous 2 water years (e.g., the 1980 reports draw on the results of monitoring conducted from October 1977 through September 1979).

In some cases, only critical period data are used, and that period may be defined by specific dates and/or flow and water temperature conditions. STORET provides the analyst with the capability of limiting a retrieval to data that fulfill any of these types of criteria. It should be mentioned, however, that retrievals based on flow values will be effective only if data are stored in STORET under the appropriate parameter codes. If flow data have not been collected at the STORET stations of interest, it may be necessary to interpolate using USGS flow data collected at nearby gaging stations.[1]

In other instances, critical conditions may be defined on the basis of spatial criteria. For example, worst-case evaluations

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[1]Technique 3-1: Transfer of USGS Flow Data to STORET Stations.

might be conducted using only data collected in the immediate vicinity of point source outfalls or near specified land uses (e.g., to evaluate the effects of urban or agricultural runoff). In any case, where assessments of existing conditions are based on data collected at critical times or locations, selection criteria should be clearly identified.

Once data selection criteria have been defined, the analyst must decide what type of data summary best suits his present information requirements. For 305(b) reporting, guidance suggests that existing and projected water quality conditions in each stream segment be reported (as depicted in Table 3-1) using numerical codes representative of the frequency of water quality standards violations.[2] For other applications statistical summary or mapping techniques may be more appropriate.[3] Where data to be aggregated have been collected over a relatively lengthy period of time, existing conditions may best be evaluated using techniques normally reserved for trend analysis studies, as discussed below.

HISTORICAL TRENDS

Water quality trend analysis can provide insights into the magnitude of water quality improvement or impairment in a specified area of concern and can indicate the impact of pollution control programs on water quality. Inferences also can be drawn using this type of analysis as to the need, if any, for additional pollution abatement programs.

Like assessments of existing conditions, trend analyses may be conducted using all data available for a particular stream segment or using only data collected at a specified critical time or location. Of primary concern here, however, is the comparability of recent and historical data. Because so many parameter values are significantly affected by changes in flow, water temperature, or other seasonal factors, the data should be normalized with respect to these factors, if possible, before further statistical manipulations are requested. Table 3-2 lists the 11 major parameter groups defined in the 305(b) guidance and indicates whether or not their values are generally dependent on flow, temperature, or season.

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[2]Technique 3-3: Assessing Existing Conditions in Terms of Standards Violations.

[3]Technique 3-5: Illustration of Historical Trends Using Statistical Summaries and Technique 3-4: Generation of Area-Shaded Maps, respectively.

TABLE 3-1
PROPOSED 305(B) REPORTING FORMAT

Segment	Classification/Remarks	THERMAL	OXYGEN DEPLETION	NUTRIENTS (Specify)	BACTERIA	SUSPENDED SOLIDS	DISSOLVED SOLIDS	pH	OIL AND GREASE	HEAVY METALS (Specify)	PESTICIDES (Specify)	OTHER TOXICS (Specify)
01-Current	Appearance of the stream is still extremely poor due to upstream segment. Class A.	0 △	3 MU CS ↑	3 MU CS U ↑	3 CS U ↑	3 MU ↑	3 MU CS U ↑	0 △	3 CS ↑	3 MU ↑	0 ↑	X △
01-Projected	Natural conditions influence violations. Class A.	0	2 C	2 CS U	3 CS U	3 MU	3 CS	0	2 CS	1 MU	0	0
02-Current	Problems are from upstream segment. Class SA.	0 △	3 MU CS →	3 D MU CS →	3 D MU CS →	3 CS MU ↓	2 MU →	0 △	0 △	0 △	0 △	3 MU →
02-Projected	Insufficient data to fully evaluate. Segment is used for water supply. Class SA.	0	1 CS	2 D MU	3 D CS	2 CS	1 MU	0	0	0	0	0

NOTES TO TABLE:

Degree of Problem

3-Major: Repeated standards violations or other severe effects (i.e. large algal blooms).
2-Moderate: Occasional standards violations or other effects,
1-Minor: Some effects but uses generally not impaired.
0-None: No noticeable effects.
X- Insufficient information for assessments.
* Unknown

Sources

Point
MU - Municipal
J - Industrial
CS - Combined Sewer Overflow

Non-Point
U - Urban
A - Agriculture
S - Silviculture
M - Mining
H - Hydrologic Modification
D - Individual
W - Solid Waste Disposal
O - Construction
Ø - Other (Specify)

Historical Trends
↑ Improvement
↓ Degredation
→ No Change
△ Trend Unknown

It is relatively simple to normalize STORET data with respect to flow -- by requesting that values be reported in terms of equivalent loads (mass as a function of time, commonly reported in pounds per day) instead of in terms of raw concentrations.[4]

TABLE 3-2
PARAMETER GROUPS AFFECTED BY FLOW, TEMPERATURE AND SEASONAL VARIATIONS

	Flow	Temperature	Seasonal
1. Thermal	X	X	X
2. Dissolved Oxygen Depletion	X	X	X
3. Nutrients	X	X	X
4. Bacteria	X	X	X
5. Suspended Solids	X		
6. Dissolved Solids	X		
7. pH	X		
8. Oil and Grease	X		
9. Heavy Metals	X		
10. Pesticides	X		X
11. Other Toxics	X		

The normalization of water quality data with respect to temperature is more complicated. For dissolved oxygen (DO), values are best normalized with respect to water temperature by computing the dissolved oxygen deficit (the difference between DO saturation and observed DO values). Although STORET does not provide for this type of arithmetic calculation, the analyst may retrieve values for both observed DO and DO saturation and elect to do the arithmetic himself. If the necessary calculations are

[4]Technique 3-2: Calculation of Equivalent Loads.

to be performed by computer, STORET output can be obtained on tape, disk, or punched cards.[5]

Seasonal variations are best accounted for by restricting a retrieval to data collected during critical time periods.

Once the data have been normalized as much as possible, it may be necessary to aggregate and summarize the normalized values in order to depict trends on the scale required. For instance, for 305(b) reporting, trends are to be reported by parameter group, within individual stream segments. If data are available for more than one station on that segment, or on more than one parameter in a specified group of parameters, it will be necessary either to aggregate the data; to choose the station and parameter that are most representative or for which the greatest amount of data are available; or to calculate trends for each station and each parameter, and then compare results to arrive at the appropriate trend symbol required on the reporting matrix (see Table 3-1).

Because STORET has such a wide variety of techniques that can be used for the purposes of trend analysis, a decision also must be made as to the output format that best suits present water quality management requirements. It is possible to illustrate trends in STORET data using statistical summaries, maps, or any of three different types of digital or line printer plots.[6] Depending upon the intended application of the analysis results, and the amount of data available, the analyst can judge which output format is most appropriate.

After trends have been measured, it may also be necessary to determine whether the observed upward or downward tendency is statistically significant. In many cases, assessments of statistical significance require analytical capabilities not directly available through the Water Quality File programs, but such procedures are available through standard, commercially available statistical packages like SAS.[7]

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[5]Technique 3-10: Formatting STORET Data for Input into SAS (Statistical Analysis System) and Technique 3-11: Output of STORET Data on Punched Cards.

[6]Technique 3-5: Illustration of Historical Trends Using Statistical Summaries; Technique 3-6: Plotting Trends over Time; Technique 3-7: Generation of Trend Maps; Technique 3-8: Plotting Stream Profiles; and Technique 3-9: Linear Regressions of Concentration Versus Time.

[7]Technique 3-10: Formatting STORET Data for Input into SAS (Statistical Analysis System).

PROJECTIONS

In addition to assessments of existing and historical conditions, water quality management program requirements may also call for projections of future water quality. While it is usually not appropriate simply to extrapolate historical trends into the future, historical data can still be used to advantage in this type of analysis -- either to provide a baseline from which qualitative predictions can be made, or to show how developments similar to those expected in the target area have affected water quality in other, similar areas. Where plans have been made for land use changes, hydrologic modifications, water quality control measures, or other pertinent developments, historical data and engineering expertise can often be used to estimate what water quality parameters will be affected, the direction and magnitude of that change, and where the effects are most likely to be felt. Because expert judgement plays a large part in qualitative assessments of this type, the role of the analyst is particularly critical in this phase of water quality management.

In summary, STORET is a valuable tool, which allows the water quality planner to evaluate extensive volumes of data in a systematic manner. General analyses can be conducted over large spatial areas, or specific problem areas can be evaluated in detail. The numerous combinations of spatial and temporal coverage that can be requested, combined with STORET's statistical and plotting capabilities, provide the analyst with an efficient, time-saving mechanism for the evaluation of historical trends in water quality.

WATER QUALITY DATA ANALYSIS
TECHNIQUE
3-1

TRANSFER OF USGS FLOW DATA TO STORET STATIONS

Flow data collected at USGS gaging stations and stored in the STORET Flow Data File can be used to estimate streamflow at established Water Quality File stations. Once flow has been stored, it can be retrieved using any WQF program that retrieves data, including programs that calculate loadings.

TECHNIQUE:	Use the Flow Data File retrieval program FLOSTR.
DATA REQUIREMENTS:	Enter beginning and ending dates, STORET agency and station codes, USGS station codes, and weighting factors relating the flows of the USGS and STORET stations.
OUTPUT:	No printed output is produced. Instead, flow values are automatically stored at the designated WQF station, under parameter code 60. After the weekend STORET update run, flow data may be retrieved using valid WQF procedures.
DOCUMENTATION:	Part FL, Chapter 3.
NOTES:	The Flow Data File contains data that have not yet been verified by Geological Survey personnel, including all values collected during the current or immediately preceding water year. If desired, these unverified data may be excluded from a retrieval. Since USGS provides EPA with updates to the Flow Data File only twice a year, data for recent months may not be available. The analyst may transfer flow data only to stations maintained by his own agency.

WATER QUALITY DATA ANALYSIS TECHNIQUE 3-2

CALCULATION OF EQUIVALENT LOADS

For purposes of comparison, it is often desirable to normalize parametric water quality data with respect to stream flow by calculating equivalent loads. For any samples that include flow measurements, STORET can calculate and print parametric values in terms of equivalent loads.

TECHNIQUE: Use the Water Quality File retrieval program MEAN. Retrieve data for any flow parameter and for other parameters of interest. Request calculation and printing of loadings with or without corresponding raw data values.

DATA REQUIREMENTS: Enter appropriate station identification and data selection keywords to define geographic area and time period of interest. Parameter codes for flow and for the other parameters under consideration must also be included.

OUTPUT: Equivalent loads for each parameter specified will be tabulated, with or without corresponding raw data values.

DOCUMENTATION: Part WQ, Chapter RET, Section 6.

NOTES: Loadings are reported in units of pounds per day, picocuries per day, or number of organisms per day, as appropriate.

Loadings can be calculated using the MEAN, PLOT or MSP retrieval programs. STORET cannot calculate or plot linear regressions of loadings.

EXAMPLE:

This example shows individual values for flow, and both concentrations and loadings for three other parameters, as measured at station 510014.

```
                                                         510014
                                                         44 14 54.4 086 19 24.9 2
                                                         MANISTEE R AT MAPLE ST BRDG; CITY OF MANISTEE
                                                         26101    MANISTEE CO., MI
                                                         MAJ BASIN: LAKE MICHIGAN 081900
                                                         MIN BASIN: MANISTEE RIVER
/TYPA/AMBNT/STREAM                                       21MICH
                                                          0000 FEET  DEPTH  CLASS 00
```

DATE FROM TO	TIME OF DAY	DEPTH FEET	00061 STREAM FLOW, INST-CFS	00940 CHLORIDE CL MG/L	00940 CHLORIDE CL LB/D	03501 BETA TOTAL PC/L	03501 BETA TOTAL PC/D	31616 FEC COLI MFM-FCBR /100ML	31616 FEC COLI MFM-FCBR NO./D
77/10/04	1115		2010.00	30.0000	325244	4.00000	19670.1	410.000	.2016E+14
77/11/08	1330		1920.00	27.0000	279613			130.000	.6106E+13
77/12/19	0820			20.0000				210.000	
78/01/12	1030		7360.00	32.0000	.1270E+07	1.00000	18006.5	140.000	.2520E+14
78/02/14	1030		2460.00	25.0000	331717			120.000	.7222E+13
78/03/21	1325		2010.00	36.0000	390293			90.0000	.4425E+13
78/04/03	1140		4210.00	32.0000	726649	2.00000	20599.8	130.000	.1338E+14
78/05/03	1050		2740.00	30.0000	443368			80.0000	.5362E+13
78/06/06	1355		2140.00	16.7000	192763			100.000	.5235E+13
78/07/25	1145		2070.00	18.9000	211020			140.000	.7090E+13
78/08/09	1210		1530.00	36.0000	297089	1.00000	3743.20	400.000	.1497E+14
78/09/12	1250		1730.00	26.0000	242612			700.000	.2962E+14
78/10/18	0940			29.0000		2.00000		650.000	
78/11/07	0820			30.0000				450.000	

WATER QUALITY DATA ANALYSIS TECHNIQUE 3-3

ASSESSING EXISTING CONDITIONS IN TERMS OF STANDARDS VIOLATIONS

This technique is particularly useful for 305(b) reporting, where the severity of water quality problems is to be assessed in terms of frequency of standards violations.

TECHNIQUE:	Use the Water Quality File retrieval program STAND; specify the printing of a violations summary.
DATA REQUIREMENTS:	Enter station identification and data selection keywords to define geographic area and time period of interest. Also enter up to 50 parameter codes and values for the standards or the criteria to be used as a point of comparison.
OUTPUT:	Output will include station identification information for each station retrieved and a summary of standards violations for each parameter specified.
DOCUMENTATION:	Part WQ, Chapter RET, Section 6.
NOTES:	If State standards are not in the same units as stored data, stored values may be converted using user-supplied conversion factors. Instead of, or in addition to, a violations summary, it is possible to print a criteria summary, or raw values on violations and supporting values, or raw values on violations only. To assess the extent of violations in a stream segment, it is possible to aggregate data from all stations on that segment and to print one violations summary for the entire segment.

EXAMPLE: This example shows summary output from the Water Quality File retrieval program STAND. Standards violations that occurred between October 17, 1977 and January 8, 1979 at station 740022 are summarized.

```
                                                                        STN  1.SUMMARY.1
                                                740022        R00220       INSCR1
                                               42 59 13.5 082 25 29.0 1
                                               WATER INTAKE FROM ST. CLAIR R.
                                               26147   MICHIGAN
                                               CITY OF PORT HURON WTP   0615
                                               ST. CLAIR RIVER BASIN
/NTRTMT/INTAKE/STREAM                          21MICH
                                                0033 FEET  DEPTH  CLASS 00
```

SUMMARY OF VIOLATIONS ON SAMPLES COLLECTED FROM 77/10/17 TO 79/01/08

	01045 IRON FE,TOT UG/L	71900 MERCURY HG,TOTAL UG/L	00410 T ALK CACO3 MG/L	00400 PH SU	32730 PHENOLS TOTAL UG/L
NO OF VALUES	6	5	5	6	6
MEAN	153.2	0.1800	82.33	8.250	1.667
MEDIAN	60.0	0.2000	79.50	8.350	1.550
NO OF VIOLS	1	0	0	2	4
PERCENT VIOL	17.	0.	0.	33.	67.
MINIMUM VIOL	560.0	0.0	0.0	8.700	1.300
MEAN VIOL	560.0	0.0	0.0	8.800	2.425
MAXIMUM VIOL	560.0	0.0	0.0	8.900	4.000
MIN CRITERIA	*********	*********	20.00	6.500	*********
MAX CRITERIA	300.0	0.1000	*********	8.500	1.000

WATER QUALITY DATA ANALYSIS
TECHNIQUE
3-4

GENERATION OF AREA-SHADED MAPS

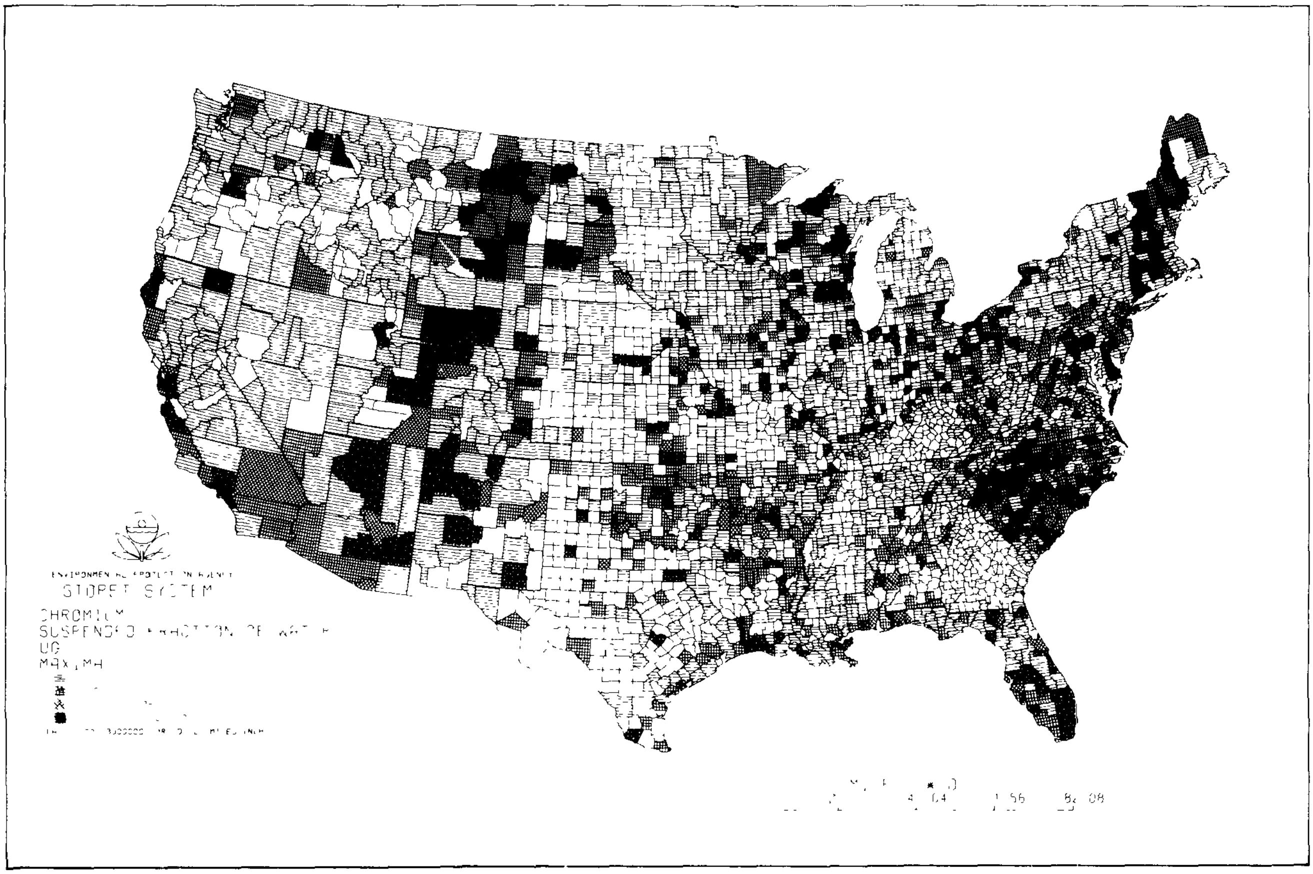
An area-shaded map can provide an effective visual summary of geographical variations in existing water quality. This technique can be particularly useful for highlighting existing or potential problem areas.

TECHNIQUE:	Use the Water Quality File retrieval program MSP. Specify that a water quality map is to be plotted, and that data are to be aggregated by State, by county, by a major, minor, or subbasin, or by a rectangular "cell" defined in seconds of latitude and longitude.
DATA REQUIREMENTS:	Enter station identification keywords to define the geographical area of interest and parameter codes corresponding to the water quality parameters to be examined. Program-specific keywords may be used to establish the time period of interest (if other than the period of record) and up to four data value intervals corresponding to an equal number of shading types.
OUTPUT:	For each plot requested, an area-shaded map is produced, illustrating spatial variations of a single function of a single water quality parameter.
DOCUMENTATION:	Part WQ, Chapter RET, Section 7.
NOTES:	Unless a standard map scale is specified, a default (probably non-standard) scale will be selected, based on the size of the area to be plotted; the maximum size of any STORET map is 24" X 49". Up to 25 plots may be specified in a single retrieval request.

If the range of data values to be plotted is unknown, the user may request that the system supply the appropriate intervals by dividing the data retrieved into four groups, each having an approximately equal number of observations.

EXAMPLE:

This map shows variations in maximum chromium levels across the United States. Data were aggregated by county.



WATER QUALITY DATA ANALYSIS
TECHNIQUE
3-5

ILLUSTRATION OF HISTORICAL TRENDS USING STATISTICAL SUMMARIES

Trend analysis is used for various purposes, notably for a State's 305(b) report. This technique computes yearly statistical summaries of parametric data and allows comparison of those summaries to identify trends.

TECHNIQUE: Use the Water Quality File retrieval program MEAN, and request that all parametric data be converted to loadings; use the statistical functions number of observations, mean, and standard deviation. Print yearly summaries for the period of record and compare yearly means to assess trends.

DATA REQUIREMENTS: Enter station identification keywords to define the geographic area of interest, up to 10 parameter codes per retrieval, including one flow parameter, and a sufficient number of observations for reliable trend analysis.

OUTPUT: For each station retrieved, this technique calculates the number of observations, the mean, and the standard deviation of loadings for all parameters specified, summarized for each year in the period of record.

DOCUMENTATION: *Part WQ, Chapter RET, Section 6.*

NOTES: It is possible to aggregate data from several stations if trends must be assessed in terms of stream segments or reaches, as recommended in the 305(b) reporting guidance.

A similar statistical summary technique can be used for bacteriologic parameters, by calculating a geometric mean instead of an arithmetic mean (refer to Technique 5-1:

Statistical Summaries of Bacteriologic Data).

MEAN program-specific keywords allow the user to eliminate outliers.

If sufficient data are available, the analyst may choose to summarize values collected during critical periods only.

EXAMPLE:

This example shows yearly numbers of observations, mean values, and standard deviations for stream flow and loadings of eight other parameters as measured at station 510014. The retrieval was restricted to observations gathered from 1974 through 1977.

```
                                                            510014
                                                            44 14 54.4 086 19 24.5 2
                                                            MANISTEE R AT MAPLE ST BRIDGE
                                                            26101   MANISTEE CO , MI
                                                            CITY OF MANISTEE        0519
                                                            MANISTEE RIVER BASIN
/TYPA/AMBNT/STREAM                                          21MICH
                                                            0000 FEET  DEPTH  CLASS 00
```

DATE FROM TO	TIME OF DAY	DEPTH FEET	00060 STREAM FLOW CFS	00310 BOD 5 DAY LB/D	00335 COD LOWLEVEL LB/D	00410 T ALK CACO3 LB/D	00630 NO2&NO3 N-TOTAL LB/D	00680 T ORG C C LB/D	03501 BETA TOTAL PC/L	32209 CHLRPHYL A LB/D	47004 TOT DISS SOL-T C LB/D
74/01/01											
YEAR	NUMBER		11.0000	11.0000		11.0000	11.0000		4.00000	2.00000	9.00000
	MEAN		2230.91	19926.0		.1728E+07	2543.90		9383.99	68.3065	.3921E+07
	STAND DEV		356.376	10008.0		278386	1992.90		7975.04	53.4337	620049
75/01/00											
75/01/01											
YEAR	NUMBER		10.0000	10.0000	10.0000	10.0000	10.0000	9.00000	4.00000	3.00000	9.00000
	MEAN		2860.30	24000.8	249280	.2202E+07	3008.51	197889	13256.5	92.6650	.4418E+07
	STAND DEV		744.605	11677.2	171593	576965	1416.25	91401.2	9353.79	59.7273	.1559E+07
76/01/00											
76/01/01											
YEAR	NUMBER		12.0000	11.0000	12.0000	12.0000	12.0000	12.0000	2.00000	1.00000	12.0000
	MEAN		3075.92	21649.8	139968	.2271E+07	3265.21	67073.0	16509.2	79.6474	.4045E+07
	STAND DEV		1340.10	29227.7	91858.3	797537	2420.78	52340.1	9673.93	72.7481	.1308E+07
77/01/00											
77/01/01											
YEAR	NUMBER		5.00000	5.00000	5.00000	5.00000	5.00000	5.00000		5.00000	5.00000
	MEAN		2900.30	13741.3	97206.1	.2426E+07	3410.54	44550.7		50.6720	.3001E+07
	STAND DEV		1657.49	17990.3	22894.6	.1576E+07	3960.40	12442.1		41.2910	.2715E+07
78/01/00											

WATER QUALITY DATA ANALYSIS
TECHNIQUE
3-6

PLOTTING TRENDS OVER TIME

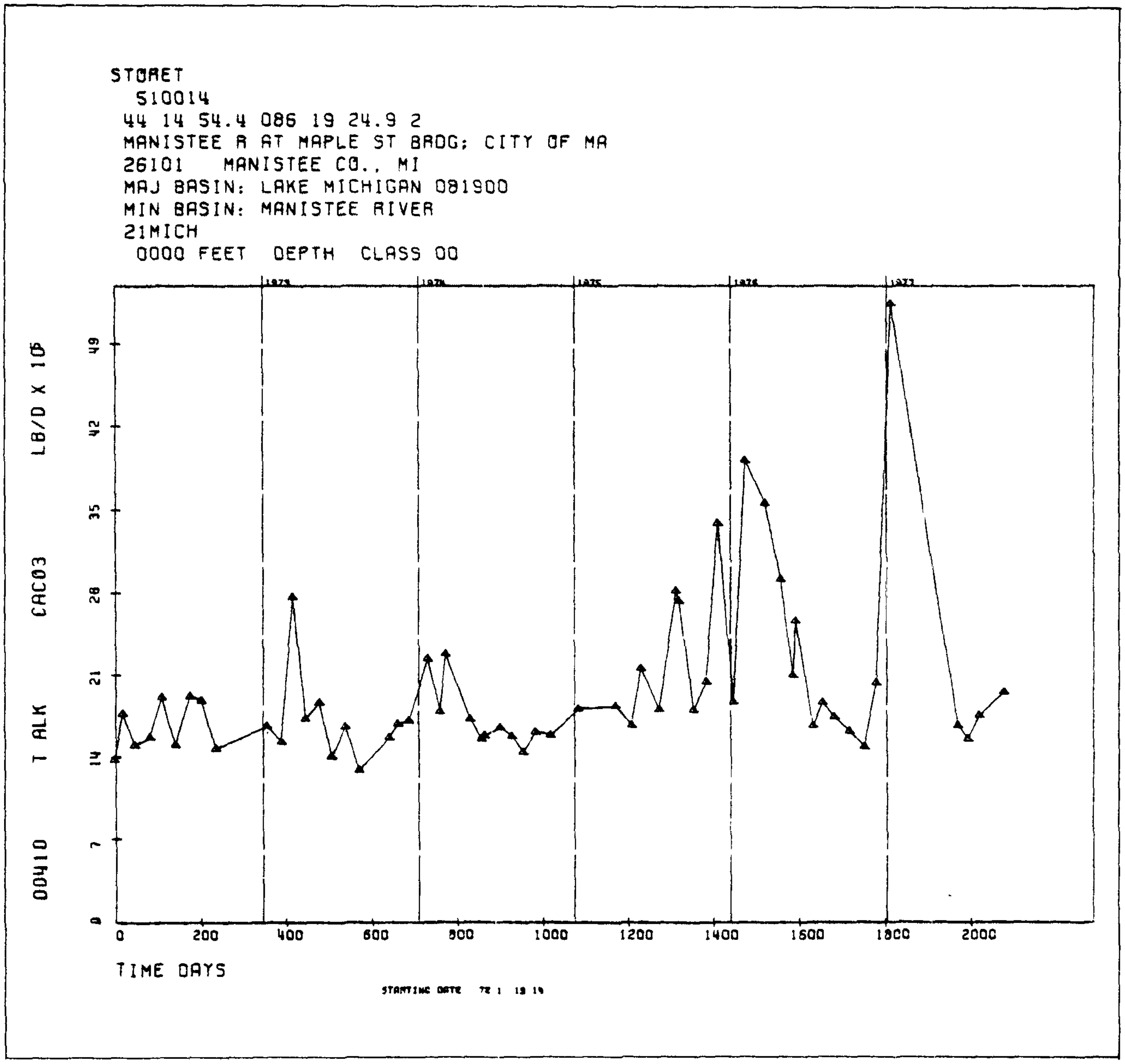
Graphical summaries can provide highly effective illustrations of water quality trends. This technique calculates and plots loadings as a function of time.

TECHNIQUE:	Use the Water Quality File retrieval program PLOT; request that loadings be calculated before plotting.
DATA REQUIREMENTS:	Enter appropriate station identification keywords, up to 10 parameter codes per retrieval, including one flow parameter, and a sufficient number of observations to show meaningful trends.
OUTPUT:	For each station and parameter specified, a plot of loadings vs. time (in days) will be printed.
DOCUMENTATION:	Part WQ, Chapter RET, Section 6.
NOTES:	It is not possible to calculate statistical summaries (e.g., means or standard deviations) of parametric data using the PLOT program; loadings plotted represent values for individual samples. Each plot may represent data from one individual station or an aggregation of data from a group of stations. If plots are requested from more than one sampling station, it is possible to specify that the same scale be used in each case. STORET can also plot raw concentrations or logarithms vs. time (as opposed to loadings vs. time) if necessary. If sufficient data are available, the analyst may choose to plot only those

values collected during critical time periods.

EXAMPLE:

This plot shows total alkalinity loadings, as measured at station 510014 from 1972 through 1977. A slight increase in alkalinity over that time period is evident.



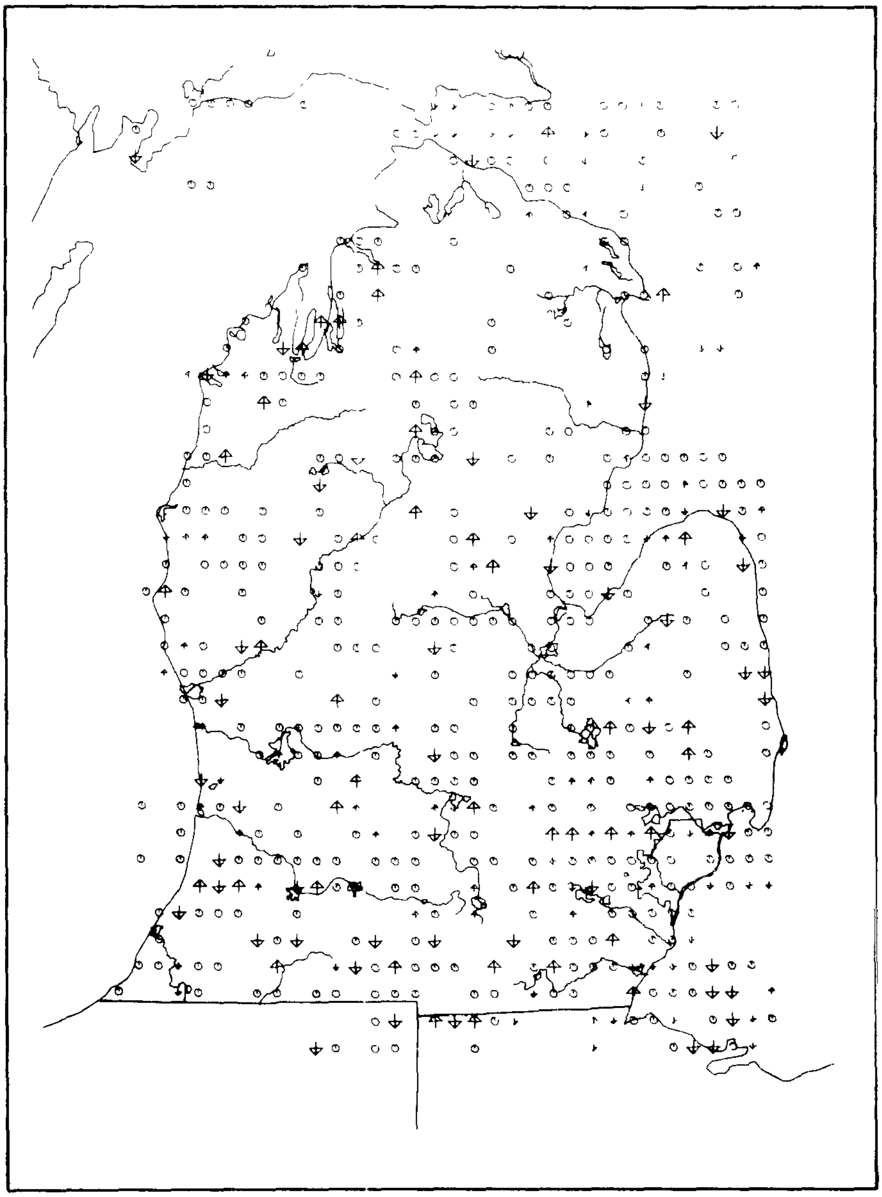
WATER QUALITY DATA ANALYSIS TECHNIQUE 3-7

GENERATION OF TREND MAPS

For purposes of illustration, it is possible to generate maps with appropriate arrows in each latitude/longitude cell, depicting the magnitude and direction of change in water quality from one block of time to another.

TECHNIQUE:	Use the Water Quality File retrieval program MSP; request two separate water quality maps, each depicting mean values of the same parameter in the same geographic area, but for different time periods. Designate one map "early" and the other map "late". Use the trend mapping keyword to combine the two map specifications and produce one trend map.
DATA REQUIREMENTS:	Enter station identification keywords to define the geographic area of interest, and one parameter code.
OUTPUT:	A trend map, with appropriate symbols plotted in each latitude/longitude cell, is plotted to show where parameter concentrations increased, decreased, or remained the same.
DOCUMENTATION:	Part WQ, Chapter RET, Section 7.
NOTES:	It is possible, using the MSP program, to plot trends in terms of logarithms or loadings, and the use of this capability may be desirable in certain situations. If data for the parameter in question are not stored for both specified time periods, no symbol will print in the corresponding latitude/longitude cell.

EXAMPLE: This map shows trends in observed levels of a single parameter in the State of Michigan. Arrows indicate the magnitude and direction of change, circles indicate a change less than 10 percent, and blank spaces indicate insufficient data.



WATER QUALITY DATA ANALYSIS
TECHNIQUE
3-8

PLOTTING STREAM PROFILES

This technique depicts, on a single plot, changes in the value of a single parameter along a waterway in two different time periods. Visual comparisons can illustrate trends over time.

TECHNIQUE: Use the Water Quality File retrieval program MSP and request a single multiple station plot. On the left-hand y-axis, plot mean concentrations for a single parameter at selected stations and during a selected time period. On the right-hand y-axis, plot mean concentrations of the same parameter at the same stations, but over a different time period. Specify that the two y-axes have the same scale.

DATA REQUIREMENTS: Enter appropriate agency and station code pairs or river mile indexes to define geographic area of interest. Also use appropriate data selection keywords to define the time periods in question, and the parameter codes for the parameters of interest.

OUTPUT: A single multiple station plot is produced, comparing changes in parameter values along a waterway for two different time periods -- one plotted on the left, and the other on the right, y-axis.

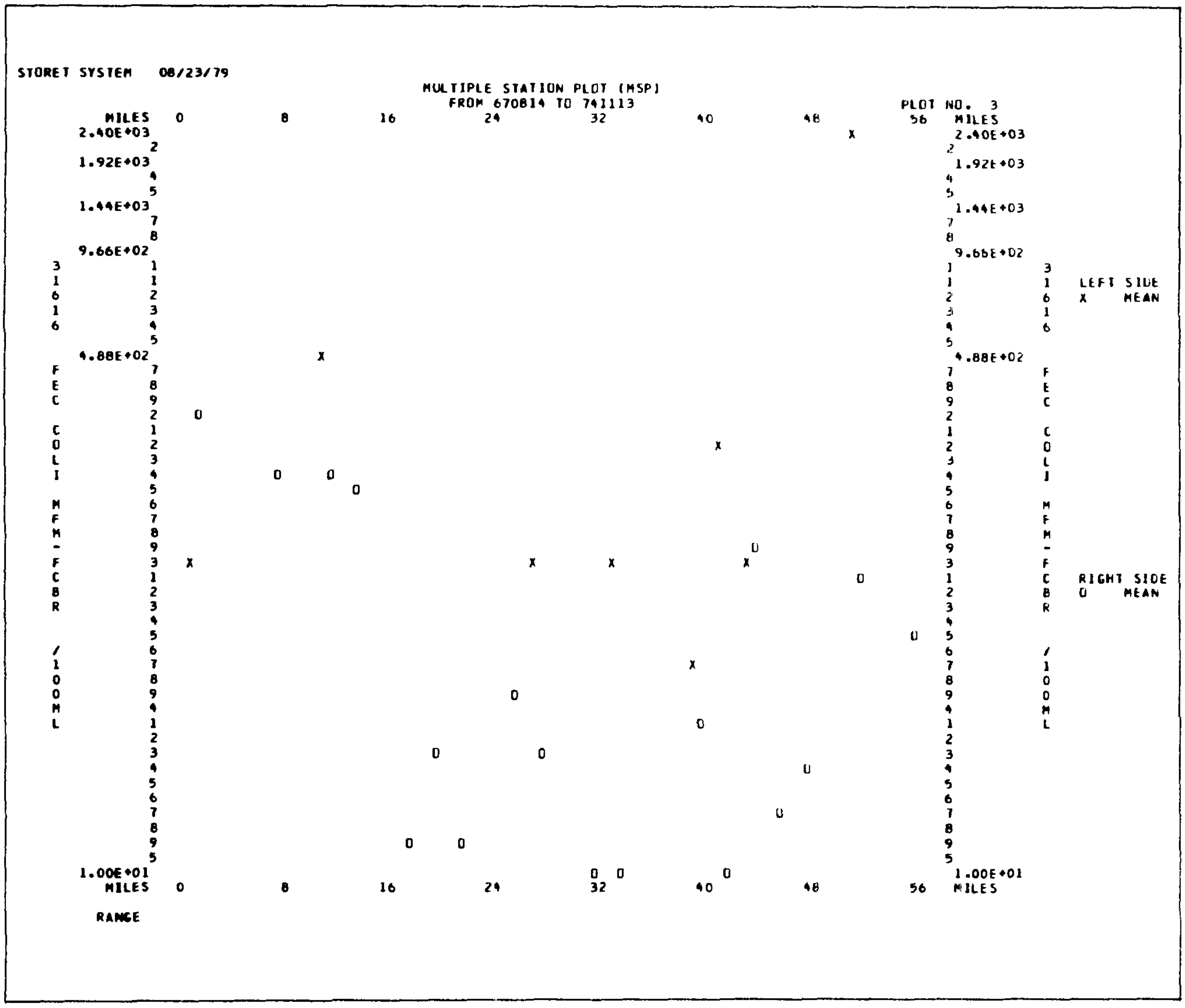
DOCUMENTATION: Part WQ, Chapter RET, Section 7.

NOTES: If river mile indexes (rmi) are not stored at the stations of interest, the plot can be made mileage-linear by inserting appropriate mileages at each station.

Instead of plotting mean concentrations, it is possible to plot mean loadings (if flow data are available) or geometric means.

Any number of stations may be specified but a maximum of 30 stations can be plotted on a single page of output. Plots of data from more than 30 stations will continue on the following page.

EXAMPLE: This example shows variations in levels of fecal coliforms at State sampling sites located along the length of Michigan's Cass River. Geometric means of data values collected prior to 1973 are plotted using the symbol "X", and geometric means of values collected during 1973 and 1974 are plotted using the symbol "O". Note that, in general, values from the later time period are lower.



WATER QUALITY DATA ANALYSIS
TECHNIQUE
3-9

LINEAR REGRESSIONS OF CONCENTRATION VERSUS TIME

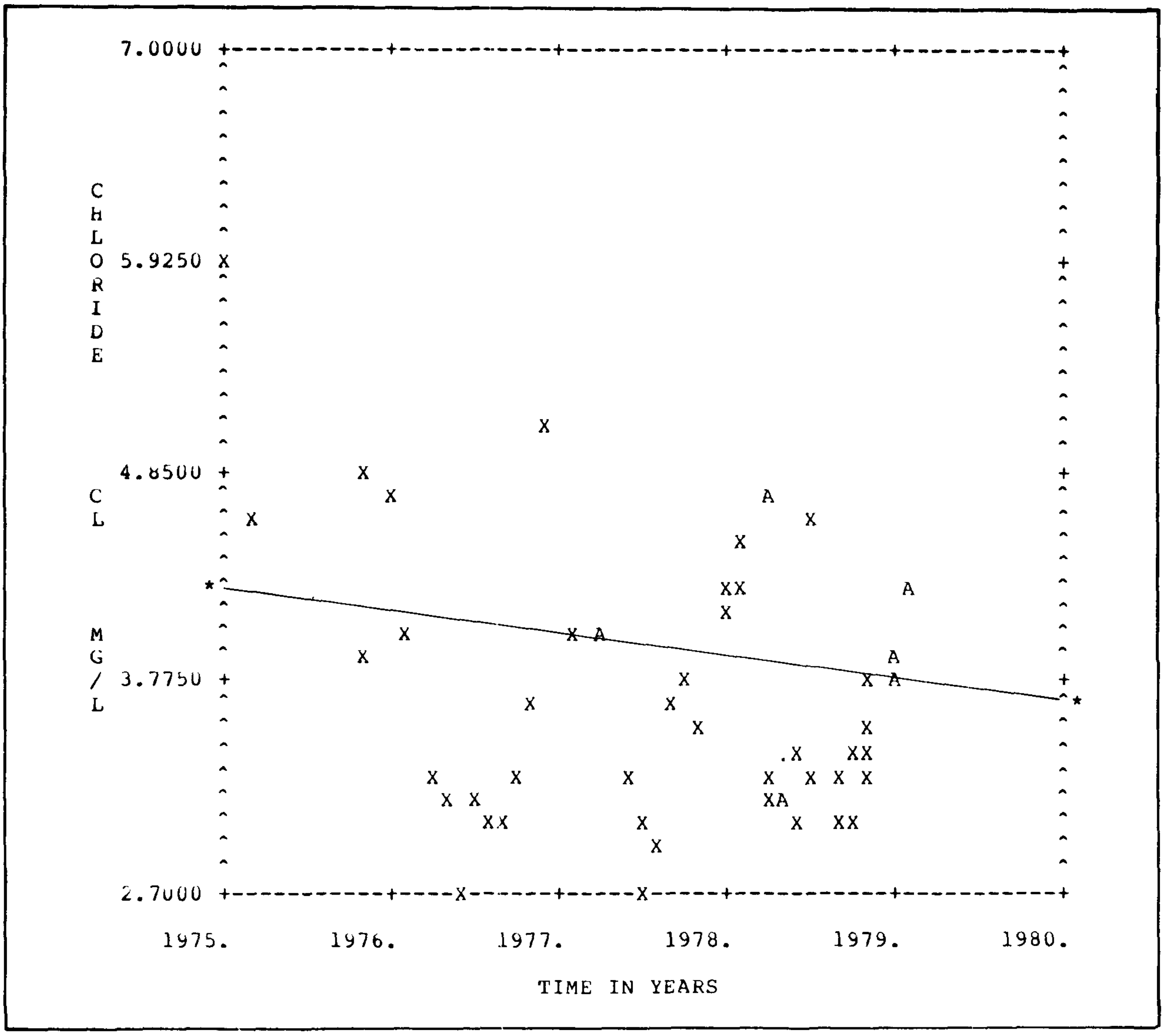
This technique calculates and plots a least-squares linear regression of raw concentrations of a single parameter vs. time at a single station. Statistical summary information also is provided on a separate page of output. The regression line can be an effective visual representation of water quality trends, and accompanying statistics provide valuable supporting evidence.

TECHNIQUE:	Use the Water Quality File retrieval program REG to calculate and plot a regression of parameter values vs. time (Type 1 regression) at a single STORET station.
DATA REQUIREMENTS:	Enter a single agency and station code pair for each plot requested. At least 20 observations for the parameter of interest, collected over a period of less than 20 years, are required.
OUTPUT:	For each regression analysis requested, this program produces a one-page statistical summary and one to four pages of graphic output (scatter diagrams produced by a line printer). Intercepts of the regression line are represented by asterisks (*) and, if a value has been provided for a quality standard line, its intercepts are represented by hyphens (-). Multiple values occurring at the same point are represented by alphabetic characters.
DOCUMENTATION:	Part WQ, Chapter RET, Section 7.
NOTES:	It is also possible to calculate and plot parameter vs. parameter regressions, using values collected at the same station (Type 2) or at different stations (Type 3).

A maximum of 10 stations and 10 parameters may be included in a single retrieval request.

The REG program plots only raw values; loadings and logarithms must be plotted using other WQF retrieval programs.

EXAMPLE: This example shows variations in chloride levels from 1975 through 1979 at a single sampling site. The regression line (drawn in by the analyst) shows that chloride levels have declined slightly over that period.



WATER QUALITY DATA ANALYSIS
TECHNIQUE
3-10

FORMATTING STORET DATA FOR INPUT INTO SAS (STATISTICAL ANALYSIS SYSTEM)

Although STORET has broad capabilities for routine statistical analysis and graphical displays, certain types of analyses cannot be done directly using STORET programs. Most of these functions, including the plotting of statistical summary information for the purposes of trend analysis, can be accomplished through an interface with SAS (Statistical Analysis System). This technique describes the mechanism used to produce a SAS-compatible input file that contains data retrieved from the Water Quality File.

TECHNIQUE: Use the Water Quality File retrieval program RET to produce listings of raw data values, including sampling dates, times, depths, and values of requested parameters; request that these data be reproduced in a machine-readable input file on disk or tape in a format compatible with SAS.

DATA REQUIREMENTS: Enter appropriate station identification and data selection keywords. Up to 50 parameter codes can be specified.

OUTPUT: No hard-copy output is produced. Instead, this technique produces an input file containing parametric data on up to 50 parameters for all stations in the Water Quality File that satisfy the station identification criteria specified. The file created for SAS input contains a 305-character record for each sample, which includes agency and station codes, along with composite data and remark codes, if stored. A 305-character delimiter record follows each data record. All records are in a condensed IBM hexadecimal format; parameter values are expressed in IBM internal floating point binary format.

DOCUMENTATION: Part WQ, Chapter RET, Section 7.

NOTES: The same technique can be used to produce input files in a variety of other formats.

It is also possible to produce machine-readable input files using output from the MEAN or MSP programs.

WATER QUALITY DATA ANALYSIS
TECHNIQUE
3-11

OUTPUT OF STORET DATA ON PUNCHED CARDS

If the analyst wishes to input STORET data into his own programs, retrieval output may be transfered either to an input file on disk or tape, as described in the previous technique, or to punched cards. This technique punches 80-column cards containing station codes, sampling dates and raw data.

TECHNIQUE:	Use the Water Quality File retrieval program PUNCH.
DATA REQUIREMENTS:	Enter station identification and data selection keywords to define the geographic area and time period of interest. Up to six parameter codes can be specified.
OUTPUT:	A deck of 80-column punched cards is produced containing the primary station number, the date and time of sampling, six data values, and a sequence number. Missing values will appear as 9999E-25. The parameter code is not punched, but parameter values are punched in the order specified in the retrieval request.
DOCUMENTATION:	Part WQ, Chapter RET, Section 6.
NOTES:	Unless otherwise specified, this program will also produce a printout of punched values. Card output from this program is not interpreted.

MANAGER'S GUIDE
TO
STORET

CHAPTER
4

POLLUTION SOURCES
AND
CONTROL PROGRAMS

CHAPTER 4

POLLUTION SOURCES AND CONTROL PROGRAMS

The identification of the point and non-point sources of existing and potential water quality problems and the development of plans for water pollution control are key elements of the Federal water quality management program. Cause and effect analyses of this nature are required as part of the management processes mandated by P.L. 92-500, including the implementation of areawide management plans (Section 208), basin plans (Section 209), and permit programs (Section 402), and the fulfillment of periodic reporting requirements (Section 305(b)).

Four interrelated data analysis tasks are involved in the elucidation of cause and effect relationships in the context of the water quality management program:

The identification of present and projected water quality problems, in terms of individual parameters or groups of parameters

The location and characterization of potential point and non-point sources

The establishment of correlations between observed problems and their probable sources, and

The evaluation of alternative structural and nonstructural measures for their control or elimination.

IDENTIFICATION OF WATER QUALITY PROBLEMS

From the point of view of water quality control and management, it is most practical to examine water quality problems in terms of specific parameters -- constituents that may enter a waterway either as a result of man's activities or as part of a natural phenomenon. Both current water quality problems and problems projected under anticipated conditions of population growth and industrial development must be taken into account in such analyses.

To a large extent, STORET capabilities for the identification of problem parameters are covered in Chapter 3. For many purposes, assessments of the severity of a given problem are best illustrated by summarizing standards violations.[1]

As with all water quality data analysis techniques, the validity of problem assessments is dependent on the selection of appropriate time and space scales. Appropriate time scales should take into account the critical period for the parameter in question, its relative chemical reactivity, and the nature of the problem (e.g., long-term accumulations vs. the results of an accidental spill). Selection of space scales also is dependent on parameter reactivity and the type of problem under consideration.

LOCATION AND CHARACTERIZATION OF POLLUTION SOURCES

Concurrently with the identification of problem parameters, the analyst should attempt to identify and characterize all potential point and non-point sources of water pollution. For point sources, this means identification of all major dischargers, including municipal and industrial facilities. For non-point sources, it means identification of dominant land uses in the area, as well as individual sites that could be associated with runoff-related problems. In addition, a comprehensive non-point source inventory requires collection of a wealth of local meteorologic, geographic and demographic information.

STORET has a variety of storage and retrieval capabilities to aid the analyst in the identification and characterization of point sources. Within the Water Quality File, in-plant sampling data may be stored at stations labeled with a special station type code.[2] In addition, capabilities are available for the storage and retrieval of NPDES (National Pollutant Discharge Elimination System) permit conditions, compliance monitoring data, and discharger self-monitoring data -- all under State agency codes assigned specifically for effluent data storage.[3] Using a special STORET command procedure, the analyst may also retrieve permit conditions and effluent data in any one of four alternative formats designed for the reporting of permit violations.[4]

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[1]Technique 3-3: Assessing Existing Conditions in Terms of Standards Violations.

[2]Technique 4-2: Retrieval of In-plant Data.

[3]Technique 4-3: Retrieval of Permit and Effluent Data.

[4]Technique 4-4: Generation of Effluent Reports.

TABLE 4-1
WATER QUALITY PARAMETERS AND POLLUTION PROBLEMS

Parameters	Water Quality & Water Use Problems
Total dissolved solids and chlorides	Agricultural, industrial and domestic water supply
Temperature	Dissolved oxygen; aquatic balance
Carbonaceous BOD & COD, total carbon	Dissolved oxygen; nutrient
Organic nitrogen	Dissolved oxygen; nutrient
Ammonia	Dissolved oxygen; nutrient
Nitrite and nitrate	Nutrient; dissolved oxygen; water supply
Phosphate	Nutrient
CCE (carbon chloroform extractables)	Water supply; food chain
Toxic metals and inorganics	Water supply; food chain
Toxic organics	Water supply; food chain
Bacteria	Water supply; recreational usage
Viruses	Water supply; recreational usage
Floating substances	Recreational usage
Suspended solids	Recreational usage; dissolved oxygen; nutrient; light limitations
Color and turbidity	Recreational usage; light limitations

Further information about municipal dischargers is stored in STORET's Municipal Waste Inventory File (MWIF).[5] The MWIF contains extensive information about the facility location, its treatment processes, projected needs for expansion and upgrading, and related data on construction grants.

Additional data on water and sewage treatment facilities are contained in the City Master File.[6] Because some of the above-mentioned capabilities for storage and retrieval of effluent data are relatively new, it may also be necessary to consult data bases outside of STORET. Potential sources of this type of information include, among others, State or Regional automated effluent data systems, manual files of discharger monitoring reports, and EPA's Permit Compliance System. For specific references to alternative sources of effluent data, refer to Appendix C: Additional Sources of Information.

STORET contains only a limited amount of data applicable to non-point source assessments. Some meteorologic data are stored in the Water Quality File under appropriate parameter codes and at stations labeled with appropriate station type codes.[7] Population figures (results of 1960 and 1970 censuses) are stored in the City Master File.[8] For further, more detailed information, it will be necessary to consult Federal, State, and/or local repositories designed specifically to handle data on land uses, soil types, geomorphology and other non-point source related subjects.

CAUSE AND EFFECT RELATIONSHIPS

Once problem parameters have been identified and potential point and non-point sources have been inventoried, the task of establishing meaningful correlations between the two data sets remains. As a starting point, Table 4-1 presents a preliminary list, relating specific groups of parameters to potential water quality problems and water use impairments. This list is not exhaustive, but it does provide a general guide for the development of more detailed analyses.

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[5]Technique 4-5: Location and Characterization of Municipal Dischargers.

[6]Technique 4-6: Retrieval of Data on Selected Communities or Facilities.

[7]Technique 4-7: Identification of Stations that Sample Weather Data.

[8]Technique 4-6: Retrieval of Data on Selected Communities or Facilities.

For 305(b) reporting purposes, it is recommended that the analyst indicate the general type(s) of point or non-point sources responsible for observed standards violations in each of 11 major parameter groups. Specifically, the 305(b) guidelines suggest characterizing point sources as municipal, industrial, or combined sewer overflows and non-point sources as urban, agricultural, silvicultural, mining, hydrologic modifications, individual, solid waste disposal, construction, or "other". (See Table 3-1.)

The first step in the application of STORET capabilities to cause and effect analyses might be to examine the Water Quality File for intensive survey data. Because intensive surveys are often conducted for the express purpose of defining causative relationships, identification of surveys conducted recently in a specific geographic area could avoid major duplications of effort.[9]

Once that possibility has been explored, more sophisticated data analysis techniques may be brought to bear, keeping in mind fundamental physical, chemical, and biological principles. One of the most basic of these concepts is the principle of conservation of mass. Simply put, this principle states that mass is neither created nor destroyed in any transformation of matter. When applied to water quality management, it requires that the total mass of a pollutant input into a water body be accounted for in any explanation of its subsequent fate.

Application of this principle can help the water quality analyst evaluate the impact of a pollution source. Theoretically, the difference between the mass (equivalent load, usually expressed in pounds per day) of a specified parameter measured upstream of a major point source and the mass measured downstream should be equivalent to the mass discharged by the point source. A demonstration of that type of equivalency can indicate that no other significant source of the parameter in question is acting within the selected ranges of time and space.

Appropriate time and space scales for this type of analysis vary, depending on the reactivity of the parameter to be measured, as illustrated in Figures 4-1 and 4-2. For conservative parameters, such as total nutrients, the data to be evaluated can be collected at reasonable distances upstream and downstream of the point source, as depicted by points A and B in Figure 4-1. Substances that may generally be considered conservative include total nitrogen, total phosphorus, total dissolved solids, and some heavy metals. For highly reactive substances, such as fecal coliforms, data should be collected as close as possible to the point of discharge, as indicated by points C and D in Figure 4-2.

---

[9]Technique 2-7: Retrieval of Intensive Survey Information.

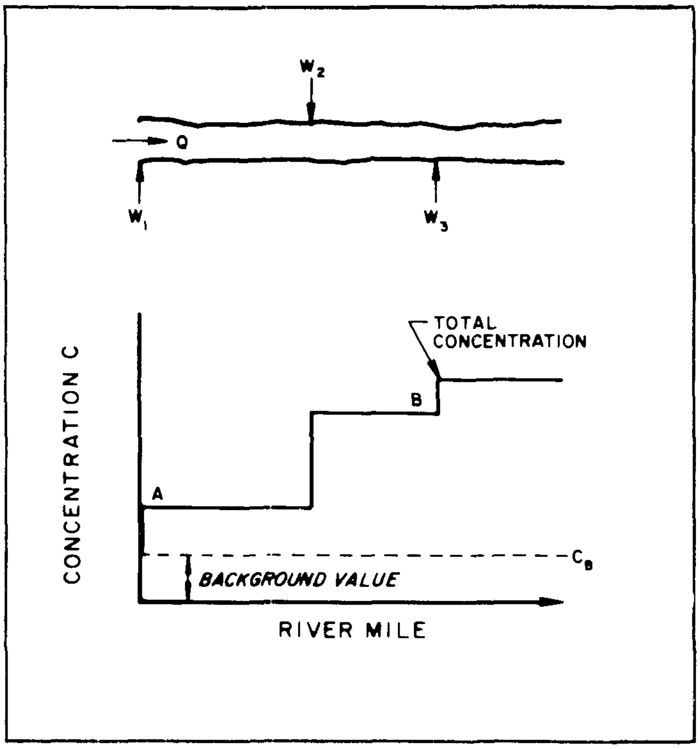


FIGURE 4-1
CONSERVATIVE SUBSTANCES

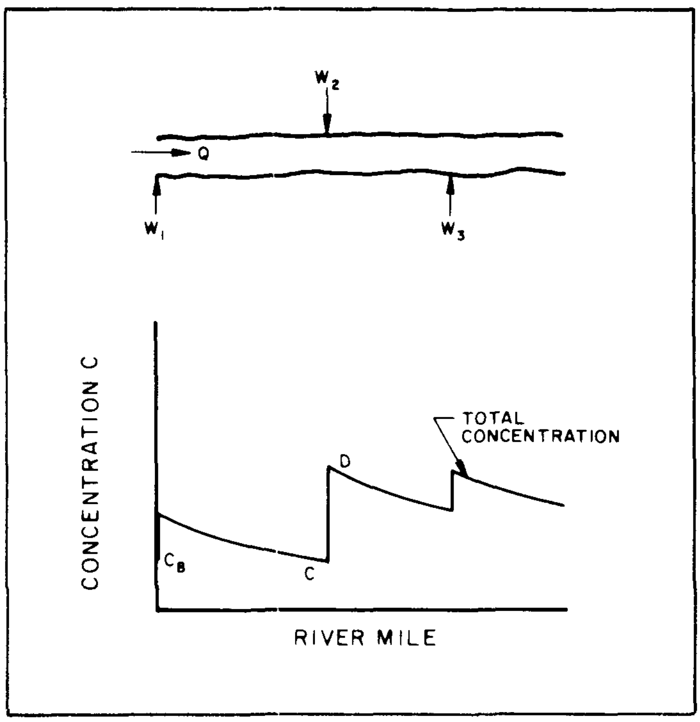


FIGURE 4-2
REACTIVE SUBSTANCES

Parameters generally regarded as reactive include coliform bacteria, biochemical oxygen demand, and ammonia.

Figures 4-1 and 4-2 illustrate typical water quality profiles of parameter concentration vs. river mile for multiple point sources of conservative and reactive parameters. Figure 4-1 shows the additive input of multiple point sources of a conservative substance, while Figure 4-2 shows the fluctuations in parameter concentration expected after multiple inputs of a reactive substance.[10] This type of plot can help pinpoint the source of observed problems and the location of that source in relation to problem areas on the waterway.

In the generation of such a plot, the averaging of data over various spatial and temporal scales may be desirable, and STORET allows the analyst considerable flexibility in that area. Data averaging minimizes random data variability and can provide a better overall picture of water quality trends over time and/or space.

Data retrieved for this type of analysis can also be used in combination with effluent data to estimate the concentration of a discharge constituent in the immediate vicinity of the outfall.[11] This value can be estimated using the following formula:

$$C_o = \frac{C_u Q_u + W}{Q_u + Q_\omega}$$

Where:

C_o = in-stream concentration at the outfall

C_u = upstream concentration

Q_u = upstream flow

Q_ω = waste stream flow

W = mass discharged

C_o should represent the maximum concentration of the parameter in question in that portion of the receiving stream. The relative contribution of the point source to the overall pollution problem can be inferred by comparing C_u to C_o.

---

[10]Technique 4-1: Use of Multiple Station Plots to Assess Cause and Effect.

[11]Technique 4-3: Retrieval of Permit and Effluent Data.

EVALUATION OF CONTROL ALTERNATIVES

Once the probable source of an observed water quality problem has been determined, it is appropriate to consider alternative structural and non-structural plans for its control. Such evaluations may be based strictly on the informed judgement of experienced personnel or, if enough data are available, on the application of more quantitative techniques, such as mathematical water quality modeling. Mathematical modeling can provide the water quality analyst with a firm technical basis for assessing alternative pollution abatement programs. Using estimated future loading conditions, models can be helpful in classifying segments as water quality or effluent limited, as required under Sections 208 and 303(e), and in developing wasteload allocations in those segments classified as effluent limited.

The complexity of mathematical models can vary from simple desk-top calculations to complex three-dimensional, time-variable eutrophication models. The acquisition of prototype data for model calibration and verification is essential to the development of a valid mathematical water quality model, and the amount of prototype data required is usually directly proportional to the model's complexity. STORET can provide the analyst with a valuable source of this prototype data and can help evaluate the adequacy of existing data to develop a given model.

In the absence of sufficient data to develop a mathematical model, alternative proposals for water quality control must be evaluated qualitatively, using experience and technical knowledge.

Once the relative effectiveness of various structural and non-structural controls has been assessed, it is still necessary to put feasible alternatives in a cost-benefit context. Because STORET contains no information on construction costs or related data, this type of evaluation must use data obtained from other sources. Once again, the role of the water quality analyst in this process is critical.

WATER QUALITY DATA ANALYSIS
TECHNIQUE
4-1

USE OF MULTIPLE STATION PLOTS TO ASSESS CAUSE AND EFFECT

This technique produces plots of concentration vs. river mile for selected parameters and stream segments. Cause and effect relationships can be inferred by correlating peaks in plotted values with the locations of point or non-point sources.

TECHNIQUE: Use the Water Quality File retrieval program MSP to generate station- or mileage-linear plots of mean concentrations for parameters of interest. Indicate that each parameter should be plotted on a left-hand axis, to avoid plotting two parameters on the same graph.

DATA REQUIREMENTS: Enter agency and station codes and, if possible, relative mileages for each station to be retrieved (or river mile index for the segment of interest). A maximum of 50 parameter codes may be specified.

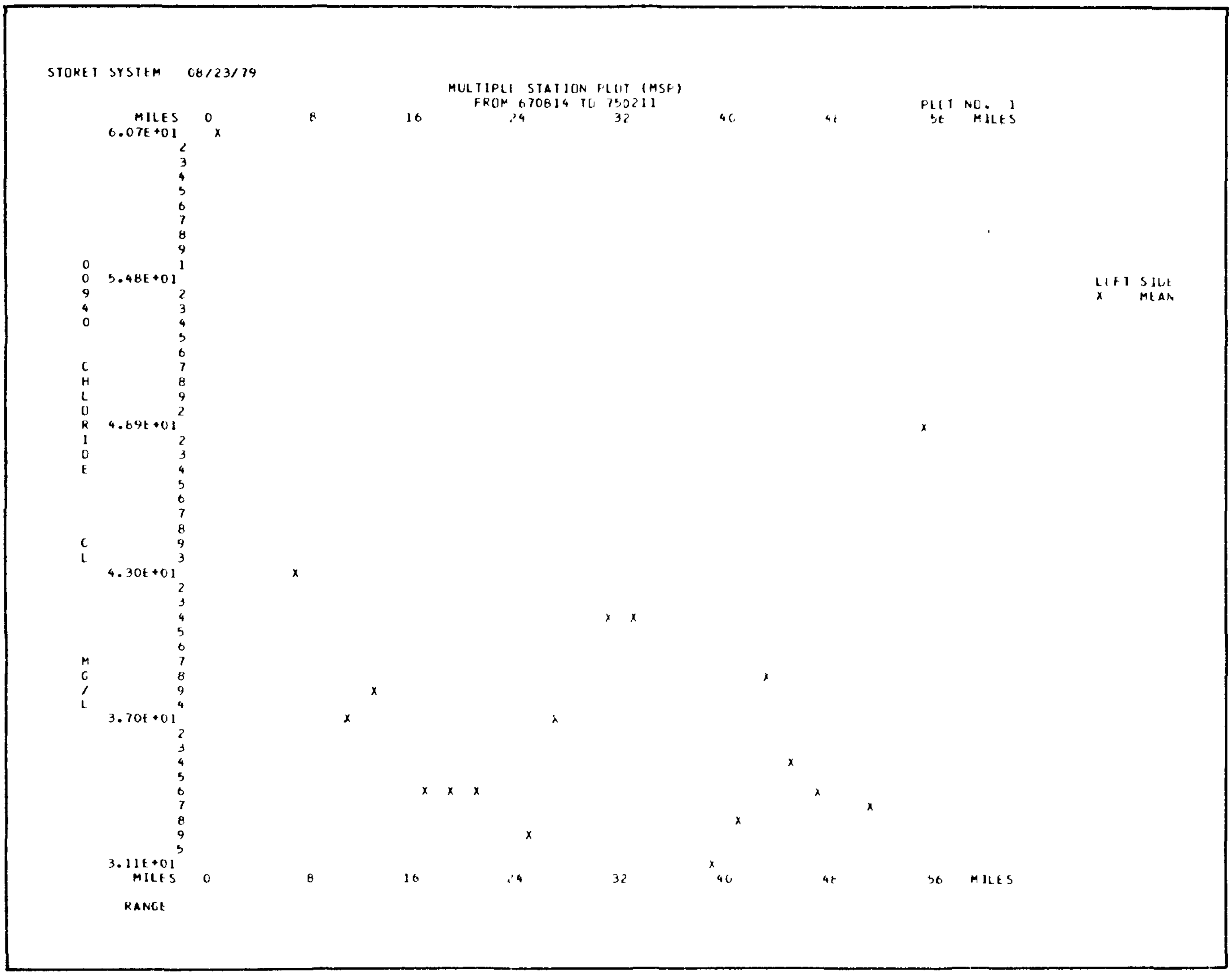
OUTPUT: One mileage- or station-linear plot of mean concentrations will be produced for each parameter requested.

DOCUMENTATION: Part WQ, Chapter RET, Section 7.

NOTES: It is also possible to plot mean loadings or geometric means, if desired, but the maximum number of parameters that may be plotted would decrease to 10.

Any number of stations may be specified, but data from a maximum of 30 stations can be plotted on a single page. If more than 30 stations are retrieved, the plot will continue on subsequent pages.

EXAMPLE: This plot shows variations in mean chloride levels as measured at State stations along the length of Michigan's Cass River. Stations are plotted in upstream order. For purposes of illustration, the analyst could insert appropriate symbols along the x-axis to indicate the locations of waste treatment plants.



WATER QUALITY DATA ANALYSIS TECHNIQUE 4-2

RETRIEVAL OF IN-PLANT DATA

Stations that monitor water quality within man-made facilities (e.g., treatment plants or industrial sites) are labeled with the station type code PIPE. This technique extracts data on all PIPE stations located in a particular geographic area. A comparison among data collected at in-stream stations upstream and downstream of the facility and data collected at these PIPE stations could help establish cause and effect relationships.

TECHNIQUE:	Use the Water Quality File retrieval program ALLPARM; extract all stations labeled PIPE; request printing of raw data and station descriptive paragraphs.
DATA REQUIREMENTS:	Enter appropriate station identification and data selection keywords to define the geographic area and time period of interest.
OUTPUT:	For each station meeting the selection criteria, the following information will be printed: station identification information, a descriptive paragraph (if stored), and tabulations of raw data collected during the specified time period.
DOCUMENTATION:	Part WQ, Chapter RET, Section 6 (ALLPARM Program). Part WQ, Appendix F (Station Type Codes)
NOTES:	Additional station type codes may be stored at PIPE stations to indicate at what stage of treatment the sample was taken and what kind of facility is involved. Not all general retrieval keywords are valid with ALLPARM; refer to the STORET User Handbook for details.

Appropriate combinations of station type codes may be used to further restrict station retrievals to outfalls.

EXAMPLE: The ALLPARM program output below includes a descriptive paragraph and the first page of raw data for station DETWWTP020.

```
                                                            DETWWTP020
                                                            42 16 35.4 083 06 28.0 1
                                                            DETROIT MI
                                                            26163   MICHIGAN
                                                            GREAT LAKES-ST.LAWRENCE
                                                            LAKE ERIE
/TYPA/MUN/TREATD/OUTFL/PIPE                                 115GLRES  770413
                                                             0000 FEET  DEPTH  CLASS 00


                                       DESCRIPTION

              THIS DATA IS FROM SELF MONITORING REPORT FILED BY THE CITY OF DETROIT
              WWTD FOR NPDES PERMIT MI0022802. IT MAY NOT REFLECT FINAL,OFFICIAL,
              REPORTS TO THE PERMIT ISSUING AGENCY,DUE TO THE LANGUAGE OF THE PERMIT.
              ITS PURPOSE IN STORET IS INFORMATIONAL AND STATISICAL. PLEASE CONTACT
              R.M.BUCKLEY AT 313-226-7811 FOR MORE INFORMATION. EST. 4/1/77
              THIS SAMPLING POINT REPRESENT AN ARITHMETIC COMPOSITE OF TWO INFLUENS.
```

```
                                                  DETWWTP020
                                                  42 16 35.4 083 06 28.0 1
                                                  DETROIT MI
                                                  26163 MICHIGAN
                                                  GREAT LAKES-ST.LAWRENCE
                                                  LAKE ERIE
/TYPA/MUN/TREATD/OUTFL/PIPE                       115GLRES  770413
                                                   0000  CLASS 00
```

PARAMETER				NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00310	BOD	5 DAY	MG/L	793	69.5233	564.565	23.7606	.341764	.843763	173.000	11.0000	75/01/01	77/06/28
00400	PH		SU	808	7.30338	.113054	.336235	.046038	.011829	8.30000	6.50000	75/01/01	77/06/30
00530	RESIDUE	TOT NFLT	MG/L	818	122.458	2263.78	47.5792	.388534	1.66357	480.000	18.0000	75/01/01	77/06/30
00535	RESIDUE	VOL NFLT	MG/L	774	70.5543	683.405	26.1420	.370523	.939655	192.000	7.00000	75/01/02	77/06/30
00550	OIL-GRSE	TOT-SXLT	MG/L	802	26.1907	211.270	14.5351	.554974	.513253	109.000	2.40000	75/01/01	77/06/30
00665	PHOS-TOT		MG/L P	791	3.41779	1.48283	1.21772	.356287	.043297	12.2300	.200000	75/01/01	77/06/30
00720	CYANIDE	CN-TOT	MG/L	744	.060345	.004232	.065056	1.07807	.002385	1.02000	.010000	75/01/01	77/06/30
00916	CALCIUM	CA-TOT	MG/L	117	59.3298	392.615	19.8145	.333972	1.83185	142.000	14.5000	75/01/20	77/06/27
00927	MGNSIUM	MG,TOT	MG/L	117	18.5132	23.4878	4.84642	.261783	.448052	29.7000	1.65000	75/01/20	77/06/27
00929	SODIUM	NA,TOT	MG/L	117	114.850	7581.85	87.0738	.758150	8.04998	700.000	54.5000	75/01/20	77/06/27
00940	CHLORIDE	CL	MG/L	799	165.972	9010.54	94.9239	.571925	3.35816	978.000	53.0000	75/01/01	77/06/30
01002	ARSENIC	AS,TOT	UG/L	122	7.24672	57.7800	7.60132	1.04893	.688191	34.0000	1.00000	75/05/04	77/06/30
01007	BARIUM	BA,TOT	UG/L	111	241.982	8757.86	93.5834	.386737	8.88255	600.000	100.000	75/03/06	77/06/27
01027	CADMIUM	CD,TOT	UG/L	809	18.8072	530.015	23.0221	1.22411	.809412	475.000	1.00000	75/01/01	77/06/30
01032	CHROMIUM	HEX-VAL	UG/L	5	56.0000	1730.00	41.5933	.742737	18.6011	100.000	10.0000	75/03/21	77/02/25
01034	CHROMIUM	CR,TOT	UG/L	818	236.846	11803.3	108.643	.456708	3.79862	820.000	10.0000	75/01/01	77/06/30
01042	COPPER	CU,TOT	UG/L	817	265.716	11295.8	106.282	.399983	3.71833	890.000	40.0000	75/01/01	77/06/30
01051	LEAD	PB,TOT	UG/L	709	121.400	7230.55	85.0326	.700431	3.19347	1400.00	.940000	75/01/20	77/06/30
01055	MANGNESE	MN	UG/L	117	283.162	13483.9	116.120	.410084	10.7353	880.000	120.000	75/01/20	77/06/27
01067	NICKEL	NI,TOTAL	UG/L	816	387.696	18129.2	134.645	.347295	4.71351	1960.00	90.0000	75/01/01	77/06/30
01092	ZINC	ZN,TOT	UG/L	810	957.469	185293	430.456	.449577	15.1247	7200.00	120.000	75/01/01	77/06/30
01105	ALUMINUM	AL,TOT	UG/L	109	1347.39	565670	752.111	.558200	72.0391	5300.00	500.000	75/05/01	77/06/26
31615	FEC COLI	MPNECMED	/100ML	825	362.536	1363255	1167.59	3.21175	40.6501	24000.0	23.0000	75/01/01	77/06/30
32730	PHENOLS	TOTAL	UG/L	805	143.227	9648.01	98.2243	.685796	3.46195	800.000	4.50000	75/01/01	77/06/30
50050	CONDUIT	FLOW	MGD	912	918.261	34299.2	185.200	.201686	6.13260	1447.00	570.000	75/01/01	77/06/30
71900	MERCURY	HG,TOTAL	UG/L	508	.442514	.176609	.420249	.949685	.018646	6.60000	.200000	75/01/20	77/06/30
74010	IRON	FE	MG/L	816	13.8632	38.5478	6.20869	.447852	.217347	42.9000	.500000	75/01/01	77/06/30

WATER QUALITY DATA ANALYSIS
TECHNIQUE
4-3

RETRIEVAL OF PERMIT AND EFFLUENT DATA

Special conventions exist for the storage and retrieval of NPDES permit conditions and/or effluent data from the Water Quality File. The output of the RET program has been modified especially for display of NPDES data.

TECHNIQUE: Use the Water Quality File retrieval program RET; restrict the retrieval to stations stored under special agency codes assigned for discharger and compliance monitoring data in the State(s) of interest.

DATA REQUIREMENTS: Enter appropriate station identification and data selection keywords to define the geographic area and time period of interest. Up to 50 parameter codes may be specified.

OUTPUT: For each station (facility) selected, tabular listings of permit conditions (including alphanumeric data for number of exceptions and frequency of analysis, etc.), followed by actual values, will be tabulated in order of pipe number.

DOCUMENTATION: Part EF, Chapter 3.

NOTES: All of the other Water Quality File retrieval programs also may be used with effluent data; if program MEAN is used, the data will be summarized by pipe within the facility.

It is also possible to specify retrieval of more than one composite value type (e.g., average concentrations and minimum loadings).

EXAMPLE:

This example shows actual composite values for five parameters, as measured at three different outfalls (P014, P101, and P102) from the Western Electric Company to Little Alamance Creek, North Carolina. The composite value type is indicated by a two-letter code under "time of day": high (HC), low (LC), and average (AC). Pipe number appears in the depth column.

```
STORET RETRIEVAL DATE 79/07/13
                                                     NC0003301      B1638000      326500015     1701
                                                     36 03 10.0 079 37 40.0 5
                                                     WESTERN ELECTRIC CO
                                                     37081   NC
                                                     GREENSBORO                   030003
                                                     RECVG STRM - LITTLE ALAMANCE CR-GUIL WTP
/TYPA/IND/NPRTMT/OUTFL/PIPE                          EPNC       751230
                                                      0999 FEET  DEPTH  CLASS 00
```

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00400 PH SU	31616 FEC COLI MFM-FCBR /100ML	50050 CONDUIT FLOW MGD
78/01/01		P014					
CP(V)-	HC		33.0	10.8	7.90	40	
78/01/01							
77/10/01		P101					
CP(V)-	AC			8.7	7.10		
	LC			8.4	6.70	60	
	HC			9.3	7.60	120	
77/10/01							
77/11/01		P101					
CP(V)-	AC			9.4	6.80		
	LC			8.5	6.30	40	
	HC			11.2	7.30	150	
77/11/01							
77/12/01		P101					
CP(V)-	AC			10.5	8.10		
	LC			9.3	7.60	60	
	HC			11.2	6.30	60	
77/12/01							
78/01/01		P101					
CP(V)-	AC			10.1	7.10		
	LC			9.6	6.80	50	
	HC			10.8	7.90	60	
78/01/01							
78/02/01		P101					
CP(V)-	AC		1.1	10.5			
	LC		0.0	10.4	6.90	20	
	HC		3.3	10.7	7.30	60	
78/02/01							
78/03/01		P101					
CP(V)-	AC		7.1	9.2			
	LC		1.1	8.6	6.70	1K	
	HC		12.1	9.6	7.70	40	
78/03/01							
77/10/01		P102					
CP(V)-	AC				7.40		0.026
	LC				7.10		0.005
	HC				8.20		0.050
77/10/01							

WATER QUALITY DATA ANALYSIS
TECHNIQUE
4-4

GENERATION OF EFFLUENT REPORTS

If NPDES permit conditions and parametric effluent data have been stored in the Water Quality File for the discharger in question, this technique can be used to retrieve those data and to summarize the number of permit violations.

TECHNIQUE: Use the STORET command procedure named EFFRPT, with print option 3, to obtain the maximum amount of detail.

DATA REQUIREMENTS: Enter agency and facility (station) codes for the discharger(s) in question. Beginning and ending dates may be specified, if required.

OUTPUT: For each facility specified, all parametric effluent data and permit conditions will be tabulated by pipe number and by reporting date within pipe number. Data will include (if stored) high, low, and average parameter concentrations; high, low, and average loadings; number of exceptions, frequency of analysis, and sample type (grab or composite); and number of violations, if any.

DOCUMENTATION: Part EF, Chapter 3.

NOTES: There are three additional print options with the command procedure EFFRPT: a summary of violations by facility, a summary of violations by pipe, and a tabulation of all data available for parameters in violation only.

If no data are reported for a parameter that is subject to permit conditions, a question mark (?) will appear instead of a number of violations.

This technique is valid only for data stored under agency codes beginning with the letters "EF".

EXAMPLE: This example shows permit conditions and DMR (discharge monitoring reports required by the NPDES program) values for seven parameters, as measured at discharge pipe no. 102 from the Western Electric Company.

```
** STORET EFFLUENT REPORT     EFNC      NC0003301    PRINT OPTION:3

FACILITY NC0003301  WESTERN ELECTRIC CO

   DISCHARGE PIPE NO. 102

     REPORTING DATE: 771001

  PARAMETER                          CONCENTRATION                         LOADING
    CODE                           LOW       AVE      HIGH         LOW       AVE       HIGH   N/X   F/A   S/T

00310     BOD     PMT COND         --        --       20.0          --        --        --          1/7   CP
 5 DAY    MG/L    DMR VALS       210.0     458.0     750.0          --        --        --                      1 VIOLATION(S)

00400      PH     PMT COND        6.00       --       9.00          --        --        --          1/7   CP
           SU     DMR VALS        7.10      7.40      8.20          --        --        --

00500   RESIDUE   PMT COND         --        --        --           --        --        --
 TOTAL    MG/L    DMR VALS         570       673       810          --        --        --

00530   RESIDUE   PMT COND         --        --         45          --        --        --          1/7   CP
TOT NFLT  MG/L    DMR VALS         120       150       180          --        --        --                      1 VIOLATION(S)

00525   TOT KJEL  PMT COND         --        --        --           --        --        --
   N      MG/L    DMR VALS       9.400    11.100    12.800          --        --        --

50050   CONDUIT   PMT COND         --        --      0.080          --        --        --          1/1   GR
  FLOW    MGD     DMR VALS       0.005     0.026     0.050          --        --        --

31616   FEC COLI  PMT COND         --        --        400          --        --        --          1/30  GR
MFM-FCBR /100ML   DMR VALS            NO REPORTED DATA                   NO REPORTED DATA                       2 VIOLATION(S)

     REPORTING DATE: 771101

  PARAMETER                          CONCENTRATION                         LOADING
    CODE                           LOW       AVE      HIGH         LOW       AVE       HIGH   N/X   F/A   S/T

00310     BOD     PMT COND         --        --       20.0          --        --        --          1/7   CP
 5 DAY    MG/L    DMR VALS       200.0     438.0     725.0          --        --        --                      1 VIOLATION(S)

00400      PH     PMT COND        6.00       --       9.00          --        --        --          1/7   CP
           SU     DMR VALS        5.00      7.40      8.00          --        --        --
```

WATER QUALITY DATA ANALYSIS TECHNIQUE 4-5

LOCATION AND CHARACTERIZATION OF MUNICIPAL DISCHARGERS

Data from STORET's Municipal Waste Inventory File (the "245" file) can be used to determine the location of sewage treatment facilities and outfalls in a particular area of interest and to obtain other types of facility information.

TECHNIQUE: Use the job control language listed in the STORET help data set named RETMUNJ. Using the appropriate control statement, specify that data are to be retrieved by State and county; by State and major/minor basin; by State and community; by State only; by major/minor basin only; by enforcement area; or by State, agency and storage date. Request that output be printed in a format that provides descriptive information on each facility and its discharges.

DATA REQUIREMENTS: Enter appropriate codes to define retrieval criteria and output format.

OUTPUT: For each facility that satisfies the retrieval criteria, descriptive information on that facility and its discharges will be printed. If a specific piece of information was not available at the time of data entry, the letter "X" will appear.

DOCUMENTATION: Part MWIF, Chapter 3.

NOTES: The Municipal Waste Inventory File contains no historic parametric data.

The example shows only one of a series of 14 alternative output formats, all of which are based on information contained on EPA Form 245. Refer to the STORET User Handbook for descriptions of all possible formats.

EXAMPLE: This example summarizes MWIF data on the Bessemer waste treatment facility in Gogebic County, Michigan, including data on location, type of discharge, and facility design.

```
EPA/OWP-DAT          MUNICIPAL WASTE FACILITY DATA           STORET SYSTEM
                               (FORMAT W)

1. LOCATION

       STATE:  (26) MICHIGAN

       MUNICIPALITY:  BESSEMER
        (093000001  )

       BASIN:  (2215  )    1                         700617101       7
       SMSA:          COUNTY:   (053) GOGEBIC
       STATE REGION NUMBER:       CONGRESSIONAL DISTRICT NUMBER:  11


2. FACILITY DISCHARGE

       RECEIVING WATER:  KALLANDER CREEK TO       BLACK RIVER
       STATE DISCHARGE PERMIT NUMBER:
       MULTI-POINT DISCHARGE:  NO
       INTERSTATE:  NO
       OUTFALL TO OPEN WATER BODY:  NO
       LAT/LONG DISCHARGE POINT:  462923/0900300
       DISTANCE OUTFALL FROM SHORE:
       DEPTH OUTFALL SUBSURFACE:  X
       EPA ENFORCEMENT CONFERENCE:  YES (046)
       EPA GRANTS AWARDED:


3. FACILITY DESCRIPTION

       EXISTING TREATMENT:  (54 ) SECONDARY-STAND.RATE TR FL
       SERVING COMMUNITY:  NO
       CENSUS POPULATION:        2,805   POPULATION SERVED:      2,550
       TYPE SEWER SYSTEM:  COMBINED
       YEAR PLANT BEGAN:  1936   YEAR OF MAJOR REVISION:  PL
       ESTIMATED ANNUAL COST O&M ($1000):  X
       AVERAGE DAILY FLOW (MGD)
           DESIGN:       .550   ACTUAL:      .670   % INDUSTRIAL:  X
       INFLUENT (MG/L)
           DESIGN BOD:  000295 ACTUAL BOD:  000173
           % INDUSTRIAL:  X    SUSPENDED SOLIDS:  X
       EFFLUENT (MG/L)
           TREATED BOD:  000029   SUSPENDED SOLIDS:  000023
       % NITROGEN REMOVAL:  X     % PHOSPHORUS REMOVAL:  X
       ALPHA TREATMENT CODES:  SH GH CM FTR NM DCRH BC

       REMARKS:  ACT SLDGE & P REM PL


4. DATE RECORD REPORTED:  APRIL 24, 1972


5. DATE OF THIS REPORT:  JULY 18, 1979
```

WATER QUALITY DATA ANALYSIS
TECHNIQUE
4-6

RETRIEVAL OF DATA ON SELECTED COMMUNITIES OR FACILITIES

STORET's City Master File (CMF) contains unique identification codes for most cities, communities, water treatment facilities, and municipal sewage facilities in the United States. Also associated with each individual community are geographic information and population data.

TECHNIQUE:	Use the job control language provided in the STORET help data set named RETCMFJ, and specify geographic area of interest.
DATA REQUIREMENTS:	Enter a valid City Master File control statement specifying that data are to be retrieved by State and county codes; by State and basin code; by State and city codes; by State codes only; or by basin codes only.
OUTPUT:	Output for each community/facility located in the area specified will include a unique numerical identification code, community name, county code and name, Congressional district, 1960 and 1970 census figures, population size group codes, basin codes, latitude and longitude, and study category.
DOCUMENTATION:	Part CM, Chapter 3.
NOTES:	The City Master File is maintained by EPA Headquarters staff; to add, delete or change CMF data, contact STORET User Assistance personnel in Washington, D.C. No parametric data are stored in the City Master File.

EXAMPLE:

This example lists data stored in the CMF on communities/facilities located in Gogebic County, Michigan. CMF output also includes a page explaining the various codes and abbreviations used in the tabulations.

MASTER CITY FILE DIRECTORY -- MICHIGAN (26) 79/08/21 PAGE 1

CITY#	COMMUNITY	CO#	COUNTY	CONGR DISTR	SMSA	CENSUS 1960	CENSUS 1970	PSGP FW	PSGP CA	S D	BASIN MJ	BASIN MN	BASIN SUB	LAT/ LONG	FIG	STUDY CATEGORY
029000001	ANVIL LOCATION	053	GOGEBIC	11		250	250	1	0		22	15		462000		00002
	**													894000		
093000001	BESSEMER	053	GOGEBIC	11		3,304	2,805	3	3		22	15		462854	*	C0002
	**													900300	*	
093100001	BESSEMER TWP	053	GOGEBIC	11		2,083	1,800	3	2		22	15		462000		00012
	**													894000		
304800001	ERWIN TWP	053	GOGEBIC	11		641	545	2	1		22	15		462000		00002
	**													894000		
380500000	GOGEBIC COUNTY	053	GOGEBIC	11		24,370	20,676	5	5		21	14		462000		
	**													894000		
475100001	IRONTON MINE	053	GOGEBIC	11		1,000	X	3	2		22	15		462000		00002
	**													894000		
476000001	IRONWOOD	053	GOGEBIC	11		10,265	8,711	5	5		22	15		462712	*	00002
	**													900924	*	
476100001	IRONWOOD TWP	053	GOGEBIC	11		2,537	2,256	3	3		22	15		462000		00002
	**													894000		
476100002	IRONWOOD TWP	053	GOGEBIC	11							22	15				00002
579000001	MARENISCO TWP	053	GOGEBIC	11		832	635	2	1		22	14		462248	*	C0002
	**													894436	*	
786000001	RAMSAY	053	GOGEBIC	11		1,158	1,068	3	2		22	15		462812	*	C0002
	**BESSEMER TWP													900000	*	
786100001	RAMSAY-ANVIL	053	GOGEBIC	11				3	2		22	15		462000		00002
	**													894000		
920800000	THOMASTON	053	GOGEBIC	11		X	100				22	15		463106	C	
	**													895530	C	
965000001	WAKEFIELD	053	GOGEBIC	11		3,231	2,757	3	3		22	15		462842	*	00002
	**													895554	*	
976500000	WATERSMEET	053	GOGEBIC	11		X	500				22	12		461606	C	
	**													891048	C	
976600001	WATERSMEET TWP	053	GOGEBIC	11		864	711	2	1		22	12		462000		00002
	**													894000		

TOTAL FOR STATE 16

TOTAL NUMBER RECORDS IN FILE 16

L E G E N D

CITY MASTER FILE

STUDY CATEGORY: (PRINT POSITIONS 125-132)

STUDY CATEGORY	CODE	RECORD NO.
WATER	00001	1500-1999
SEWAGE	00002	0001-0499
INDUSTRIAL IMPLEMENTATION	00004	
MUNICIPAL IMPLEMENTATION	00010	
CONTRACT AWARDS	00020	
INDUSTRIAL WASTE INVENTORY	00040	050 -1499
FEDERAL INSTALLATION	00100	
BOND SALES	00200	
MINE DRAINAGE INVENTORY	00400	
THERMAL	01000	2000-2029 (FOSSIL) 2030-2039 (NUCLEAR)
AGRICULTURE	02000	
CONSTRUCTION GRANTS	04000	
FISH KILLS	10000	

LATITUDE/LONGITUDE: - FLAG FIELD (PRINT POSITION 123)

N = NEW ATLAS RECORD WITH CITY LAT/LONG
* = LAT/LONG UPDATED BY ATLAS DATA
= (BLANK) - CENTER OF COUNTY LAT/LONG
C = LAT/LONG OF CITY CHANGED BY HQ OFFICE

POPULATION SIZE GROUP

FWQA CODING:	CONTRACT AWARDS CODE:
1 = UNDER 499	0 = UNDER 500
2 = 500 - 999	1 = 500 - 999
3 = 1,000 - 4,999	2 = 1,000 - 2,499
4 = 5,000 - 9,999	3 = 2,500 - 4,999
5 = 10,000 - 24,999	4 = 5,000 - 9,999
6 = 25,000 - 49,999	5 = 10,000 - 24,999
7 = 50,000 - 99,999	6 = 25,000 - 49,999
8 = 100,000 - 249,999	7 = 50,000 - 99,999
9 = 250,000 - 499,999	8 = 100,000 - 249,999
0 = 500,000 & OVER	9 = 250,000 & OVER

SANITARY DISTRICT CODE

- (BLANK) CITY ONLY
1 = WATER DISTRICT
2 = SANITARY DISTRICT
3 = FIRE, SCHOOL, DISTRICTS, ETC.

/AFB/	AIR FORCE BASE
/BORO/	BOROUGH
/C/	CITY
/COMM SERV DIST/	COMMUNITY SERVICES DISTRICT
/COMM UTIL/	COMMUNITY UTILITY
/CORR INST/	CORRECTIONAL INSTITUTE
/ELEM SCH/	ELEMENTARY SCHOOL
/FWSD/	FIRE WORKS SANITARY DISTRICT
/G STA/	GAS STATION
/GEN STA/	GENERATING STATION
/H/	HAMLET
/H SCH/	HIGH SCHOOL
/HOUS AUTH/	HOUSING AUTHORITY
/HOUSING PROJ/	HOUSING PROJECT
/HOUSING UNT/	HOUSING UNIT
/IMP DIST/	IMPOUNDED DISTRICT
/IMPROV DIST/	IMPROVEMENT DISTRICT
/IND WTR AUTH/	INDEPENDENT WATER AUTHORITY
/IRRIG DIST/	IRRIGATION DISTRICT
/JT AUTH/	JOINT AUTHORITY
/MAIN DIST/	MAINTENANCE DISTRICT
/MUN AUTH/	MUNICIPAL AUTHORITY
/MSD/	MUNICIPAL SEWER DISTRICT
/MSS/	MUNICIPAL SEWER SYSTEM
/MUT WTR CO/	MUTUAL WATER COMPANY
/PUD/	PUBLIC UTILITY DISTRICT
/S D/	SANITARY DISTRICT
/SCH DIST/	SCHOOL DISTRICT
/SEW DISP DIST/	SEWER DISPOSAL DISTRICT #1
/STP/	SEWER TREATMENT PLANT
/SHOP CTR/	SHOPPING CENTER
/ST HOSP/	STATE HOSPITAL
/ST PK/	STATE PARK
/ST REC. AREA/	STATE RECREATION AREA
/SUBD/	SUBDIVISION
/T/	TOWN
/TWP/	TOWNSHIP
/TR PK/	TRAILER PARK
/TRT PLT/	TREATMENT PLANT
/UNIC AREA/	UNINCORPORATE AREA
/UTIL DIST/	UTILITY DISTRICT
/VLY WTR AUTH/	VALLEY WATER AUTHORITY
/VICIN OF/	VICINITY OF
/V/	VILLAGE
/WW DISP PLT/	WASTEWATER DISPOSAL PLT
/WTR SEW DIST/	WATER & SEWER DISTRICT
/WTR ASSOC/	WATER ASSOCIATION
/W D/	WATER DISTRICT
/WTR SAN DIST/	WATER SANITARY DISTRICT
/WTR SYS/	WATER SYSTEM
/WTR WKS/	WATER WORKS

ENVIRONMENTAL PROTECTION AGENCY

MONITORING & DATA SUPPORT DIVISION

79/08/21

WATER QUALITY DATA ANALYSIS TECHNIQUE 4-7

IDENTIFICATION OF STATIONS THAT SAMPLE WEATHER DATA

The Water Quality File contains a limited amount of weather data that can be useful for non-point source assessments. Stations at which such data are stored should be labeled with the appropriate station type code(s).

TECHNIQUE: Use the Water Quality File retrieval program ALLPARM. Restrict the retrieval to stations in the geographic area of interest that are labeled with at least one of the level 5 station type codes RUNOFF (monitors stormwater), PRECIP (monitors rainwater), or MET (monitors meteorologic data). Request printing of raw data and descriptive paragraphs.

DATA REQUIREMENTS: Enter station identification and data selection keywords to define geographic area and time period of interest.

OUTPUT: For each station retrieved, output will include a descriptive paragraph (if stored), station identification information, and raw data on all parameters sampled.

DOCUMENTATION: Part WQ, Chapter RET, Section 6 (ALLPARM Program).

Part WQ, Appendix F (Station Type Codes).

NOTES: Not all general retrieval keywords are valid with ALLPARM; refer to the STORET User Handbook for details.

Other sources of weather data are listed in Appendix C: Additional Sources of Information.

If desired, output may be restricted to data on specific parameters related to weather conditions.

EXAMPLE:

This example includes a descriptive paragraph and the first page of raw data stored at station CA0101, which was established for the storage of data on urban rainfall and runoff quality.

```
                                                  CA0101
                                                  37 48 15.0 122 26 43.0 2
                                                  SAN FRANCISCO BAKER ST
                                                  06075   CALIFORNIA
                                                  CALIFORNIA                  140
/LND/PRECIP                                       SAN FRANCISCO BAY REGION
                                                  22CACITY  780707
                                                   0999 FEET  DEPTH  CLASS 00


                                   DESCRIPTION

                   DATA FOR THIS STATION WERE ASSEMBLED AS PART OF EPA PROJECT 68-30-0496,
                   ESTABLISHMENT OF AN URBAN RAINFALL-RUNOFF-QUALITY DATA BASE. FOR FURTHER
                   INFORMATION, SEE THE FINAL REPORT BY W.C.HUBER AND J.P.HEANEY, "URBAN
                   RAINFALL-RUNOFF-QUALITY DATA BASE", EPA-600/8-77-009, JULY 1977.
```

```
                                    CA0101
                                    37 48 15.0 122 26 43.0 2
                                    SAN FRANCISCO BAKER ST
                                    06075 CALIFORNIA
                                    CALIFORNIA                14
                                    SAN FRANCISCO BAY REGION
/LND/PRECIP                         22CACITY  780707
                                     0999  CLASS 00
```

PARAMETER				NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00061	STREAM	FLOW,	INST-CFS	41	13.3814	184.330	13.5768	1.01460	2.12[illegible]34	61.8[illegible]	3.26000	69/04/04	69/11/05
00093	SOLIDS	FLOAT	MG/L	43	1.93255	6.91264	2.62919	1.36048	.400948	1[illegible].5000	.100000	69/04/04	69/11/05
00095	CNDUCTVY	AT 25C	MICROMHO	47	734.636	.110E+08	3320.71	4.52019	484.375	23[illegible]00.0	127.000	69/04/04	69/11/05
00099	TOXICITY	96HRS	%	5	96.0000	80.0000	8.94427	.093169	4.00000	1[illegible]0.000	80.000	69/10/15	69/11/[illegible]5
00101	SOLIDS	% ON	74U FILT	47	44.6978	1270.21	35.6400	.797355	5.19863	1[illegible].000	1.70000	69/04/04	69/11/05
00102	SOLIDS	% ON	14U FILT	47	27.2872	832.510	28.8533	1.05739	4.20868	112.000	.000000	69/04/04	69/11/05
00103	SOLIDS	% ON	5U FILT	33	6.60303	128.131	11.3195	1.71429	1.97[illegible]47	58.0000	.000000	69/04/04	69/11/05
00104	SOLIDS	% ON	.45U FIL	31	6.22258	41.6824	6.45619	1.03754	1.15957	21.7[illegible]	.000000	69/04/04	69/11/05
00129	PRECIP	INT LOCI	IN/HR	274	.058167	.00745[illegible]	.086316	1.48391	.005215	.78[illegible]	.000000	69/04/04	69/11/05
00310	BOD	5 DAY	MG/L	17	29.6470	417.369	20.4296	.689094	4.95490	8[illegible].0000	5.00000	69/04/04	69/11/05
00340	COD	HI LEVEL	MG/L	46	122.565	11900.0	109.087	.890035	16.[illegible]840	626.000	12.0000	69/04/04	69/11/05
00400	PH		SU	18	6.97777	.068862	.262416	.037607	.061852	7.4[illegible]00	6.60000	69/04/04	69/11/05
00410	T ALK	CACO3	MG/L	32	52.4437	766.268	27.7176	.528522	4.8998[illegible]	152.[illegible]00	24.6000	69/04/04	69/11/[illegible]
00530	RESIDUE	TOT NFLT	MG/L	47	86.6808	4854.39	69.6735	.803793	10.1629	34[illegible].000	2[illegible].000	69/04/04	69/11/05
00535	RESIDUE	VOL NFLT	MG/L	47	51.9149	1088.82	32.9973	.635603	4.81315	155.000	15.0000	69/04/04	69/11/05
00545	RESIDUE	SETTLBLE	ML/L	47	1.86595	2.51360	1.58543	.849664	.231259	5.50000	.400000	69/04/04	69/11/05
00552	OIL-GRSE	TOT-HEXN	MG/L	42	11.9285	354.768	18.8353	1.57901	2.90635	11[illegible].3[illegible]0	.100000	69/04/04	69/11/[illegible]
00610	NH3-N	TOTAL	MG/L	47	1.48170	.737944	.859036	.579766	.125303	3.80000	.2[illegible]000	69/04/04	69/11/05
00620	NO3-N	TOTAL	MG/L	47	6.48722	16.2736	4.03405	.621846	.588427	14.9[illegible]00	1.60000	69/04/04	69/11/05
31505	TOT COLI	MPN CONF	/100ML	3[illegible]	1.00000	.000000	.000000		.000000	1.00000	1.00000	69/04/04	69/11/[illegible]5
31615	FEC COLI	MPNECMED	/100ML	33	1.00000	.000000	.000000		.000000	1.[illegible]0000	1.[illegible]0000	69/04/04	69/11/05
70507	PHOS-T	ORTHO	MG/L P	45	.910661	.467223	.683537	.750595	.101896	[illegible].30000	.0[illegible]0000	69/04/04	69/11/[illegible]

MANAGER'S GUIDE
TO
STORET

CHAPTER
5

BIOLOGICAL MONITORING

CHAPTER 5

BIOLOGICAL MONITORING

The establishment of a comprehensive biological monitoring program that complements physical/chemical water quality monitoring efforts is a relatively new emphasis of the water quality management program. This new direction is reflected both in the Basic Water Monitoring Program (1978), which proposes a pilot biomonitoring program, and in the most recent guidance for preparation of the States' 305(b) reports, which devotes a separate section to specifications for describing biological monitoring and reporting on its results.

Because STORET was originally conceived as a data base for physical/chemical parametric data, its capabilities for storage and analysis of biological data are limited, particularly where hierarchical taxonomic information is required. The greatest volume of biological data contained in the Water Quality File at this time relates either to bacteria counts or to chlorophyll determinations. In addition, data on all pollution-caused fish kills reported to EPA are contained in STORET's Fish Kill File.

BACTERIA

The bacteriologic data stored in the Water Quality File can be manipulated using any of the standard STORET retrieval programs and in most of the applications described in the preceding chapters of this Guide. There is one significant difference, however, between bacteria counts and values of common physical and chemical parameters. Unlike other parameters, bacteria concentrations may vary by orders of magnitude within relatively brief spatial and temporal spans. For this reason, representations of trends in bacteriologic parameters are more clearly illustrated on a logarithmic scale, and statistical summaries of these data are properly performed on the logarithms of the stored values (i e., a geometric mean is preferable to an arithmetic mean). Several of the WQF programs allow calculations of common logarithms prior to statistical analysis or plotting, and this capability should be utilized where appropriate.[1]

Bacteriologic parameters for which the greatest numbers of observations are stored include fecal and total coliforms, fecal streptococci, and total plate counts. The analyst can take advantage of the relatively large volume of data on these parameters to perform a specialized type of cause and effect

---

[1]Technique 5-1: Statistical Summaries of Bacteriologic Data.

analysis. It is commonly agreed that the value of the ratio of fecal coliforms to fecal streptococci is dependent on the source of the bacteriologic contamination. Ordinarily, a ratio greater than 4 indicates recent human pollution, whereas a ratio less than 1 indicates animal, or livestock, pollution.[2]

Like many other parameters stored in the Water Quality File, bacteria counts may be entered under any one of several individual parameter codes, depending on the method of analysis used, and this variability must be taken into account when reviewing tabulations of bacteriologic data. For instance, the membrane filter (MF) technique for assessing coliform contamination commonly yields lower values than the most probable number (MPN) technique. Reasons for this discrepancy include the safety factor built into the statistically-based MPN tables; the stress induced by disinfection or by discharge of fecal coliforms into a saline environment; and the stress induced by the drying process in the membrane filter test.

CHLOROPHYLL

Chlorophyll measurements are commonly available from the Water Quality File. Frequently used parameter codes in this group represent levels of chlorophyll "a", chlorophyll "b", chlorophyll "c", pheophytin, total chlorophyll, and total algae.

Because algae are the primary food producers in aquatic communities, and because chlorophyll is an indication of the amount of free-floating alga biomass present in a water body, chlorophyll is often used as a measure of eutrophication. Various levels of chlorophyll "a" have been used as water quality objectives throughout the country, but the acceptable level of chlorophyll varies considerably, depending on the type of water body (lake, river, or estuary), water use, and region of the country (see Figure 5-1). For example, the objective for a rich, productive fishery like the San Joaquin Delta in California is much different from the objective for an oligotrophic lake like Lake Superior (Hydroscience, 1976b). Eutrophication determinations are discussed in greater detail in Chapter 6.

---

[2]Technique 5-2: Using Bacterial Data to Assess the Source of Fecal Contamination.

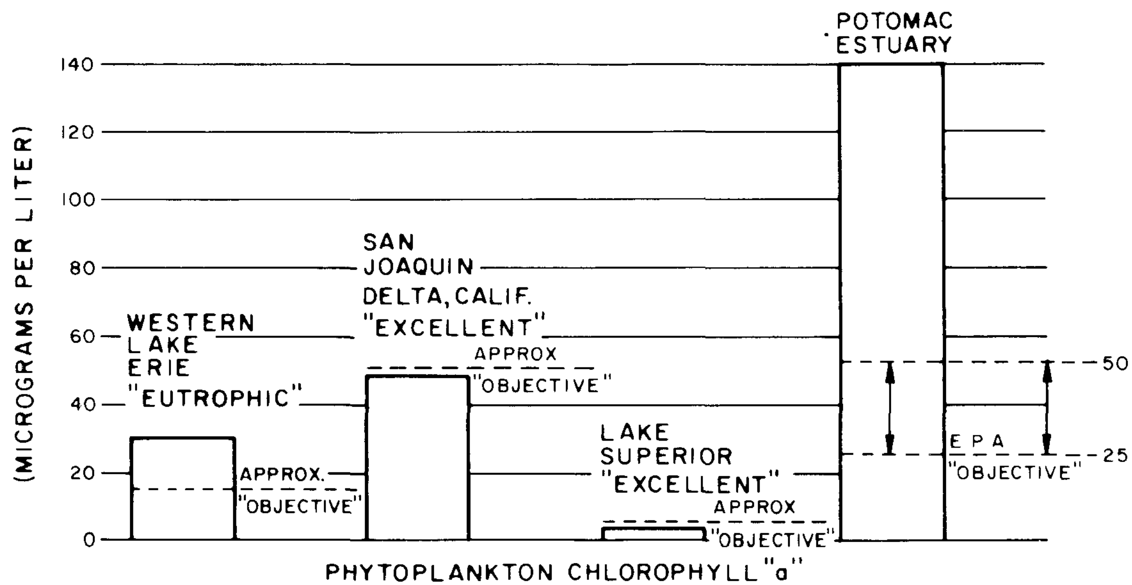


FIGURE 5-1
COMPARISON OF REGIONAL CHLOROPHYLL "A" OBJECTIVES

FISH KILLS

The 305(b) guidance specifically states that major fish kills and other large-scale impacts should be discussed in the State's report on its biological monitoring program. The requisite information for such a discussion should be readily available to the analyst in a simple, usable format through STORET's Fish Kill File, which contains information on the cause and location of pollution-caused fish kills, as well as data on the number and kinds of the fish killed.[3]

Other sources of information may be necessary for reporting on species diversity, and for devising other summary reports on aquatic macroinvertebrates, fish, and shellfish that may be required for water quality management purposes. At present, large volumes of biological data are being collected in the field and stored in manual files or other types of data bases because of STORET's limitations with respect to biological data. At this time, these files and others like them are the primary source for biological water quality data.

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[3]Technique 5-3: Retrieval of Fish Kill Data.

WATER QUALITY DATA ANALYSIS
TECHNIQUE
5-1

STATISTICAL SUMMARIES OF BACTERIOLOGIC DATA

Because bacteria concentrations vary by orders of magnitude, data for those parameters are most appropriately analyzed in terms of logarithmic values. This technique computes statistical summaries of the logs of bacteriologic data and allows comparison of yearly geometric means for the analysis of trends.

TECHNIQUE: Use the Water Quality File retrieval program MEAN and the statistical functions number of observations, mean, and standard deviation. Specify that these functions be performed on the logarithms of the stored values. Compare yearly geometric means to assess trends.

DATA REQUIREMENTS: Enter appropriate station identification keywords and a sufficient number of observations for reliable trend analysis. Parameter codes for up to 10 bacteriologic parameters may be specified.

OUTPUT: For each station retrieved, yearly statistical summaries of the logs of the data collected will be tabulated.

DOCUMENTATION: Part WQ, Chapter RET, Section 6.

NOTES: Statistical summaries may be printed for individual stations or for an aggregation of data from a number of stations (e.g., all key stations on the segment in question).

MEAN program-specific keywords allow the user to eliminate outliers.

If desired, the data summarized may be restricted to samples collected during critical periods (e.g., summer months).

EXAMPLE:

This example shows yearly numbers of observations, geometric means, and standard deviations of bacteria data collected at station 510014. Data indicate an upward trend in bacteria levels (particularly fecal coliforms) at this station.

```
 510014
44 14 54.4 086 19 24.9  2
MANISTEE R AT MAPLE STREET BRDG
26101MANISTEE CO., MI
CITY OF MANISTEE        0819
MANISTEE RIVER BASIN
21MICH                                                      /TYPA/AMBNT/STREAM
 0000 FEET  DEPTH  CLASS 00

                          31616    31679
  DATE    TIME DEPTH FEC COLI  FECSTREP
  FROM     OF        MFM-FCBR  MF M-ENT
   TO     DAY  FEET   /100ML    /100ML
                        LOG       LOG
74/01/01
YEAR      NUMBER      11.0000
          MEAN        27.3285
          STAND DEV   3.37516
75/01/00
75/01/01
YEAR      NUMBER      10.0000   2.00000
          MEAN        84.8704   22.3606
          STAND DEV   3.72427   3.12067
76/01/00
76/01/01
YEAR      NUMBER      12.0000   12.0000
          MEAN        95.1319   21.2834
          STAND DEV   2.74378   3.00696
77/01/00
77/01/01
YEAR      NUMBER      12.0000   12.0000
          MEAN        206.168   42.4631
          STAND DEV   1.73477   2.98835
78/01/00
78/01/01
YEAR      NUMBER      12.0000   7.00000
          MEAN        201.600   48.5257
          STAND DEV   2.19579   3.01256
79/01/00
79/01/01
YEAR      NUMBER      4.00000
          MEAN        267.767
          STAND DEV   1.36380
80/01/00
```

WATER QUALITY DATA ANALYSIS
TECHNIQUE
5-2

USING BACTERIAL DATA TO ASSESS THE SOURCE OF FECAL CONTAMINATION

It is possible to determine whether observed bacterial pollution problems are due primarily to human or to animal wastes by calculating the ratio of fecal coliforms (FC) to fecal streptococci (FS). It is commonly agreed that an FC/FS ratio greater than 4 indicates that pollution is most likely due to human wastes and that an FC/FS ratio of less than 1 indicates wastes of animal origin. This technique calculates FC/FS ratios, using available data for fecal coliforms and fecal streptococci.

TECHNIQUE: Use the Water Quality File retrieval program MEAN. Extract stations that have values stored for both fecal coliforms and fecal streptococci and request calculation of the FC/FS ratio. Specify printing of individual samples rather than statistical summary information.

DATA REQUIREMENTS: Enter appropriate station identification and data selection keywords to specify the geographic area and time period of interest. Parameter codes for fecal coliforms, fecal streptococci, and the FC/FS ratio must be specified.

OUTPUT: For each station retrieved, station identification information and tabulations of raw FC and FS data, as well as the calculated FC/FS ratio will be printed.

DOCUMENTATION: Part WQ, Chapter RET, Section 6.

NOTES: If printing of individual samples is not specified, summaries by year and period of record will be calculated, as well as a summary of data from all stations retrieved.

The MEAN program may also be used to calculate dissolved oxygen saturation (using values for temperature and dissolved oxygen) and unionized ammonia (using values for temperature, pH and total ammonia).

WATER QUALITY DATA ANALYSIS TECHNIQUE 5-3

RETRIEVAL OF FISH KILL DATA

STORET contains a separate Fish Kill File that stores information on fish kills that have occurred within the United States as a result of a variety of industrial, municipal, agricultural, and transportation-related operations. Data may be retrieved from this file by State, county, city, basin, period of record, or pollution cause code.

TECHNIQUE:	Use the job control language listed in the STORET help data set named FKRETRV. Indicate the criteria by which data are to be reported.
DATA REQUIREMENTS:	Enter appropriate codes to specify the geographic area, time period, or pollution cause of interest.
OUTPUT:	Five tables will be printed, including: a summary of all kills of more than 100,000 fish; codes used for pollution cause, kill severity, and area affected; a listing of all kills retrieved, by city within each State; a summary by State and month of the year; and a summary by number of fish killed.
DOCUMENTATION:	Part FK, Chapter 3.

EXAMPLE:

This example summarizes fish kills reported throughout the country in 1960-1964. The retrieval was not limited geographically. The tables below detail major kills and kills reported in the State of Alabama. Tables on the following pages show reporting codes and summary information.

MAJOR KILLS -- 100,000 OR OVER

LAKE OR STREAM	NEAR OR IN	STATE	YEAR	NUMBER OF FISH	OPERATION
COOSA RIVER	ANNISTON	ALABAMA	1961	200,000	OTHER INDUSTRIAL
WHISKEY CHUTE	ELAINE	ARKANSAS	1963	100,000	POISONS
SHASTA LAKE	REDDING	CALIFORNIA	1963	100,000	MINING
COASTAL WATERS	SAN DIEGO	CALIFORNIA	1962	37,800,000	OTHER OPERATIONS
LOS ANGELES HARB	SAN PEDRO	CALIFORNIA	1961	120,200	OTHER INDUSTRIAL
LOS ANGELES HARB	SAN PEDRO	CALIFORNIA	1961	277,860	OTHER INDUSTRIAL
SANTA BARB HARBO	SANTA BARBARA	CALIFORNIA	1964	2,000,000	SEWERAGE SYSTEM
LOS ANGELES HARB	WILMINGTON	CALIFORNIA	1963	692,000	PETROLEUM
LOS ANGELES HARB	WILMINGTON	CALIFORNIA	1963	252,000	PETROLEUM
LOS ANGELES HARB	WILMINGTON	CALIFORNIA	1963	148,000	PETROLEUM
LOS ANGELES HARB	WILMINGTON	CALIFORNIA	1964	340,000	PETROLEUM
ANACOSTIA RIVER	DIST OF COL	DISTRICT OF COLUMBIA	1962	3,180,000	SEWERAGE SYSTEM
LAKE JESSUP	SANFORD	FLORIDA	1964	1,000,000	SEWERAGE SYSTEM
WAHIAWA RESERVOI	WAHIAWA OAHU	HAWAII	1963	2,000,000	UNKNOWN
MILNER RESVR	BURLEY	IDAHO	1961	100,000	OTHER INDUSTRIAL
SNAKE/MILNER RES	BURLEY	IDAHO	1963	250,000	OTHER INDUSTRIAL
RILEY CREEK	HAGERMAN	IDAHO	1962	235,970	OTHER OPERATIONS
SPOON RIVER	DAHINDA	ILLINOIS	1962	176,523	MINING
COON CREEK	HAMPSHIRE	ILLINOIS	1964	185,451	FOOD PRODUCTS
ILLINOIS RIVER	CREVE COUER	ILLINOIS	1961	5,387,580	POISONS
SANGAMON RIVER	SPRINGFIELD	ILLINOIS	1963	121,353	MINING
KISHWAUKEE S&E B	SYCAMORE	ILLINOIS	1963	228,612	UNKNOWN
COTTONWOOD RIVER	COTTONWD FALLS	KANSAS	1964	340,000	MANURE DRAINAGE
COTTONWOOD RIVER	EMPORIA	KANSAS	1964	240,000	MANURE DRAINAGE
ARKANSAS RIVER	FORT DODGE	KANSAS	1964	365,000	MANURE DRAINAGE
LEVEL CR W FK CR	WHITE CITY	KANSAS	1963	115,000	MANURE DRAINAGE

FISH KILLS REPORTED

ALABAMA

RIVER OR LAKE	CITY OR TOWN	DATE MM DD YY	CAUSE CODE	TYPE %GAME	TYPE %NON-GAME	COMMERCIAL FISH LOSS(%)	ESTIMATED FISH KILLED	SEVERITY (1)	SEVERITY (2)	SEVERITY (3)	SEVERITY (4)	AREA AFFECTED	D A	H R
LAKE MARTIN	ALEXANDER CITY	6 05 64	50	90%	10%	-	300				-	-	-	-
COOSA RIVER	ANNISTON	5 14 61	28	20%	40%	40%	200,000		2			120M	21	-
SWAN CREEK	ATHENS	5 14 62	31	-	-	-	-				-	-	-	-
CAHABA RIVER	BRENT	9 - 62	28	5%	-	95%	-		2			-	1	-
CAHABA RIVER	CENTREVILLE ALA	11 23 60	28	10%	20%	70%	-				-	-	-	-
CAHABA RIVER	CENTREVILLE ALA	7 22 60	90	10%	20%	70%	-		2			1M	-	12
VLLY CR WARRIOR	CONCORD	10 03 64	31	43%	57%	14%	11,000		2			2M	7	-
HATCHECHUBBEE CR	COTTONTON	11 20 64	28	65%	35%	15%	6,000		2			7M	21	-
HATCHECHUBBEE CR	COTTONTON	10 23 64	28	60%	40%	15%	-		2			7M	-	-
COTTONWOOD CREEK	GALLION	7 13 64	31	30%	70%	70%	-				4	2M	-	-
MOORES CREEK	LANGDALE	9 04 63	90	53%	47%	-	350	1				3M	1	-
TOMBIGBEE RIVER	MCINTOSH	6 14 64	24	8%	92%	62%	327			3		6M	-	-
TOMBIGBEE RIVER	MCINTOSH	6 21 64	24	9%	91%	76%	7,985		2			-	-	12
TOMBIGBEE RIVER	MCINTOSH ALA	6 15 60	90	-	-	100%	1,000				4	-	-	12
SPANISH RIVER	MOBILE	6 15 64	26	-	100%	-	2,800		2			2M	-	-
THREE MILE CREEK	MOBILE	6 15 64	31	-	100%	-	430			3		-	-	4
THREE MILE CREEK	MOBILE	7 08 64	31	-	100%	-	5,700		2			-	-	6
SHADES CREEK	MOUNTAIN BROOK	9 23 63	31	75%	25%	-	-		2			3M	1	-
TOMBIGBEE RIVER	NANEOLA	9 - 62	28	-	-	-	-				-	-	-	-
NOLAND CREEK	PRATTVILLE ALA	7 20 60	11	5%	15%	80%	500		2			1M	-	8
BIG CREEK	TUSCALOOSA	8 26 62	31	8%	-	92%	-	1				5M	-	-

POLLUTION CAUSE CODES AS USED IN THE FISH KILL REPORTS

CAUSE:

10 AGRICULTURAL OPERATIONS
- 11 PESTICIDES
- 12 FERTILIZERS
- 13 MANURE, SILO, FEEDLOT DRAINAGE, ETC.

20 INDUSTRIAL OPERATIONS
- 21 MINING
- 22 FOOD & KINDRED PRODUCTS
- 23 PAPER & ALLIED PRODUCTS
- 24 CHEMICALS
- 25 PETROLEUM
- 26 METALS
- 27 COMBINATIONS
- 28 OTHER

30 MUNICIPAL OPERATIONS
- 31 SEWERAGE SYSTEM
- 32 REFUSE DISPOSAL
- 33 WATER SYSTEM
- 34 SWIMMING POOL
- 35 POWER

40 TRANSPORTATION OPERATIONS
- 41 RAIL
- 42 TRUCK
- 43 BARGE OR BOAT
- 44 PIPE LINE

50 OTHER OPERATIONS

90 UNKNOWN

SEVERITY:	AREA AFFECTED:
1 COMPLETE	"A"=ACRES "M"=MILES
2 HEAVY	LAST 2 COLUMNS IN REPORT:
3 MODERATE	
4 LIGHT	"DA"=DAYS "HR"=HOURS

----- NUMBER OF FISH KILL REPORTS -----

STATES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
ALABAMA					2	6	4	1	4	2	2		21
ARIZONA										2			2
ARKANSAS	4	2	1		2		4	7	1		2	1	24
CALIFORNIA	2	5	1	6	2	18	15	30	25	15	5	4	128
COLORADO				1					1	1	3		6
CONNECTICUT			1	6	6	13	7	7	1	1		1	43
DELAWARE				1		2							3
DISTRICT OF COLUMBIA									2				2
FLORIDA	1	1	1		4	3	3	2	2	2	1		20
GEORGIA	1	1	3	2	1	5	7	5	2	1	3	3	34
HAWAII	1				1			1		1	2	4	10
IDAHO		2	1		1	2					1	2	9
ILLINOIS	5	2	2	4	10	11	23	23	15	1	9		105
INDIANA	1	3	1	1	9	14	11	11	17	9	5	8	90
IOWA	1	2	1	4	7	11	13	11	8	2	1		61
KANSAS	3	2		4	9	6	6	4	4	2		1	41
KENTUCKY					3	2	1	2	2	3		1	14
LOUISIANA				2		15	46	41	7			4	115
MAINE						6	12	1	1		1	2	23
MARYLAND	1	1		1		3		2	1			1	10
MASSACHUSETTS				1	1	7	5	4	1				19
MICHIGAN	1	1		6	3	14	15	8	10	2		3	63
MINNESOTA		3	1			5	4	8	4			1	26
MISSISSIPPI							1		1				2
MISSOURI	5	7	3	4	23	7	17	12	4	2	3	1	88
MONTANA			1	1		3	8	2	1			1	17
NEBRASKA				1	7	5	7	4	1	3	1	1	30
NEVADA							2						2
NEW HAMPSHIRE					2	1	11	5		1			20
NEW JERSEY	4	2	2	4	2	10	7	11	7	2	6	2	59
NEW MEXICO				1	1	1	1				1		5
NEW YORK	2		2	3	6	15	30	19	16	7	3	12	115
NORTH CAROLINA				1	3	7	5	3	5	3	2		29
NORTH DAKOTA		1				2			1				4
OHIO	4	3	4	3	10	29	27	9	11	7	2	2	111
OKLAHOMA						1	1	2					4
OREGON	1	3	1		5	8	6	4	3	1	2	2	36
PENNSYLVANIA	6	3	16	11	37	53	60	51	42	24	13	13	329
RHODE ISLAND				1	1	2	3		3				10
SOUTH CAROLINA						1			1		1		3
SOUTH DAKOTA		1				1							2
TENNESSEE	1	3	4	7	8	7	1	3	3	6	3	3	49
TEXAS	13	7	15	24	17	36	32	25	17	8	8	12	214
UTAH	2	1	1		3	1	3	2		1	1		15
VERMONT				1				1					2
VIRGINIA	1	1	3	6	11	4	5	9	3	1		1	45
WASHINGTON	2	1	5	6	5	7	3	2	1	1	1		34
WEST VIRGINIA	2	2	1	1	3	4	2	5	7	2	3	1	33
WISCONSIN			1	2	1	5	4	1	2	1		2	19
WYOMING		1	1	1			1	2		1	1	1	9
**** TOTALS	64	61	73	117	206	353	413	340	237	115	86	90	2155

--FISH KILL GROUPING BY SIZE --

NUMBER OF FISH KILLED BY SIZE GROUP	TOTAL REPORTS	REPORTED NO . OF REPORTS	FISH KILLED NO. OF FISH
1 - 1,000	606	606	177,925
1,000 - 10,000	467	467	1,628,345
10,000 - 100,000	170	170	5,427,632
100,000 - 1,000,000	33	33	8,461,743
>=1,000,000	13	13	77,496,156
UNKNOWN	866	145	1,603,000
**TOTAL	2,155	1,434	94,794,801

MANAGER'S GUIDE
TO
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CHAPTER
6

LAKE WATER QUALITY

CHAPTER 6

LAKE WATER QUALITY

Section 314(a) of the Federal Water Pollution Control Act requires that each State identify its publicly owned freshwater lakes and classify them according to eutrophic condition. In addition, the Act calls for the development of plans and feasibility studies for lake pollution control and restoration projects. The most recent guidance for preparation of the States' 305(b) assessments suggests that this responsibility be fulfilled by incorporating the required information into a chapter of that biennial report.

Much of the information specified in the guidance for development of lake classification schemes and restoration feasibility studies is directly available from STORET. Stations that sample lake water quality are clearly identified in the Water Quality File, and the data stored at those stations can be manipulated using any appropriate analytical program.[1]

EXISTING WATER QUALITY

Among other things, the guidance for development of lake classifications suggests that the preliminary inventory include a "summary of available chemical and biological data demonstrating the current water quality of the lake". Similarly, the feasibility studies for lake restoration projects are to describe the water quality problems involved, using historical data and one year of current baseline data. The guidance recommends that baseline data be used to describe: present trophic conditions; the physical, chemical, and biological impact of important tributaries; an assessment of nitrogen and phosphorus inflows and outflows; and vertical profiles of temperature and dissolved oxygen levels.

The optimal data analysis technique for assessment of lake water quality depends upon the size of the lake involved and the number of STORET stations located on or near the lake. If data are available only at a very limited number of stations, the best method may be to summarize data values from one individual station or to aggregate data from all stations on the lake and

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[1]Technique 6-1: Identification of Lake Stations.

summarize accordingly.[2] If a large number of stations is involved and a significant amount of data is available, contour or area-shaded mapping techniques may be used.[3]

TABLE 6-1

TROPHIC INDEXES

INVESTIGATORS	SINGLE PARAMETER	MULTIPLE PARAMETER
Rodhe (1969)	Organic Matter	
Beeton and Edmondson (1972)	Nutrients	
Carlson (1977)	Secchi depth	
Michalski and Conroy (1972)		X
Uttormark and Wall (1975)		X
Brezonik and Shannon (1971)		X
EPA National Eutrophication Survey		X

Where the current trophic condition of a lake is of concern, that aspect of water quality is traditionally described using one of a number of available trophic indexes. (A sampling of trophic indexes, including the parameters used, is listed in Table 6-1). Although STORET has no capability for the calculation of such an

[2]Technique 3-3: Assessing Existing Conditions in Terms of Standards Violations; Technique 3-5: Illustration of Historical Trends Using Statistical Summaries; and Technique 3-6: Plotting Trends Over Time.

[3]Technique 6-4: Using Contour Maps to Illustrate Lake Water Quality and Technique 3-4· Generation of Area-Shaded Maps.

index, it does provide the means of retrieving the necessary raw data, in either hard copy or machine-readable formats.[4]

Guidance for development of lake classifications also recommends inclusion of an indication of whether the lake was surveyed in EPA's National Eutrophication Survey (NES). Data collected as part of the NES was stored in the Water Quality File and should be readily available to all STORET users.[5]

The "impact of important tributaries" and "nitrogen and phosphorus inflows and outflows" may be assessed using techniques described in Chapter 4, Pollution Sources and Control Programs. If enough data are available, probably the most useful type of analysis would be a multiple station plot.[6]

Vertical temperature and dissolved oxygen measurements, essential to the determination of whether a lake is stratified, also are required as part of the State's 314(a) inventory. The appropriate technique for this type of analysis depends on the size of the lake, the number of stations, and the amount of data available. For a relatively small lake, or one for which STORET contains a limited amount of data, the most effective illustration of vertical profiles is a regression analysis of parameter values versus depth at a single STORET station.[7] For a larger lake, a series of contour maps using data collected at different depth ranges could provide a more complete picture of stratified conditions.[8]

EVALUATION OF CONTROL ALTERNATIVES

If analysis of lake water quality indicates a stressed condition or a trend toward water quality degradation, the next step is an evaluation of causative factors. As part of the inventory required by Section 314(a), all major point and non-point source

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[4]Technique 2-4: Retrieval of Raw Data; Technique 3-10: Formatting STORET Data for Input into SAS (Statistical Analysis System); and Technique 3-11: Output of STORET Data on Punched Cards.

[5]Technique 6-2: Retrieval of National Eutrophication Survey Data.

[6]Technique 4-1: Use of Multiple Station Plots to Assess Cause and Effect.

[7]Technique 6-3: Displaying Lake Stratification.

[8]Technique 6-4: Using Contour Maps to Illustrate Lake Water Quality.

loads must be identified, and the relative magnitude of each quantified.[9]

To assess the relative merits of various control alternatives, the analyst can attempt to define the controllable portion of the waste load using STORET data on flow, water quality, and effluents. Once the controllable portion has been defined, appropriate data can be input into a mathematical model to determine whether water quality would improve significantly after implementation of the various control alternatives.

Mathematical models of varying levels of complexity are available for the quantification of the relationship between waste inputs and lake water quality. Relatively detailed models, which include specification of phytoplankton, zooplankton, and the nitrogen and phosphorus cycles, were pioneered by Chen (1970) and DiToro, et al. (1971). These and similar models require significant data collection efforts for calibration and have been incorporated in planning studies where significant water resource decisions are to be made (Thomann, 1975 and Hydroscience, 1976b).

For preliminary screening, a simpler modeling framework is probably more cost-effective. For reference purposes, Rechkow (1979) provides a summary and review of available single-compartment (total phosphorus) models, and Thomann (1977) compares detailed models to loading plot models (starting with the classical work of Vollenweider (1968)), and details the assumptions of the simpler approach.

In the final analysis, the relative water quality improvements expected from the different control alternatives also have to be placed in a cost-benefit context. As STORET capabilities for the storage of cost information are limited, most of the data for this final phase of analysis must be derived from other sources.

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[9]Technique 4-2: Retrieval of In-plant Data; Technique 4-3: Retrieval of Permit and Effluent Data; and Technique 4-5: Location and Characterization of Municipal Dischargers.

WATER QUALITY DATA ANALYSIS
TECHNIQUE
6-1

IDENTIFICATION OF LAKE STATIONS

This technique screens STORET stations in the area of interest and restricts retrieval to those located on lakes. It can be especially useful as a preliminary step in the States' Clean Lakes inventories.

TECHNIQUE: Use the Water Quality File retrieval program RET; extract stations labeled with the station type LAKE; specify printing of descriptive paragraphs and station identification information only.

DATA REQUIREMENTS: Enter appropriate station identification keywords defining the geographic area of interest.

OUTPUT: Station header information and a descriptive paragraph will be printed for each lake station in the geographic area specified.

DOCUMENTATION: Part WQ, Chapter RET, Section 6 (RET Program).

Part WQ, Appendix F (Station Type Codes).

NOTES: If the analyst does not specify printing of station identification information and descriptive paragraphs only, raw parametric data values also will be printed.

The information contained in the descriptive paragraph is entirely up to the individual who stores the station, and may be extremely variable.

EXAMPLE: This example shows the station identification information and descriptive paragraph stored under station 270003, which is maintained by the State of Michigan on Lake Superior.

```
                                                 270003
                                                46 42 32.0 089 58 41.0 2
                                                L SUPERIOR
                                                26053   GOGEBIC CO., MI
                                                IRONWOOD TWP, SEC 30      2213
                                                OFF PORCUPINE MTN PARK
/TYPA/AMBNT/LAKE                                21MICH
                                                 0003 FEET  DEPTH  CLASS 00


                                       DESCRIPTION
                  LAKE SUPERIOR AT PORCUPINE MOUNTAIN STATE PARK (LAKE SUPERIOR
              TRAIL), OFFSHORE OF MIDDLE OF ISLAND, GOGEBIC COUNTY, T50N, R45W,
              SECTION 30, IRONWOOD TOWNSHIP
                  GREAT LAKES SHORELINE DATA ARE TAKEN AT THIS STATION. HISTORICAL
              BACTERIA INFORMATION IS FOUND HERE.
```

WATER QUALITY DATA ANALYSIS
TECHNIQUE
6-2

RETRIEVAL OF NATIONAL EUTROPHICATION SURVEY DATA

The identification of lakes that were studied as part of the National Eutrophication Survey is required as part of the States' Clean Lakes assessments. This technique can be used to determine where National Eutrophication Survey stations are located in a specified geographic area.

TECHNIQUE:	Use the Water Quality File retrieval program INDEX; retrieve stations stored under the agency code 11EPALES.
DATA REQUIREMENTS:	Enter appropriate station identification keywords to define the geographic area of interest.
OUTPUT:	This technique retrieves station identification information for each station selected, including State name, State and county codes, brief location description, agency and station codes, basin codes, latitude/longitude coordinates, river mile indexes (if stored), and station type.
DOCUMENTATION:	Part WQ, Chapter RET, Section 6.
NOTES:	This program retrieves no parametric data.

EXAMPLE: This is the first page of output from an INDEX retrieval, which lists modified station identification information for stations in the State of Michigan that were stored under agency code 11EPALES.

```
STORET RETRIEVAL DATE 79/08/01                                                                              PAGE  1
*********************************************************************************************************************
STATE          ST/CO #     LOCATION                                   COUNTY              BASIN CODE STORAGE DATE
               STATION TYPE
               USER CODE     STATION     SECONDARY STATIONS                           MAJ/MIN/TERM
                    LAT/LONG              MILESLV1      LV2      LV3      LV4      LV5    LV6    LV7    LV8    LV9    LV10    LV11

                         INDEX
*********************************************************************************************************************

MICHIGAN       26049 HOLLOWAY RESERVOIR                                                  210491
               /TYPA/AMBNT/LAKE
               11EPALES       26A001                                             BASIN
               43 07 17.0 083 29 21.0
                         INDEX

MICHIGAN       26049 HOLLOWAY RESERVOIR                                                  210491
               /TYPA/AMBNT/LAKE
               11EPALES       26A002                                             BASIN
               43 06 52.0 083 27 32.0
                         INDEX

MICHIGAN       26087 HOLLOWAY RESERVOIR                                                  210491
               /TYPA/AMBNT/LAKE
               11EPALES       26A003                                             BASIN
               43 07 16.0 083 26 12.0
                         INDEX

MICHIGAN       26    CARO RESERVOIR                                                      210492
               /TYPA/AMBNT/LAKE
               11EPALES       26A101                                             BASIN
               43 27 30.0 083 24 30.0
                         INDEX

MICHIGAN       26055 BOARDMAN HYDRO POND                                                 081692
               /TYPA/AMBNT/LAKE
               11EPALES       26A201                                             BASIN
               44 40 00.0 085 25 00.0
                         INDEX

MICHIGAN       26055 BOARDMAN HYDRO POND                                                 081692
               /TYPA/AMBNT/LAKE
               11EPALES       26A202                                             BASIN
               44 40 00.0 085 25 00.0
                         INDEX

MICHIGAN       26005 ALLEGAN LAKE                                                        083093
               /TYPA/AMBNT/LAKE
               11EPALES       260301                                             BASIN
               42 32 00.0 085 52 00.0
                         INDEX
```

WATER QUALITY DATA ANALYSIS
TECHNIQUE
6-3

DISPLAYING LAKE STRATIFICATION

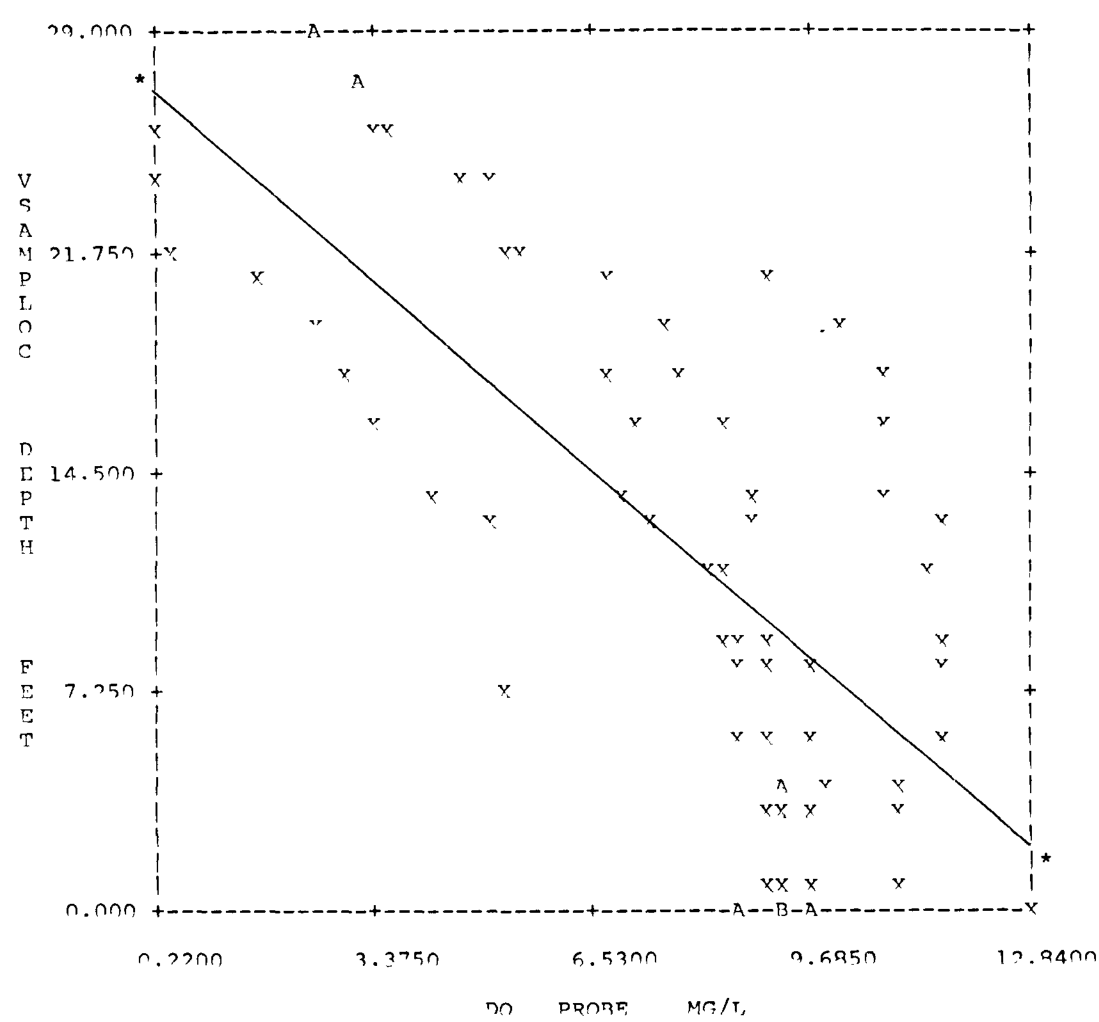
This technique plots regressions of dissolved oxygen versus depth and temperature versus depth at a single lake station to illustrate lake stratification. It is a practical way of illustrating vertical profiles in a small lake that has only a few sampling sites.

TECHNIQUE:	Use the Water Quality File retrieval program REG; request the calculation and plotting of linear regressions of dissolved oxygen versus depth and temperature versus depth at a specified STORET station (parameter versus parameter, or Type 2, regressions).
DATA REQUIREMENTS:	Enter a single agency and station code pair; parameter codes for depth, dissolved oxygen, and temperature; and data selection keywords to define time period of interest.
OUTPUT:	For each of the two regressions requested, a statistical summary page and one to four pages of graphic output are produced showing the correlation between the two parameters involved. The graphic output consists of a scatter diagram (line printer plot) on which single data points are represented by X's, multiple data points by alphabetic characters (A=2 points, B=3 points, etc.), and y-axis intercepts of the regression line by asterisks (*).
DOCUMENTATION:	Part WQ, Chapter RET, Section 7.
NOTES:	This technique could also be used to display vertical profiles of other parameters. There are multiple parameter codes in STORET for dissolved oxygen and temperature, so it may be advisable to

provide alternative codes in case data are not stored in the units of choice.

EXAMPLE:

This example shows a plot of dissolved oxygen (DO) vs. depth at a single sampling site, using data collected from May 1978 through June 1979. By connecting the asterisks on the left and right y-axes, the analyst could show a direct negative correlation between DO and depth, indicating stratified conditions. Output from program REG also includes a page of summary statistics.



WATER QUALITY DATA ANALYSIS
TECHNIQUE
6-4

USING CONTOUR MAPS TO ILLUSTRATE LAKE WATER QUALITY

For large lakes or bays where there are a significant number of sampling sites, this technique can be a useful way of depicting spatial variations in parameter values. Alternatively, a series of contour maps can provide an effective visual representation of trends over time or depth.

TECHNIQUE:	Use the Water Quality File retrieval program MSP. Request the printing of a contour map depicting variations over space in mean parameter values.
DATA REQUIREMENTS:	Enter latitude/longitude coordinates to define the approximate perimeter of the lake in question, data selection keywords to define the time period of interest (if other than the period of record), and a single parameter code.
OUTPUT:	A contour map is produced, which illustrates how concentrations of a single parameter vary over space.
DOCUMENTATION:	Part WQ, Chapter RET, Section 7.
NOTES:	This technique is not as effective for illustrating water quality in streams or small lakes, because of the spatial distribution of sampling sites. It is possible to print a specified symbol or data values on the map, or neither; however, care must be exercised to provide sufficient visual resolution.

EXAMPLE: This map shows the distribution of chlorophyll in Saginaw Bay. Plus signs (+) indicate the locations of sampling sites.

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APPENDIXES

APPENDIX A

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APPENDIX B

GLOSSARY

AGENCY CODE: a one- to eight-character alphanumeric code that uniquely identifies an organization responsible for collecting water quality data and entering it into STORET.

ALGAL BLOOM: a proliferation of living algae on the surface of lakes, streams, or ponds, stimulated by nutrient enrichment.

AMBIENT MONITORING: the collection of uniform data on representative parameters for the assessment of long-term progress toward national water quality goals.

ARITHMETIC MEAN: the average obtained by dividing a sum by the number of its addends. See also GEOMETRIC MEAN.

BACTERIA: single-celled microorganisms that lack chlorophyll. Some bacteria are capable of causing human, animal, or plant diseases; others are essential in pollution control because they break down organic matter in the water.

basin: see RIVER BASIN.

BIOCHEMICAL OXYGEN DEMAND (BOD): a measure of the amount of oxygen consumed in the biological processes that break down organic matter in the water. Large amounts of organic wastes use up large amounts of dissolved oxygen; thus, the greater the degree of organic pollution, the greater the BOD.

BIOLOGICAL MONITORING: the determination of the effects on aquatic life in receiving waters due to the discharge of pollutants, by appropriate techniques and procedures and at appropriate frequencies and locations.

CHEMICAL OXYGEN DEMAND (COD): a measure of the amount of oxygen required to oxidize organic and oxidizable inorganic compounds in water. The COD test, like the BOD test, is used to determine the degree of pollution in an effluent.

CITY MASTER FILE: one of several independent files that make up the STORET system. The City Master File contains a listing of unique identification codes for most U.S. cities, communities, water treatment facilities, and municipal sewage facilities.

CLEAN WATER ACT OF 1977: Public Law 95-217, including amendments to the Federal Water Pollution Control Act.

COD: see CHEMICAL OXYGEN DEMAND.

COEFFICIENT OF VARIATION: the ratio of the measure of variability to the average about which the variation occurs.

coliform bacteria: see FECAL COLIFORM BACTERIA.

COMMAND PROCEDURE: a prearranged set of computer instructions, permanently stored in an on-line data set, that enables STORET users to execute a frequently-used set of instructions by simply referencing the appropriate procedure; most Water Quality File retrievals utilize the command procedure RET.

COMMON LOGARITHM: the exponent expressing the power to which the number 10 must be raised in order to produce a given number.

COMPLIANCE MONITORING: water quality sampling and analysis conducted to check compliance of an NPDES permittee with permit limitations. Compliance monitoring is usually conducted annually and covers only those parameters that are listed in the permit.

COMPOSITE SAMPLE: a combination of individual samples obtained at intervals over a period of time (e.g., several grab samples spanning a 24-hour period and placed in a single container or a series of samples taken at equal distances across a stream section). See also GRAB SAMPLE.

CONSERVATIVE PARAMETERS: substances that do not decay with time or disappear from the water system by settling, adsorption, or other means.

CRITERIA: the levels of pollutants that affect the suitability of water for a given use. Generally, water use classifications include: public water supply, recreation, propagation of fish and other aquatic life, agricultural use, and industrial use.

CRITICAL PERIOD: the time during which the adverse combination of relevant parameters causes the greatest degradation in water quality to occur, such as the warm-temperature, low-flow summer period for dissolved oxygen.

DATA: records of observations and measurements of physical facts, occurrences, and conditions, in written form.

DATA BASE: a collection of data used for information retrieval and reporting, usually a collection of data sets.

DATA SELECTION KEYWORDS: STORET keywords that enable a user to restrict the parametric data retrieved to specific parameters, sampling dates, sampling depths, and sampling conditions.

DATA SET: a collection of data records that have a logical relationship to one another, reside within a computer system, and are accessible to users.

DESCRIPTIVE PARAGRAPH: up to 1080 alphanumeric characters that provide textual information about the location and sampling activities of a STORET station.

DISCHARGER MONITORING REPORT: a report filed by NPDES permittees that describes the parametric loadings of a facility's discharge for parameters listed in the permit, based on effluent guidelines that define pounds of discharge per pound of production for several parameters known to be discharged by a given industrial category.

DISK: a stack of round, flat plates on which information is magnetically stored, and which is mounted on a single spindle and rotated past a set of read/write heads in such a fashion that very rapid access is possible to any data location.

DISSOLVED OXYGEN (DO): the oxygen dissolved in water or sewage. Adequate dissolved oxygen is necessary for the life of fish and other aquatic organisms and for prevention of offensive odors. Low dissolved oxygen concentrations often are due to the point source discharge of wastewater with high BOD, the result of inadequate waste treatment.

DISSOLVED SOLIDS: the total amount of dissolved material, organic and inorganic, contained in water or wastes. Excessive dissolved solids make water unpalatable for drinking and unsuitable for industrial uses.

EFFLUENT: a discharge of pollutants into the environment, either partially or completely treated or in their natural state.

ENRICHMENT: the addition of nitrogen, phosphorus and carbon compounds or other nutrients into a lake or other waterway that greatly increases the growth potential for algae and other aquatic plants.

EQUIVALENT LOAD: the product of the flow and the pollutant concentration, usually expressed in pounds or kilograms per day, which represents the mass of material discharged to a body of water per unit of time.

EUTROPHIC LAKE: a lake rich in dissolved nutrients, often characterized by large amounts of algae, low water transparency, low dissolved oxygen, and often shallow and weed-choked at the edges.

EUTROPHICATION: the normally slow aging process by which a lake evolves into a bog or marsh and ultimately assumes a completely terrestrial state and disappears. During eutrophication the lake becomes so rich in nutritive compounds that algae and other microscopic plant life become superabundant, thereby causing the lake eventually to fill up with settled material.

FECAL COLIFORM BACTERIA: a group of organisms common to the intestinal tracts of man and animals. The presence of fecal coliform bacteria in water is an indicator of pollution and of potentially dangerous bacterial and viral contamination.

FECAL STREPTOCOCCI: nonmotile, chiefly parasitic bacteria, often pathogens, which normally inhabit the intestines of man and animals. Fecal streptococci are an important indicator of sanitary quality in natural waters.

FEDERAL WATER POLLUTION CONTROL ACT AMENDMENTS OF 1972: Public Law 92-500, the Federal law that authorized the water quality management program, as part of a comprehensive Federal program to restore and maintain the chemical, physical, and biological integrity of the Nation's waterways.

FILE: synonymous with DATA SET.

FISH KILL FILE: one of several independent files that make up the STORET system. The Fish Kill File contains information on pollution caused fish kills, as reported to EPA.

FLOW: the movement of water in a stream or river in the direction of lower elevation, usually quantified in cubic feet per second.

FLOW DATA FILE: one of several independent files that make up the STORET system. The Flow Data File contains stream flow data collected by the U.S. Geological Survey.

GAGING STATION: a location on a stream or conduit where discharges are measured. The station usually has a recording or other gage for measuring the elevation of the water surface in the channel or conduit.

GEOMETRIC MEAN: the "nth" root of the product of "n" factors. See also ARITHMETIC MEAN.

GRAB SAMPLE: an individual water quality sample collected at a specific date and time. See also COMPOSITE SAMPLE.

HARD COPY: computer output, usually on paper, that can be read by a human without mechanical or electronic assistance.

HYDROLOGY: the branch of physical geography concerned with the origin, distribution and properties of the waters of the earth, on the surface of the land, in the soil and underlying rocks, and in the atmosphere.

INPUT: the transfer of information into a computer's main memory, or the information so transferred.

INTENSIVE SURVEY: the frequent sampling of certain parameters at representative points (including points of effluent discharge) for a relatively short period of time to assess water quality conditions, causes, effects, and cause-and-effect relationships.

JOB: the major unit of work of a computer system. A job consists of one or several related steps defined by a series of job control language (JCL) statements.

JOB CONTROL LANGUAGE (JCL): a user-written computer control language used to define a job and its requirements to the computer system. JCL tells the computer who submitted the job, what program to run, where to find the input, and where to route the output. IBM JCL statements have slashes (//) in columns 1 and 2 of each line.

KEYWORD: an alphabetic word, letter, or expression that defines the information to be retrieved from the Water Quality File and how that information is to be presented. Valid combinations of keywords and their values make up STORET retrieval requests.

LAND USE: the physical mode of utilization or conservation of a given land area at a given point in time.

LINEAR REGRESSION: a measure of the best-fit straight-line relationship between two variables, expressed as a first-degree algebraic equation.

loading: see EQUIVALENT LOAD.

logarithm: see COMMON LOGARITHM.

MATHEMATICAL MODELING: essentially an analytical abstraction of the real world, which incorporates only those phenomena that are relevant to the problem under consideration. These phenomena are defined using mathematical relationships, which can be solved to depict past, present or future conditions.

mean: see ARITHMETIC MEAN; GEOMETRIC MEAN.

MEMBRANE FILTER (MF): a thin, semi-permeable material used to separate matter from a solution as it passes through it; may be used in determination of bacteria counts in water quality samples.

modeling: see MATHEMATICAL MODELING.

MONITORING: periodic or continuous determination of the amount of pollutants or radioactive contamination present in the environment. See also AMBIENT MONITORING; BIOLOGICAL MONITORING; COMPLIANCE MONITORING; INTENSIVE SURVEY.

MOST PROBABLE NUMBER (MPN): the number of organisms per unit volume that, in accordance with statistical theory, would be more likely than any other number to yield the observed test result with the greatest frequency.

MUNICIPAL WASTE INVENTORY FILE (245 FILE): one of several independent files that make up the STORET system. The Municipal Waste Inventory File contains information on municipal waste sources and disposal systems.

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES): the national discharger permitting system authorized under Section 402 of P.L. 92-500, including any State permit program that has been approved by the EPA Administrator.

NON-POINT SOURCE: generalized discharge of waste into a water body that cannot be located as to a specific source, including agricultural or silvicultural activities, mining, construction, disposal of pollutants in wells or in subsurface excavations, saltwater intrusion, or hydrologic modifications.

NPDES: see NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM.

NUTRIENT: an element or compound essential as raw material for organism growth and development, including carbon, nitrogen and phosphorus.

OBSERVATION: a measurement, or sampling, of a single parameter at a specific location or station, at a specific point in time.

OLIGOTROPHIC LAKES: generally deep lakes having a limited supply of nutrients, biologically relatively unproductive, and characterized by high water transparency and high dissolved oxygen content.

OUTFALL: the final length of pipe or the mouth of a sewer, drain, or conduit where an effluent is discharged into receiving waters.

OUTLIER: a statistical observation not homogeneous in value with others in a sample.

OUTPUT: the transfer of data out of a computer system's main memory, or the data so transferred.

PARAMETER CODE: one of a set of standard five-digit codes used in STORET to identify individual elements with which values relating to water quality are associated.

PARAMETRIC DATA: Water Quality File information describing the conditions under which a sample was taken (such as date, time, and depth) as well as the results of the sample analyses.

PERMIT: a legal document that establishes the limits of allowable discharges into navigable waters. Permits are granted to individual dischargers only after they show that their effluents will not contaminate a waterway in excess of established water quality standards, or will not lower its existing water quality.

pH: the reciprocal of the logarithm of the hydrogen ion concentration, in grams per liter of solution.

PHYTOPLANKTON: free-floating or weakly motile microscopic plants, found in various quantities in natural waters.

POINT SOURCE: any discernible, confined and discrete conveyance, including but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged, or from which there is or may be a thermal discharge.

PROGRAM: a logically self-contained sequence of instructions that can be executed by a computing system to perform a specific task.

QUALITY ASSURANCE PROGRAM: a prescribed, systematic set of precautions to be taken in the course of the monitoring and sample analysis processes to ensure that samples are collected, preserved, and analyzed according to approved methodologies.

RAW DATA: actual sample values that have not been summarized or manipulated in any way by STORET's various statistical routines.

REACH: a stream segment extending from confluence to confluence or from confluence to stream end, as defined by a special hydrologic numbering scheme developed by EPA.

REACTIVE PARAMETERS: substances that decay or degrade in the environment due to physical, chemical and/or biological activity.

regression: see LINEAR REGRESSION.

RETRIEVAL: the process of extracting data from a data base in a desired format.

RETRIEVAL REQUEST: a collection of keywords and values that describes a specific request for information to be obtained from a STORET data file. Each retrieval request constitutes one computer job.

RIVER BASIN: the total area drained by a river and its tributaries, usually measured in square miles.

RIVER MILE INDEX: a numerical code that identifies the location of a sampling station on a river system by defining its distance from and relationship to the mouth of the river system.

RUNOFF: the portion of rainfall, melted snow, or irrigation water that flows across ground surface and eventually is returned to streams. Runoff can pick up pollutants and carry them to receiving waters.

SAMPLE: a representative part of a body of water collected for subsequent analysis for the presence of pollutants. See also COMPOSITE SAMPLE; GRAB SAMPLE.

SAS (STATISTICAL ANALYSIS SYSTEM): a commercially available software package for data management and statistical analysis; SAS combines statistical routines, plotting, data manipulation and report-writing capabilities.

SCATTER DIAGRAM: a two-dimensional graph consisting of points whose coordinates represent corresponding values of two variables whose relationship is being studied.

SECCHI DEPTH: the depth below the water surface at which a white 20-cm diameter disk is no longer visible to a trained observer; a method of estimating the depth to which light can penetrate in a water body.

Section 208 plan: see WATER QUALITY MANAGEMENT PLAN.

SECTION 305(b) REPORT: an assessment of existing and projected water quality conditions and progress toward national goals, submitted by each State to the Congress, as mandated in Section 305(b) of the Federal Water Pollution Control Act.

self-monitoring: see DISCHARGER MONITORING REPORT.

STANDARD: a plan for water quality management containing four major elements: the use to be made of the water; criteria to protect those uses; implementation and enforcement plans; and an antidegradation statement to protect existing high quality waters.

STANDARD DEVIATION: the square root of the arithmetic average of the square of the deviations from the mean in a frequency distribution.

STANDARD ERROR: a measure of the variance to be expected in making statistical estimates of an unknown parameter; equal to the standard deviation of the original frequency distribution divided by the square root of the sample size.

STATION: a specific location, or collection point, where water quality data are sampled.

STATION CODE: a one- to fifteen-character alphanumeric code that identifies a specific geographic location where STORET water quality data are collected. Each sampling site defined to the STORET system has a single primary station code, which is unique within a given agency, and up to three secondary station codes, or aliases.

STATION DATA: Water Quality File information that describes the geographical location of a sampling site.

STATION HEADER: a brief, highly structured summary of station location information, which is printed at the top of outputs from many Water Quality File retrieval programs.

STATION IDENTIFICATION KEYWORD: one of a series of STORET keywords that specify which water quality stations are to be retrieved from the Water Quality File, including both station selectors and station restrictors.

STATION TYPE CODE: one of a series of alphabetic codes depicting the characteristics of a STORET station, such as where the station monitors water (in the open sea, a lake, a well, or a pipe).

STORET: the acronym used to identify the computerized data base utility maintained by EPA for the STOrage and RETrieval of data relating to the quality of the waterways within and contiguous to the United States.

STRATIFICATION: a condition in which horizontal or vertical layers of a body of water exhibit distinctive and different characteristics, especially with temperature, chloride, and dissolved oxygen. Adjacent layers are clearly delineated in most cases.

SUSPENDED SOLIDS: solids that either float on the surface of or are in suspension in water, wastewater, or other liquids, and which are largely removable by laboratory filtering.

SYSTEM: a group of computer programs that interlock to perform user-specified tasks.

TAPE: a reel of magnetic tape on which information is stored.

TERMINAL: a keyboard device used for human to computer intercommunication.

TOTAL SOLIDS: the sum of dissolved and undissolved constituents in water or wastewater, usually stated in milligrams per liter.

TROPHIC INDEX: a means of quantifying the degree of eutrophication in a lake through a calculation based on one or more parameters related to the growth of phytoplankton.

TURBIDITY: a cloudy condition in water due to the suspension of silt or finely divided organic matter, which interferes with the passage of light through water.

TURNAROUND TIME: the elapsed time between the submission of a job to a computer system and the return of results.

WASTE LOAD ALLOCATION: the assignment of target loads to point and non-point sources to achieve water quality standards in the most effective manner.

WASTEWATER: water carrying wastes from homes, businesses, and industries; a mixture of water and dissolved or suspended solids.

WATER POLLUTION: the addition of sewage, industrial wastes, or other harmful or objectionable material to water in concentrations or in sufficient quantities to result in measurable degradation of water quality.

water quality criteria: see CRITERIA.

WATER QUALITY FILE: one of several independent files that make up the STORET system. The Water Quality File contains physical and chemical parametric water quality data as well as station information.

WATER QUALITY MANAGEMENT PLAN: a management document that identifies the water quality problems of a State-approved planning area or designated areawide planning area and sets forth an effective management program to alleviate those problems and to achieve and preserve water quality for all intended uses, in accordance with Section 208 of the Federal Water Pollution Control Act.

WATER QUALITY MANAGEMENT PROGRAM: activities conducted on the Federal, State, and local levels for the purpose of evaluation, and planning for the control of, water quality in the Nation's waterways; it encompasses activities mandated in Sections 106, 208, 303(e), and 305(b) of the Federal Water

Pollution Control Act, as amended, as well as related program guidance.

water quality standard: see STANDARD.

WATER YEAR: a continuous 12-month period during which a complete annual cycle occurs. The U.S. Geological Survey uses the period from October 1 to September 30.

ZOOPLANKTON: passively floating or weakly swimming microscopic animals found in natural waters.

APPENDIX C

ADDITIONAL SOURCES OF INFORMATION

This appendix lists the many sources from which additional information helpful to water quality management analysts can be obtained. For ease of reference, these sources have been grouped into three categories: Maps; Meteorological, Climatological, and Air Quality Data; and Water-related Data.

MAPS

Several types of informative maps are available to aid the water quality analyst. These maps, when used properly, can be excellent sources of data and helpful in understanding and identifying "the whole picture" of a project.

A. United States Geological Survey Maps.

The U.S. Geological Survey offers a wide variety of topographical maps of all areas of the United States, including:

1. Standard Topographical Maps, which depict roads, towns, political boundaries, some land use and land cover information, landmarks, and locations of U.S. Geological Survey streamflow gages as well as topographic information (available in quadrangles, usually at a scale of 1:24,000).

2. Topographic County Maps, which are similar in content to the standard topographical maps except that they are drawn at a different scale (either 1:50,000 or 1:100,000) and are available on a county-by-county basis. (This series of maps is available for certain areas only.)

3. Base Maps, which depict only water bodies, principal towns, and county boundaries on a state-by-state basis (at a scale of 1:500,000).

4. State Hydrologic Unit Maps, which add the drainage basin and sub-basin outlines to the base maps described above.

5. Land Use, Land Cover, and Associated Maps, which depict land use and land cover, political unit, hydrologic unit, census county subdivision, Federal land ownership, or State land ownership (available at scales of 1:100,000 and 1:250,000 for certain areas only).

6. State Water Resource Investigation Folders, which contain large maps depicting stream-gaging stations, observation wells, water quality sampling stations, and areas in which current hydrologic investigations are proceeding. Smaller maps depict other significant hydrologic aspects.

Information regarding each of these map series for areas east of the Mississippi River can be obtained from:

Branch of Distribution
U.S. Geological Survey
1200 South Eads Street
Arlington, Virginia 22202
Telephone: (703) 557-2751

For areas west of the Mississippi River, information can be obtained from:

Branch of Distribution
U.S. Geological Survey
Box 25286, Federal Center
Denver, Colorado 80225
Telephone: (303) 234-3832

Maps may be purchased through the above outlets, through certain Geological Survey offices (over the counter), or, although usually at a higher price, through authorized local map stores.

B. National Oceanic and Atmospheric Administration.

A variety of maps and charts are available from NOAA, including:

1. Conventional Nautical Charts, which are available for navigable bodies of water (including the Great Lakes) in the United States. These maps depict water depth by use of contour lines and sounding depths, locations of buoys and markers, type of bottom sediments, navigation hazards, and other specialized nautical information (scales are usually between 1:5,000 and 1:80,000).

2. Small Craft Charts, which are folding versions (of varying detail) of the Conventional Nautical Charts designed to be used in boats.

3. Bathymetric Maps, which depict water depth by using color tint.

4. Tidal Current Charts and Tables, Tidal Current Diagrams, and Tide Tables, which include daily current predictions, current velocities, duration of slack tide

periods, tidal height at any time, and other useful information for estuarine and marine waters.

5. Special Issue Charts, Special Maps, and Projections.

Purchase information, including five free nautical chart catalogs and a list of authorized nautical chart agencies, can be obtained from:

Distribution Division, C44
National Ocean Survey
Riverdale, Maryland 20840
Telephone: (301) 436-6990

C. Defense Mapping Agency.

The Defense Mapping Agency Hydrographic/Topographic Center is a good source of topographic and nautical maps on a worldwide basis. These maps display a wide variety of information at scales ranging from world-wide to local.

1. U.S. Army Corps of Engineers Navigation Charts, which depict the channel centerline, centerline distances, navigation hazards, and other information for many navigable waterways in the United States, are available through this agency.

2. Many specialized charts are also available, including, among others:

Great Circle Sailing Charts
Loran A and C Plotting Charts, and
Aeronautical Charts.

A catalog of available charts and purchase information can be obtained from:

DMOADS, Attn: DDCP
6500 Brookes Lane
Washington, D.C. 20315
Telephone: (202) 227-2495

METEOROLOGICAL, CLIMATOLOGICAL, AND AIR QUALITY DATA

A. National Oceanic and Atmospheric Administration.

The best source of long-term rainfall data in the United States is the National Weather Service. Data can be obtained from the National Climatic Center either on tape files or through published daily and hourly summaries. Data are available for most first-order stations.

Detailed climatological data can also be obtained for stations in each State from the National Climatic Center. These data are published in two forms:

1. Climatological Data monthly summaries (State-wide), which include daily temperature extremes and precipitation at every station within a State as well as daily evaporation, wind, soil temperature, snowfall, and other supplemental information, where available, and

2. Local Climatological Data monthly summaries (individual stations), which include hourly precipitation information and 3-hour temperature, cloud cover, cloud ceiling, wind, visibility, dew point and relative humidity information for individual first-order stations.

Meteorological and climatological data can be obtained by contacting:

U.S. Department of Commerce
National Climatic Center
NOAA Environmental Data Service
Federal Building
Asheville, North Carolina 28801
Telephone: (704) 258-2850

Yearly summaries are also available for first-order stations, and special climatological data, such as solar radiation, are available for certain select stations.

B. Environmental Protection Agency.

EPA provides a good source of air quality information through its Storage and Retrieval of Aerometric Data system, SAROAD, which is a centralized data bank containing ambient air quality sampling data collected nation-wide. These data can be important in estimating atmospheric rainout, fallout, and washout loads to water bodies and groundwater. Information regarding SAROAD can be obtained from:

Surveillance and Analysis Division
U.S. Environmental Protection Agency
Research Triangle Park, North Carolina 27711
Telephone: (919) 629-5491

WATER-RELATED DATA

A. U.S. Geological Survey.

Four of the water quality data sources provided by USGS are described below.

1. The WATer Data STOrage and REtrieval System, WATSTORE, contains data collected from stream-gaging stations, lakes and reservoirs, surface water quality sampling stations, water temperature stations, sediment stations, water level observation wells, and ground water quality wells. Data can be obtained through the USGS Water Resources Division's 46 district offices, which are usually located in the State capitals, or from the National Center at the address below:

   Chief Hydrologist
   U.S. Geological Survey
   437 National Center
   Reston, Virginia 22092
   Telephone: (703) 860-7000

2. Publications of Water Resources Data provide surface water quantity information (Part 1) and water quality information (Part 2) indexed by water year and State. Much of the information contained in WATSTORE is also contained in these publications, which can be acquired through:

   U.S. Department of Commerce
   National Technical Information Service
   Springfield, Virginia 22161
   Telephone: (703) 557-4650

3. For specific inquiries, the USGS Water Resources Division's 46 district offices, often located in the State capital, can be the best source of information, especially if only a limited amount of data or recently-collected (unpublished) data are desired (e.g., flow records for one river during one year).

4. Information is also available from the USGS NAtional Water Data EXchange, NAWDEX. NAWDEX is not intended to provide access to individual data records, although access to WATSTORE and STORET data is possible through this system. Its primary function is to index the data held by its 350 member organizations and participants to provide a central index of information. Sources of water data information can be identified through a computerized Water Data Sources Directory, and the sampling sites, periods of record, and type of data available from each source can be determined through the Master Water Data Index. The computer searches can be performed at USGS Water Resources Division district offices and at certain member organization locations. Information regarding NAWDEX can be obtained from:

National Water Data Exchange
U.S. Geological Survey
421 National Center
Reston, Virginia 22092
Telephone: (703) 860-6031

B. National Oceanic and Atmospheric Administration.

NOAA has many useful sources of water data. Its three major sources are described below.

1. The National Oceanographic Data Center, NODC, houses the world's largest usable collection of marine data. Some estuarine and coastal data are available as well. This information is available through:

   National Oceanographic Data Center
   National Oceanic and Atmospheric Administration
   Washington, D.C. 20235
   Telephone: (202) 634-7500

2. The National Geophysical and Solar-Terrestrial Data Center, NGSDC, disseminates solid earth and marine geophysical data as well as ionospheric, solar, and other space environmental data. This information is available through:

   National Geophysical and Solar-Terrestrial Data Center
   National Oceanic and Atmospheric Administration
   Boulder, Colorado 80302
   Telephone: (303) 499-1000, Ext. 6215

3. NOAA also offers computerized data base location retrieval services through its ENvironmental Data EXchange (ENDEX) system. The Environmental Data Base Directory, EDBD, is an ENDEX subsystem which enables users to locate relevant data. An EDBD data file description lists types of parameters and quantity of data available, methods used to collect samples, data formats, restrictions on data availability, when and where the data were collected, who to contact for additional information, and estimated cost of obtaining the data. This subsystem is also integrated into the previously described NAWDEX system. Further information is available through:

   National Oceanographic Data Center
   Data Index Branch, D782
   2001 Wisconsin Avenue, N.W.
   Washington, D.C. 20235
   Telephone: (202) 634-7298

C. U.S. Environmental Protection Agency.

An updated Environmental Systems Directory, which will describe all available systems, will be available from:

Management Information and Data Systems Division
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460
Telephone: (202) 755-0984

While STORET is the primary EPA water quality data base, other specialized, water-related data and information systems are available through EPA, including the following:

1. The Model State Information System, MSIS, is used in determining compliance with the National Interim Primary Drinking Water Regulations. It is a decentralized system used by several EPA regions and States. Information pertaining to this system is available through:

   Office of Drinking Water
   U.S. Environmental Protection Agency
   401 M Street, S.W.
   Washington, D.C. 20460
   Telephone: (202) 426-9805

2. The Technical Assistance Data System, TADS, is used to reduce the effects of oil and hazardous materials spills by providing on-line access to information on material characteristics and emergency response procedures. Information pertaining to this system is available through:

   Office of Water Program Operations
   U.S. Environmental Protection Agency
   401 M Street, S.W.
   Washington, D.C. 20460
   Telephone: (202) 245-3045

3. The Contracts Information System, CIS, tracks the status of procurement requests and provides summary information on all agency procurements other than small purchases. It contains a master file listing over 3,200 active contracts and 12,000 modifications or other ancillary records. Information pertaining to this system is available through:

   Procurements and Contract Management Division
   U.S. Environmental Protection Agency
   401 M Street, S.W.
   Washington, D.C. 20460

Telephone: (202) 557-7716

4. The Hazardous Wastes Data Management System/Underground Injection Control, HWDMS/UIC, contains permit information for facilities involved with disposal of hazardous wastes that are regulated by EPA. Information pertaining to this system is available through:

   Office of Solid Wastes - State Programs
   and Resource Recovery Division
   U.S. Environmental Protection Agency
   401 M Street, S.W.
   Washington, D.C. 20460
   Telephone: (202) 755-9150

5. The Surface Impoundment Assessment System, SIAS, contains an inventory of the names and locations of surface impoundments in the United States, with more detailed information for certain locations. Information pertaining to this system is available through:

   Office of Drinking Water
   U.S. Environmental Protection Agency
   401 M Street, S.W.
   Washington, D.C. 20460
   Telephone: (202) 426-9805

6. The Spill Prevention Control and Countermeasures system, SPCC, contains descriptions of individual oil spills, hazardous chemical spills, and tank ruptures as well as facility inspection records. The data contained in this system are not extensive, as many EPA regions keep separate records and do not (and are not required to) use this system. Information pertaining to this system is available through:

   Office of Water Program Operations
   U.S. Environmental Protection Agency
   401 M Street, S.W.
   Washington, D.C. 20460
   Telephone: (202) 245-3045

7. The Chemicals in Commerce Information System, CICIS, is being established to handle data and information pertaining to the implementation of the Toxic Substances Control Act including health and environmental effects studies, chemical activities within EPA, and a large volume of confidential private business information. Information pertaining to this system is available through:

Office of Toxic Substances - Chemical
Information Division
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460
Telephone: (202) 426-2447

8. The Construction Grants Management System, GICS, is a management information system used to keep track of past, present, and projected EPA grants. Information available through this system includes grant awards, status of projects, financial breakdown of projects, and more. Information pertaining to this system is available through:

Grants Administration Division
PM 216
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460
Telephone: (202) 755-9251

9. The Federal Reporting Data System, FRDS, contains an inventory of community and non-community public water supplies as well as pertinent water quantity and quality information. Much of the data contained in this system comes from the decentralized MSIS system previously discussed. Information pertaining to this system is available through:

Office of Drinking Water
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460
Telephone: (202) 426-9805

10. The Permit Compliance System, PCS, contains an inventory of NPDES permits and relevant information, including facilities inspections, discharge monitoring activities, compliance schedules, permit issuance and expiration dates, and other scheduling information. Information pertaining to this system is available through:

Office of Water Enforcement
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460
Telephone: (202) 755-0994

11. The Establishment, Registration and Support System, ERSS, contains confidential information pertaining to the production and distribution of pesticides by registered, pesticide-producing establishments.

Information pertaining to this system is available through:

Pesticides and Toxic Substances Division
EN-342
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460
Telephone: (202) 755-0630

12. The National Eutrophication Survey system, NES, contains detailed records of phytoplankton species found in over 600 lakes during the National Eutrophication Survey. Spring, summer, and fall data are available for each lake. Associated physical and chemical conditions are contained in STORET. Information pertaining to this system is available through:

Environmental Monitoring Systems Laboratory
U.S. Environmental Protection Agency
P.O. Box 15027
Las Vegas, Nevada 89114
Telephone: (702) 736-2969, ext. 327

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