TITLE: Dynamic Toxics Wasteload Allocation Model (DYNTOX) Version 2.1 User's Manual

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ABSTRACT

The 1991 U.S. EPA Technical Support Document (TSD) for Water Quality-based Toxics Control recommends development of effluent limits based on the frequency and duration of violations of water quality criteria. The duration and frequency of violations depend on the daily variation in receiving water and effluent flow, combined with daily variation in effluent toxicity. Dynamic models should be used to calculate the frequency distribution of instream concentrations for any given duration because accurate determination of the occurrence of violations can be difficult using conventional steady-state methods.

This document is the User's Manual for a user-friendly version of the Dynamic Toxics Waste Load Allocation Model (DYNTOX) developed for EPA in 1985. The model is designed for use in wasteload allocation of toxic substances and uses three different simulation techniques to calculate the frequency and severity of instream toxicity at different effluent discharge levels. DYNTOX simulates multiple reaches and discharges along a 1-dimensional freely flowing stream. This version of DYNTOX also includes several enhancements and features (e.g., ammonia toxicity, hardness dependent criteria, incomplete mixing) not available in the original mainframe version.

The manual provides a description of the basic theory and concepts of the models contained in DYNTOX, detailed instructions on input requirements, and general guidance on how to use DYNTOX.

KEYWORDS: Wasteload Allocations, Models, Dynamic, Water Quality Criteria, Acute, Chronic, 1-D

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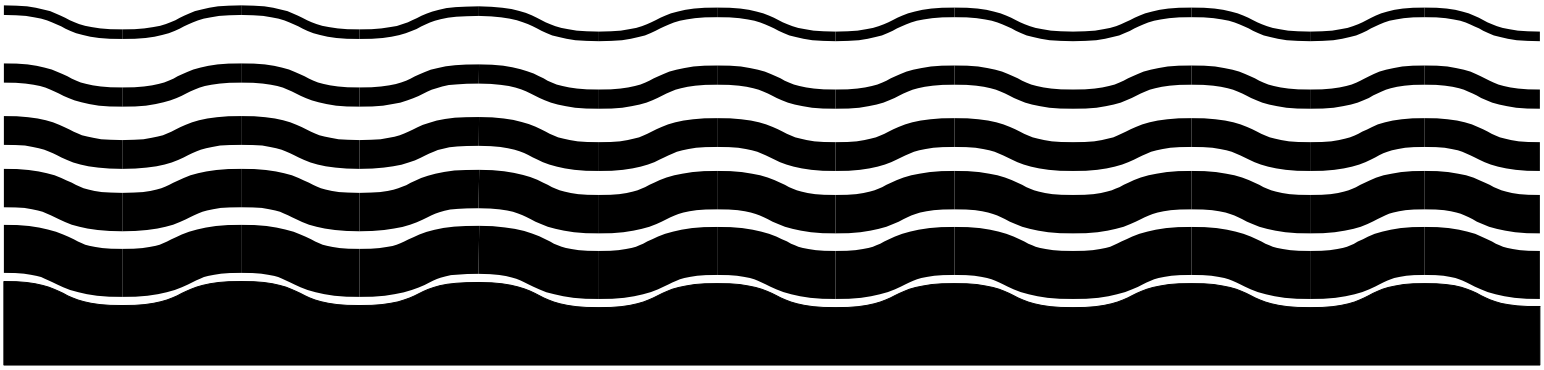
Dynamic Toxics Wasteload Allocation Model (DYNTOX) Version 2.1 User's Manual



ACKNOWLEDGMENT

The contents of this section have been removed to comply with current EPA practice.

ABSTRACT

As part of ongoing efforts to keep EPA's technical guidance readily accessible to water quality practitioners, selected publications on Water Quality Modeling and TMDL Guidance available at http://www.epa.gov/waterscience/pc/watqual.html have been enhanced for easier access.

The 1991 U.S. EPA Technical Support Document (TSD) for Water Quality-based Toxics Control recommends development of effluent limits based on the frequency and duration of violations of water quality criteria. The duration and frequency of violations depend on the daily variation in receiving water and effluent flow, combined with daily variation in effluent toxicity. Dynamic models should be used to calculate the frequency distribution of instream concentrations for any given duration because accurate determination of the occurrence of violations can be difficult using conventional steady-state methods.

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GLOSSARY

Acute – Intense, severe while having a sudden onset and short duration.

Bioavailability – A measure of the physicochemical access that a toxicant has to the biological processes of living organisms. The less the bioavailability of a toxicant, the less its toxic effect on an organism.[1]

Biologically-based method – Calculating the return period of standards violations; counts the number of non-overlapping periods that occur where average concentrations exceed the criterion, no more than 5 exceedances of the standard, within a 120-day period.

Chronic – Continuing for a long time or marked by frequent recurrence.

Continuous simulation – Analysis designed to perform the water quality model calculations for a numerous daily events; requires a daily time sequence of observed values for the model inputs - wastewater flow (Qw), wastewater concentration (Cw) upstream receiving water flow (Qup), and upstream concentration (Cup). These inputs are provided to the water.

Correlation coefficient – Determined using the logarithms of the observed data and any statistical software package.

Drainage area ratio – Specification for each reach of the system under study to account for nonpoint sources of water entering the stream.

Duration – A length time during which something exists or lasts.

Dynamic – A model used to calculate the frequency distribution of instream concentrations for any given duration.

Effluent – Wastewater – treated or untreated – that flows out of a treatment plant, sewer, or industrial outfall. Generally refers to wastes discharged into surface waters.[2]

Frequency – "Number of repetitions of a periodic process in a unit of time, such as the number of complete alternations per second of an alternating current"[3]

Gage – Provides 30 years of continuous flow data, with monthly water quality data collected for the past 10 years.

Hardness-dependent criteria – Waters that consist of heavy metals not found in constant or ammonia toxicity waters.

Impairment – A condition of diminished strength, value, or quality.

Instream fate processes – Water quality processes that govern the instream fate of one or more pollutants.

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[1] U.S. Environmental Protection Agency (EPA), Terminology Reference System. 2006. "Bioavailability." http://oaspub.epa.gov/trs/trs_proc_qry.navigate_term?p_term_id=16299&p_term_cd=TERMDIS

[2] U.S. Environmental Protection Agency (EPA). 2006. "Terms of Environment: Glossary, Abbreviations, and Acronyms." http://www.epa.gov/OCEPAterms/eterms.html.

[3] Merriam-Webster Online. "Frequency". http://www.m-w.com/cgi-bin/dictionary.

Linear Interpolation – Data synthesis method for stream flow

Log Normal Analysis – Selected only when one discharge is considered and assumption of using log normal is not violated for the parameters; cannot consider multiple reaches or instream decay

Mean – Numerical value of parameters divided by total number of parameters

Monte Carlo – Uses statistical distributions to describe the observed variability for each model input.

Multiple Markov Synthesis – Process is designed to handle cases of non-stationary processes, where the mean and/or variance are known to change over time allows the user to divide a non-stationary process into as many repeating stationary periods as necessary. Each period requires data describing its mean value, standard deviation, and auto-correlation. These values must be calculated before performing a wasteload allocation.

Partial mix factor – Fraction of upstream flow assumed to mix with effluent at edge of mixing zone

Partioning – Heavy metals that are between the dissolved and particulate phases.

Percentile – A value on a scale of one hundred that indicates the percent of a distribution that is equal to or below it.[4]

Receiving – Accepting or taking in. (receiving water – water body into which some discharge is delivered).

Reliability – The extent to which something is consistent or dependable.

Return period – The average length of time between occurrences of the same level of pollutant concentration; can also be used to refer to flood magnitudes and rainfall events.

Simple Markov synthesis – A technique in which data for a given day is determined randomly from the overall data mean, overall data variance, the previous day's value, and an auto-correlation coefficient based on how closely a given day's value is related to the previous day's value.

Standard deviation – A recognized criterion or measure of comparison for some value or quality.

Standards – A statistical measure of how spread out the values in a data set are around the mean. The more tightly clustered around the mean the data values are, the closer to zero the standard deviation will be.

Steady state – State in which a system has reached equilibrium for the measurement or phenomenon concerned.

Time of travel – The time it takes for a parcel of water, contaminant, or tracer to flow from one point to another.

Toxicity – The degree to which a substance or mixture of substances can harm humans or animals. *Acute toxicity* involves harmful effects in an organism through a single or short-term exposure. *Chronic toxicity* is the ability of a substance or mixture of substances to

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[4] Merriam-Webster Online. "Percentile". http://www.m-w.com/cgi-bin/dictionary.

cause harmful effects over an extended period, usually upon repeated or continuous exposure sometimes lasting for the entire life of the exposed organism. *Subchronic toxicity* is the ability of the substance to cause effects for more than one year but less than the lifetime of the exposed organism.[5]

Variation – The extent of change or difference.

Wasteload allocation – 1. The maximum load of pollutants each discharger of waste is allowed to release into a particular waterway. Discharge limits are usually required for each specific water quality criterion being, or expected to be, violated. 2. The portion of a stream's total assimilative capacity assigned to an individual discharge.[6]

Water quality criteria – Levels of water quality expected to render a body of water suitable for its designated use. Criteria are based on specific levels of pollutants that would make the water harmful if used for drinking, swimming, farming, fish production, or industrial processes.[7]

[5] U.S. EPA. 2006. "Terms of Environment: Glossary, Abbreviations, and Acronyms." http://www.epa.gov/OCEPAterms/tterms.html.
[6] U.S. EPA. 2006. "Terms of Environment: Glossary, Abbreviations, and Acronyms." http://www.epa.gov/OCEPAterms/wterms.html.
[7] U.S. EPA. 2006. "Terms of Environment: Glossary, Abbreviations, and Acronyms." http://www.epa.gov/OCEPAterms/wterms.html

CHAPTER 1: INTRODUCTION

BACKGROUND

At present, most States' regulations for setting allowable discharge limits for toxic pollutants use steady state models to assess exposure and calculate wasteload allocations. These models are used to calculate the allowable effluent load that just meets toxicity standards at a critical low flow. These analyses typically do not consider issues of frequency and duration. They generally consist only of a simple dilution equation; do not include instream fate processes; and only examine a single environmental condition for a single discharge at a single design specification.

In contrast, the extent of biological impairment from toxic discharges depends on the duration of exposure above certain levels as well as the number of times (frequency) these violations occur. The U.S. EPA Technical Support Document (TSD) for Water Quality-based Toxics Control (EPA, 1991) specifically recommends development of effluent limits based on the frequency and duration of violations of water quality criteria. The duration and frequency of violations depend on the daily variation in receiving water and effluent flow, combined with daily variation in effluent toxicity. Accurate determination of the occurrence of violations can be difficult using conventional steady-state methods. Therefore, dynamic models should be used to calculate the frequency distribution of instream concentrations for any given duration. The current durations of interest are four days for chronic toxicity and one hour for acute toxicity. The one hour duration period is often approximated as a one day period because hourly data are generally not available.

Modeling techniques are available that incorporate the effects of variable stream and effluent conditions to calculate the frequency and duration of exposure at different concentration levels. These more thorough methods simulate the entire distribution of receiving water concentrations (expressed as a probability distribution), rather than a single "worst case" based on critical conditions. This allows each alternative control strategy to be evaluated in terms of the total risk of toxic concentration. The data used to define criteria for toxic levels of substances incorporate the concepts of duration and frequency. It is only appropriate that the procedures used to regulate these substances also incorporate these concepts.

EPA developed the DYNTOX (DYNamic TOXics) model in 1985 (Limno-Tech, 1985). The model is designed for use in wasteload allocation of toxic substances and uses three different simulation techniques to calculate the frequency and severity of instream toxicity at different effluent discharge levels. The usefulness of the original model was somewhat curtailed, however, by the original target platform, a non-interactive batch-oriented mainframe computer environment. To make the advantages of the DYNTOX modeling approach more available to all parties, EPA's Office of Science & Technology has supported development of a user-friendly version of the DYNTOX model. This user-friendly DYNTOX is designed to work on the widely available PC-compatible microcomputers and takes full advantage of the PC's interactive capabilities. The new DYNTOX also includes several enhancements and features (e.g., ammonia toxicity, hardness-dependent criteria, incomplete mixing) not available in the earlier version.

PURPOSE

The purpose of this manual is three-fold:

1) Provide a description of the basic theory and concepts of the models contained in DYNTOX.
2) Provide detailed instructions on input requirements.
3) Provide general guidance on how to use DYNTOX.

ORGANIZATION OF THIS MANUAL

This chapter (Chapter 1) describes the purpose and background of the DYNTOX model. Chapter 2 provides a brief discussion of the concepts and theory behind the water quality model contained in DYNTOX and describes each of the three simulation techniques. Chapter 3 describes the inputs required to run the DYNTOX model using each of the three simulation techniques. Chapter 4 details the actual use of the model, including inputs, model simulation, and output. Chapter 5 provides a brief discussion on how to select the technique best suited for an individual wasteload allocation and how to qualitatively assess the reliability of the results. Chapter 6 demonstrates case study application of DYNTOX.

CHAPTER 2: THEORY AND MODELING TECHNIQUES

EPA guidance suggests consideration of three components when implementing water quality standards: magnitude, duration, and frequency. Typical critical conditions analyses often provide incomplete information regarding duration and frequency considerations. To overcome these difficulties, EPA developed three probabilistic modeling methods to more explicitly account for duration and frequency issues in the wasteload allocation process. The three techniques are: 1) Continuous Simulation, 2) Monte Carlo Simulation and 3) Log Normal Analysis.

These techniques consider variability in all model inputs, examine the total range of water quality responses, and express results in terms of probability of exceedance, rather than a single value.

These methods could potentially be applied to a wide range of receiving water situations. Within the DYNTOX model, however, they are applied strictly to one-dimensional rivers.

THEORY

All three dynamic modeling techniques contained in DYNTOX are based upon the same water quality modeling framework. This type of framework is described in EPA's Technical Guidance Manual for Performing Wasteload Allocations (1984a) as "One Dimensional, Steady State Model of Nonconservative Total Pollutant". This modeling approach predicts the concentration of the total form of a nonconservative pollutant in the water column throughout a one dimensional stream reach under steady state conditions.

The model performs calculations using three basic equations. The first mass balance equation predicts the instream concentrations in response to a discharge load:

$$C = \frac{C_{riv}Q_{riv} + C_w Q_w}{Q_{riv} + Q_w} \qquad (1)$$

where

C	=	concentration after mixing has occurred (M/L^3)
C_{riv}	=	concentration in the river upstream of the discharge (M/L^3)
Q_{riv}	=	flow in the river upstream of the discharge (L^3/T)
C_w	=	wastewater concentration (M/L^3)
Q_w	=	wastewater flow (L^3/T)

Instream pollutant loss is simulated via a first order loss coefficient, i.e.

$$C_x = C \bullet e^{-k\frac{x}{u}} \qquad (2)$$

where

C_x	=	concentration at a distance x downstream (M/L^3)
k	=	overall loss coefficient (1/T)
x	=	distance downstream (L)
u	=	stream velocity (L/T)

Equation 2 is used to simulate pollutant decay between the upstream monitoring station and the first discharge, or between multiple discharges. Instream pollutant loss is not considered in the Log Normal analysis feature of DYNTOX, which can consider only a single discharge.

The new version of DYNTOX also allows consideration of incomplete lateral mixing at the point of discharge. This is accomplished through the use of a partial mix factor (pmf), which allows the effluent to mix with only a fraction of the upstream flow:

$$C_{mix} = \frac{C_{riv}(pmf)\,Q_{riv} + C_w Q_w}{pmf\,Q_{riv} + Q_w} \qquad (3)$$

where

pmf	=	fraction of upstream flow assumed to mix with effluent at edge of mixing zone

Equations 1 and 2 are used to predict the fate and transport of a pollutant along the length of the stream. Starting with discharge 1 in Figure 1, equation 1 is used to predict the instream concentration after complete mixing occurs. Equation 2 uses this result to predict pollutant fate and transport downstream to just above discharge 2. Equation 1 is then applied to predict the instream concentration after discharge 2 enters the stream; and equation 2 is applied to predict the concentration just above discharge 3. Equations 1 and 2 are repeated in this fashion to predict instream concentrations at the beginning and end of each reach. Equation 2 is also used at the most upstream end of the system, to predict instream decay of pollutant as it travels from the upstream boundary monitoring station to just upstream of the first discharge.

Equation 3 is applied in those unique situations where an instream concentration estimate is required before complete mixing occurs, i.e. consistent with some State mixing zone standards that allow mixing with only a fixed fraction of upstream flow. The results from equation 3 are used to determine compliance with water quality standards. DYNTOX assumes that complete lateral mixing of effluent always occurs before the next downstream discharge is reached, so no overlapping mixing zones are allowed.

As discussed in EPA (1984a) several assumptions accompany the use of this type of model:

> All pollutant loss and transformation processes can be adequately described using a single first order loss coefficient.
>
> The average river and wasteload conditions represent a steady state condition over the course of one day.

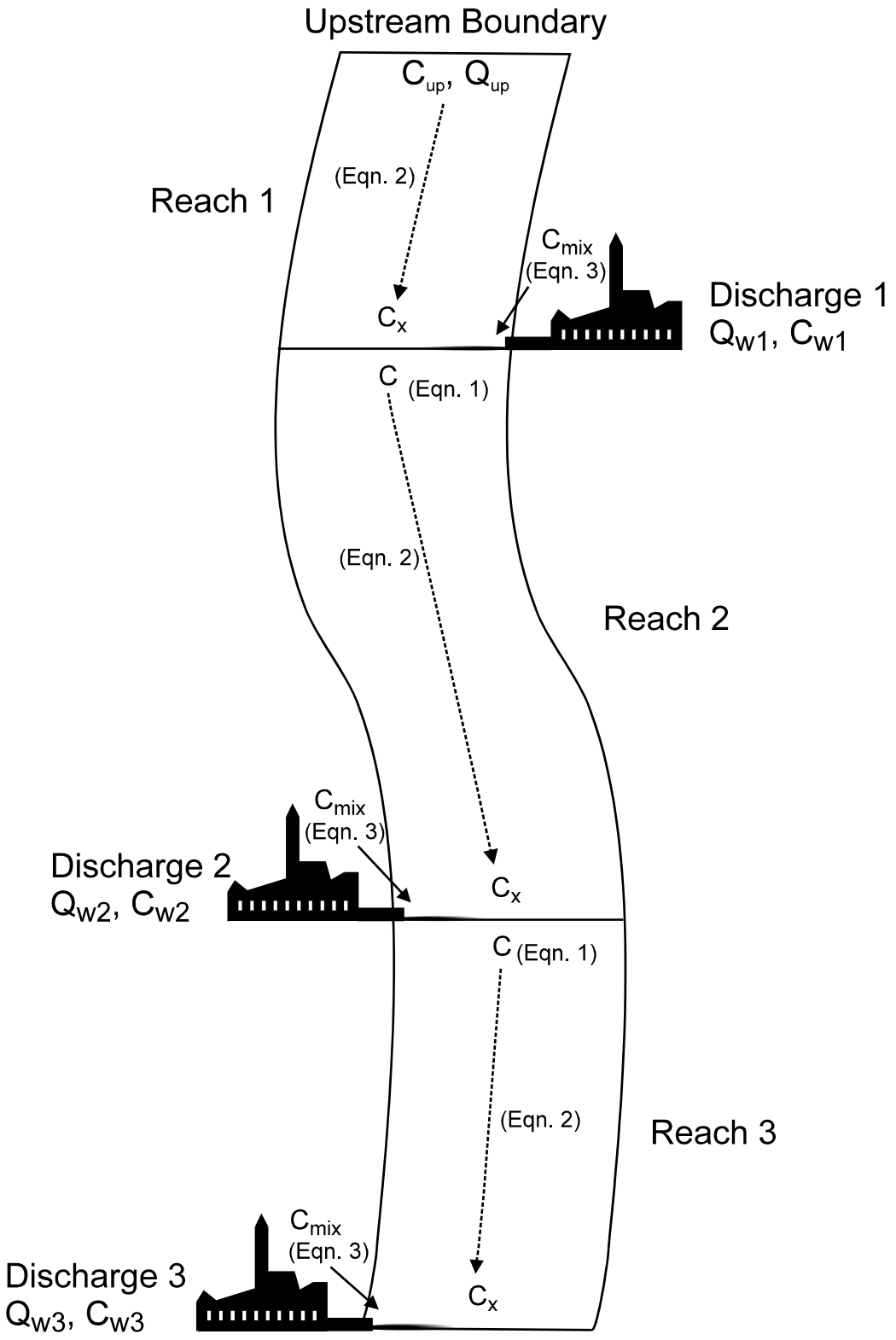

Figure 1. Schematic of DYNTOX Water Quality Model Framework

Dispersion is negligible in the longitudinal direction (i.e., free flowing streams vs. impounded areas).

This type of model framework typically assumes that USGS flow gaging information is available directly upstream of the first discharge, and that nonpoint sources of flow are not significant. DYNTOX provides some flexibility in this regard. The concept of drainage area ratios is applied to allow use of USGS gaging data from sites located some distance from the system upstream boundary. The equation used in DYNTOX is:

$$Q_{up} = Q_{USGS} \cdot DAR \tag{4}$$

where

Q_{USGS} = flow measured at USGS gage
DAR = ratio of drainage area for model upstream bound:drainage area for USGS gage.

Drainage area ratios can be specified for each reach of the system under study to account for nonpoint sources of water entering the stream. DYNTOX also allows use of USGS gaging data collected downstream of some of the dischargers of concern. In these cases, flow at the model upstream boundary is adjusted to account for any wastewater flows that enter the river upstream of the gaging station:

$$Q_{up} = Q_{USGS} - \sum_{i=1}^{NABOV} Q_{wi} \tag{5}$$

where

NABOV = number of discharges located upstream of the USGS gage

METAL TRANSLATOR

When simulating metals, DYNTOX has the capability to consider the bioavailability of metals in terms of fraction dissolved, consistent with EPA (1993) guidance. When comparing instream concentrations to WQS, only the dissolved concentration is considered:

$$C_{mix,d} = C_{mix} \cdot f_d \tag{6}$$

where

$C_{mix,d}$ = dissolved metal concentration at point of mix (M/L^3)
f_d = fraction of total metal concentration in dissolved form.

The fraction of metal in dissolved form can be estimated through the use of a linear partition coefficient, K_d, by:

$$f_d = \frac{1}{1 + K_d \cdot TSS \cdot 10^{-6}} \tag{7}$$

where

K_d = linear partition coefficient for metal of interest (l/kg)
TSS = total suspended solids concentration (mg/l)

Selection of appropriate partition coefficients is discussed in Chapter 3.

MODELING TECHNIQUES

Continuous Simulation

Continuous simulation analysis is designed to perform the water quality model calculations, using the theory described above, for each of numerous daily events. As seen in part ① of Figure 2, the continuous simulation method requires a daily time sequence of observed values for the model inputs - wastewater flow (Q_w), wastewater concentration (C_w) upstream receiving water flow (Q_{up}), and upstream concentration (C_{up}). These inputs are provided to the water quality model (step ② in Figure 2) on a day by day basis, to calculate downstream receiving water concentrations at the discharge point of mix (C_{mix}). The unique aspect of Continuous Simulation is that each input is described as a daily time sequence of observed values. The model predicts a simulated history of instream concentrations in chronological order corresponding to the same time sequence of the model inputs (step ③). The calculated daily downstream concentrations are subsequently ranked from the lowest to the highest without regard to time sequence (step ④). A probability distribution plot is constructed (step ⑤) from these ranked values, and the recurrence frequency of any concentration of interest can be obtained (C_{mix} vs. frequency). Running average concentrations for four days, or for any other averaging period, can also be computed from the simulated concentrations, ranked in order of magnitude, and also presented as a probability distribution.

The probability distribution plot generated by the Continuous Simulation technique will indicate the predicted frequency of criteria violations. These frequencies can be compared for different effluent alternatives. If evaluations of recurrence intervals of three or more years are desired, then at least 30 years of flow data should be available. This is needed to provide a sufficiently long record to accurately estimate the probability of rare events. (The same data requirements are also true to obtain accurate results for the Log Normal and Monte Carlo methods).

The advantages and disadvantages of Continuous Simulation are discussed in Appendix 1.

Monte Carlo

Monte Carlo analysis is similar to Continuous Simulation in that model calculations are performed repetitively, but differs in the means in which inputs are selected. When Continuous Simulation draws inputs directly from the observed time history, Monte Carlo analysis uses statistical distributions to describe the observed variability for each model input. Inputs for each individual model simulation are randomly selected from pre-specified distributions (Figure 3), and used as input to a single simulation. This process is repeated a number of times (called

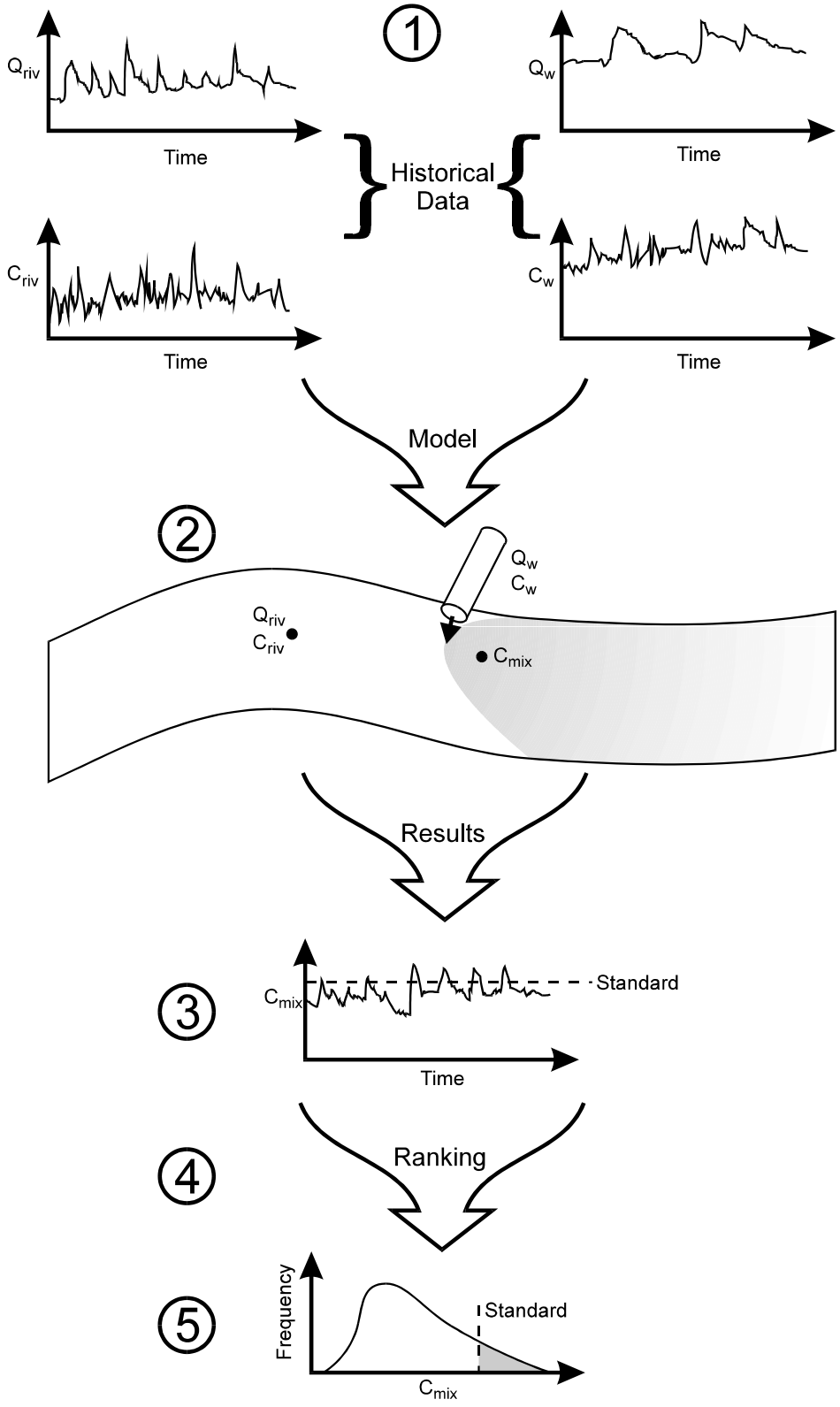

Figure 2. Continuous Simulation Method

iterations), with results for each iteration stored and statistically analyzed. Monte Carlo model theory states that the variability in model results can be accurately determined, as long as the variability in inputs is properly characterized.

Using Figure 3 as an example, the pre-specified distribution stated that wastewater flow (Box 1) had an equal probability of occurrence for all values between 20 and 80. For the specific model iteration depicted here, a value of 25.1 was selected. Upstream flow (Box 2) was specified to follow a normal distribution with a mean of 500; for this iteration, a value of 650 was randomly selected from that distribution. Similarly, specific values for wastewater concentration (30.1, Box 3) and upstream concentration (0.7, Box 4) were randomly selected from their pre-specified distributions. These four values are input into the model equation (Box 5) to predict instream concentration after mixing. In this case, the predicted mix concentration is 1.8. This information is incorporated into the predicted frequency distribution for C_{mix} (Box 6), which Figure 3 shows as now having a higher probability of occurrence for concentrations equal to 1.8. By repeating the above process enough times, a complete frequency distribution for instream concentrations can be generated.

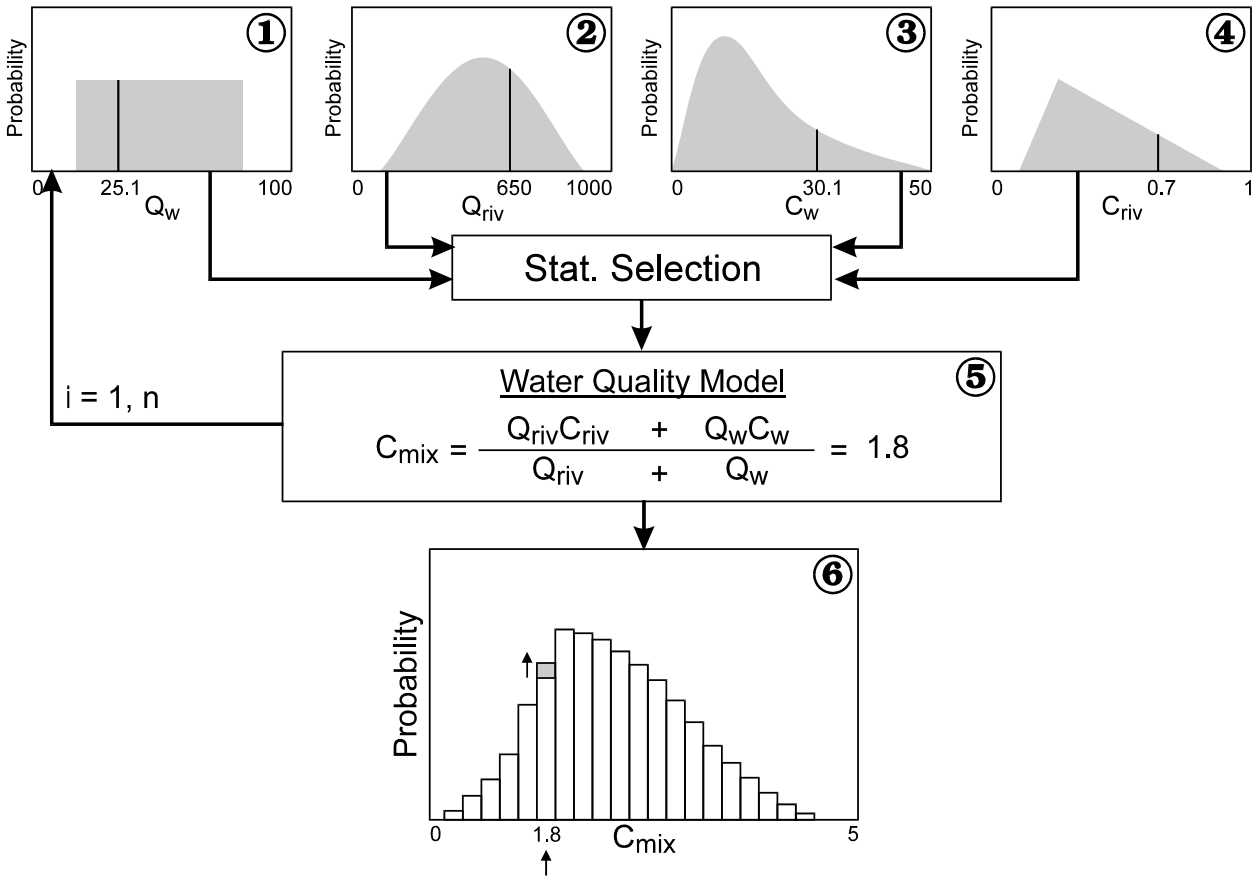

Figure 3. Monte Carlo Method

For acute impacts, which are measured as daily predicted concentrations, inputs are defined in terms of their distributions of daily average values. Chronic impacts, on the other hand, are generally measured as 4-day average concentrations. Therefore, chronic inputs are appropriately defined in terms of distributions of consecutive 4-day average values. The DYNTOX user can either enter 4-day (or, more generally, n-day) distribution variability directly, or allow DYNTOX to estimate this variability from the daily average distribution.

By combining statistical information on environmental conditions with deterministic model calculations, a statistically predicted forecast of water quality is obtained. The input distributions statistically reflect our best understanding of model inputs. The predicted concentration distributions, therefore, reflect the best estimate of the range in predicted water quality conditions. Analysis of this distribution can provide information on the probability of water quality problems and their severity. For a more in-depth discussion of using Monte Carlo to perform wasteload allocations, the user is referred to Freedman and Canale (1983). The advantages and disadvantages of Monte Carlo analysis are discussed in Appendix 1.

Log Normal Analysis

Continuous Simulation, Monte Carlo and Log Normal analysis are based upon the same dilution equation, which predicts the concentration below a discharge based upon upstream concentration, upstream flow, wastewater concentration, and wastewater flow (see Equation 1). Where Continuous Simulation and Monte Carlo analysis solve this equation many thousands of times using different values for the inputs, Log Normal analysis uses a totally different technique.

Log Normal analysis requires the assumption that each model input follows a log normal statistical distribution; this causes the probability distribution for each equation to be well defined mathematically. The probability that the river concentration at the point of mix (C_{mix}) exceeds any given value, C^*, can be expressed as a multiple integral of the joint probability density functions over the values of flows and concentrations for which $C_{mix} > C^*$. Since the variation of each input variable is defined by a mathematical equation, numerical integration can be conducted to determine the probability that $C_{mix} > C^*$. By repeating this integration for different values of C^*, the probability distribution for C_{mix} can be calculated. The probability of exceedance can be estimated for durations other than one day by using inputs representative of multiple-day averages, as is discussed above for the Monte Carlo method. The advantages and disadvantages of Log Normal Analysis are discussed in Appendix 1. For a more complete description of the theory behind Log Normal probabilistic analysis, see DiToro (1984).

CHAPTER 3: INPUT REQUIREMENTS

This chapter describes all inputs required by DYNTOX, so that the user can use this Chapter as guidance when creating a site-specific input file. DYNTOX typically requires a large amount of input data; however, these data can be divided into a relatively small number of categories:

Inputs Common to All Techniques
Continuous Simulation Input Requirements
Monte Carlo Input Requirements
Log Normal Input Requirements

INPUTS COMMON TO ALL TECHNIQUES

The three analytical techniques contained in DYNTOX, although conceptually quite different, have several common input requirements. All three analytical techniques in DYNTOX require the same two general types of input data:

1. **Stream flow and concentration data**: used to describe flow and concentration in the river upstream of the discharge(s).

2. **System constants**: used to describe water quality standards, time of travel between outfalls, and first-order decay rate for the pollutant of concern.

Upstream boundary flow and concentration data can be obtained from STORET; DYNTOX provides the capability to convert STORET retrievals to DYNTOX-usable format. In cases where data are available from sources other than STORET, the user may enter data into a computer file to be read by DYNTOX. System data must be determined by the user prior to performing any simulations.

This section describes the requirements common to all three techniques. Input format and inputs specific to a given technique will be discussed later in their respective sections.

Stream Flow Data

DYNTOX requires data describing the daily river flow upstream of the effluent discharges. Data describing these flows are maintained for most rivers by the United States Geological Survey (USGS) and are available through STORET. Users should contact their USGS State or District Office if they have questions about whether the flow record needs to be adjusted for point source inputs or water withdrawals. The first step in obtaining boundary flow data for DYNTOX is selecting the USGS gaging station to be used. The recommended location for the USGS gage is the closest gage upstream of the first discharge. Care should be taken to ensure that no major tributaries enter the river between the USGS gaging and the first outfall. If no stations are available that meet the above criterion, the nearest gage downstream should be used. If the river is ungaged, it may be possible to use the flow record of a nearby river with similar drainage characteristics and proportion the daily flows by drainage area.

When the appropriate gaging station has been selected, flow values can be retrieved using the FLOSTR option of STORET. Details for this procedure are contained in the STORET User Handbook (U.S. EPA, 1982), and an example STORET retrieval session is provided in Appendix 2 of this manual. DYNTOX requires data that best represents expected future variability in flows. The user must determine if the streamflow has been regulated by dams at any time before retrieving flow data for toxics analysis. This information is available in the Water Resources Data book published for each state by the USGS. If stream flow has been regulated, use only the data for the period which represents existing conditions.

The following paragraph demonstrates how to use the drainage area ratio to adjust stream flows. Figure 4 shows a map of the Kalamazoo River, indicating the name and location of the USGS flow gage. The hypothetical discharge of concern, Anytown WWTP, is located downstream of the gage. If significant additional sources of stream flow are expected between the available gage and the discharge, the flows can be incorporated in DYNTOX through the use of drainage area ratios. The steps involved in calculating these drainage area ratios are:

1) **Determine the drainage area for the USGS gage.** This information is available for each gage in the USGS Water Resources Data book published for each state. For the example shown in Figure 4, the drainage area of the USGS gage is listed as 1600 mi^2.

2) **Calculate the drainage area of the river corresponding to the discharge of concern.** This information will typically not be readily available, and will usually require assistance from a hydrologist and manual calculation of the drainage area from topographic maps. For the example in Figure 4, the drainage area for the WWTP is 2000 mi^2 (1600 mi^2 for the gage plus 400 mi^2 additional downstream area).

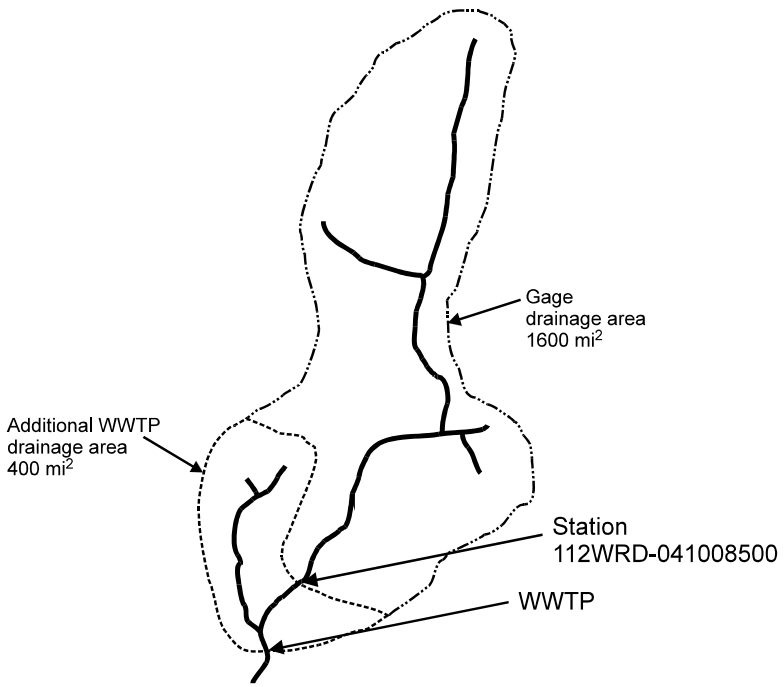

Figure 4. Selection of Flow Gage and Drainage Area Ratio

3) **Calculate the drainage area ratio (DAR) by dividing the drainage area for the discharge by the drainage area for the USGS gage.** This ratio will be less than 1.0 if the discharge is located upstream of the gage and greater than 1.0 if the discharge is located downstream of the gage. For the example in Figure 4, this ratio is 1.25 (2000/1600). When DYNTOX generates upstream flows for the WWTP, observed USGS flows will be multiplied by 1.25 (following Equation 4 on page 6).

Concentration Data

STORET data are also often available for describing upstream concentration data. Since concentration data are usually taken at USGS gaging stations, the same station used for flow data can often be used for concentration data. Unlike upstream flow, there are cases when STORET data for upstream concentrations cannot and should not be used. The first such case is when the USGS gage is located downstream of one of the modeled discharges. "Upstream" concentration data in this case would be biased by the effluent concentration and therefore not representative of conditions upstream of the discharge.

Concentration data can be retrieved from STORET using the RETRIEVE command. Further documentation on STORET retrieval is located in the STORET User Handbook, as well as Appendix 2. Users can retrieve multiple parameters at one session; DYNTOX will prompt the user for the desired parameter during program operation.

Data from sources other than STORET can also be used by DYNTOX, as long as they are stored in the proper format. The format consists of one date (mm/dd/yy) and one observed value per line, separated by spaces, i.e.

01/01/82	63.9
01/02/82	43.8
01/03/82	29.4
.	.
.	.
.	.
.	.

Separate files of this type can be used for each DYNTOX input requiring observed data.

System Constants

There are several types of required information describing the river system. These include:

- Simulation title
- Type of simulation
- Model averaging period
- Number of discharges
- Discharge upstream of gage
- Water quality criteria
- Reach constants

Each type of information in discussed below.

Simulation Title: The simulation title is specified by the user to provide descriptive information on the run being conducted. This can contain information such as site name or input assumptions, and will be printed at the top of all model output.

Type of Simulation: The user must specify which type of DYNTOX simulation is desired: Continuous Simulation, Monte Carlo, or Log Normal.

Model Averaging Period: This input represents the duration (i.e., averaging period) to be used for the water quality criterion of interest.

Number of discharges, number discharges above gage: The total number of discharges to be simulated, as well as the number of these discharges located above the flow gage, are required information as discussed in the model theory section.

Water quality criteria: Water quality criteria can be specified as one of three types: 1) constant, 2) ammonia toxicity, or 3) hardness dependent. Constant criteria are used for most organic toxicants, and consist of a single numeric value (the criterion) for acute or chronic toxicity. Log Normal analysis can only consider constant criteria. Ammonia toxicity criteria vary as a function of fishery type (warm vs. cold water) and ambient pH and temperature. When simulating ammonia toxicity in DYNTOX, the user must specify as part of the basin constants whether the fishery is warm or cold water. The user will subsequently need to specify the temperature, pH, and alkalinity of all upstream and wastewater sources. Given this information, DYNTOX will calculate the applicable water quality standard as a function of predicted instream pH and temperature using published EPA (1984b) criteria. The equations used to define ammonia criteria require no user inputs and all required calculations are performed internal to the DYNTOX code.

The third criteria option represents hardness-dependent criteria. Water quality standards (WQS) for most heavy metals are written in the form

$$\text{Total Recoverable Metal } WQS = e^{[a\ell n(\text{hardness})+b]} \tag{8}$$

where

a,b = metal-specific constants defined as part of the water quality criterion

Users selecting hardness-dependent criteria need to specify the constants a and b for the metal of concern, as well as subsequently specifying the hardness of all upstream and wastewater sources. EPA policy is to recommend the use of dissolved metal to set and measure compliance with water quality standards, because dissolved metal more closely approximates the bioavailable fraction of metal in the water column than does total recoverable metal. Freshwater and saltwater criteria conversion factors for dissolved metals are used to modify equation 8:

$$\text{Dissolved Metal } WQS = e^{[a\ell n(\text{hardness})+b]}(CF) \tag{8a}$$

where

CF = metal specific acute or chronic criteria conversion factor

Table 1 shows values of a and b for several metals which are listed in Federal (EPA, 1986a, 1987) criteria, along with freshwater conversion factors.

Table 1a: Chronic Hardness-Dependent Dissolved Criteria for Several Metals

Metal	a	b	CF	ug/l @100 mg/l hardness
Cadmium	0.7852	-3.49	0.909	1.0
Chromium III	0.819	1.561	0.86	180
Copper	0.8545	-1.465	0.96	11
Lead	1.273	-4.705	0.791	2.5
Nickel	0.846	1.1645	0.997	160
Silver	-	-	-	-
Zinc	0.8473	0.7614	0.986	100

Table 1b: Acute Hardness-Dependent Dissolved Criteria for Several Metals

Metal	a	b	CF	ug/l @100 mg/l hardness
Cadmium	1.128	-3.828	0.944	3.7
Chromium III	0.819	3.688	0.316	550
Copper	0.9422	-1.464	0.96	17
Lead	1.273	-1.46	0.791	65
Nickel	0.846	3.3612	0.998	1400
Silver	1.72	-6.52	0.85	3.4
Zinc	0.8473	0.8604	0.978	110

EPA has recommended that hardness dependent metals criteria have an applicability range of 25 - 400 mg/l hardness as $CaCO_3$, and that the criteria conversion factors for cadmium and lead be themselves hardness dependent (the listed factors were developed at a hardness value of 100). DYNTOX does not incorporate these refinements.

DYNTOX also considers metals bioavailability in terms of partitioning between dissolved and particulate phases. Users may specify either an assumed constant fraction dissolved, or a partition coefficient that will allow the fraction dissolved to vary as a function of solids concentration, as described previously in equation 7 on page 6.

Historical data presented in EPA (1984a) indicate that the observed partition coefficients for many metals in streams vary as a function of suspended solids concentration. A regression of partition coefficients vs. solids yielded the following predictive equation:

$$K_d = K_{d0} \cdot \ TSS^{\alpha} \tag{9}$$

where

K_{d0}	=	baseline partition coefficient (l/kg)
TSS	=	total suspended solids (mg/l)
α	=	metal-specific correction factor

Table 2 lists the calculated regression coefficients for several metals in streams from EPA (1984a).

Table 2: Partition Coefficient Regression Constants (from EPA, 1984a)

Metal	$K_{d,o}$	α
Arsenic	0.48×10^6	-0.7286
Cadmium	4.00×10^6	-1.1307
Chromium	3.36×10^6	-0.9304
Copper	1.04×10^6	-0.7436
Lead	0.31×10^6	-0.1856
Mercury	2.91×10^6	-1.1356
Nickel	0.49×10^6	-0.5719
Zinc	1.25×10^6	-0.7038

EPA (1993) suggests that site-specific data be collected to calculate partition coefficients. There is evidence of possible quality assurance problems with the data used to estimate the regression coefficients in Table 2, and the regressions cannot adequately characterize every site. Table 2 values are recommended for use only as an interim measure until sufficient site-specific data can be collected.

Table 3 shows how DYNTOX calculates an acute criterion for copper where the receiving water hardness (after mixing) is 100 mg/l and suspended solids concentration is 50 mg/l.

Table 3. Example Calculation of Acute Copper Criterion

Parameter	Calculation	Source	Result
Copper criterion (total)	$e^{(0.9422[\ln 100]-1.464)}$	Eqn. 8	17.7 ug/l
Copper criterion (dissolved)	17.7(0.96)	Table 1	17 ug/l
Partition coefficient	$(1.4 \times 10^6)50^{-0.7436}$	Eqn. 9	5.67×10^4 l/kg
Fraction dissolved	$1/(1+50 \times 5.67 \times 10^4 \times 10^{-6})$	Eqn. 7	0.261
Total copper concentration corresponding to WQS for dissolved	17/0.261	Eqn. 6	65 ug/l

Reach Constants: The final category of System Constants consists of reach constants, which must be specified once for each reach/discharge. These include drainage area ratios from each outfall to the USGS gage, partial mix factors, time of travel (velocity), and instream decay. The drainage area ratio from each outfall to the USGS gage was discussed previously. Information on time of travel is required by the Continuous Simulation and Monte Carlo techniques for calculating instream fate (instream decay is not considered in the Log Normal analysis) for use in Equation 2. Time of travel information is necessary to describe passage from the upstream boundary station to the first outfall and for the stretch of river between each outfall (in multiple discharge situations). Time of travel information can be obtained in one of two ways. First, dye studies can be conducted to determine the time of travel for each required stretch of river. Second, current meters can be used to calculate the average velocity in a reach. Time of travel information is determined from velocity measurements by dividing reach length by velocity.

The user has two options for specifying time of travel. Time of travel may be described as constant or varying as a function of flow. Flow-dependent time of travel is recommended and is calculated by the equation:

$$\text{Time of Travel} = aQ^b \tag{10}$$

where Q is river flow and a and b are empirical constants. The coefficients a and b can be determined by plotting observed time of travel (distance/velocity) values at different flows on a log-log scale. The coefficient a is the y-intercept of the best fit line through the data, while b is the slope of the line. Note that b should be negative, as time of travel will decrease with increasing flow. Typical values for b range from -0.34 to -0.70 (Thomann, 1972). Constant time of travel requires only one input value that will be used for all flow conditions, and should be used when insufficient data are available to calculate flow-dependent time of travel. Figure 5 demonstrates this concept using data from the multiple discharge case study presented in Chapter 6; in this example a = 4 and b = -0.4.

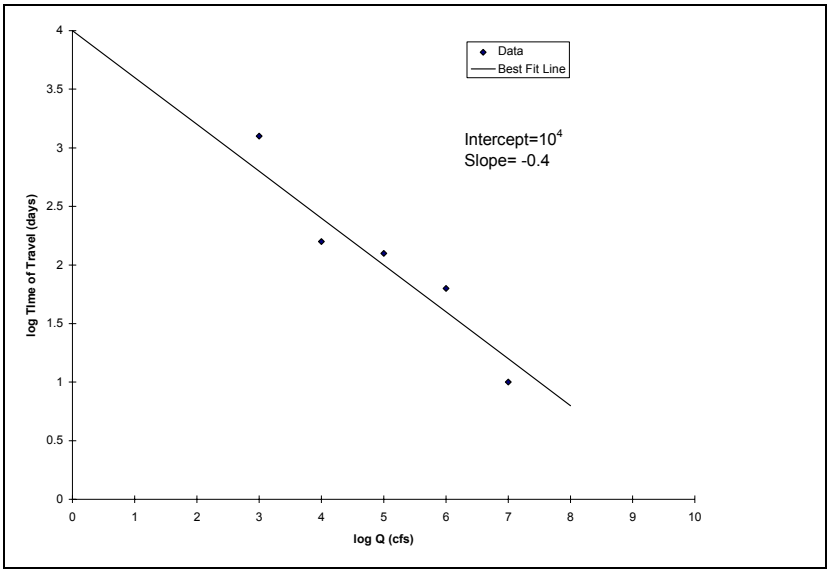

Figure 5. Calculation of Time of Travel Coefficients

The Continuous Simulation and Monte Carlo techniques in DYNTOX treat the instream fate of a toxic as a first-order decay process and therefore require a first-order decay rate. Calculating this decay rate requires several data points taken from different stations on the river with a known time of travel and no pollutant sources between them. The natural logarithm of the concentration should be plotted versus time of travel on semi-log paper and the decay rate calculated as the slope of the best fit line (Figure 6). This decay rate can change with changes in treatment for future scenarios. However, unless data are available to indicate otherwise, the same decay rate observed in-stream should be used for all wasteload allocation projections. When no in-stream data are available, the user should assume zero decay.

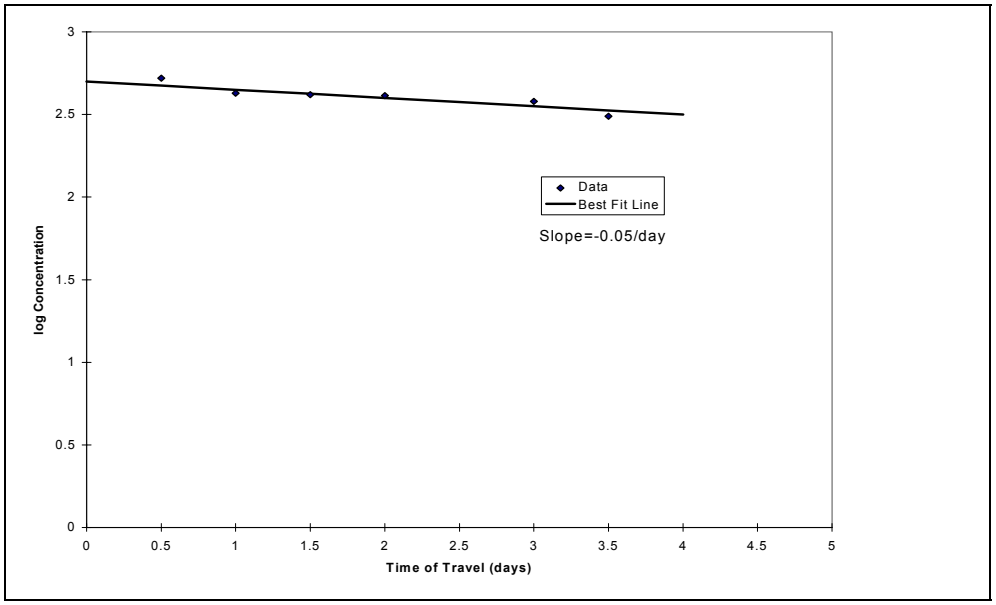

Figure 6. Calculation of First-Order Decay Rate

CONTINUOUS SIMULATION INPUT REQUIREMENTS

This section details the input requirements specific to the Continuous Simulation technique. The inputs can be generally categorized into three groups:

General Information,
Upstream Data, and
Effluent Data.

These specific inputs are listed in Appendix 4, and will be discussed individually in this section.

General Information

The first two pieces of information required by the Continuous Simulation method both correspond to the period of the simulation, and consist of the beginning and the end date of the simulation. The beginning and end dates typically correspond to the first and last date for which continuous stream flow data are available. This period should be as long as possible, since the power of the Continuous Simulation technique increases with the amount of observed data.

Sometimes it is necessary to use a subset of the available data record, if portions of the historical data are no longer representative of present conditions. Specific reasons for excluding some parts of the full historical record are: 1) changes in stream flow regulation, 2) changes in upstream boundary water quality, due to changes in land use or Best Management Practices.

The number of discharges located above the flow gage, the averaging period, and water quality criterion were all discussed previously in the section "Inputs Common to All Techniques".

Stream Data

The Continuous Simulation technique requires time series information on upstream boundary flow and concentration, and effluent flow and concentration. The Continuous Simulation technique requires a data value for each individual day of the simulation. Typically many "holes" will exist in the data set, days which have no data for a given parameter. A method to synthesize or fill in data for missing days is required. Three methods are available in DYNTOX for synthesizing missing data for the Continuous Simulation technique:

1. linear interpolation
2. simple Markov synthesis
3. multi-period Markov synthesis

Each is discussed in Appendix 3 as needed for use in this program. The reader is referred elsewhere for a more thorough discussion of data synthesis methods (Fiering and Jackson, 1971). Should the user desire a data synthesis technique other than that supported by DYNTOX, they may perform the appropriate synthesis external to the program and store the results to file in the DYNTOX format described previously.

Effluent Data

Similar to upstream data, daily input values are needed in the model for effluent flow and concentration (or toxicity). The source of these data must be user specified. As for the upstream data, gaps are likely to exist in any data set. Here again, the user must use either linear interpolation, simple Markov, or multi-period Markov to synthesize data for missing days. Any significant downstream tributary inputs occurring between discharges should be considered as a separate effluent input.

MONTE CARLO INPUT REQUIREMENTS

This section details the input requirements specific to the Monte Carlo technique. These inputs are listed in Appendix 4, and will be discussed in detail in this section. The inputs can be categorized into three groups:

General Information,
Upstream Data, and
Effluent Data

General Information

The Monte Carlo method requires one primary model parameter, the number of iterations. The Monte Carlo technique requires a sufficient number of iterations to adequately define the probability of occurrence of downstream concentrations. However, specifying too many iterations can waste computer time. DYNTOX provides some assistance in choosing the proper number of iterations, via the Run Status screen (discussed subsequently in Figure 16 on page 30) that displays the return period of violations below each discharge. At the beginning of a Monte Carlo simulation, the predicted return period(s) will vary substantially as each additional iteration is conducted. As the number of iterations conducted increases, this variability will begin to decrease and eventually approach a constant value. A sufficient number of simulations should be conducted to reduce this variability to a level that is acceptable to the user. It is typically apparent within the first 50,000 iterations whether the return period is significantly above or below the desired frequency (e.g., 3 years). On the order of 1,000,000 iterations is often required to rigorously determine a 3 year return period value within +/- 0.2 years.

The Monte Carlo (as well as Log Normal) method also requires the user to specify whether the program should automatically adjust the variance of inputs for averaging periods longer than one day. As described in Chapter 2, Monte Carlo analysis for n-day average concentrations requires that model input distributions be representative of n-day average conditions (n being the averaging period.) By selecting automatic variance reduction, the user may enter the distribution parameters for daily average data and have DYNTOX automatically estimate the appropriate distribution parameters for n-day average conditions. By declining this option, the program assumes that distribution parameters have been entered for n-day average data. The automatic variance adjustment assumes that each day's values are independent of surrounding days (i.e. no serial correlation); if this assumption is violated then direct entry by the user of n-day average distribution statistics will typically produce a more accurate result. Automatic variance reduction does not apply to one day averaging periods.

Upstream Data

The Monte Carlo technique requires statistical input distributions for the upstream boundary flow and concentration. The Monte Carlo technique allows the use of assumed data distributions or the observed data when selecting input distributions.

Six input distribution types can be used for Monte Carlo. The first four are standard statistical distributions: uniform (rectangular), normal (Gaussian), Log Normal, and triangular. The last two distribution types, termed exceedance and data-defined, are non-standard statistical distributions. These last two choices can be used to create statistical distributions beyond the standard four described above, or in cases where the observed data follow no standard statistical distribution. The parameters required to describe all DYNTOX distributions are described below. DYNTOX allows comparison of the observed data distribution to the idealized distribution selected by the user.

The uniform distribution represents the case where each value within a given range has an equal probability of occurrence. Two parameters are required to define a uniform distribution, the minimum and maximum value (See Figure 7). The normal or Gaussian distribution is also shown in Figure 7. Two parameters are required to define this distribution, the mean value and the standard deviation.

The log normal distribution (Figure 7) is a variation of the normal distribution that assumes that the logarithms of the observed data follow a normal distribution. It is perhaps the most commonly used distribution to describe variability in environmental and effluent parameters. The log normal distribution requires two parameters, the mean value and standard deviation.

A sample triangular distribution is shown in Figure 7. The triangular distribution requires three parameters - the minimum value, most likely value (i.e., mode), and maximum value - and can therefore have a variety of different shapes.

An example of the exceedance distribution is shown in Figure 7. This distribution can take on an infinite number of shapes and can be used to simulate any desired distribution. The exceedance distribution requires information on the minimum value, maximum value, and number of intervals (also called bins) to be used. For each interval, the user must specify the cumulative probability of exceedance for that range.

The last distribution shown in Figure 7 is the data defined distribution. This distribution type can also take any shape. The user must specify as input a file containing the complete record of observed data for the parameter of interest. DYNTOX will randomly select one value from this file to use for each model iteration.

Effluent Data

Similar to upstream data, statistical distributions are needed in the model for effluent flow and concentration. For each effluent parameter, the user must specify a statistical distribution using the same technique described in the upstream boundary data section.

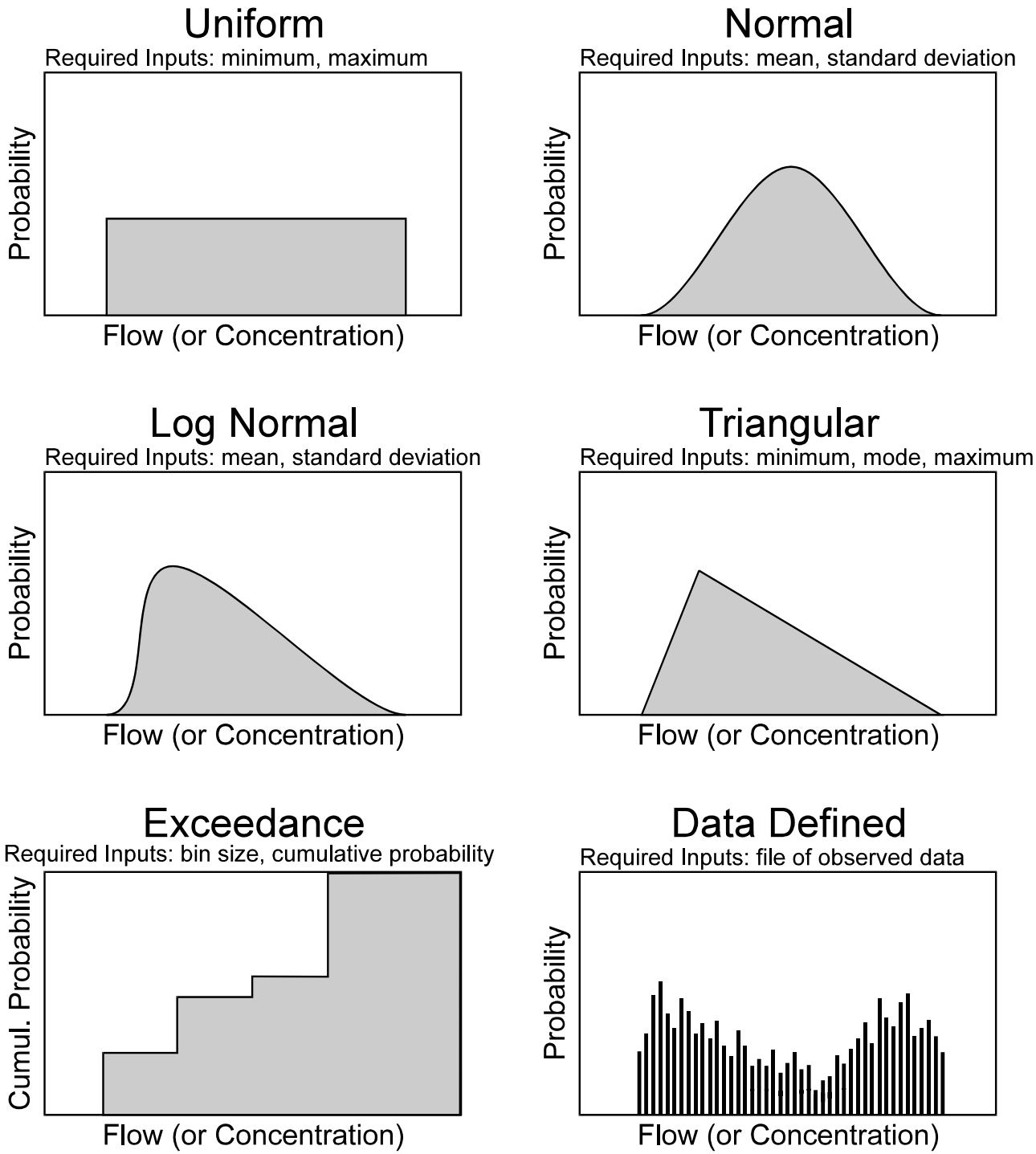

Figure 7. Statistical Distributions in DYNTOX Monte Carlo

LOG NORMAL INPUT REQUIREMENTS

This section details the specific input requirements for the Log Normal technique. These inputs are summarized in Appendix 4, and will be discussed in detail in this section. The inputs can be categorized into three groups:

General Information,
Upstream Data, and
Effluent Data.

General Information

The user must specify the minimum and maximum output concentration of interest before running the simulation, and DYNTOX will calculate the probability of exceedance (and return period) for values within this range. The numerical solution technique used to perform Log Normal analysis it not well suited to consider concentrations that are always exceeded. For example, if concentrations at the point of mix are expected to range between 100-200 ug/l, the Log Normal method will be unable to compute the probability of exceedance for instream concentrations of 1 ug/l. The user should exercise some judgment to choose a minimum value that has a probability of exceedance less than 100%.

The Log Normal (as well as Monte Carlo) method also requires the user to specify whether the program should automatically adjust the variance of inputs for averaging periods longer than one day. As described in Chapter 2, Monte Carlo analysis for n-day average concentrations requires that model input distributions be representative of n-day average conditions (n being the averaging period.) By selecting automatic variance reduction, the user may enter the distribution parameters for daily average data and have DYNTOX automatically estimate the appropriate distribution parameters for n-day average conditions. By declining this option, the program assumes that distribution parameters have been entered for n-day average data. The automatic variance adjustment assumes that each day's values are independent of surrounding days (i.e. no serial correlation); if this assumption is violated then direct entry by the user of n-day average distribution statistics will typically produce a more accurate result. Automatic variance reduction does not apply to one day averaging periods.

Stream Data

The Log Normal technique requires the mean and standard deviation of the input distributions for the upstream boundary flow and concentration. DYNTOX provides the ability to determine the distribution parameters from observed upstream boundary flow and concentration, although this capability requires observed data defining these conditions.

The required form of this data includes the arithmetic mean and standard deviation value for each parameter. These values can also be determined from any statistical software package, as can the adequacy of the assumption of log normality. In addition, the log normal method allows consideration of correlation between: 1) river flow and effluent flow, and 2) river flow and river concentration, through the use of a linear correlation coefficient. The correlation coefficient can be determined using the logarithms of the observed data and any statistical software package.

Effluent Data

Similar to upstream data, log normal distribution parameters are needed in the model for effluent flow and concentration (or toxicity). For each effluent parameter, the user must specify a mean and standard deviation using the same technique described in the upstream boundary data section. DYNTOX provides the capability to calculate these values directly from observed effluent data. Other statistical software may also be used to calculate these parameters before performing Log Normal analysis. The final effluent requirement is the cross-correlation between effluent flow and concentration, which may also be determined using statistical software packages.

CHAPTER 4: ACCESS AND USE OF DYNTOX

The modifications to DYNTOX incorporated in Version 2.0 are intended to provide a more user-friendly tool for probabilistic wasteload allocation modeling. As such, the program is menu driven, with the main features of the program divided into distinct sections. This portion of the manual discusses all aspects of program operation. It first discusses model installation and is subsequently divided into sections discussing specific aspects of program operation:

Hardware/Installation Requirements
Main Menu
Read Input File
Create/Edit Input File
Save Input File
Run DYNTOX Model
View DYNTOX Results
Save DYNTOX Results
Reformat STORET Data File
Exit to DOS

HARDWARE/INSTALLATION REQUIREMENTS

DYNTOX is designed to run on any PC-compatible computer with DOS Version 3.1 or higher. Although 512K of RAM is sufficient, 640K is recommended. Because of its memory requirements, it is best to run DYNTOX directly from DOS, without running Windows™ concurrently. An EGA (or higher) graphics board and monitor is recommended; DYNTOX will run with or without a math co-processor. No files other than DYNTOX.EXE are necessary to run the program. Sample input files are also provided. To execute the program, type DYNTOX at the DOS prompt. The operation of specific aspects of DYNTOX is described in the following sections.

MAIN MENU

The main menu of program options (Figure 8) is designed to control all DYNTOX activities. DYNTOX will always display this screen upon entry to the program. A typical DYNTOX session for a system with a previously saved data file would follow steps 1 through 5 in chronological order: 1) Read previously saved inputs from disk, 2) Edit input file, 3) Save edits to disk, 4) Run DYNTOX model, 5) View Results. The first time DYNTOX is applied to a system, Step 1 is skipped (because there will be no DYNTOX file to read; this step will typically be replaced with reformatting of STORET inputs into a format that can be read by DYNTOX). To select a desired option, the cursor can be moved by using the up and down arrow keys or typing the number directly. Pressing the Enter key will activate the selected option. The remainder of this section will describe the operation of each menu option. Sample screens will be provided demonstrating the use of each option as applied to the case study sites shown in Chapter 6.

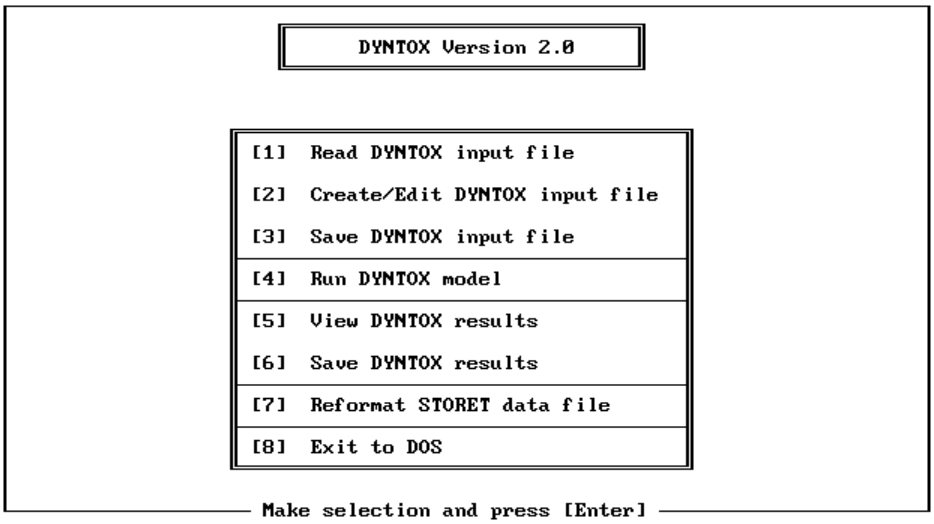

Figure 8. DYNTOX Main Menu Screen

READ DYNTOX INPUT FILE (MENU OPTION 1)

The purpose of this option is to read previously entered model inputs from disk in order to edit them and/or perform a model simulation. By selecting this option from the main menu, the screen shown in Figure 9 is displayed. The default file specification *.DDF appears in the top rectangle when first entering the Read Inputs from File option. All files fitting this file specification are shown below in the File Name box. By pressing the tab key, the desired file can be read in by using the arrow keys to highlight the file and pressing Enter. File names specified by users must consist of up to eight alpha-numeric characters. The extension .DDF is automatically added to the file name to identify the file as DYNTOX data file if a file extension is not specified. To change directories, press the tab key a second time to highlight the rectangle in the Change Directory box and press the Enter key. Select the desired directory in the same manner described above to select a file. Repeat the process again to select the input file desired from the new directory.

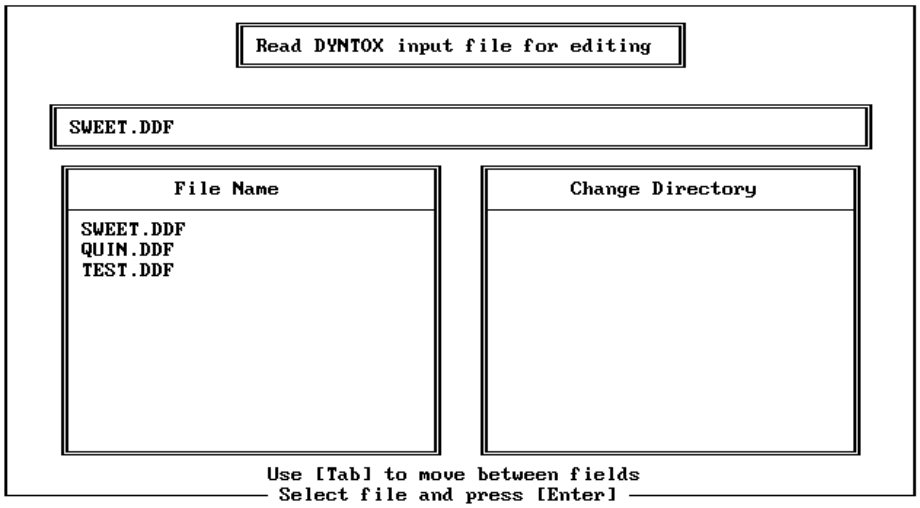

Figure 9. Read Inputs from File Screen

A new model input file can be created by first entering the name of a file that does not currently exist. When this occurs, DYNTOX will ask if you want to create a new file using the name just specified. You have the option to answer "no" if you do not wish to create a new file.

CREATE/EDIT DYNTOX INPUT FILE (MENU OPTION 2)

This program option allows the user to enter new inputs for a model simulation (create a file) or modify existing inputs (edit a file). All model inputs required for model simulation can be accessed from this section. The Create/Edit Inputs option is divided into three screens, each specific to a certain type of information:

Model Parameters/Basin Constants
Upstream River Inputs
Discharge/Reach Inputs

The program can be routed to any desired input option through the use of the Function keys as follows: [F1] Upstream Inputs, [F2] Reach/discharge Inputs, [F3] Model Parameters/Basin Constants. The Escape Key [Esc] can be pressed at any time to exit the input editor and return to the main menu. The program goes to the Basin Constants screen upon initial selection of this option. The following paragraphs describe the features available and the proper application of the above three options.

Model Parameters/Basin Constants

This is the first screen that appears when selecting the Create/Edit Input file option. This screen allows the user to enter descriptive information that pertains basinwide. The screen, as shown in Figure 10, first requires information on the run title and simulation type. The run title can accommodate up to 40 characters of text, and is designed to contain descriptive information on the simulation contained in the input file. For example, the Run Title in Figure 10 is "Quinnipiac River Case Study". The simulation type (Continuous Simulation, Monte Carlo, or Log Normal) can be selected by typing the first letter of the desired technique (C, M, or L) or using the space bar to toggle through the options. Continuous Simulation was selected as the simulation type in Figure 10.

The next input is the averaging period (in days) to be used. Figure 10 shows an averaging period of 4 days. The next input depends upon the simulation type selected. Continuous Simulation analysis requires specification of the start and end date of the simulation (Figure 10); Monte Carlo requires specification of the number of simulations; Log Normal analysis requires specification of the minimum and maximum concentration of interest.

The next group of inputs requires information on the total number of discharges to be simulated, as well as the number of these discharges that are located above the USGS gage used for flow information. For this example, a single discharge is simulated which is located downstream of the flow gage.

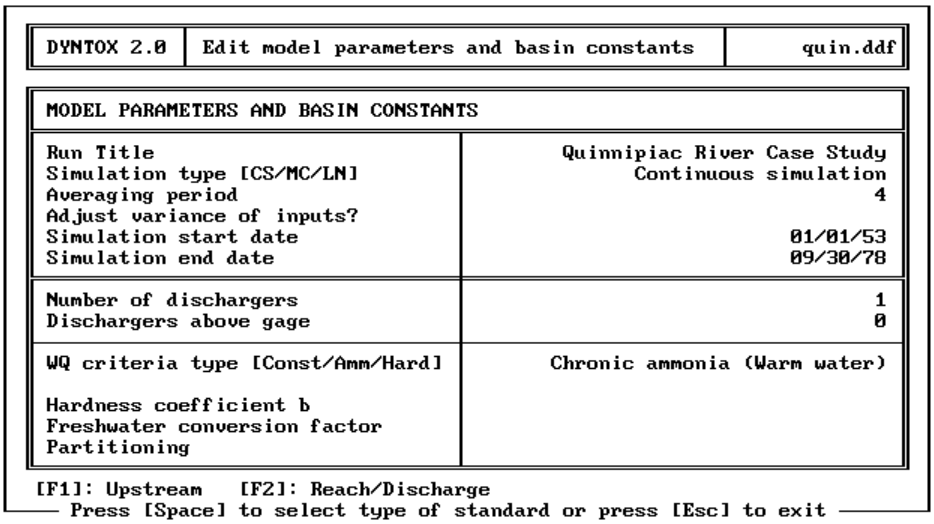

Figure 10. Basin Constants Input Screen

The final group of inputs pertains to the water quality standard. The first input is the type of criterion desired (Constant, Ammonia toxicity, or Hardness-dependent) and can be specified by typing the first letter of the selection or toggling through the choices using the space bar. Depending upon the criteria selected, the user must specify:

1. **Constant criterion**: criterion value
2. **Ammonia toxicity**: acute or chronic, and warm or cold water fishery (Figure 10)
3. **Hardness-dependent**: hardness coefficients a and b, freshwater conversion factor, and type of partitioning relationship.

The ammonia toxicity criteria type (i.e. acute or chronic, warm- or cold-water fishery) can be selected by A toggling through the four choices using the space bar.

Upstream Inputs

Upstream inputs are accessed from anywhere within the input editor by pressing the [F1] key. The upstream inputs screen requires, at a minimum, information on flow and pollutant concentration at the model upstream boundary. Depending upon the criterion type selected, the user may also be required to provide information on pH, temperature, and alkalinity (for ammonia toxicity calculations) or hardness and/or TSS (for hardness-dependent criteria).

The format for entering upstream information is generally consistent across the three modeling techniques, with only slight variations on the information required. The first column of user inputs is always used to specify the file name containing observed data (if any). For the example shown in Figure 11, the data files QUIN2.PRN and QUINTEM.PRN have been specified for upstream flow and temperature, respectively. The remaining columns are used to provide supplemental input on each parameter, and vary depending upon the simulation type. For Continuous Simulation (Figure 11) the second column of input is used to describe the data synthesis technique to be used to account for gaps in the observed data file. Acceptable choices for this input are: 1) linear **I**nterpolation, 2) **S**imple Markov, or 3) **M**ultiple period Markov. For

the example shown in Figure 11, simple Markov is used for upstream concentration, pH, and alkalinity; linear interpolation is used for upstream flow and temperature. Should one of the Markov methods be used, the user must also specify the mean, variance, and (optionally) autocorrelation coefficient for each parameter.

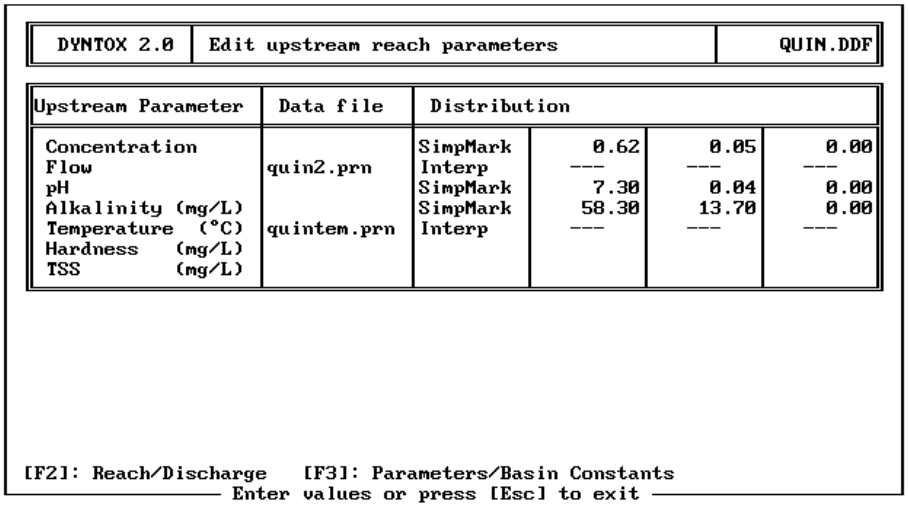

Figure 11. Upstream Inputs Screen for Continuous Simulation

For the Monte Carlo method, the first column under Distribution is used to specify the type of distribution to be used for the parameter. The choices: **N**ormal, **L**og Normal, **U**niform, **T**riangular, **E**xceedance or **D**ata Defined can be selected by typing the first letter of the distribution or toggling through the choices using the space bar. The remaining columns are used to define the parameters for the specific distribution selected (Figure 12). Input format for the Log Normal method is essentially identical as to Monte Carlo, except that the distribution type must be set to Log Normal. The only other difference is that Log Normal analysis allows cross-correlation between: 1) effluent flow and upstream flow, and 2) upstream flow and upstream concentration, via specification of a correlation coefficient in the last column.

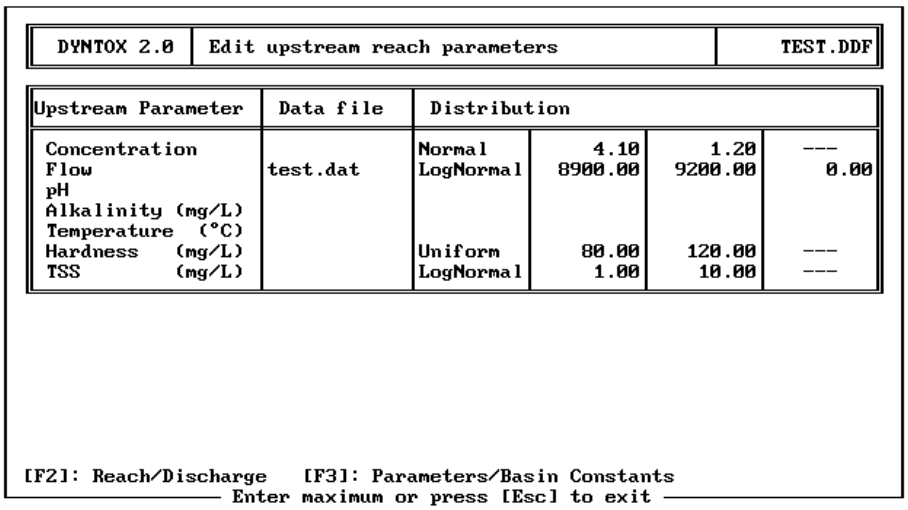

Figure 12. Upstream Inputs Screen for Monte Carlo/Log Normal

The DYNTOX input editor provides two useful features to assist in the preparation of input files. The first is automatic calculation of the mean and standard deviation of the observed data, which are required inputs for Log Normal analysis and certain features of Continuous Simulation and Monte Carlo. This is accomplished by moving the cursor to the line containing the parameter of interest, and pressing the [F9] key. DYNTOX will read the data file specified by the user, calculate the mean and standard deviation of the data, and automatically update the DYNTOX input file.

The second useful feature of the DYNTOX editor is the ability to compare the observed frequency distribution of the data in the specified file to the distribution selected by the user. This feature works for both Monte Carlo and Log Normal analysis, and is activated by pressing the [F10] key for any input parameter that has a data file and specified distribution. As shown in Figure 13, the distribution of the observed data is represented by a histogram, while the user-specified distribution is represented by a solid line. This graph can be used to provide a qualitative indication of how well the selected distribution describes the variability in observed data. The specific numeric values used for the comparison are shown in the upper right hand corner of Figure 13; in this example the mean (8890) and standard deviation (9204) specified by the user represent the values calculated from the observed data.

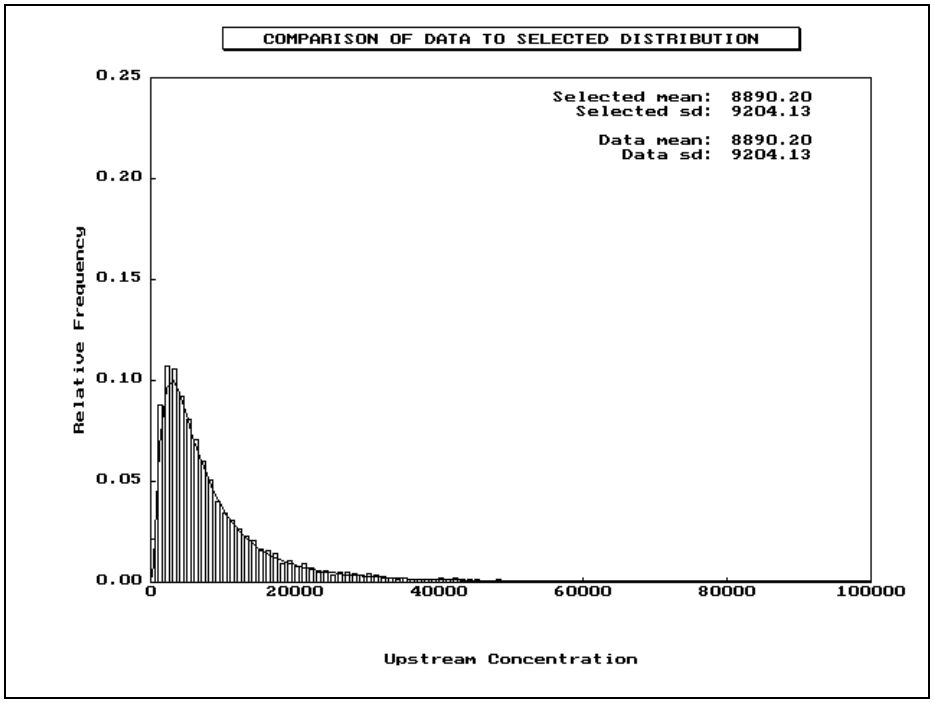

Figure 13. Comparison of Selected Distribution to Observed Data

Discharge/Reach Inputs

The discharge/reach parameters are accessed by pressing the [F2] key from anywhere within the input editor. The screen is divided into two halves, corresponding to discharge parameters and reach constants (Figure 14). Specification of discharge parameters is conducted identically to specification of upstream parameters, as discussed previously.

The bottom half of the input screen contains information specific to the river reach upstream of and including the discharge of concern. The first input is used to correct for discrepancies between the USGS gaged flow and the expected flow directly above the discharge. The value of 1.0 used in Figure 14 indicates that the gaged flow accurately represents conditions directly upstream of the discharge. The second input is the partial mix factor for the discharge of interest. The value of 1.0 used in Figure 14 indicates that complete mixing was selected. The third input (if hardness-dependent criteria is selected) corresponds to the partitioning of metals between the particulate and dissolved phase. These inputs will depend upon the type of partition relationship selected in the Basin Constants section and will consist of: 1) Fraction dissolved, if constant fraction dissolved is selected; or 2) Partition coefficient (K_{d0}) and solids correction factor (α), if partition coefficient is selected. The next input, located at the bottom right of the screen, is the first-order loss coefficient for the pollutant in the reach. For the example in Figure 14, a decay rate of zero indicates conservative pollutant behavior. The final inputs relate to the type of equation used to predict time of travel through the stream reach (Constant or Flow-variable). A constant time of travel requires specification only of the time in days, while flow variable time of travel requires specification of the coefficients a and b discussed in the model theory chapter.

Continuous Simulation and Monte Carlo analyses in DYNTOX allow consideration of multiple discharge scenarios. The water quality model in DYNTOX divides the river of interest into segments called reaches, with the end of each reach defined by a discharge (see Figure 1). Reach 1, therefore, extends from the model upstream boundary to the first discharge. Reach 2 begins immediately after the first discharge and extends until the second discharge. Input screens for additional discharges can be accessed from with the reach discharge area in the input editor by pressing the PgDn (to move downstream) or PgUp keys.

DYNTOX 2.0 | Edit reach 1 and discharge 1 parameters | QUIN.DDF

Discharge Parameter	Data file	Distribution			
Concentration		SimpMark	2.00	1.40	0.00
Flow		Constant	15.00	---	---
pH		Constant	7.70	---	---
Alkalinity (mg/L)		Constant	250.00	---	---
Temperature (°C)	quintem.prn	Interp	---	---	---
Hardness (mg/L)					
TSS (mg/L)					

Reach Constants

Drainage area ratio	1.000	Decay rate	0.000
Partial mix factor	1.000	Time of travel type	Constant
Partition coef (Kd0)		Time of travel	1.000
Correction (alpha)		Travel coefficient B	

[F1]: Upstream [PgUp/PgDn]: Other reaches [F3]: Parameters/Constants

Enter values or press [Esc] to exit

Figure 14. Discharge/Reach Inputs

SAVE DYNTOX INPUT FILE (MENU OPTION 3)

The purpose of this option is to allow the user to store the current set of inputs to a file for later use. The execution of this option is exactly the same as the Read Inputs from File. An example screen is shown in Figure 15.

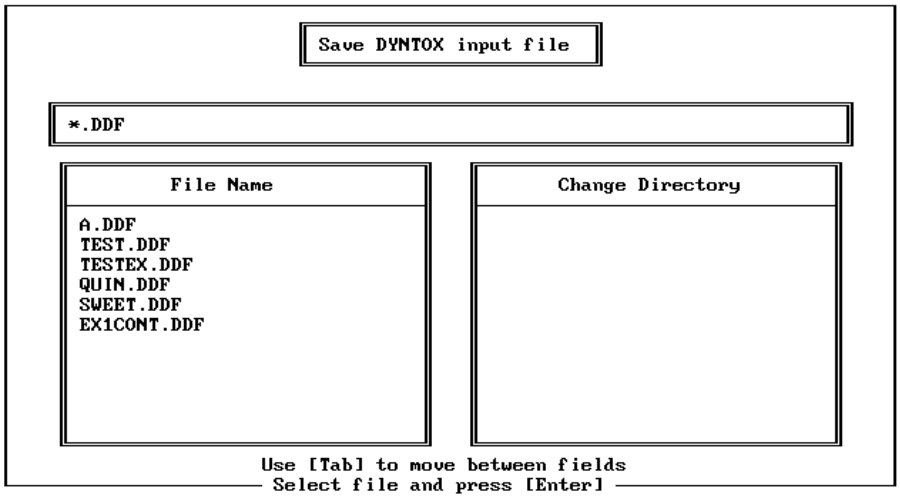

Figure 15. Save DYNTOX Input File Screen

RUN DYNTOX MODEL (MENU OPTION 4)

Selection of this option from the main menu executes a DYNTOX simulation using the current input data set. During model execution, DYNTOX provides a program status screen (Figure 16) that provides interim model results as they are calculated. For each discharge/reach, DYNTOX shows the percent of time that violations are predicted, as well as the return period for violation (in years). For the example in Figure 16, DYNTOX has completed 5707 of the 9403 days in the Continuous Simulation, with violations predicted once every 3.910 years. The user may terminate any simulation in progress by pressing the [Esc] key. Upon successful completion of a model simulation, DYNTOX immediately proceeds into the next program option, View DYNTOX Results.

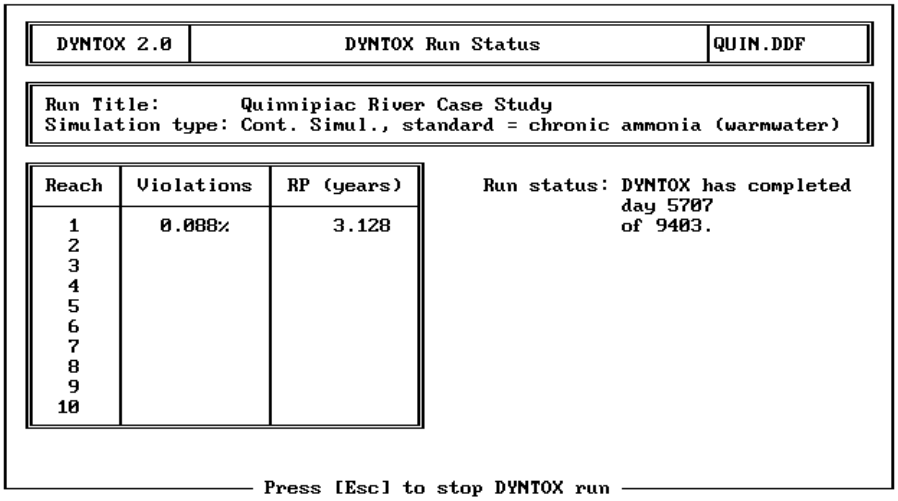

Figure 16. DYNTOX Run Status Screen

VIEW DYNTOX RESULTS (MENU OPTION 5)

This program option is automatically exercised after completion of a model simulation, and can also be activated from the main menu. It provides results of the most recent DYNTOX simulation in either tabular or graphic form. This first screen shown upon entry to this program option contains tabular results (Figure 17). The left half of the screen shows the percent of time that water quality standard violations are predicted below each discharge, and the corresponding return period. The right half of the screen shows the percent of time that predicted receiving water quality falls in different concentration ranges, and the return period for selected concentrations. In Figure 17, the concentration falls between 0 and 1.0 99.89% of the time. Interpretation of results for ammonia-toxicity and hardness-dependent criteria are complicated by the fact the criteria values change on a day to day basis in response to changing environmental conditions. To account for this water quality standards that change from day to day, DYNTOX tracks the ratio of predicted concentration:water quality standard for each day of simulation. Following this protocol, any ratio above 1.0 would indicate a violation of the water quality standard, while ratios of 1.0 or less would indicate compliance. Pressing the F10 key from within the tabular results screen will provide a graphic display of results, as shown in Figure 18.

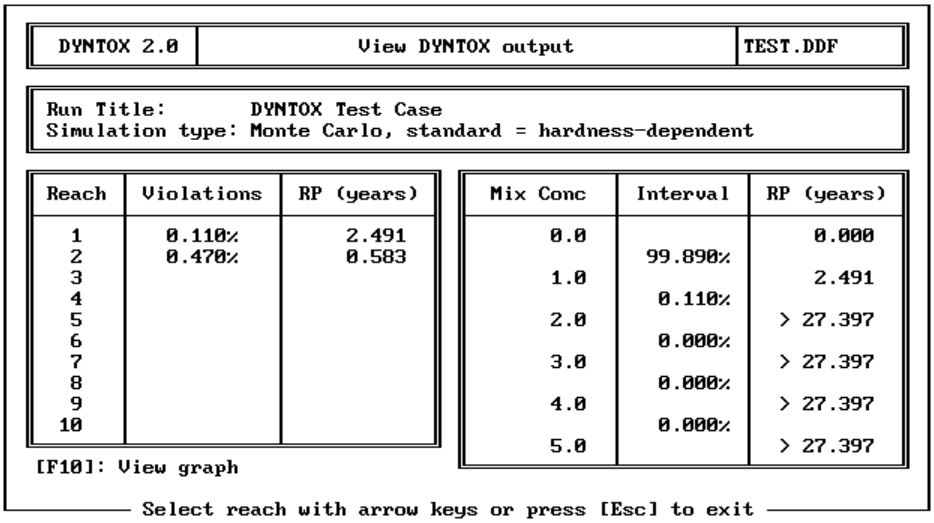

Figure 17. DYNTOX Tabular Results

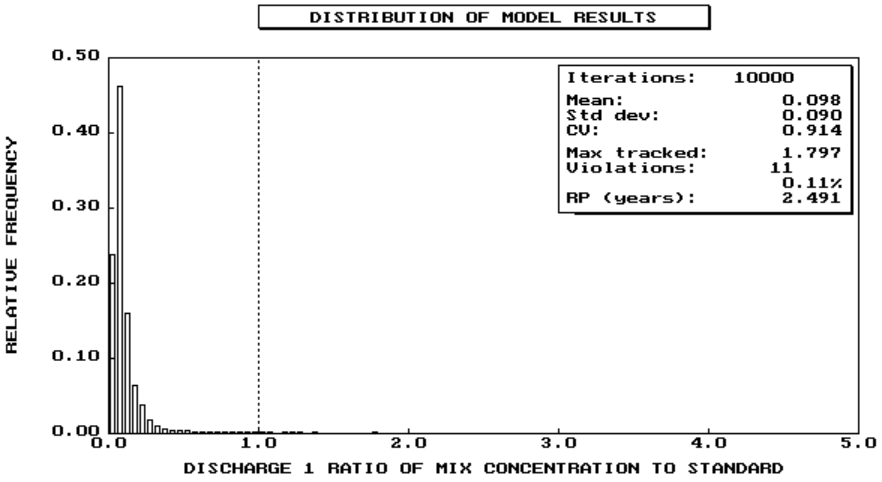

Figure 18. DYNTOX Graphical Results

SAVE DYNTOX RESULTS (MENU OPTION 6)

DYNTOX provides the capability to save model results to disk for later examination or use. This is accomplished by choosing option 6 from the main menu, and specifying the name of a file to be used.

REFORMAT STORET DATA FILE (MENU OPTION 7)

DYNTOX also provides the ability to convert files retrieved from EPA's STORET system into a format that can be read by DYNTOX. This is accomplished by choosing option 7 from the main menu. The user will be required to specify the name of the STORET file to be read, the dataset number of interest, and the name of the file in which to store the reformatted data. In Figure 19, the STORET data file TEST.STO contains data for the parameters ammonia and copper.

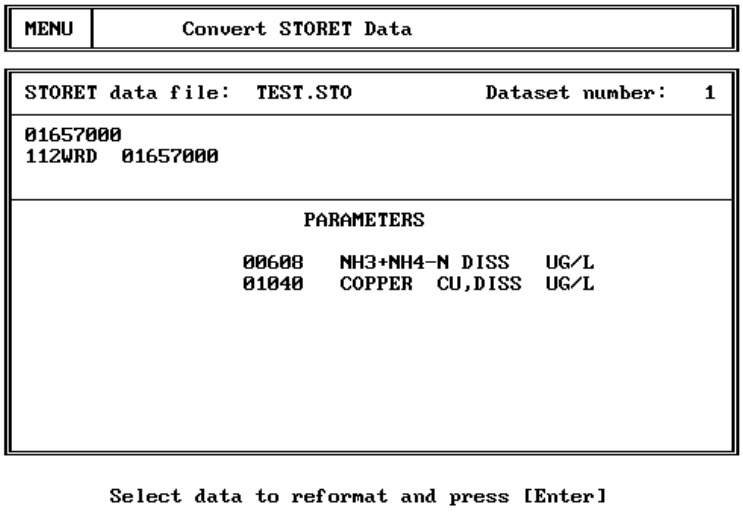

Figure 19. Convert STORET Option

EXIT TO DOS (MENU OPTION 8)

Selection of this option terminates the DYNTOX program.

CHAPTER 5: APPLICATION CONSIDERATIONS

Each of the three techniques documented herein - Continuous Simulation, Monte Carlo, and Log Normal - can potentially be used to perform toxics wasteload allocations. However, not all techniques should be applied in all situations. In general, Continuous Simulation should be used in cases where time series information on model inputs is well defined. Log Normal should be used in single discharge cases where all model parameters are approximately log normally distributed, or where only a rough estimate of expected frequency of violation is required. Monte Carlo should be used when neither of the other techniques is applicable, or in conjunction with the other techniques. In some cases, the available data may be insufficient to use any of the three techniques.

This chapter discusses at an introductory level the conditions under which each of the techniques may be applied, and gives brief guidelines for selecting between them. The chapter also briefly discusses how to perform wasteload allocations for single and multiple discharge cases and how to calculate the return period. Last is a discussion of toxic concentration criteria. Discussions provided herein are very brief; only as necessary to alert the users to important technical issues. More detailed discussion is beyond the scope of this user's manual.

SELECTING BETWEEN TECHNIQUES

Each of the three techniques can be applied to perform toxics wasteload allocations and no one technique is necessarily preferable to any other on a theoretical basis. However, all three techniques are not similarly accurate or appropriate in all situations. This section highlights when each technique should be applied.

Continuous Simulation

Continuous Simulation is the most powerful technique, but only when sufficient time-series data are available to define the input parameters. The power of Continuous Simulation decreases significantly when data must be synthesized to replace missing historical values. The guidelines for selecting Continuous Simulation as a function of time-series data availability can be summarized as follows:

Time-Series Data Availability	Applicability of Continuous Simulation
All input parameters available and complete	Very high
Only one effluent parameter missing or significantly incomplete	High
Both effluent parameters missing but other data is complete	Fair
All other cases	Poor

Continuous Simulation can be very reliable when analyzing the frequency distribution of concentrations for existing conditions where all parameters are well defined. However, the technique is at best fair when projecting concentrations for future treatment alternatives because

the sequential nature of effluent flow and concentration cannot typically be defined as treatment changes. If the user is uneasy about this problem it is possible to use Continuous Simulation to simulate the concentration distribution for existing conditions and the Monte Carlo technique for projecting the impact of future treatment alternatives.

Monte Carlo

Monte Carlo analysis has the least stringent input requirements of any of the three techniques and therefore the widest applicability. It is best used in situations when parameter values are not strongly correlated to other parameters (cross-correlation) or when one day's value for a parameter is not strongly influenced by the previous days (serial correlation); in these cases Continuous Simulation is preferred where data are available. It can be applied in cases where the available data are inadequate for either Continuous Simulation or for Log Normal analyses. However, if the data are limited, the reliability of results must be considered. Since data defined distributions can be used for even the most limited data sets, care should be taken to ensure that sufficient data exists to provide meaningful results.

Monte Carlo analysis can provide a false sense of security regarding reliability of results, as several thousand model iterations can be easily generated. The model user must always be keenly aware that the reliability of model results is only as good as the assumptions made regarding input distributions.

Log Normal

The Log Normal technique is attractive because it requires far less computational expense than the other two techniques. However, it can only be applied for wasteload allocations with single discharges and where all input parameters are assumed to be log normally distributed. The Log Normal technique can also be used as a lower-cost screening technique when parameters are not all log normally distributed before conducting more complex analyses with Continuous Simulation or Monte Carlo. In examining the consistency of data to log normality, special emphasis should be placed on the "tail ends" of the distribution curves. It is typically at the extremes of the input distributions where water quality problems occur and thus where the assumption of log normality must be the most rigorously justified.

ALLOWABLE EFFLUENT LOADS

Water quality criteria are currently defined for maximum concentrations of a constituent for a three year return period. Although the criteria for acute toxicity were determined for a one hour duration, the criterion will generally be interpreted on a daily averaged basis because more frequent calculations cannot be practically supported by data. For chronic toxicity, the instream concentration for a four day average should not exceed the chronic standard more than once in three years. Allowable effluent loads should be calculated to maintain these conditions.
The wasteload allocation process determines the effluent concentration and flow that will result in a three year return period for the desired instream concentration. This is accomplished in DYNTOX by inspecting the return period for an in-stream concentration equal to the water quality standard criterion. If the return period is less than three years, the effluent load is too

large and must be decreased. If the return period is greater than three years, the effluent load may be increased. The wasteload allocation process using this technique consists of finding the largest effluent load that will result in an in-stream return period of three years or greater for the water quality standard.

MULTIPLE DISCHARGES

Establishing allowable toxic loads among multiple discharges in one system involves technical and policy issues handled differently by different states. One simple approach is to calculate the maximum allocations successively, upstream to downstream, although this approach tends to provide proportionally larger loads to the most upstream discharge. A second approach would be to require consistent removal efficiencies from all discharges, ignoring that the assimilative capacity may not be fully used in all river segments or allowing individual increases. A third would be to assume no decay and allocate proportional to flow. The list of options is extensive. The specific policy and procedure is a State issue which involves technical, policy, and political considerations. However, DYNTOX can generally be adapted to address most any State policy.

CALCULATING THE RETURN PERIOD

Two common methods exist to calculate the return period for a given concentration from probabilistic modeling. They are termed herein as:

1) the percentile method
2) the extrema method

The percentile method uses a listing of all in-stream concentrations and ranks them. The return period for a concentration is then calculated based upon percentile occurrence. In the extrema method, only annual extreme values are used in the ranking. The return periods calculated from these two methods are equally valid statistical representations, but neither necessarily predicts annual occurrence frequency.

The percentile method assumes that all violations of the in-stream criteria are independent from one another. Each exceedance of the criteria is treated equally, including multiple violations in the same year. Results from this method therefore represent an "average" return period. The disadvantage to this technique is that multiple violations related to the same extended event (e.g. drought river flow) are treated as separate events, which could lead to an estimation of the recurrence interval which is more frequent than actually characteristic. The advantage to the percentile technique is that multiple, independent violations occurring in the same year are correctly incorporated into the return period analysis.

The extrema method uses only the largest concentration for each year in calculating the return period value. This technique predicts the return period for an annual extreme value and has the advantage of not "double counting" multiple violations that are caused by the same event. The disadvantage to the extrema method is that when multiple independent violations occur in the

same year, only one violation is considered in the return period analysis. This can lead to an estimate of the return period which may be longer than truly characteristic.

Subsequent to the development of the original DYNTOX model, EPA (1986b) developed what was called the "biologically-based" method for calculating the return period of standards violations. The biologically based method counts the number of non-overlapping periods that occur where average concentrations exceed the criterion. However, within any 120 day period, the biologically based method will count no more than five exceedances of the standard. For all analyses conducted using DYNTOX, the percentile method is used. Users have the ability to perform extrema analysis by running Continuous Simulation one year at a time and manually tabulating the extreme in-stream concentration for each year. There is no capability in this version of DYNTOX to calculate compliance with the biologically based method, although the Continuous Simulation routine could be easily modified to do so.

CHAPTER 6: EXAMPLE APPLICATIONS

This chapter demonstrates the use of the DYNTOX model for three situations typical to those expected for many toxic permitting situations:

Ammonia toxicity
Copper toxicity in a multiple discharge situation
Organic toxicant (lindane).

Each example is divided into sections discussing:

Available Data
Model Input Selection
Wasteload Allocation

AMMONIA TOXICITY

This first case study demonstrates the use of DYNTOX Continuous Simulation to analyze ammonia toxicity for a municipal wastewater treatment plant discharge to the Quinnipiac River near Wallingford, CT. This example was selected to match an example application of the DESCON model presented in the DESCON User's Manual.

Available Data

The relevant basin information for this site can be summarized as follows:

Single discharge, located directly below the USGS gaging station 01196500, near New Haven, Connecticut (state code = 09)
Chronic toxicity by un-ionized ammonia is the parameter of concern,
Chronic toxicity criteria duration is four days, and
Warm water fishery.

The USGS flow gage contains continuous flow data up through 1978, with monthly water quality data collected over the last 20 years. Water quality measurements have been conducted for all parameters relevant to ammonia toxicity analysis in DYNTOX, i.e. pH, temperature, and alkalinity. The available data were retrieved from STORET following the procedures outlined in Appendix 2.

Model Input Selection

This section will progress through a screen by screen description of the process used to prepare the DYNTOX input file. The first step in the DYNTOX application is to select the "Create/Edit Input File" from the main menu. This selection will produce a blank input screen, because no existing files have been read.

The completed basin constants input screen for this example is shown in Figure 20. The selection of each input is discussed below. The Run Title selection is self explanatory. Continuous Simulation was chosen for this example to provide more direct analogy to the existing DESCON simulation (DESCON is based upon a Continuous Simulation-type approach). A four day averaging period was selected to match the specified duration for chronic toxicity. The end date of September 30, 1978 corresponds to the cessation of daily flow measurements at the USGS gage. This example considers a single discharger, located immediately below the USGS gage. The fishery to be protected is warm water.

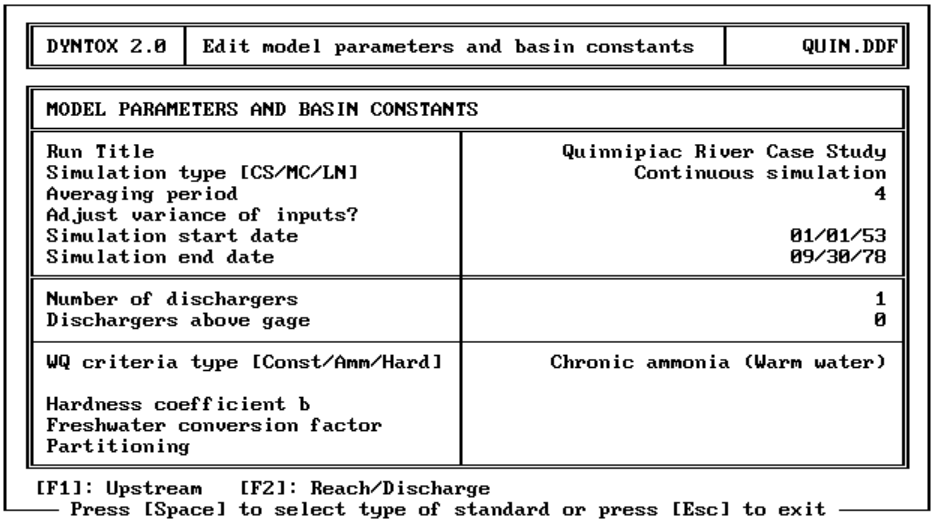

Figure 20. Basin Constants Input Screen for Quinnipiac River

Upstream Input: With respect to upstream conditions, the STORET flow data have been stored in the file QUIN2.PRN (Figure 21). Linear interpolation was specified as the data synthesis method for stream flow, due to the completeness of the data record. Simple Markov data synthesis was specified for upstream ammonia concentrations (mean = 0.62, s.d. = 0.05), pH (mean = 7.30, s.d. = 0.04), and alkalinity (mean = 58.3, s.d. = 13.7), using the means and standard deviations calculated from the STORET data. Values for all serial correlation coefficients were set at 0.0. Linear interpolation was used to describe the seasonal variation in temperature, with a single value specified for the midpoint of each month. These temperature data were stored in the file QUINTEM.PRN. The variability in upstream ammonia and pH were reduced for purposes of this example, because observed levels result in violation of Federal ammonia criteria even in the absence of a discharge. (This was not a problem with the DESCON case study, because it used an ammonia criterion much higher than the Federal WQC.)

Reach/Discharge Inputs: The average discharge ammonia concentration was initially set at 20 mg/l, to correspond to the technology-based limits specified in the DESCON example (Figure 22). This value represents the maximum effluent concentration possible; DYNTOX will be used to determine to what extent this concentration will need to be reduced to meet water quality standards. The standard deviation for effluent concentration was set at 14 mg/l, corresponding to an assumed coefficient of variation of 0.7.

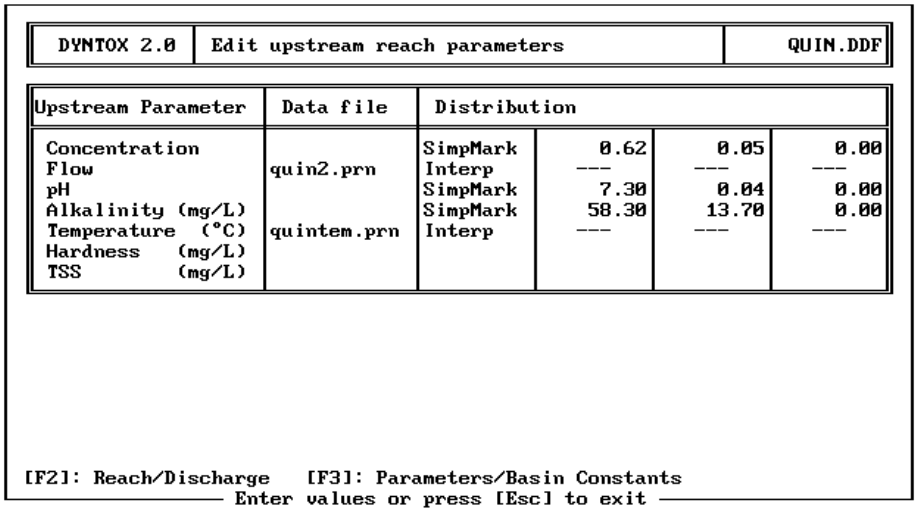

Figure 21. Upstream Inputs Screen for Quinnipiac River

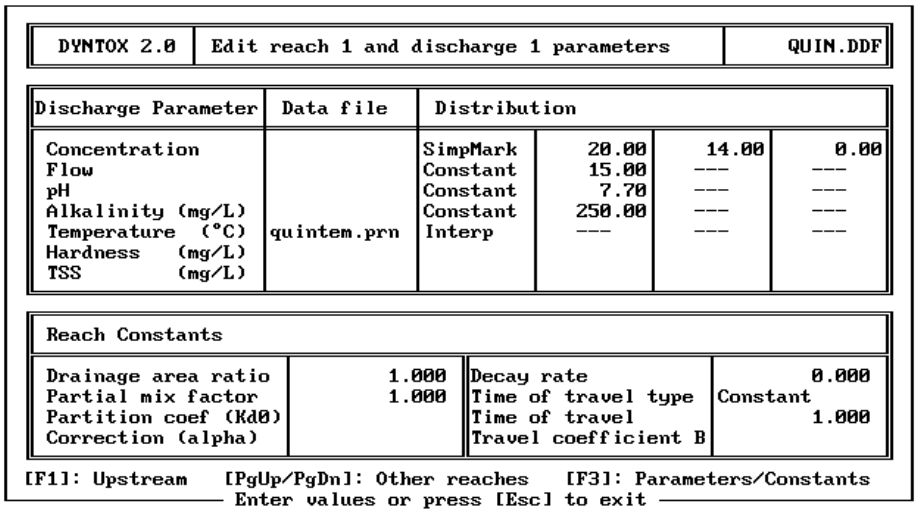

Figure 22. Reach Discharge Inputs for Quinnipiac River

Effluent flow (15), pH (7.7), and alkalinity (250), were held constant to remain consistent with the DESCON case study. Effluent temperature followed the same seasonal variation used for stream temperature. Decay rates, time of travel, and drainage area ratios were left at default values, because this example considered only a single discharge with upstream data collected directly above the discharge.

Wasteload Allocation

The first step in the wasteload allocation process is to determine the expected frequency of violation under present (technology-based) loading conditions. The results of this simulation are shown in Figure 23 and indicate that violations are expected 68% of the time, corresponding to a return period of 0.004 years (Figure 23).

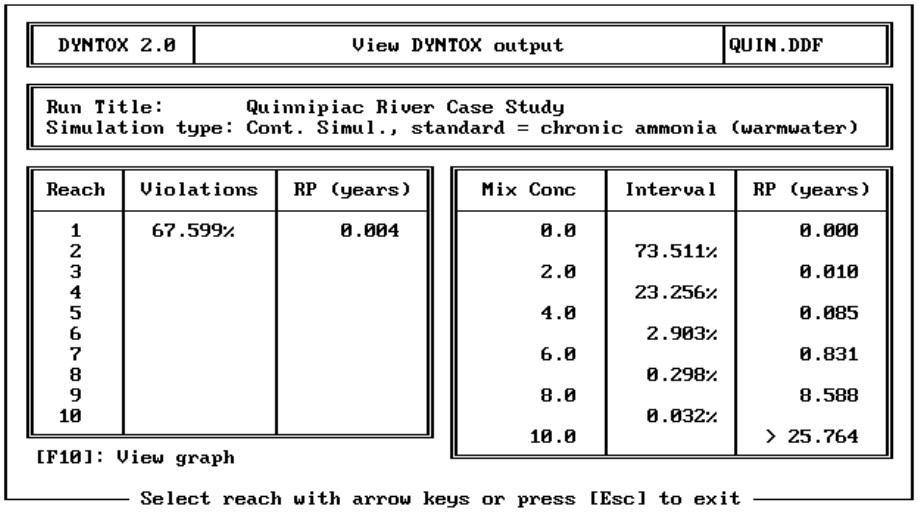

Figure 23. Quinnipiac Results with Effluent Ammonia = 20 mg/l

The wasteload allocation procedure proceeds by reducing the effluent ammonia concentration on a trial and error basis until DYNTOX results indicate an acceptable return period for violations. In this example, the effluent concentration was reduced to a mean of 2 mg/l and standard deviation of 1.4 mg/l (Figure 24). A new simulation was performed, resulting in an acceptable return period of greater than 3 years (Figure 25).

This wasteload allocation can be converted into a permit limit following the steps outlined in EPA's Technical Support Document for Water Quality-based Toxics Control (1991). For a dynamic wasteload allocation model such as DYNTOX, those steps can be summarized as:

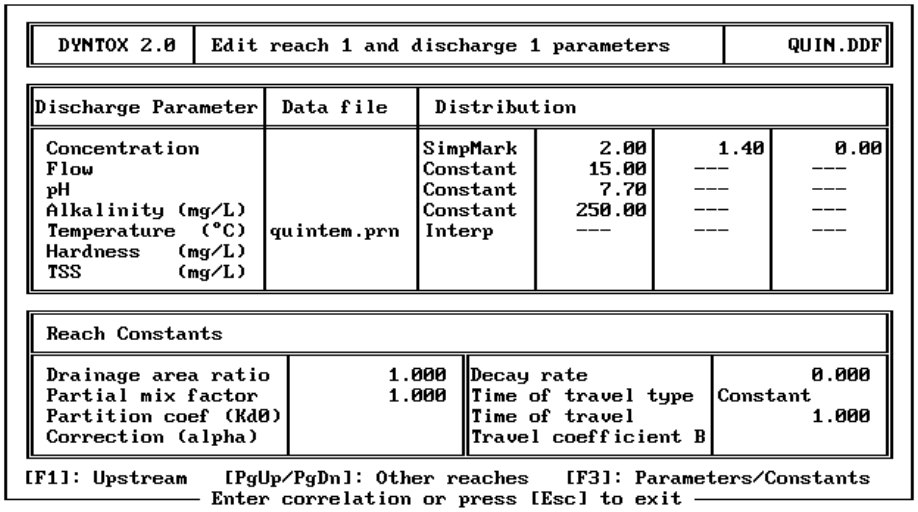

Figure 24. Effluent Ammonia Reduced to 2 mg/l

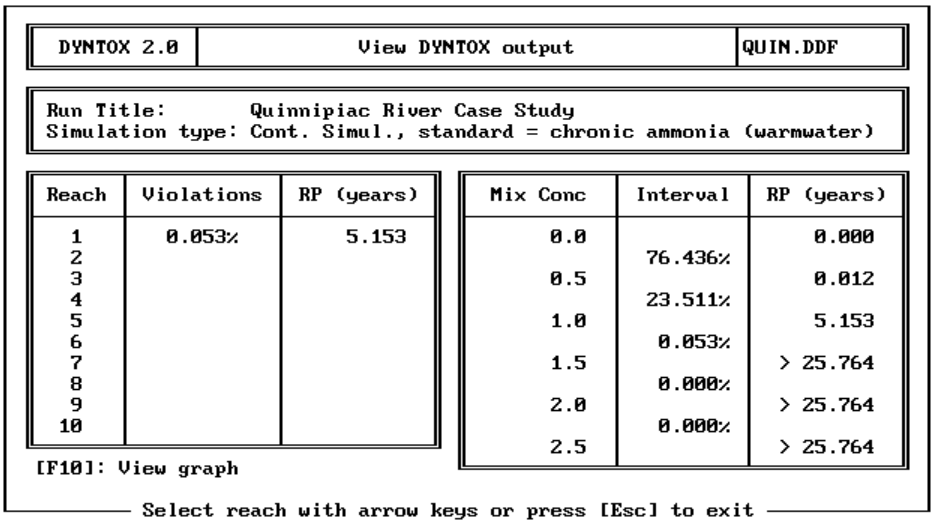

Figure 25. Quinnipiac Results with Effluent Ammonia = 2 mg/l

1. Determine Long Term Average (LTA) concentrations corresponding to the acute and chronic WLAs. The allowable discharge concentrations provided by DYNTOX directly correspond to the required LTAs.
2. Compare LTAs for acute and chronic toxicity, and select the lowest.
3. Define number of samples per month and acceptable percentage.
4. Calculate average monthly limit (AML) and maximum daily limit (MDL) as follows:

$$MDL = LTA\ e^{\left[z\sigma - 0.5\sigma^2\right]}$$

where

σ^2 = $\ln(CV^2+1)$
CV = coefficient of variation of effluent concentration
z = statistical parameter
= 1.645 for 95th percentile probability
= 2.326 for 99th percentile probability

$$AML = LTA\ e^{\left[z\sigma_n - 0.5\sigma_n^2\right]}$$

where

σ^2_n = $\ln(CV^2/n+1)$
n = number of samples per month

For this example, step 2 was bypassed because it was assumed (in the DESCON example) that chronic toxicity produced the most restrictive WLA. The number of samples per month and acceptable probability level were set by the permitting authority at 30 and 95%, respectively. The coefficient of variation for the effluent concentrations used is defined as the standard deviation divided by the mean; in this example the coefficient of variation is equal to 0.7. The resulting permit limits are therefore

$$MDL = 2\ e^{[(1.645)\ (0.631)\ -\ 0.5(.399)]} = 4.63\ mg/l$$

$$AML = 2\ e^{[(1.645)(.127)-0.5(.016)]} = 2.45\ mg/l$$

MULTIPLE DISCHARGES OF METALS

The second example demonstrates DYNTOX analysis for two dischargers of copper, to the watershed shown in Figure 26.

Available Data

The schematic for this sample site is shown in Figure 26. The relevant basin information is as follows:

> USGS Gaging and Water Quality Station located above the discharges
> Two discharges; one located immediately below the gage and the other located further downstream as shown in Figure 26.
> Acute and chronic toxicity caused by copper are the water quality parameters of concern.

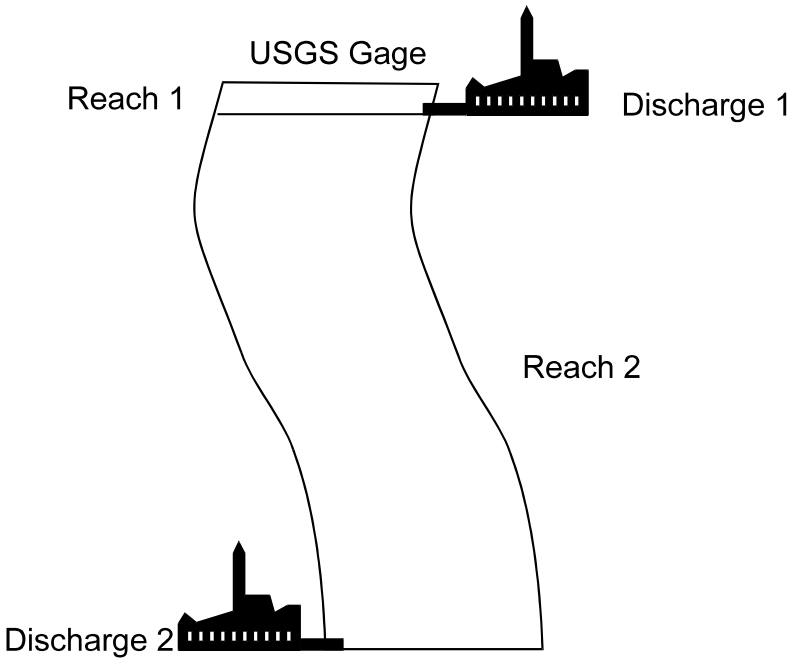

Figure 26. Case Example Site Schematic

The USGS gage provides 30 years of continuous flow data, with monthly water quality data collected for the past 10 years. Total and dissolved copper concentrations at the USGS gage have been measured monthly for the last five years. Suspended solids data are not available, but the available copper data indicate that approximately 50% of the copper is in dissolved form. Flow and concentration data are available on a weekly basis for both of the wastewater treatment plants. All available data have been stored in disk files compatible with the DYNTOX format.

Water quality and dye surveys are available to document instream fate of copper and time of travel throughout the system.

Model Input Selection for Acute Toxicity

This section will progress through a screen by screen description of the process used to prepare the DYNTOX input file. The first step in the DYNTOX application is to select the "Create/Edit Input File" from the main menu. This will produce a "blank" input screen for basin constants, because no existing files have been read.

Basin Constants: The completed basin constants input screen for this example is shown in Figure 27. The selection for each input is discussed below.

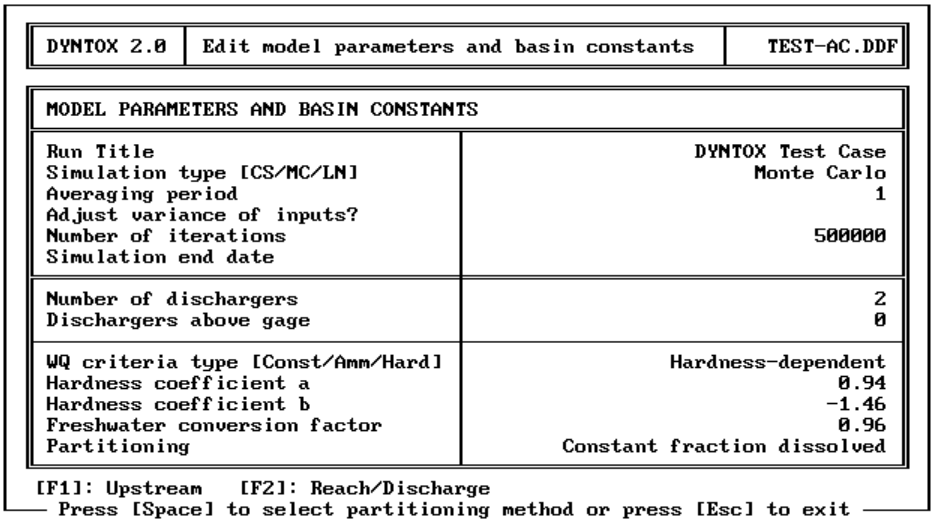

Figure 27. Basin Constants Inputs for Acute Example Application

The Run Title selection is self-explanatory. Monte Carlo analysis was selected over Continuous Simulation because continuous data were available for only one of the four primary input parameters (upstream flow). Log Normal analysis was not selected because two discharges are being considered. A one day averaging period was selected because acute toxicity is the parameter of concern for this example. The water quality criterion for copper is hardness-dependent, and of the form (EPA, 1984c):

$$WQS = e^{(0.9422[\ell n(\text{hardness})]-1.464)}$$

Consequently, the empirical coefficients a and b are 0.9422 and -1.464, respectively. The freshwater conversion factor is 0.960. A constant fraction dissolved was specified to account for the lack of data on total suspended solids.

Upstream Inputs: With respect to upstream conditions (Figure 28), the available flow data are stored in the file TEST.DAT. USGS records indicated that the flow record had a mean of 8900 cfs and standard deviation of 9200 cfs. An initial assumption was made that the variability in flow followed a normal distribution; this assumption was tested by pressing the [F10] key and comparing the observed data distribution to an idealized normal. As shown in Figure 29, the assumption of normality did not fit the observed data very well. This analysis was repeated with the assumption of a log normal distribution. This provided a much better comparison (Figure 30) and resulted in the use of a log normal distribution. A similar analysis was conducted to define the upstream concentration data as a normal distribution with a mean of 2.05 and a standard deviation of 0.6. Information on upstream hardness was analyzed, and a uniform distribution from 80 to 120 mg/l was selected.

DYNTOX 2.0 | Edit upstream reach parameters | TEST-AC.DDF

Upstream Parameter	Data file	Distribution			
Concentration		Normal	2.05	0.60	---
Flow	test.dat	LogNormal	8900.00	9200.00	0.00
pH					
Alkalinity (mg/L)					
Temperature (°C)					
Hardness (mg/L)		Uniform	80.00	120.00	---
TSS (mg/L)		Constant	0.00	---	---

[F2]: Reach/Discharge [F3]: Parameters/Basin Constants
Enter values or press [Esc] to exit

Figure 28. Upstream Inputs for Acute Example Application

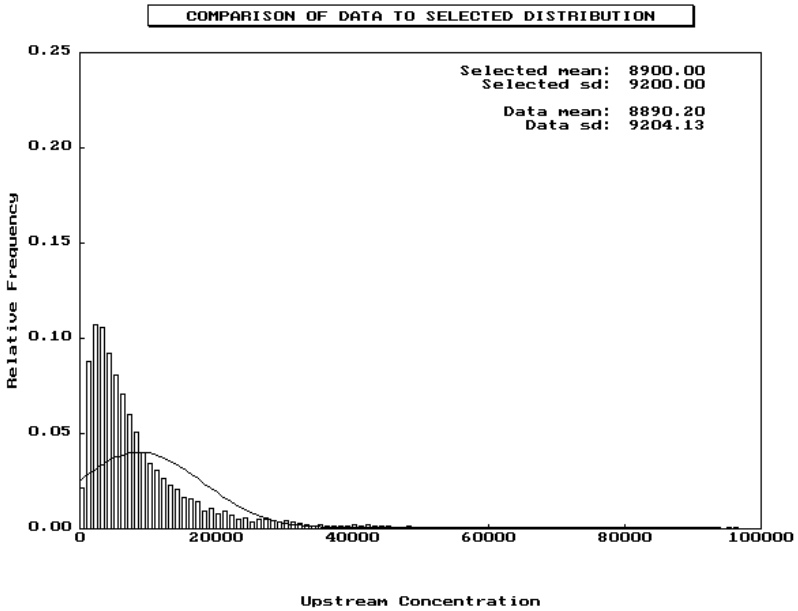

Figure 29. Comparison of Observed to Assumed Normal Distribution for Upstream Flow

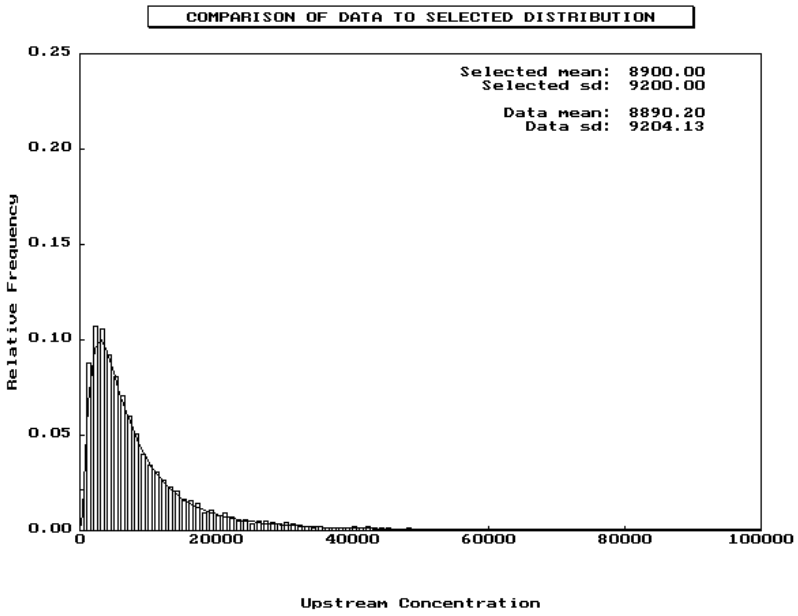

Figure 30. Comparison of Observed to Assumed Log Normal Distribution for Upstream Flow

Reach/Discharge Inputs: Parameter inputs for the second discharge in this example are shown in Figure 31. Parameter distributions for effluent flow (mean = 1000, s.d. = 600), copper concentration (mean = 20, s.d. = 2), and hardness were determined from the available data for each discharge. A drainage area ratio of 1.0 was used for the first discharge, because it was located directly downstream of the USGS gage. The drainage area ratio for the second reach was set at 1.25 following the steps described previously on pages 12-13. The partial mix factor was set at 0.25 for each discharge because complete mixing between ambient and effluent flow did not occur in the direct vicinity of each discharge. The fraction dissolved was set at 0.5 to represent the observation that 50% of the copper was in dissolved form. A decay rate of 0.05/day was determined as described on page 17 and used to reflect losses due to settling.

Time of travel between the first and second discharge was assumed to be flow-dependent; the coefficients were determined as shown previously in Figure 5.

Acute Wasteload Allocation

The first step in the wasteload allocation process is to determine the expected frequency of violation under present effluent loading conditions. This was achieved by performing a DYNTOX model simulation using all of the inputs described above. The results of this simulation are shown in Figure 32, and indicate that violations are expected below each discharge on the order of 14-15% of the time. This corresponds to a return period of much less than 3 years (0.02 years), and indicates an unacceptably large frequency of violations.

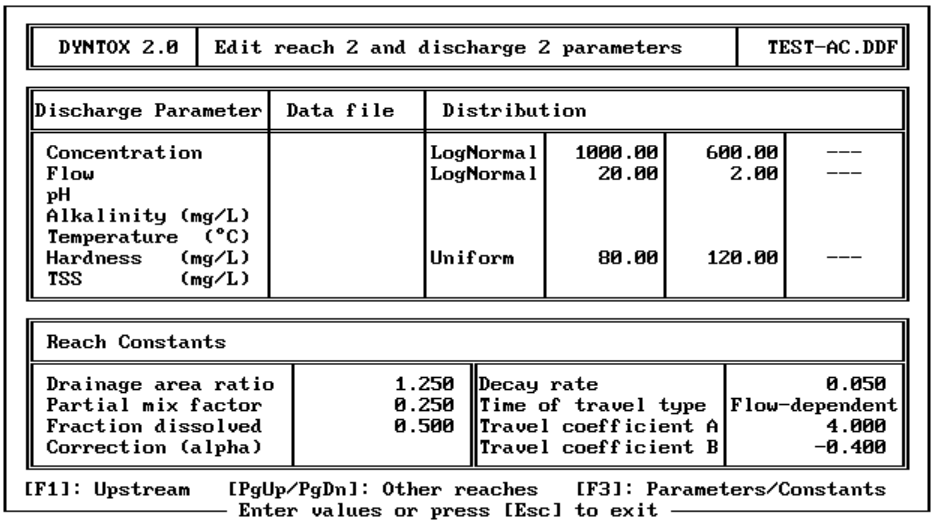

Figure 31. Reach/Discharge Inputs for Example Acute Application

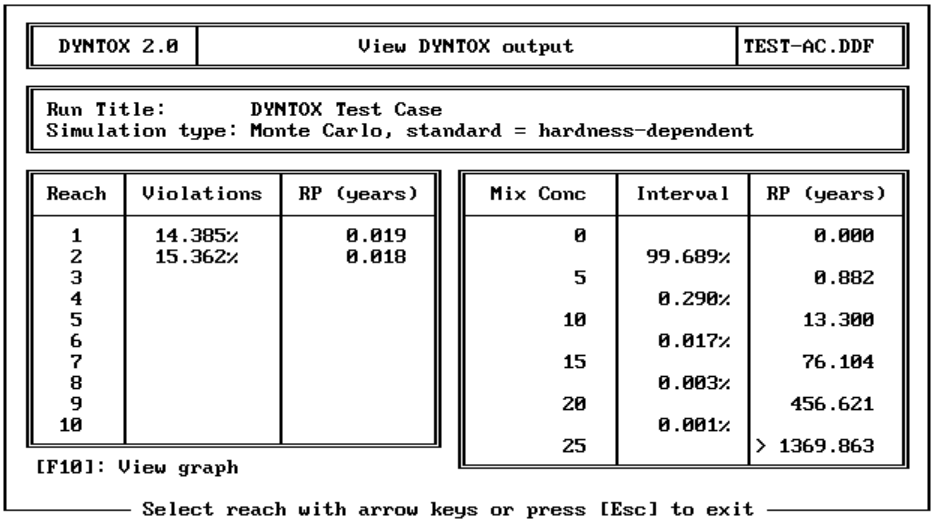

Figure 32. Acute Case Example Results for Current Loading

The State policy in effect for performing multiple discharge wasteload allocations (assumed for this example) is to require equal effluent concentrations for all discharges, and to assume that the variability in future effluent concentrations will remain unchanged (i.e., equal coefficient of variation). The wasteload allocation for this example is performed on a trial and error basis, with different effluent concentrations tested until the frequency of violations is acceptably close to once in three years. The first "trial" in this approach was to assume that effluent concentrations at both discharges were reduced from 1000 to 200 ug/l. Given the assumption of a constant coefficient of variation, the standard deviation of the effluent concentrations decreased from 600 to 120 ug/l. A new DYNTOX simulation was conducted for this scenario; the results are shown in Figure 33.

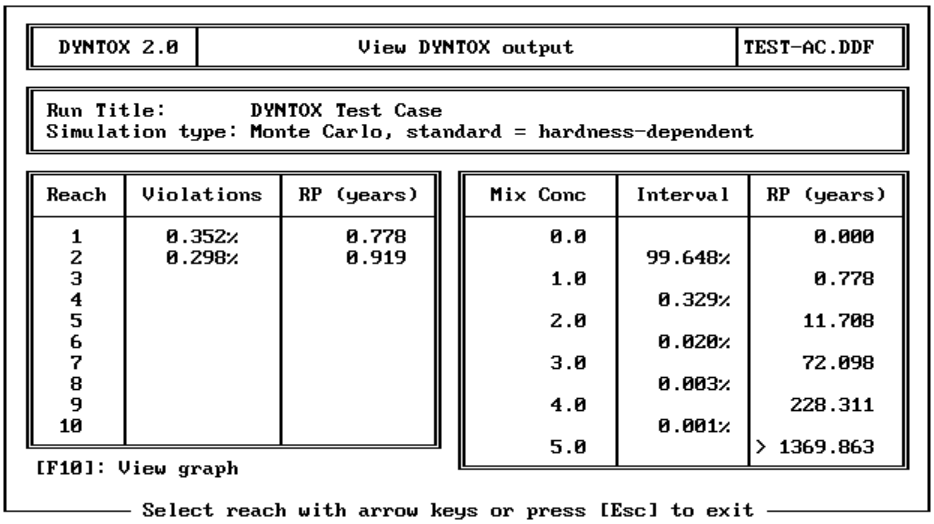

Figure 33. Acute Case Example Results from Effluent Concentrations = 200 ug/l

A total of 500,000 iterations was required to achieve stability in the predicted return periods. This results in an unacceptable return period for violations of 0.778 years below the first discharge, and an unacceptable return period of 0.919 years below the second discharge.

To reduce the frequency of violation even further, effluent concentrations for both discharges were further reduced to 130 ug/l, with a corresponding decrease in the standard deviation to maintain a constant coefficient of variation. The results of this analysis are shown in Figure 34, and indicate an acceptable (i.e., >3 years) return period of violations below both discharges. For purposes of this analysis, an effluent concentration of 130 ug/l is deemed a suitable wasteload allocation for acute copper toxicity.

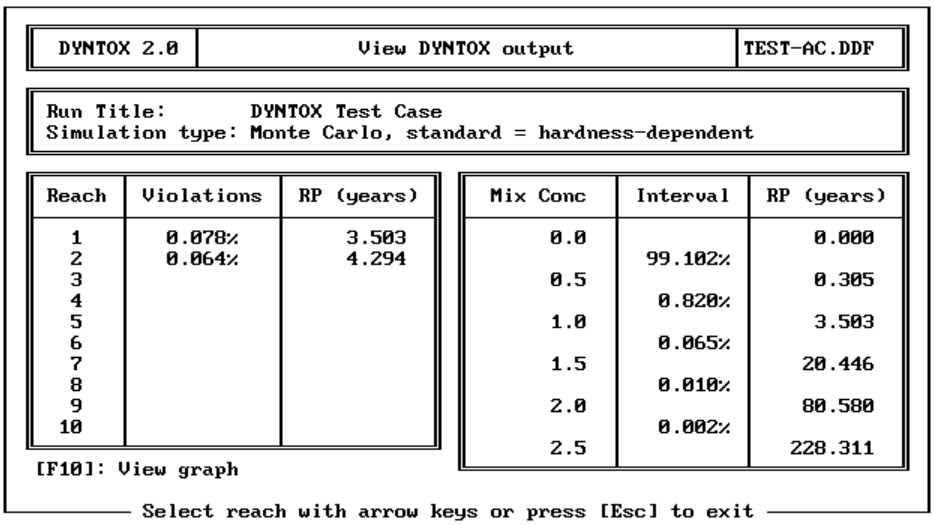

Figure 34. Final Results of Example Acute Wasteload Allocation

Model Input Selection for Chronic Toxicity

The next step in the permit development for this site consists of repeating the above analysis for chronic toxicity. This procedure requires: 1) changing the averaging period from one to four days, 2) adjusting the water quality criterion to represent the values for chronic toxicity, and 3) adjusting input distributions to represent the variability of four day average conditions. Results (i.e., average allowable effluent concentration) from the chronic criteria simulation can then be compared to results for acute toxicity, with the lower concentration serving as the basis of NPDES permit limits as shown for the previous example. This section provides a step-by-step description of the chronic analysis.

Basin Constants: The completed basin constants input screen for this example is shown in Figure 35. Most inputs are the same as for the acute analysis with the exception of the averaging period, the "Adjust variance of inputs?" entry and the hardness-based criterion coefficients (the freshwater conversion factor stays the same). These inputs are discussed below.

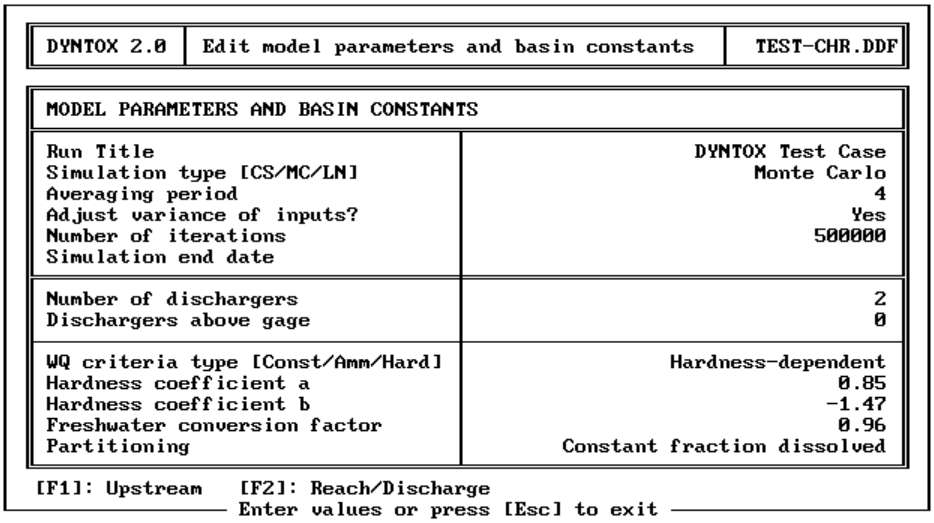

Figure 35. Basin Constants Inputs for Example Chronic Application

A four day averaging period was selected because chronic toxicity is the parameter of concern for this example. "Yes" is entered for the input variance adjustment question so that the program will adjust variances automatically. The water quality criterion for copper is hardness-dependent, and of the form (EPA, 1984c):

$$WQS = e^{(0.8545[\ell n(\text{hardness})]-1.465)}$$

Consequently, the empirical coefficients a and b are 0.8545 and -1.465, respectively. The freshwater conversion factor is 0.960. A constant fraction dissolved was specified to account for the lack of data on total suspended solids.

Upstream Inputs: With respect to upstream conditions (Figure 36), the available flow data are stored in the file TEST.DAT. The inputs are the same as in the acute analysis, since the program was told to automatically adjust for chronic conditions.

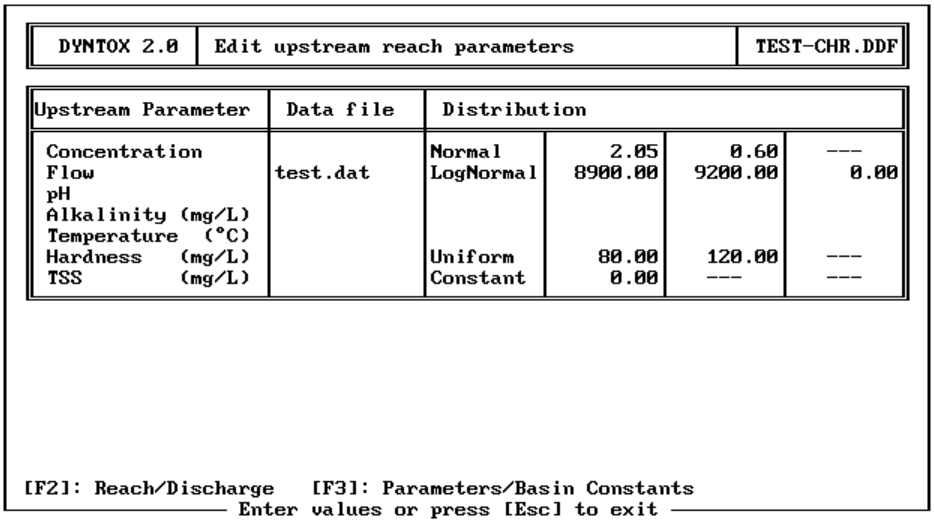

Figure 36. Upstream Inputs for Example Chronic Application

Reach/Discharge Inputs: Parameter inputs for the first discharge are shown in Figure 37. Parameter distributions for effluent flow, copper concentration, and hardness were the same as those determined for the acute analysis. The partial mix factor was set at one for each discharge because complete mixing between ambient and effluent flow was assumed to occur within the chronic mixing zone. The fraction dissolved was set at 0.5 to represent the observation that 50% of the copper was in dissolved form. A decay rate of 0.05/day was again used to reflect losses due to settling.

Chronic Wasteload Allocation

The first step in the wasteload allocation process is to determine the expected frequency of violation under present effluent loading conditions. This was achieved by performing a DYNTOX model simulation using all of the inputs described above. The results of this simulation are shown in Figure 38, and indicate that violations are expected below the first discharge only 0.009% of the time. This corresponds to a return period much greater than 3 years (29 years), and indicates an acceptable frequency of violations. However, violations downstream of the second discharge occur more frequently, 0.173% of the time (return period 1.6 years). Discharge concentrations therefore need to be reduced.

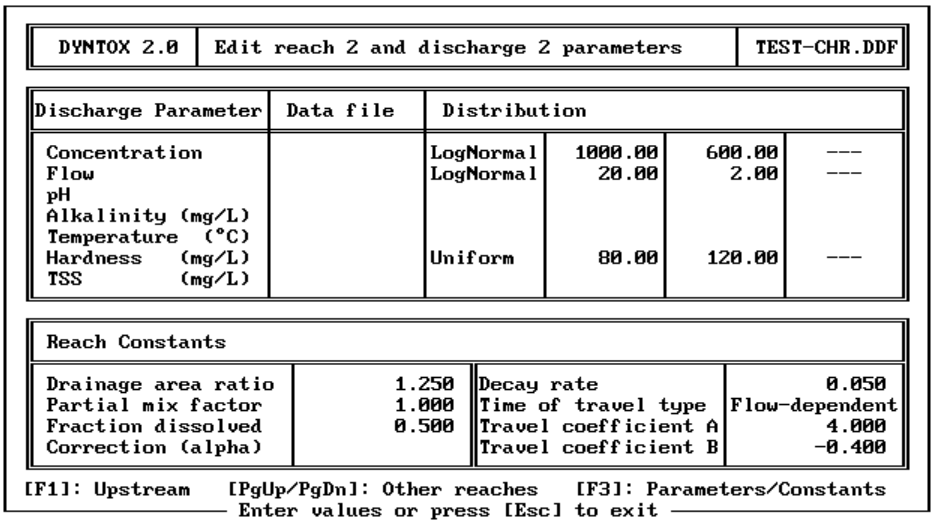

Figure 37. Reach/Discharge Inputs for Example Chronic Application

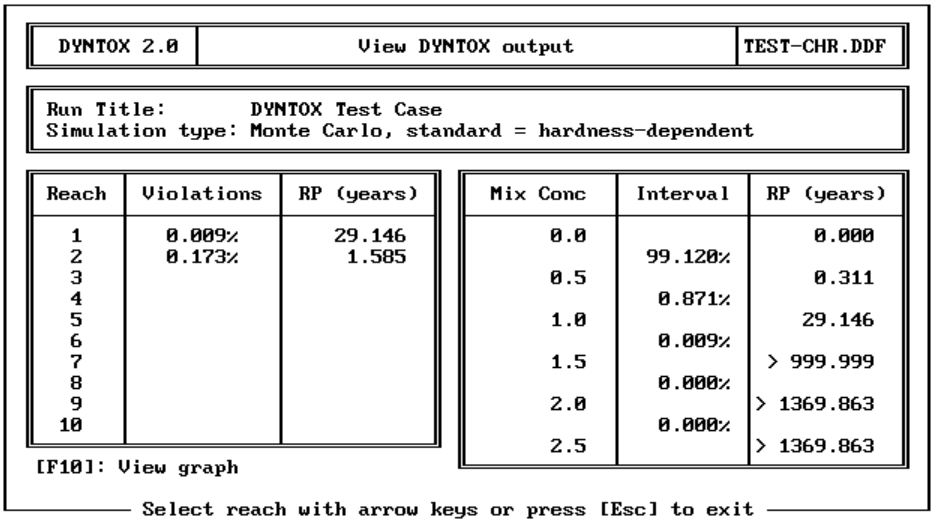

Figure 38. Chronic Case Example Results for Current Loading

To reduce the frequency of violation, discharge concentrations were reduced to 900 ug/l. This decrease resulted in an acceptable frequency of violations, as shown in Figure 39.

Comparison of Acute and Chronic Allocations

The acute and chronic wasteload allocations determined using DYNTOX can be compared to determine the governing criterion, and the critical WLA can be converted into a permit limit following the Steps outlined in EPA's Technical Support Document for Water Quality-based Toxics Control (1991). These steps can be summarized as:

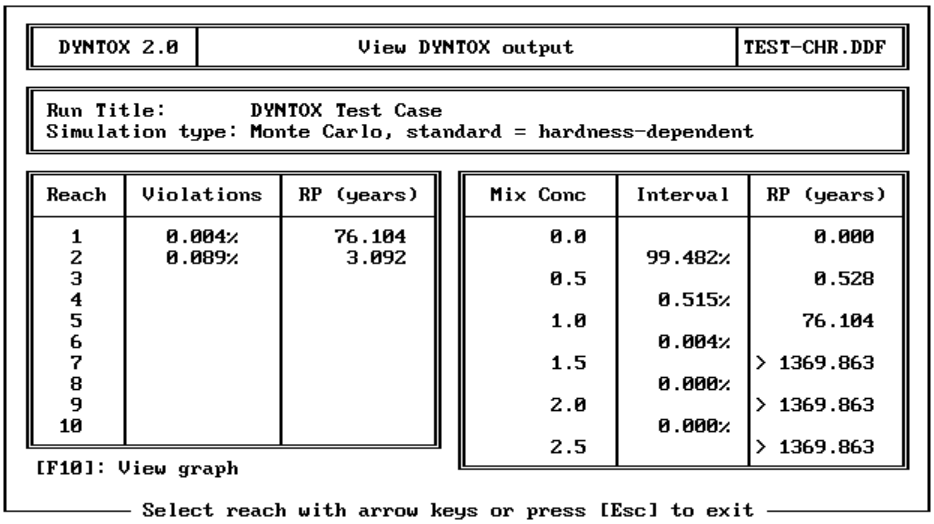

Figure 39. Final Results of Example Chronic Wasteload Allocation

1. Determine Long Term Average (LTA) concentrations corresponding to the acute and chronic WLAs. The allowable discharge concentrations determined using DYNTOX are the LTAs.
2. Compare LTAs for acute and chronic toxicity, and select the lowest.
3. Define number of samples per month and acceptable percentage.
4. Calculate average monthly limit (AML) and maximum daily limit (MDL) as described on Page 42.

For this case study, comparison of the LTAs indicates that the acute LTA (130 ug/l) is lower than the chronic LTA (900 ug/l), and is therefore the critical value. The number of samples per month is four, the acceptable probability level is 99%, and the coefficient of variation is 0.6. The resulting permit limits are therefore

$$\text{AML} = 130 \cdot \ e^{[2.326(.294)-0.5(.086)]} = 247 \ ug/l$$
$$\text{MDL} = 130 \cdot \ e^{[2.326(.555)-0.5(.307)]} = 405 \ ug/l$$

SWEETWATER BRANCH LINDANE

This example considers the discharge of the organic chemical lindane from the Gainesville Regional Utilities Main Street WWTP to Sweetwater Branch near Gainesville, Florida.

Available Data

The available information for the site can be summarized as follows:

Single, continuous discharge of lindane

Detailed effluent flow data, with nine lindane measurements

No USGS gaging station on Sweetwater Branch; gaging data available for nearby Hogtown Creek

No measurements of upstream lindane

Chronic toxicity standard for lindane of 10 ng/l

Average effluent concentration = 17 ng/l

Model Input Selection

This section will go through a screen by screen description of the process used to prepare the DYNTOX input file.

Basin Constants: The completed basin constants input screen for this example is shown in Figure 40. The selection rationale for each input is discussed below.

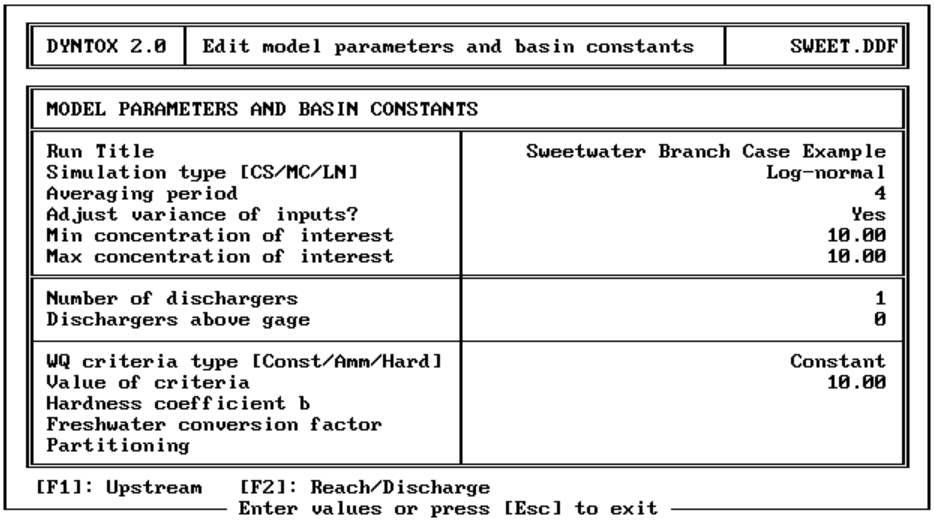

Figure 40. Sweetwater Branch Basin Constants

The Run Title selection is self explanatory. Log Normal analysis was selected because only a single discharge was considered, and the assumption of log normality was not seriously violated for any of the input parameters. Since the state water quality standard was for chronic toxicity only, a four day averaging period was used. The program was allowed to adjust variances because it was concluded that an accurate estimate of serial correlation of Sweetwater Creek flows could not be determined using gaging data from a different stream. The example considered only a single discharge, which was not located upstream of the USGS gaging station. The water quality standard for lindane was 10 ng/l.

Upstream Inputs: The only stream inputs required for an organic toxicant are total pollutant concentration and flow (Figure 41). No lindane data were available for Sweetwater Branch. The State had assumed a concentration of zero for their previous permit because no significant upstream sources of lindane existed. That assumption of negligible (mean = 0.01) upstream lindane was maintained for this case study. The flow statistics specified correspond to those obtained from STORET for Hogtown Creek (mean = 0.9, s.d. = 1.96). These values will be adjusted for Sweetwater Branch as discussed in the next section.

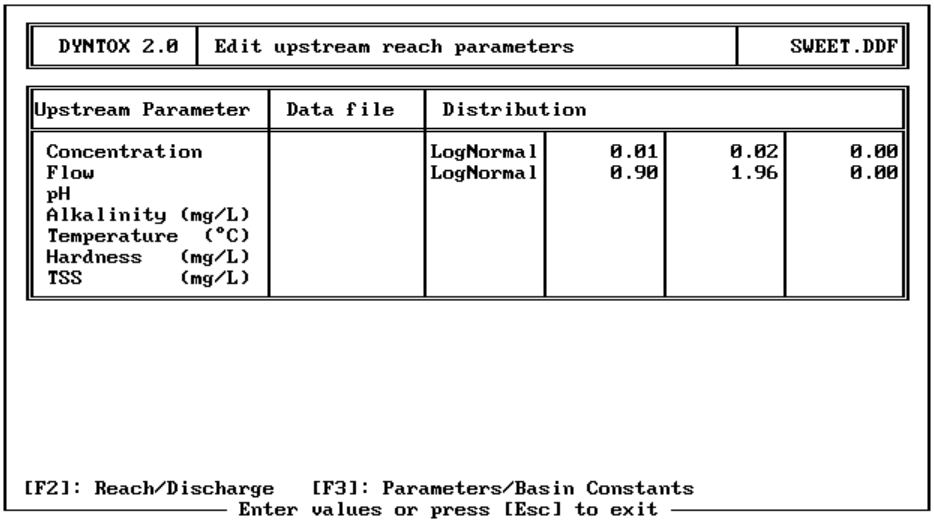

Figure 41. Upstream Input Screen for Sweetwater Branch

Reach/Discharge Inputs: Only two parameter inputs were required for this case study, effluent flow and lindane concentration (Figure 42). Discharge monitoring data were available describing the mean (7.87) and standard deviation (3.3) of the flow. Insufficient data were available to describe the variability of effluent lindane, so a log normal distribution with a coefficient of variation of 0.6 was assumed. For the observed mean effluent concentration of 17 ng/l, this results in a standard deviation of 10.2 ng/l.

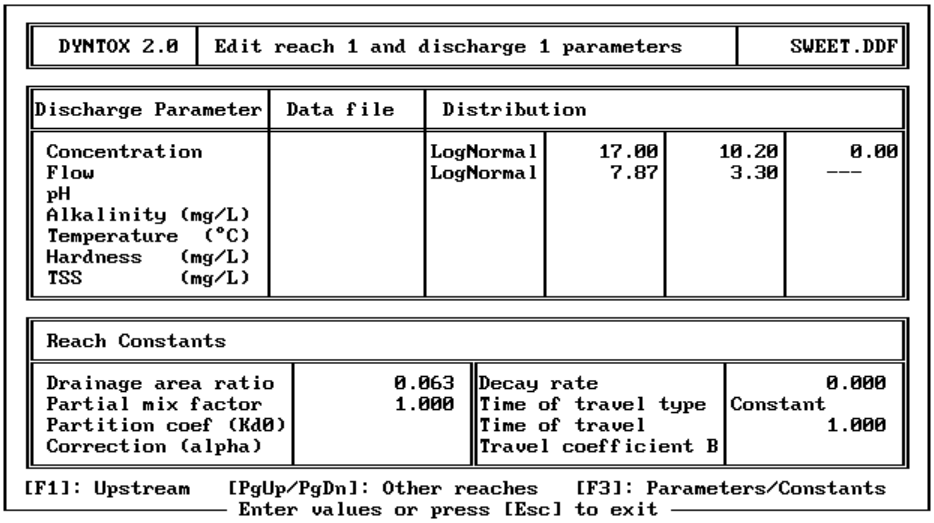

Figure 42. Reach/Discharge Input Screen for Sweetwater Branch

The only reach input of consequence to log normal analysis is the drainage area ratio, since log normal cannot consider multiple reaches or instream decay. Since no USGS gaging station was available for Sweetwater Branch, the following steps were taken:

1) The USGS topographic map for the Sweetwater Branch was obtained.
2) The watershed boundary for Sweetwater Creek was drawn on the topographic map.
3) This watershed boundary was traced onto graph paper, and the size of the drainage area calculated as 2.6 mi^2.
4) The drainage area for Hogtown Creek was taken from USGS Water Resource Data records as 41.2 mi^2.
5) The drainage area ratio was calculated as 0.063 (2.6/41.2).

Wasteload Allocation

Results for existing effluent loading conditions are shown in Figure 43, and indicate that the chronic water quality standard is expected to be violated 95% of the time.

DYNTOX 2.0 | View DYNTOX output | SWEET.DDF

Run Title: Sweetwater Branch Case Example
Simulation type: Log Normal, standard = 10.000

Reach	Violations	RP (years)
1	94.898%	0.003
2		
3		
4		
5		
6		
7		
8		
9		
10		

[F10]: View graph

Mix Conc	Interval	RP (years)
0.0		0.000
	0.000%	
2.0		0.000
	0.000%	
4.0		0.003
	0.037%	
6.0		0.003
	0.794%	
8.0		0.003
	4.271%	
10.0		0.003
	94.898%	

Select reach with arrow keys or press [Esc] to exit

Figure 43. DYNTOX Output for Existing Load

The wasteload allocation procedure consisted of lowering the mean effluent concentration (and lowering the standard deviation to maintain a coefficient of variation equal to 0.6) until an effluent load was found that met water quality standards. Figure 44 shows a reduction in the average effluent lindane concentration from 17 to 4.2 ng/l.

Wasteload allocation results for an effluent lindane concentration of 4.2 ng/l are shown in Figure 45, indicating compliance with the objective of a three year return period. This WLA value of 4.2 ng/l would serve as input to the permit derivation process described for the first example.

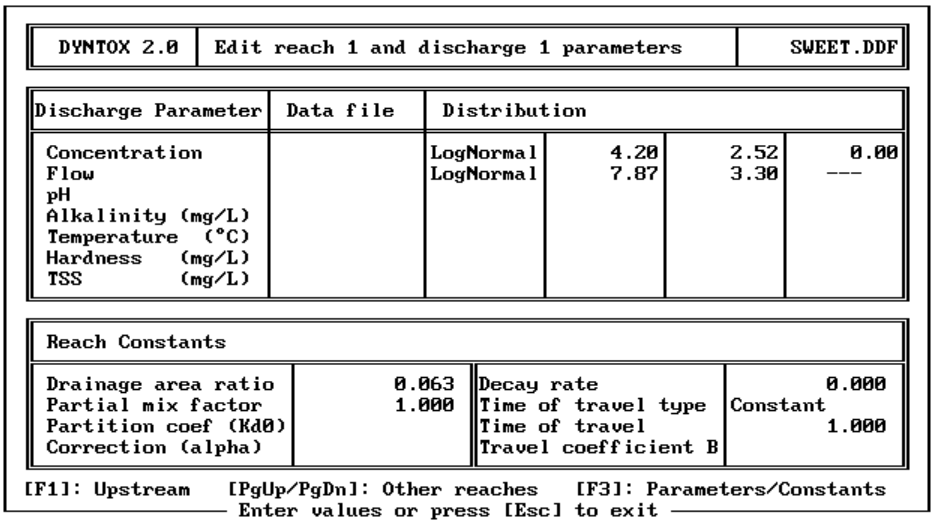

Figure 44. Reduction in Effluent Lindane

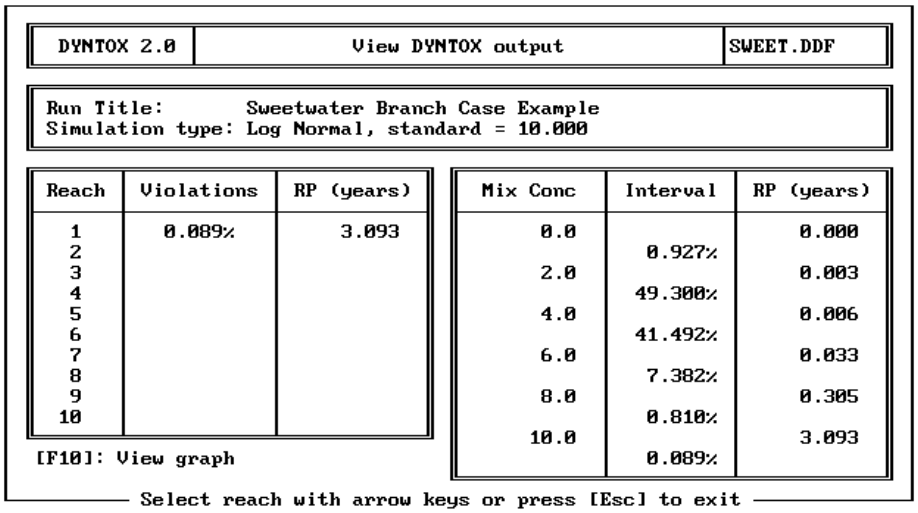

Figure 45. DYNTOX Results at Effluent Concentration = 4.2 ng/l

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APPENDIX 1: ADVANTAGES AND DISADVANTAGES OF ALL THREE DYNTOX METHODS

CONTINUOUS SIMULATION

Advantages

The Continuous Simulation model has three primary advantages compared to steady state modeling, Monte Carlo and Log Normal analysis. First, the advantage over steady state modeling is that Continuous Simulation can predict the frequency and duration of toxicant concentrations in a receiving water; steady state analysis cannot. Second, the inclusion of instream fate processes is an advantage over Log Normal, which cannot simulate instream fate and is limited to simulations for one effluent discharge. Third, by using simultaneous observations for all input parameters, the Continuous Simulation model can directly incorporate the observed effects of serial and cross correlation of inputs. When calculating four day average instream concentrations, Continuous Simulation correctly does the averaging on the model results. Monte Carlo and Log Normal estimate four day average instream concentrations by averaging model inputs.

Disadvantages

The primary disadvantage of Continuous Simulation is the large data requirement. A long period of historical data is required for all parameters. Although time series data can be synthesized for missing parameters, synthesis of time-series data for more than one parameter greatly reduces the merit of this technique. Additional data are required for the calibration/verification of instream fate processes. A second disadvantage to Continuous Simulation is the potentially large requirement of computer time and storage; however, continuing advances in computer technology have minimized this problem.

MONTE CARLO

Advantages

The Monte Carlo technique has several advantages over steady state modeling and the non-steady state techniques Continuous Simulation and Log Normal Analysis. The main advantage over steady state modeling is that Monte Carlo can predict the frequency and duration of toxicant concentrations in a receiving water. The inclusion of instream fate processes is an advantage over Log Normal analysis, which cannot simulate instream fate and is limited to simulations for one effluent discharge. Another advantage of Monte Carlo is that model input data are not required to follow a specific statistical function, as in the Log Normal process.

Disadvantages

The primary disadvantage of Monte Carlo is the data requirement. Data on model input parameters are required to define the statistical distributions or the assumptions therein. Additional data are required for the calibration/verification of instream fate processes. However, in contrast to Continuous Simulation, the Monte Carlo Simulation can proceed and provide good results with a relatively sparse (i.e., numerous measurements, but not every day) data set. Continuous Simulation requires a very complete data set. A secondary disadvantage to Monte Carlo is the inability to directly calculate running averages for results, as Continuous Simulation is able to do. Monte Carlo, like Log Normal, cannot directly calculate multiple day average instream concentrations but must estimate them by using multiple day averages to describe model inputs. A secondary disadvantage of the Monte Carlo technique is the large computational requirement. Like Continuous Simulation, however, the problem of excessive computer requirements is being minimized through continuing advances in computer technology.

LOG NORMAL ANALYSIS

Advantages

The primary advantage of the Log Normal technique is the ability to predict the frequency distribution of the river concentration without the excessive computational requirements of Continuous Simulation or Monte Carlo. Whereas Continuous Simulation and Monte Carlo require several thousand iterations of the model to predict the concentration distribution, Log Normal can proceed much faster through numerical integration. It is well suited for screening level analysis.

Disadvantages

The disadvantages of Log Normal are the inability to simulate multiple discharge situations and the requirement of the assumption that all parameters follow log normal distributions. In many cases, parameter data only approximately conform to a log normal distribution. This introduces errors which are exaggerated at the infrequent recurrence levels of the probabilistic simulation. Log Normal also has the same disadvantage as Monte Carlo in that multiple day average in-stream concentrations can only be approximated through the use of averaged inputs. Continuous Simulation is the only technique that allows exact determination of multiple day average results. Rigorous application of Log Normal analysis also requires significantly more input data than steady state models, but no more than Continuous Simulation or Monte Carlo.

APPENDIX 2: DATA RETRIEVAL USING STORET

This section shows you how to retrieve appropriate data from STORET using STORET's own interface. You may use the STORET interface tool to carry out three functions that will aid you in retrieving data for DYNTOX:

1. You may identify USGS flow gaging stations in a specified geographic area.

2. You may identify water quality monitoring stations in a specified geographic area.

3. You may retrieve water quality and flow data from these monitoring stations.

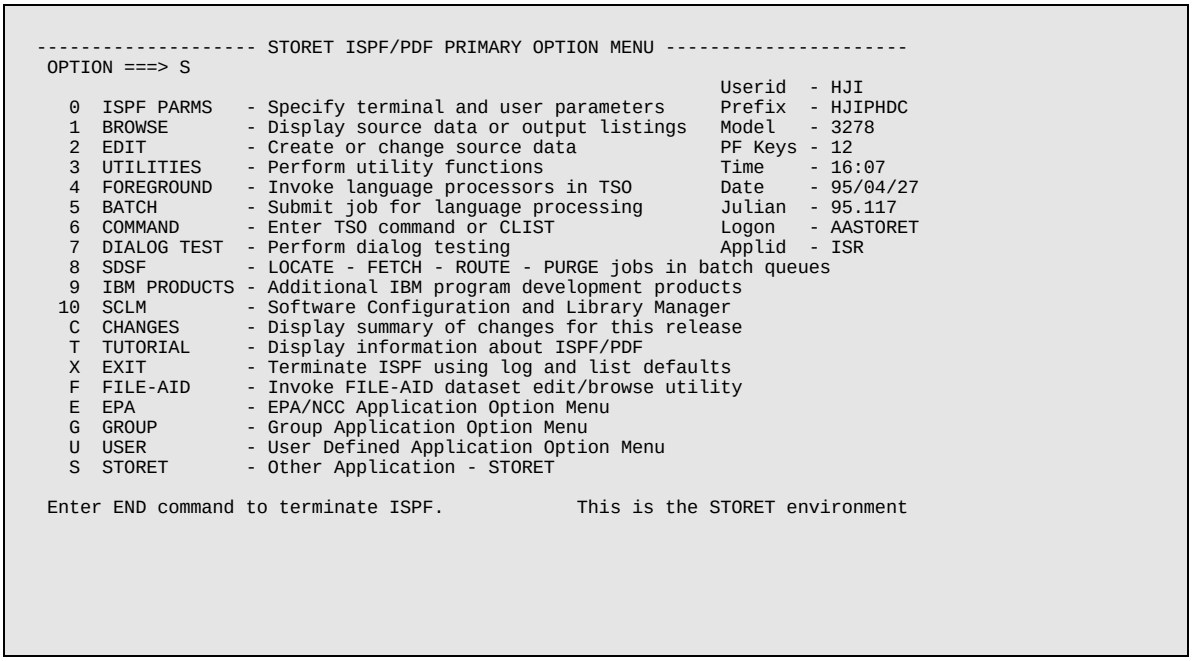
Three sample runs are provided in this section along with notes to show you exactly how to do the three functions described above. To get to the ISPF main menu, type 'ISPF' when you are at the READY prompt.

In order to use the STORET interface, you must first go to the ISPF main menu.

A2.1 Using the STORET interface to identify flow gaging stations in a specified geographic area

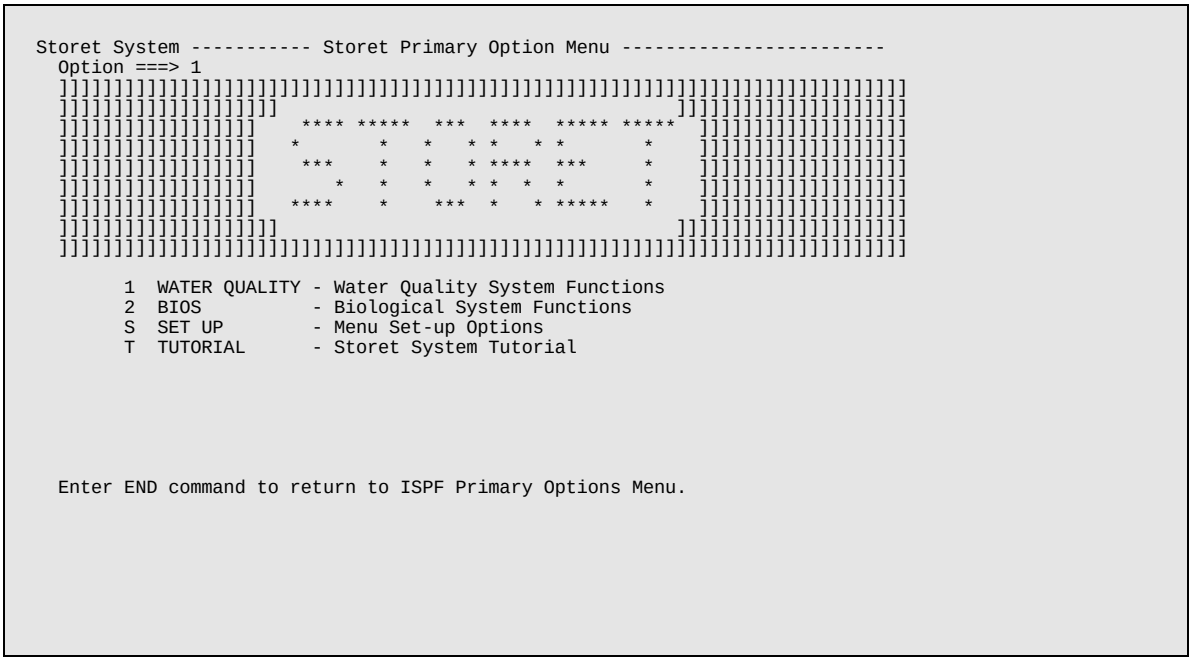
The sample run consists of instructions that are provided in a series of steps, along with the screens that appear for each step.

STEP 1. Select STORET applications from the ISPF main menu by entering "S" at the command line.

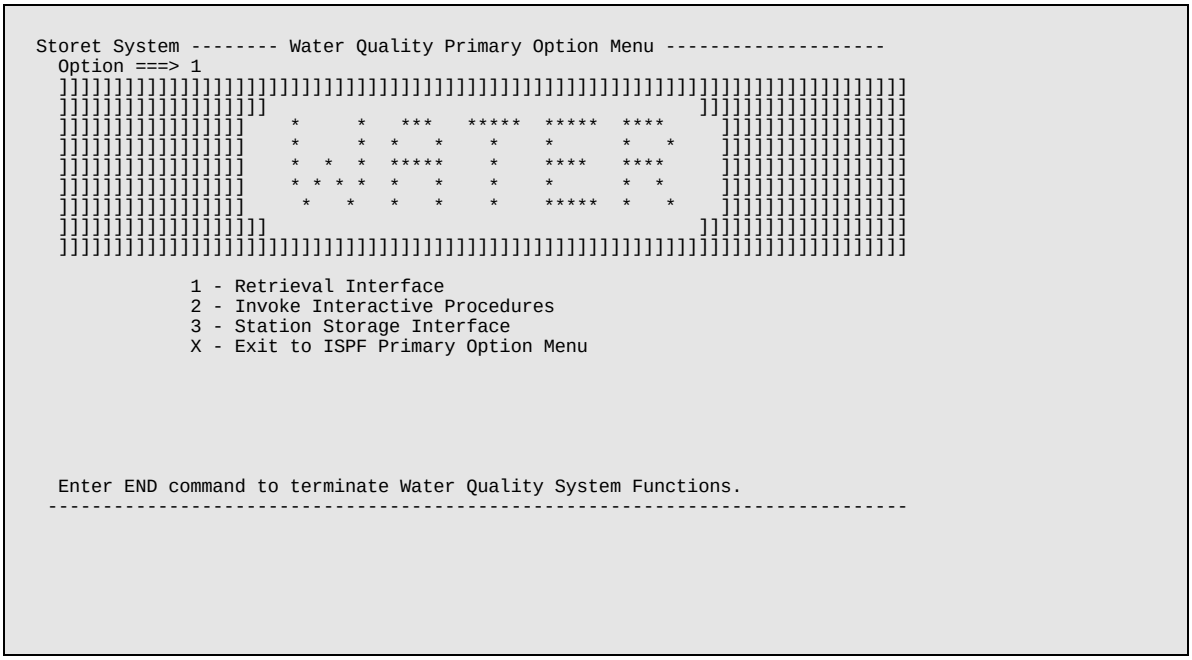


```
-------------------- STORET ISPF/PDF PRIMARY OPTION MENU ----------------------
 OPTION ===> S
                                                          Userid  - HJI
   0  ISPF PARMS   - Specify terminal and user parameters     Prefix  - HJIPHDC
   1  BROWSE       - Display source data or output listings   Model   - 3278
   2  EDIT         - Create or change source data             PF Keys - 12
   3  UTILITIES    - Perform utility functions                Time    - 16:07
   4  FOREGROUND   - Invoke language processors in TSO        Date    - 95/04/27
   5  BATCH        - Submit job for language processing       Julian  - 95.117
   6  COMMAND      - Enter TSO command or CLIST               Logon   - AASTORET
   7  DIALOG TEST  - Perform dialog testing                   Applid  - ISR
   8  SDSF         - LOCATE - FETCH - ROUTE - PURGE jobs in batch queues
   9  IBM PRODUCTS - Additional IBM program development products
  10  SCLM         - Software Configuration and Library Manager
   C  CHANGES      - Display summary of changes for this release
   T  TUTORIAL     - Display information about ISPF/PDF
   X  EXIT         - Terminate ISPF using log and list defaults
   F  FILE-AID     - Invoke FILE-AID dataset edit/browse utility
   E  EPA          - EPA/NCC Application Option Menu
   G  GROUP        - Group Application Option Menu
   U  USER         - User Defined Application Option Menu
   S  STORET       - Other Application - STORET

 Enter END command to terminate ISPF.           This is the STORET environment
```

STEP 2. ***The STORET primary option appears in response. Select STORET water quality functions.***



STEP 3. ***Select the water quality retrieval interface.***



STEP 4. ***Choose the EDIT option to build a new retrieval. Enter a name for the retrieval. If the name is not entered and earlier retrievals have been saved, a selection list of earlier retrievals will be displayed.***

```
Storet Retrieval ---------- Request Option and Name --------------------------
 Command ===>


  Request Option ==> 1_

       1  EDIT    - Create or Modify a Retrieval Request
       2  SUBMIT  - Submit a Completed Retrieval Request for Execution

    Request Name ==> CTFLOW__ (Leave blank to display request selection list)


             ------------------------------------------------
            ]            For Assistance Please Call:          ]
            ]                                                 ]
            ]                SDC User Support                 ]
            ]                  (800)424-9067                  ]
             ------------------------------------------------



 Press ENTER key to continue.
 ------------------------------------------------------------------------------
```

STEP 5. ***Select a general water quality retrieval by selecting option 1.***

```
Storet Retrieval --------------- Request Path ---------------- "CTFLOW" IS NEW
 Command ===>


    Request Path Option ==> 1


     1 GENERAL       - General water quality retrieval.

     2 GROUND WATER  - Retrieval of ground water data that was stored in
                       accordance with the data standards and procedures
                       established in the EPA Office of Ground Water
                       Protection's Data Management Manual.




    Note: Once a request's path has been specified it may NOT be changed.


 Press ENTER key after selecting desired option.
 ------------------------------------------------------------------------------
```

STEP 6. Select option 2, INVENT.

```
Storet Retrieval ------------ Format Selection -------------------------------
 Command ===>

    Format ==> 2

     1  STA      - Station ID Listing By Agency
     2  INVENT   - Data Summary for Unlimited Parameters
     3  RET      - Data Listing for up to 50 Parameters
     4  ALLPARM  - Data Listing for Unlimited Parameters
     5  LOC      - Station Location Map
     6  INDEX    - Station Index Listing
     7  PLOT     - Plot of Data Over Time for up to 10 Parameters
     8  STAND    - Compare Samples Against a Specified Standard
     9  MEAN     - Perform Statistics for up to 50 Parameters
    10  REG      - Correlate and Regress WQF Database Information
    11  DOWNLOAD - Tabular Raw Data File for Unlimited Parameters




 Press ENTER key after selecting desired Format.
 ------------------------------------------------------------------------------
```

STEP 7. This screen is for information only. When editing a saved retrieval, it can be used to jump to a specific part of the retrieval.

```
Storet Retrieval ------------ Station Selection -------------------------------
 Command ===>
                                                    Request Name - CTFLOW
      ---- 1 ----                                         Format - INVENT
     ]  Format   ]
     ] Selection ]                                  Jump to box number ==>
      ----------- ---- 2 ----
                 ]  Station  ]  <-- You Are Here
 *   *           ] Selection ]
 *  *             ----------- ---- 3 ----
 **    *                     ]  Sample   ]
    *                .  .    ] Selection ]
  0  * * *      .*.*.*.*.*.*.  ----------- ---- 4 ----
     *         *.*.*.*.*.*.*.*                ] Parameter ]
 _/ *  *       .*.*.*.*.*.*.*                 ] Selection ]
 **      (**)  *.*.*.*.*.*.*                   -----------  ---- 5 ----
 *  *   (****)   *.*.*                                    ]  Special  ]
 *   *   (**)     ] ]                                     ]  Options  ]
       ]]       ] ]           ._______]___.               ----------- ---- 6 ----
 WWWWWWWWWWWWWWWWWWWWWWWWW        ]   EPA    /                        ]    Job    ]
 WWWWWWWWWWWWWWWWWWWWWWWWWWW vMvMvMvMvMvMvMvMvMvMvMvMvMv               ]  Options  ]
                                                                        -----------
 Press ENTER key to continue.
 ------------------------------------------------------------------------------
```

STEP 8. ***This selection limits the scope of the stations to be retrieved. Since the user only wants stations from a limited geographic area, station selection within states and counties is used.***

```
Storet Retrieval ------------ Station Selection ------------------------------
 Command ===>

 Station Selection Option ==> 2

   1   By Agency Codes and Station IDs.
   2   Within States and Counties.
   3   Within Aquifers.
   4   By Latitude/Longitude Methods
   5   Within USGS Hydrologic Units.
   6   Within EPA Drainage Basins.
   7   By Station Type/Parameter Attributes.
   8   By EPA Reaches.
   9   Within EPA Ecoregions.









 Press ENTER key after selecting desired option.
 --------------------------------------------------------------------------------
```

STEP 9. ***Enter the state FIPS or state abbreviation, and the county FIPS or name. You can enter "?" in the FIPS columns to get help with state and county FIPS codes. Any number of states and counties can be specified. Use the STORET tutorial to learn how to add lines to this screen.***

```
Storet Retrieval ------------ Station Selection -------------  ROW 1 TO 2 OF 2
 Command ===>                                                  Scroll ===> CSR

 Enter the FIPS code, postal abbreviation, or name of the desired state.  The
 other state entries on the line will be automatically filled in.  The same
 applies for the county FIPS code and name.  A '?' entered in the state (or
 county) FIPS field will display a comprehensive listing of states (or counties
 within the state identified on the same line).  The desired state (or counties)
 may then be selected from the list.

     State  Postal                              County
 CMD FIPS   Abbrev          State Name           FIPS       County Name
 --- ?----  ------ ---------------------------- ?----- --------------------
 ___  09      CT   CONNECTICUT                   009   NEW HAVEN
 ___  __      __   ____________________________ ___   ____________________
 ********* BOTTOM ******* PRESS ENTER TWICE TO CONTINUE ******** BOTTOM ********
```

STEP 10. ***Here the user has the option to further limit the station selection. Select restriction by agency and restriction by station type by entering "S" next to those options as shown on the screen.***

```
Storet Retrieval ------------ Station Restriction -----------------------------
 Command ===>

  You have selected stations by State-County.  You may further limit the
  stations already selected by specifying one or more of the options below.
  Select an option by typing an 's' next to the Option Description.

 --------------------------- Option Descriptions ----------------------------

  S_  Restrict to Specific Agencies or Stations ==> INCLUDE (INCLUDE or EXCLUDE)

  S_  Restrict to Specific Station Type/Parameter Attributes
  __  Restrict to Specific Archive Data Classes
  __  Restrict to Specific USGS Hydrologic Units









 Press ENTER key after selecting desired option(s).
 ------------------------------------------------------------------------------
```

STEP 11. ***The agency code for USGS stations is 112WRD.***

```
Storet Retrieval ------------ Station Restriction -----------  ROW 1 TO 2 OF 2
 Command ===>                                                 Scroll ===> CSR

 Limit selected Stations to only those Agencies specified below:

 CMD   Agency Code
 ---   -----------
 ___   112WRD
 ___   _______
 ********* BOTTOM ******* PRESS ENTER TWICE TO CONTINUE ******** BOTTOM ********
```

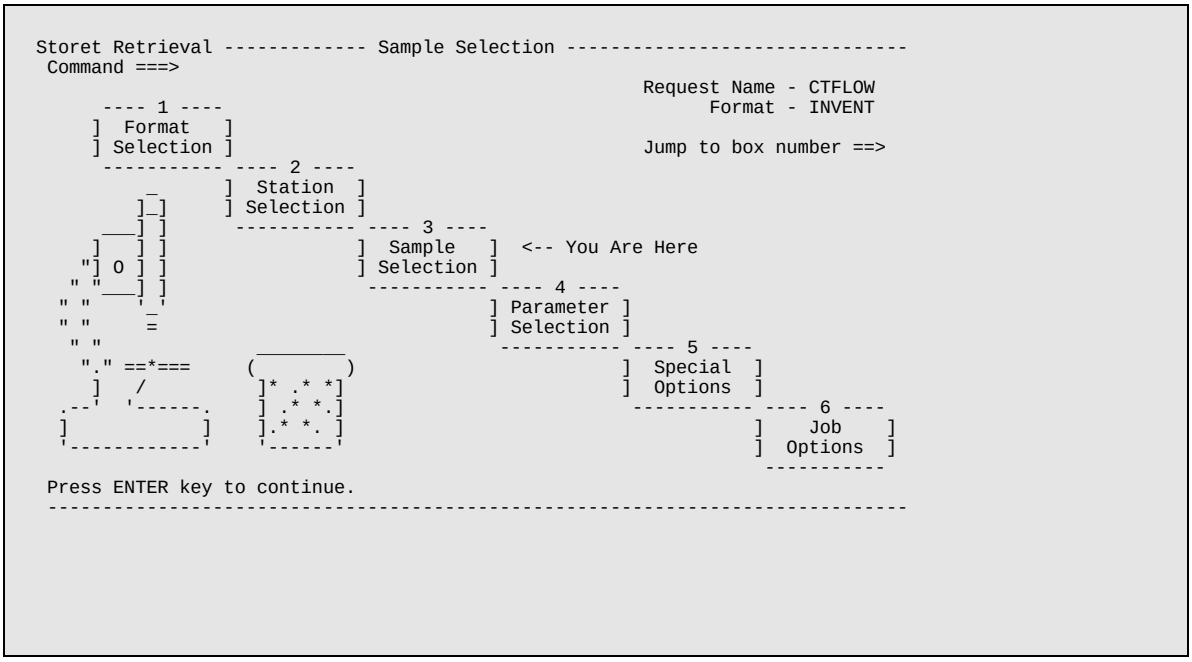
STEP 12. Select stream monitoring stations by entering STREAM as shown. Help on what you may enter is available by typing HELP at the command prompt.

```
Storet Retrieval ------------ Station Restriction -----------  ROW 1 TO 2 OF 2
 Command ===>                                                  Scroll ===> CSR

 Enter a station type/parameter attribute expression.  Operators AND and OR may
 be used to combine attributes.  The NOT operator may precede any attribute.
 You may continue the attribute expression on additional lines as needed.

 CMD   Logical expression specifying station type and parameter attributes
 ---   ------------------------------------------------------------------------
 ___   STREAM

 ___   ________________________________________________________________________

 ********* BOTTOM ******* PRESS ENTER TWICE TO CONTINUE ******** BOTTOM ********
```

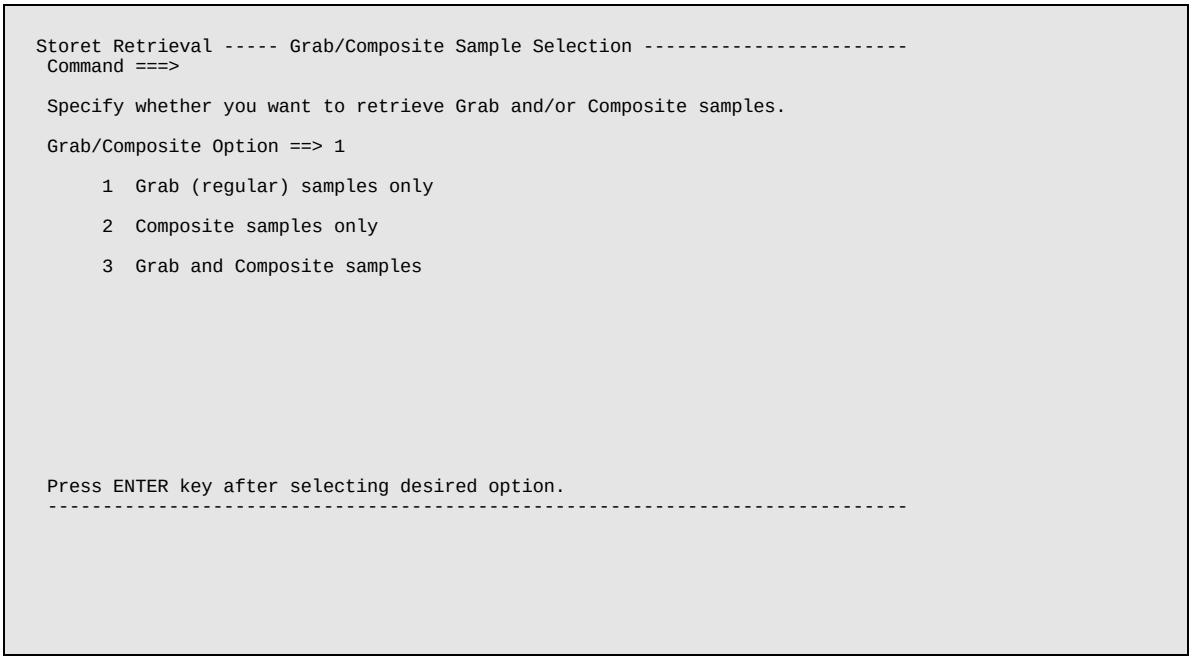
STEP 13. Data aggregation is not needed for this retrieval so press ENTER to move to the next screen.

```
Storet Retrieval ----------- Station Aggregation ------------------------------
 Command ===>


 Station Aggregation Option ==>    (Leave Blank for no Aggregation)

      1  State                    7  USGS Hydrologic Region
      2  County                   8  USGS Hydrologic Sub-Region
      3  EPA Major Basin          9  USGS Hydrologic Accounting Unit
      4  EPA Minor Basin         10  USGS Hydrologic Cataloging Unit
      5  EPA Sub-Basin           11  All Stations
      6  EPA Reach

     12  Latitude-Longitude Cell:   Height (Latitude)  ==>        (Seconds)
                                    Width  (Longitude) ==>        (Seconds)







 Press ENTER key to continue.
 -------------------------------------------------------------------------------
```

STEP 14. This screen is for information only. Press ENTER to proceed.



STEP 15. Select data for grab samples only. This option is not important for this retrieval. Grab only or grab and composite samples may be selected as well.



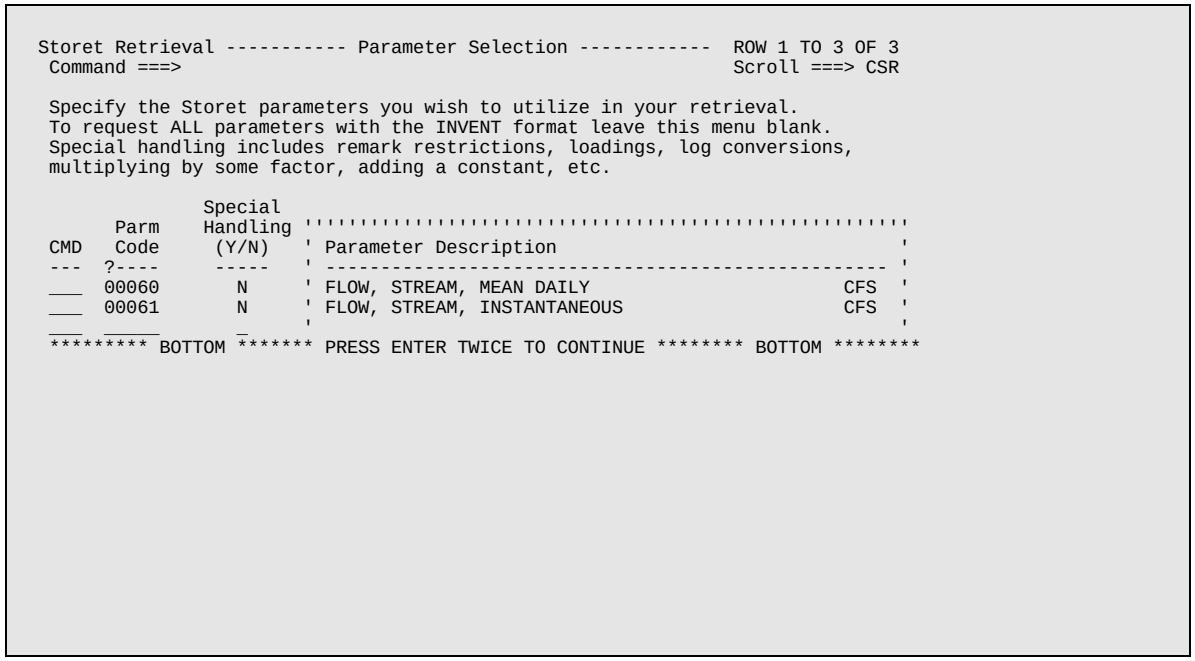
STEP 16. Do not further restrict sample selection.

```
Storet Retrieval ------------- Sample Selection ------------------------------
 Command ===>

  Samples gathered at the specified stations may be selected based upon
  one or more of the options below.  Select an option by typing an 's'
  next to the Option Description.

 ---------------------------- Option Descriptions ----------------------------

  __  Date Ranges
  __  Time Ranges
  __  Seasonal Ranges
  __  Depth Ranges
  __  Depth Type
  __  Aquifers
  __  Intensive Surveys
  __  Locked Status
  __  Parameter Content



 Press ENTER key after selecting desired option(s).
 --------------------------------------------------------------------------------
```

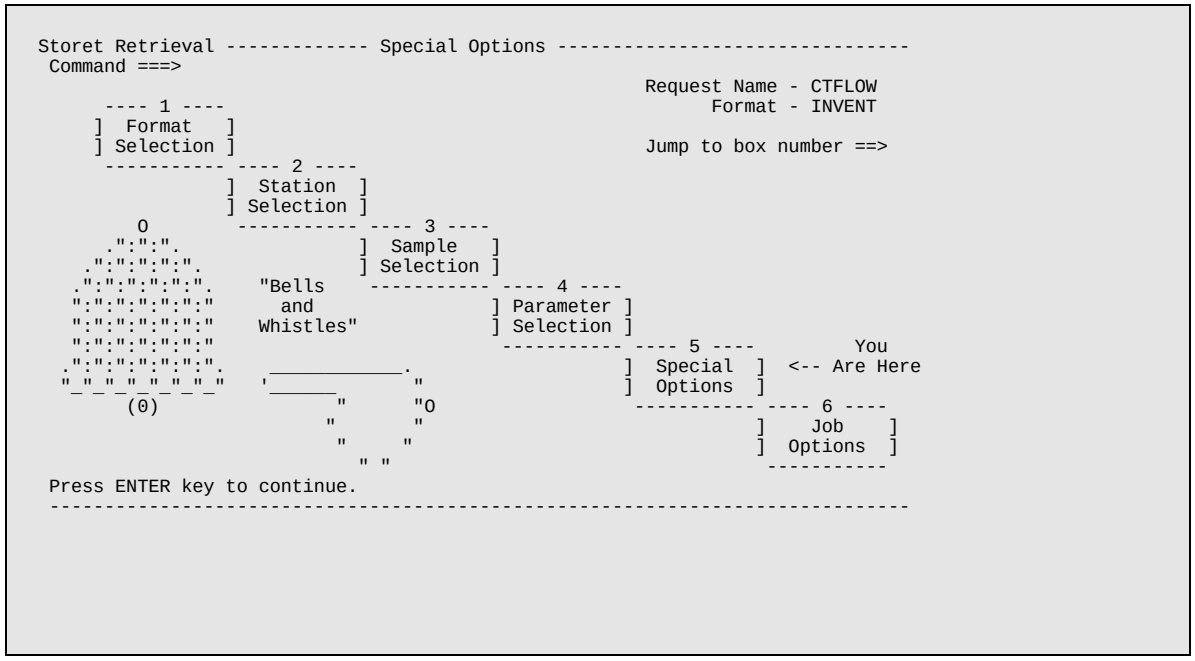
STEP 17. This screen is for information only. Press ENTER to proceed.

```
Storet Retrieval ----------- Parameter Selection -----------------------------
 Command ===>
                                                    Request Name - CTFLOW
     ---- 1 ----                                          Format - INVENT
    ]  Format   ]
    ] Selection ]                                   Jump to box number ==>
     ----------- ---- 2 ----
               ]  Station  ]
               ] Selection ]
       Cl       ----------- ---- 3 ----
       ]                   ]  Sample   ]
   Cl--C--F                ] Selection ]
       ]          NH        ----------- ---- 4 ----
       Cl           3                  ] Parameter ]  <-- You Are Here
                                       ] Selection ]
                           Br H         ----------- ---- 5 ----
 Hg++         Cl H         ]  ]                   ]  Special  ]
              ]  ]         C==C            PO     ]  Options  ]
          Cl--C--C--H      ]  ]              4     ----------- ---- 6 ----
              ]  ]         H  Br                              ]    Job    ]
    pH        Cl H                    DDT                     ]  Options  ]
                                                               -----------
 Press ENTER key to continue.
 --------------------------------------------------------------------------------
```

STEP 18. Enter the STORET parameter codes for flow values. A "?" in the parameter code field will provide help in identifying parameter codes of interest.



STEP 19. This screen is for information only. Press ENTER to proceed.



STEP 20. Select gross summary for all stations with individual station summaries. The purpose of this retrieval is to identify the individual stations which have data.

```
Storet Retrieval ----------- Inventory Summaries -----------------------------
 Command ===>

 Summary option ==> 1


      1  Gross summary of all STATIONs with individual STATION summaries
         (excluding STATIONs with no sample data)

      2  Gross summary of all STATIONs with individual STATION summaries
         (including STATIONs with no sample data)

      3  Gross summary of all STATIONs









 Press ENTER key after selecting desired option.
 ------------------------------------------------------------------------------
```

STEP 21. No specific break points are needed so move to the next screen by pressing ENTER.

```
Storet Retrieval ---------- Inventory Break Points ----------------------------
 Command ===>


 The system segregates data by medium and remark code before the statistics are
 calculated.  This ensures tissue data is not combined with water data when
 determining the mean of a constituent.  You may change the break points by
 placing a 'S' beside one or more of the option descriptions below or you
 may choose to break only when the parameter changes.

  -------------------------- Option Descriptions ----------------------------

  __  Break only when the parameter changes.

  __  Segregate the data for a parameter by medium.
  __  Segregate the data for a parameter by remark code.
  __  Segregate the data for a parameter by composite value type.
  __  Segregate the data for a parameter by the system multi-purpose key.
  __  Separate the samples with a value of zero before statistics are
      calculated.


 Press ENTER key to continue.
 ------------------------------------------------------------------------------
```

STEP 22. No selection is needed for this screen.

```
Storet Retrieval ----------- Data Transformations -----------------------------
 Command ===>


 The INVENT program performs the following data transformations if the
 ingredient constituents are present in the sample: temperature in degrees
 celsius to degrees fahrenheit and vice versa, DO saturation percentage,
 un-ionized ammonia, coliform to Strep count ratio, and hardness.

 To suppress these data transformations place a 'S' in the field below.


                     __  Suppress all data transformations.









 Press ENTER key to continue.
 -------------------------------------------------------------------------------
```

STEP 23. No input is needed for this screen.

```
Storet Retrieval -------------- Print Options --------------------------------
 Command ===>


 Do you want the station header to print on the left side of the page
 or on the right side of the page? ==> R  (L or R)

 Enter up to 5 lines of text to be printed at the top of each page
 across from the station header.

 ==>
 ==>
 ==>
 ==>
 ==>









 Press ENTER key to continue.
 -------------------------------------------------------------------------------
```

STEP 24. Identify your job submission parameters. Correct any erroneous or missing information.

```
Storet Retrieval --------------- Job Options ---------------------------------
 Command ===>

      The job submission parameters displayed below will be used when
      request CTFLOW is submitted for execution.  If saved in your
      permanent profile, these parameter values will become the default
      (assumed) values for future requests.


      Modify any of the following job submission parameters you wish:

          PRIORITY ==> 2     (1 or 2)
          TIME     ==> 1     (Minutes)
                   ==> 00    (Seconds)
          BIN/ROOM ==> C811
          NOTIFY   ==> YES   (YES or NO)
          ROUTE    ==> HOLD
          JCL ECHO ==> MIN   (MAX, MIN, or NONE)

      Save these parameters in your permanent profile? ==> NO  (YES or  NO)


 Press ENTER key to continue.
 ------------------------------------------------------------------------------
```

STEP 25. Save the retrieval request and enter a description if desired.

```
----------------------------- Request Disposition ------- "CTFLOW" IS COMPLETE
 Command ===>


     Disposition ==> SAVE   (SAVE, CANCEL, or AGAIN)

             SAVE     Save this request under the specified name
             CANCEL   Discard this request without saving
             AGAIN    Process this request again


     Request Name - CTFLOW     Name for Save ==> ________ (If different)


     Description ==> INDEX OF USGS FLOW GAGES IN NEW HAVEN CT
                 ==> ____________________________________________________
                 ==> ____________________________________________________




 Press the ENTER key to continue.
 ------------------------------------------------------------------------------
```

STEP 26. Once the request has been saved, it must be submitted to retrieve the requested information.

```
Storet Retrieval ---------- Request Option and Name --------------------------
 Command ===>


  Request Option ==> 2_

       1  EDIT    - Create or Modify a Retrieval Request
       2  SUBMIT  - Submit a Completed Retrieval Request for Execution

    Request Name ==> CTFLOW__ (Leave blank to display request selection list)


             ------------------------------------------------
            ]            For Assistance Please Call:          ]
            ]                                                 ]
            ]                SDC User Support                 ]
            ]                  (800)424-9067                  ]
             ------------------------------------------------



 Press ENTER key to continue.
 -------------------------------------------------------------------------------
```

STEP 27. Review the job submission parameters and correct any erroneous or missing information.

```
Storet Retrieval -------- Job Submission Parameters ---------------------------
 Command ===>

         Status- COMPLETE     Format- INVENT      Path- GENERAL RETRIEVAL
     Description- INDEX OF USGS FLOW GAGES IN NEW HAVEN CT
                -
                -
      The job submission parameters displayed below will be used when
      request CTFLOW is submitted for execution.  If saved in your
      permanent profile, these parameter values will become the default
      (assumed) values for future requests.

          PRIORITY ==> 2     (1 or 2)
          TIME     ==> 1     (Minutes)
                   ==> 00    (Seconds)
          BIN/ROOM ==> C811
          NOTIFY   ==> YES   (YES or NO)
          ROUTE    ==> HOLD
          JCL ECHO ==> MIN   (MAX, MIN, or NONE)

      Save job parameters in your permanent profile? ==> NO  (YES or NO)

 Press ENTER to submit this request or END to specify a different request.
 -------------------------------------------------------------------------------
```

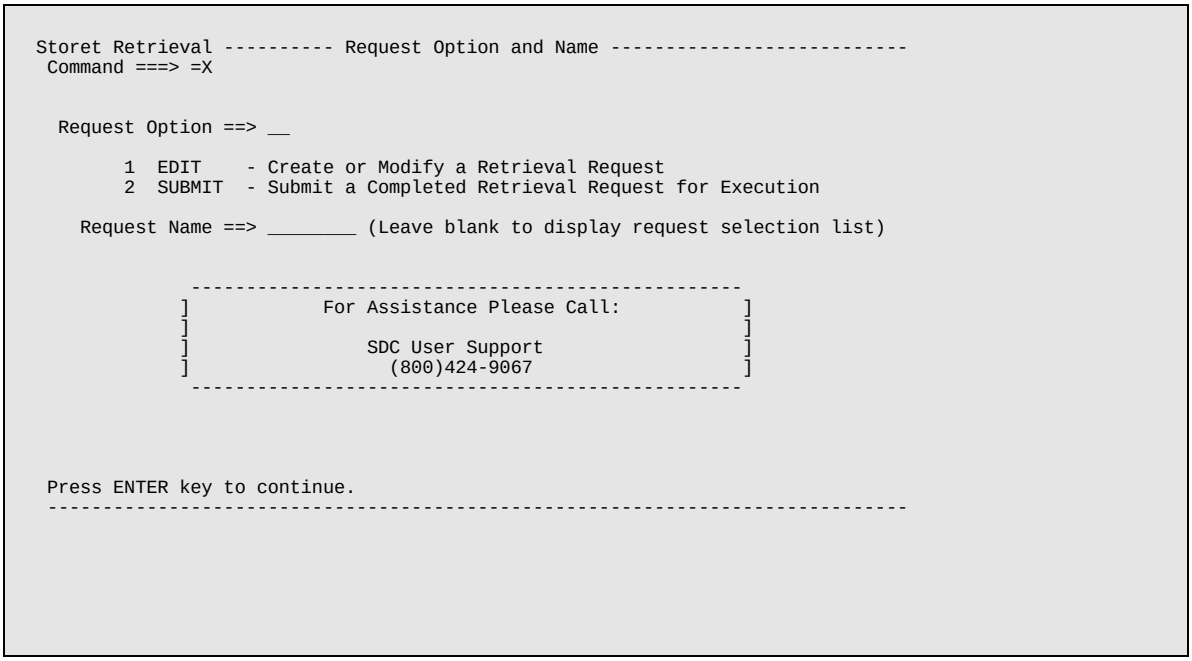
STEP 28. This screen is for information only. No action should be taken.

```
Storet Retrieval ------------- Job Submission --------------------------------

                        ----------------------------
                       ]      Please Stand By       ]
                        ----------------------------

    Request Name - CTFLOW     Format - INVENT          Path - GENERAL RETRIEVAL


          Status        Step
          ------------  ------------------------------------------------
          (Complete)    Format Selection

          (Complete)    Station Selection

          (Complete)    Sample Selection

          (Complete)    Parameter Selection

          (Complete)    Special Options

          (Processing)  Completing Job Submission

 ------------------------------------------------------------------------------
```

STEP 29. The job number is displayed. The user can use SDSF to view and retrieve the output. The output will contain summary information about all USGS flow gage data in the specified geographic area. Flow data listed in this retrieval is limited and does not reflect all of the data available for the specified gage.

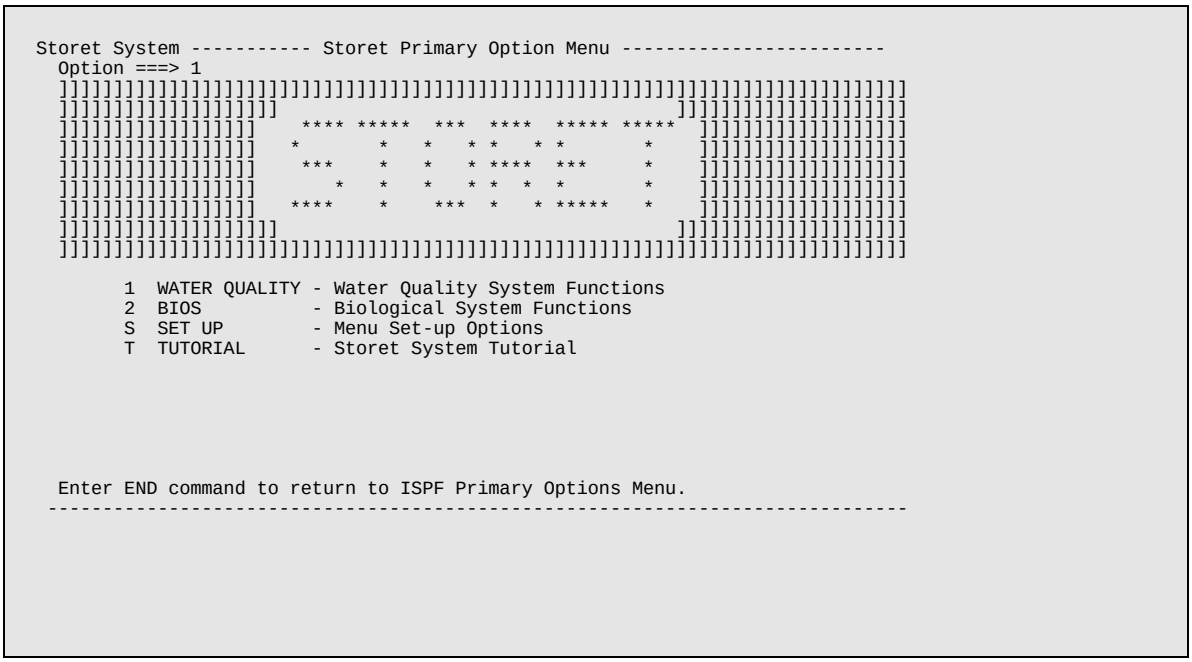
```
Storet Retrieval ------------- Job Information --------------------------------
 Command ===>

                            Your Job Name is HJI65
                           Your Job Number is 20865

      Request Name - CTFLOW     Format - INVENT       Path - GENERAL RETRIEVAL

      Your request has been permanently saved in STORET.REQUESTS(CTFLOW)

      SDSF should be used for the following job processing functions:

         -   Select jobs from the Output queue
         -   View jobs in the Input queue
         -   View jobs currently executing (active jobs)
         -   Route jobs to a remote destination
         -   Purge unwanted jobs

      SDSF is accessed from the ISPF primary options menu.  Enter RETURN
      on the Command line to return to the ISPF primary options menu.


 Press ENTER key to continue.
 ------------------------------------------------------------------------------
```

STEP 30. The "=X" command can be used to return to the READY prompt. The command "8.ST" can be used to access SDSF and review the job status.

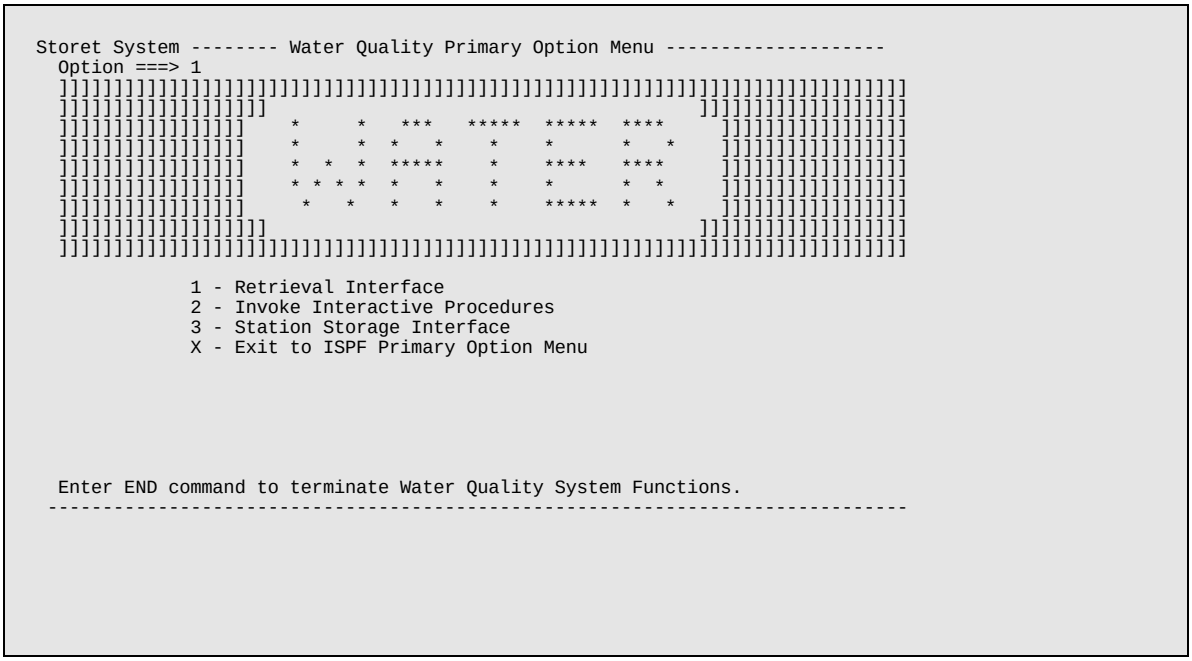


A2.2 Using STORET to identify water quality monitoring stations

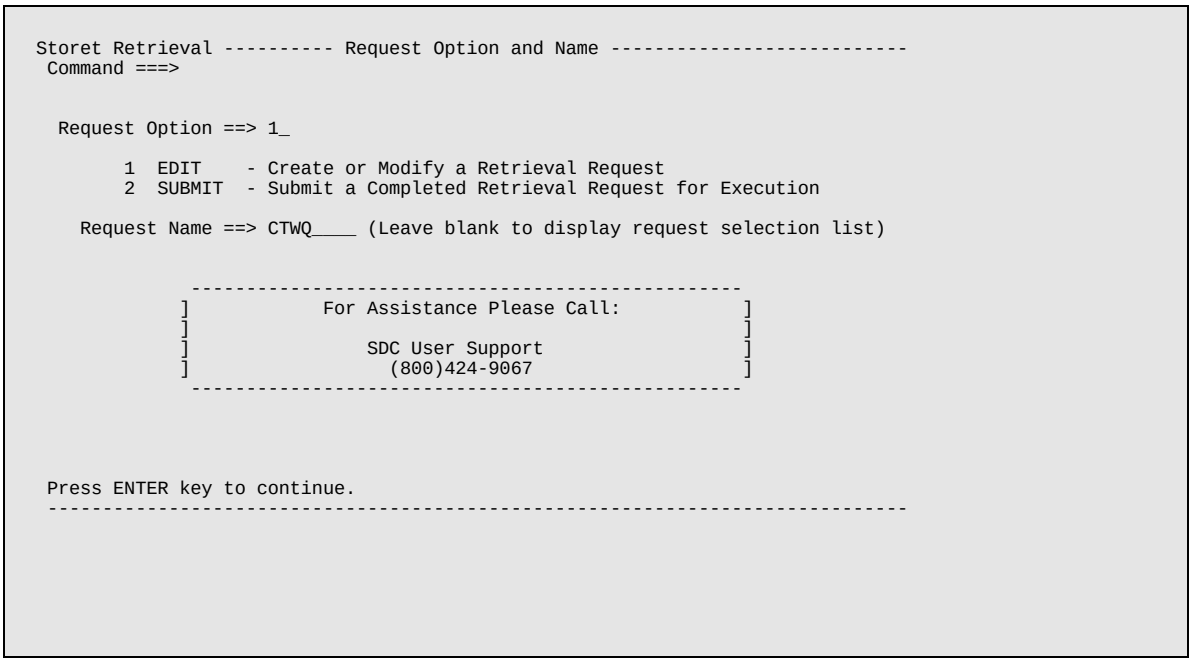
STEP 1. Select STORET water quality functions by entering "S" at the command prompt.



STEP 2. ***Select the water quality retrieval interface.***



STEP 3. ***Choose edit to build a new retrieval. Enter a name for the retrieval. If the name is not entered and earlier retrievals have been saved a selection list of earlier retrievals will be displayed.***



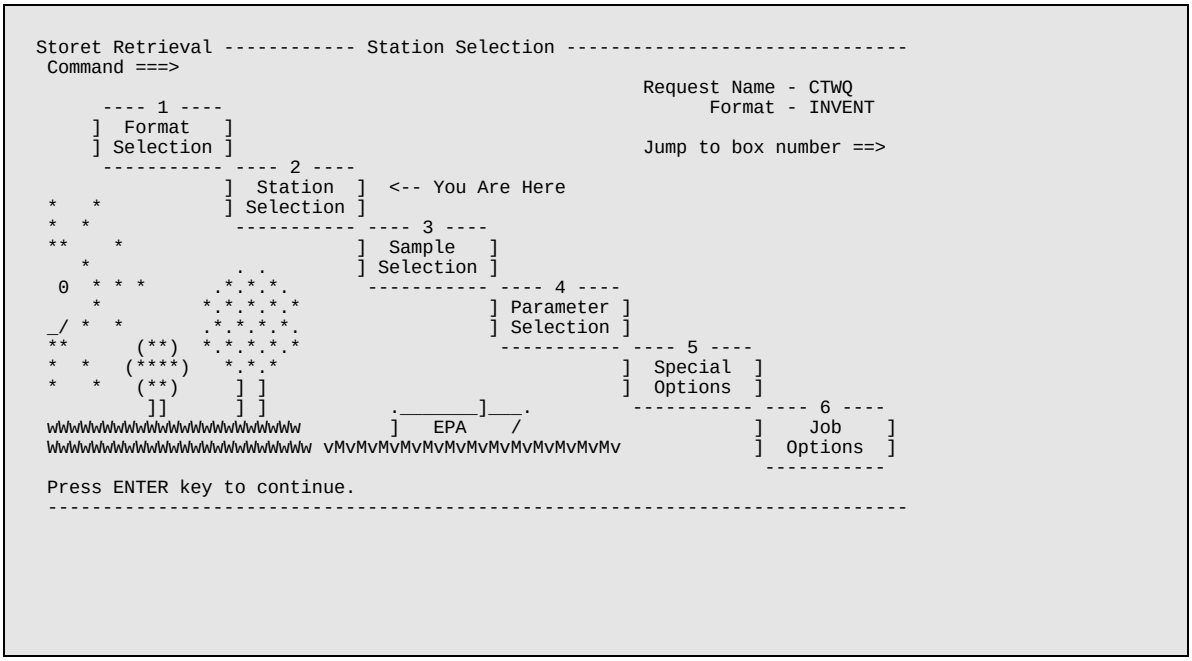
STEP 4. Select a general water quality retrieval.

```
Storet Retrieval --------------- Request Path ---------------- "CTWQ  " IS NEW
 Command ===>


    Request Path Option ==> 1


     1 GENERAL       - General water quality retrieval.

     2 GROUND WATER  - Retrieval of ground water data that was stored in
                       accordance with the data standards and procedures
                       established in the EPA Office of Ground Water
                       Protection's Data Management Manual.







    Note: Once a request's path has been specified it may NOT be changed.


 Press ENTER key after selecting desired option.
 --------------------------------------------------------------------------------
```

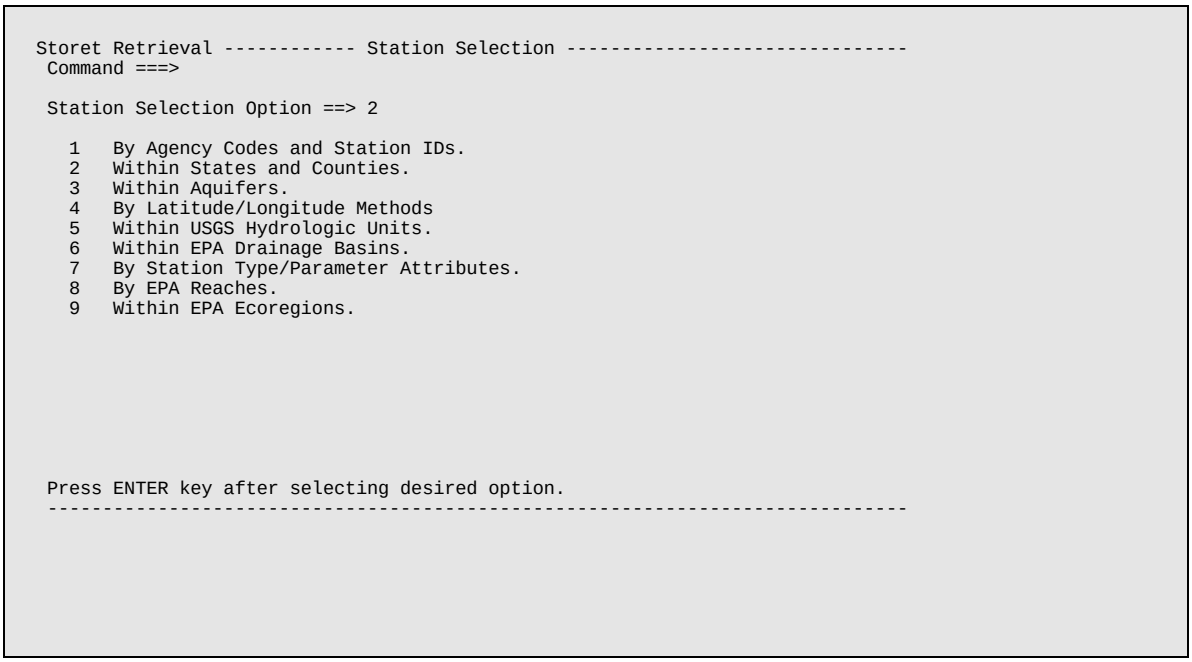
STEP 5. Select the invent program.

```
Storet Retrieval ------------ Format Selection -------------------------------
 Command ===>

    Format ==> 2

     1  STA      - Station ID Listing By Agency
     2  INVENT   - Data Summary for Unlimited Parameters
     3  RET      - Data Listing for up to 50 Parameters
     4  ALLPARM  - Data Listing for Unlimited Parameters
     5  LOC      - Station Location Map
     6  INDEX    - Station Index Listing
     7  PLOT     - Plot of Data Over Time for up to 10 Parameters
     8  STAND    - Compare Samples Against a Specified Standard
     9  MEAN     - Perform Statistics for up to 50 Parameters
    10  REG      - Correlate and Regress WQF Database Information
    11  DOWNLOAD - Tabular Raw Data File for Unlimited Parameters




 Press ENTER key after selecting desired Format.
 --------------------------------------------------------------------------------
```

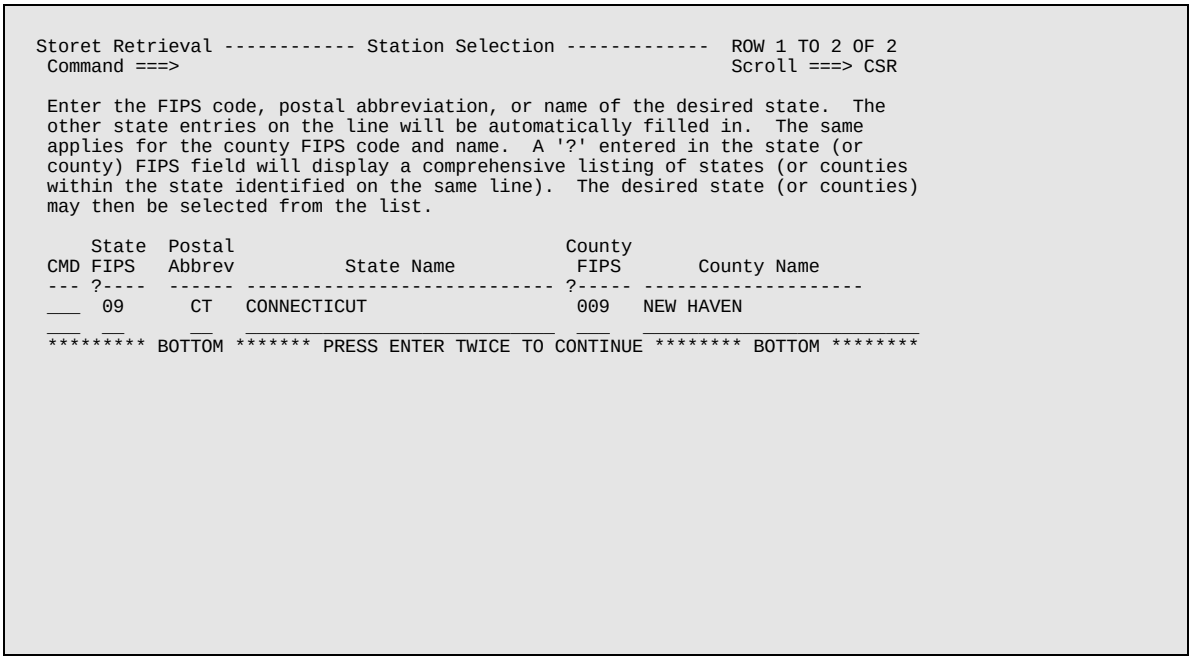
STEP 6. ***This screen is for information only. When editing a saved retrieval, it can be used to jump to a specific part of the retrieval.***



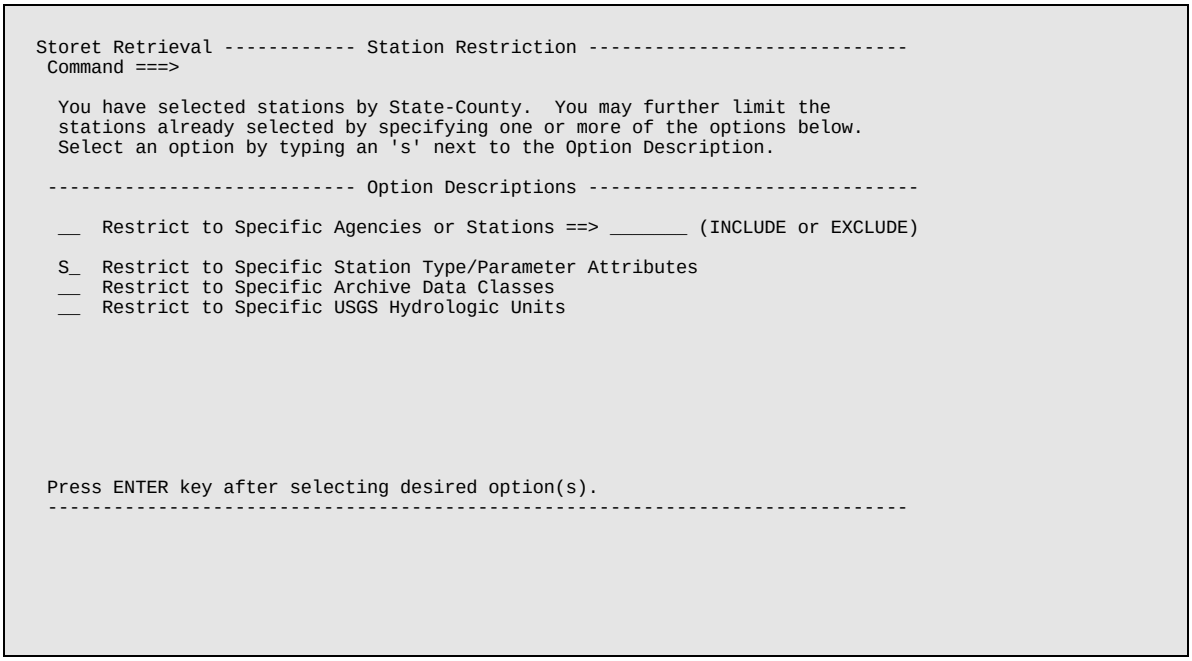
STEP 7. ***This selection limits the scope of the stations to be retrieved. Since the user only wants stations from a limited geographic area, station selection within states and counties is used.***



STEP 8. ***Enter the state FIPS or state abbreviation, and the county FIPS or name. You can use "?" in the FIPS columns to get help with state and county FIPS codes. any number of states and counties can be specified. Use the STORET tutorial to learn how to add lines to this screen.***



STEP 9. ***Here the user has the option to further limit the station selection. Select restriction by station type.***



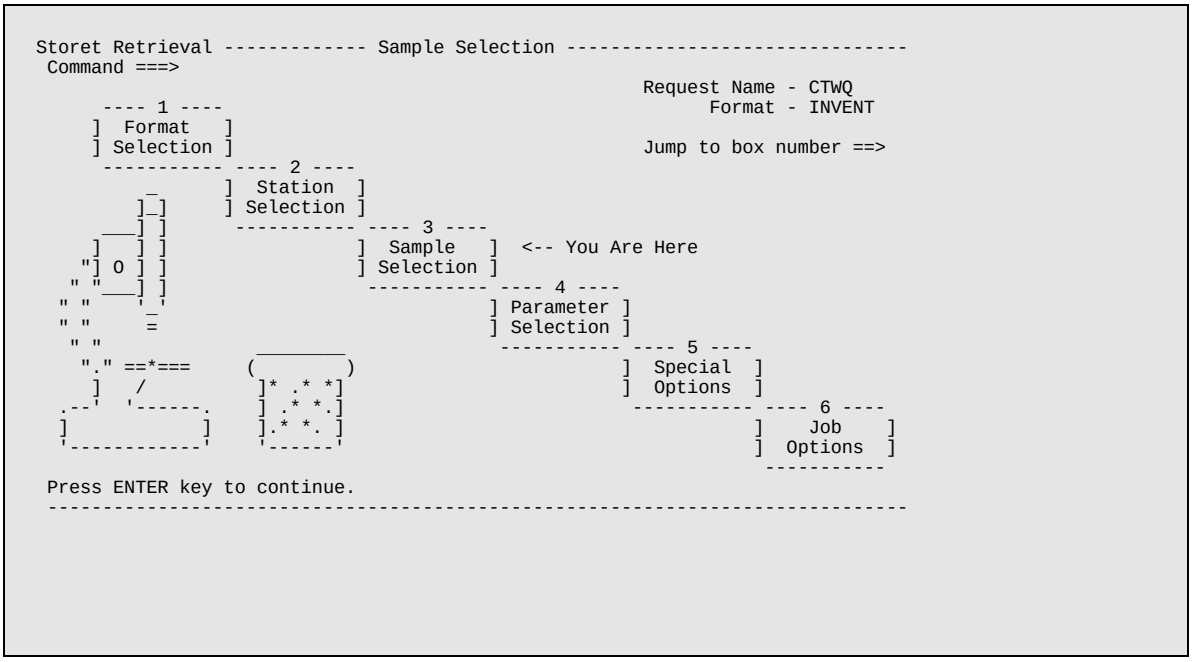
STEP 10. Select stream monitoring stations. As with all STORET screens help is available by typing HELP at the command prompt.

```
Storet Retrieval ------------ Station Restriction -----------  ROW 1 TO 2 OF 2
 Command ===>                                                  Scroll ===> CSR

 Enter a station type/parameter attribute expression.  Operators AND and OR may
 be used to combine attributes.  The NOT operator may precede any attribute.
 You may continue the attribute expression on additional lines as needed.

 CMD   Logical expression specifying station type and parameter attributes
 ---   ------------------------------------------------------------------------
 ___   STREAM

 ___   ________________________________________________________________________

 ********* BOTTOM ******* PRESS ENTER TWICE TO CONTINUE ******** BOTTOM ********
```

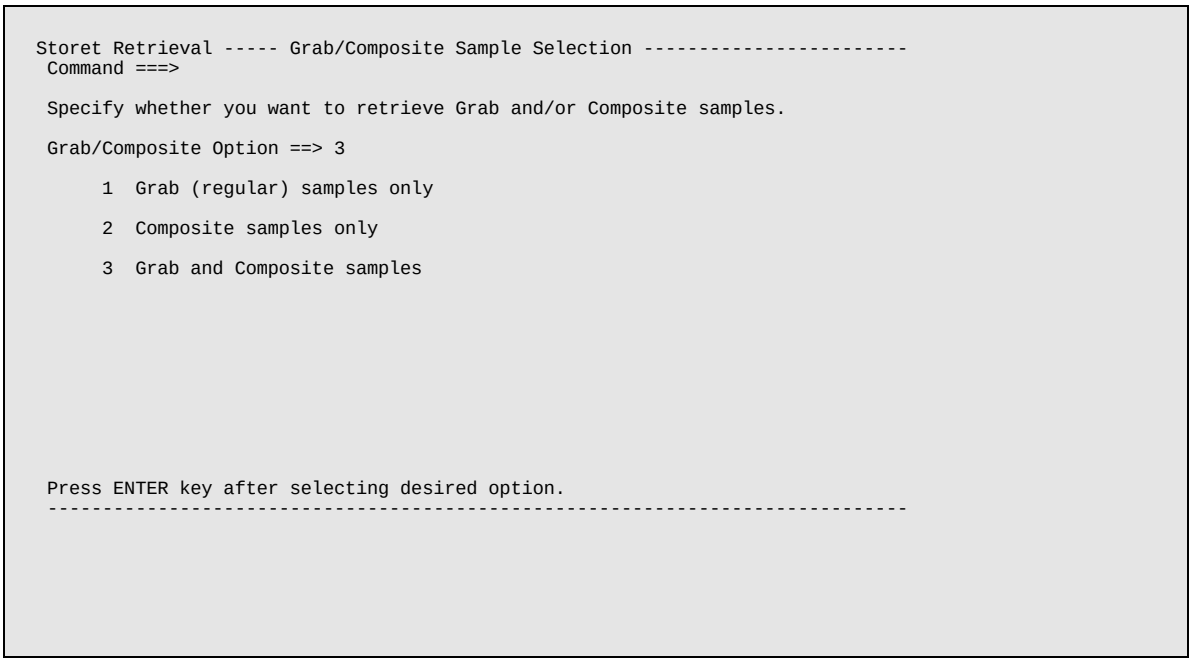
STEP 11. Data aggregation is not needed for this retrieval.

```
Storet Retrieval ----------- Station Aggregation -----------------------------
 Command ===>


 Station Aggregation Option ==>    (Leave Blank for no Aggregation)

      1  State                    7  USGS Hydrologic Region
      2  County                   8  USGS Hydrologic Sub-Region
      3  EPA Major Basin          9  USGS Hydrologic Accounting Unit
      4  EPA Minor Basin         10  USGS Hydrologic Cataloging Unit
      5  EPA Sub-Basin           11  All Stations
      6  EPA Reach

     12  Latitude-Longitude Cell:   Height (Latitude)  ==>        (Seconds)
                                    Width  (Longitude) ==>        (Seconds)







 Press ENTER key to continue.
 -------------------------------------------------------------------------------
```

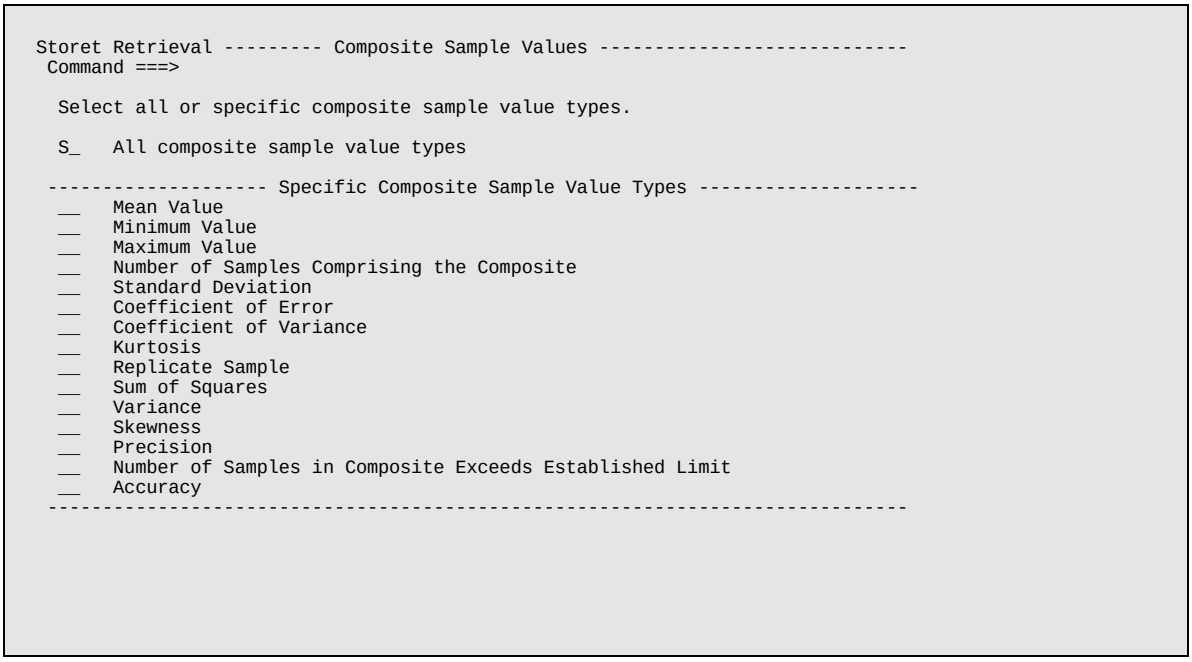
STEP 12. This screen is for information only.



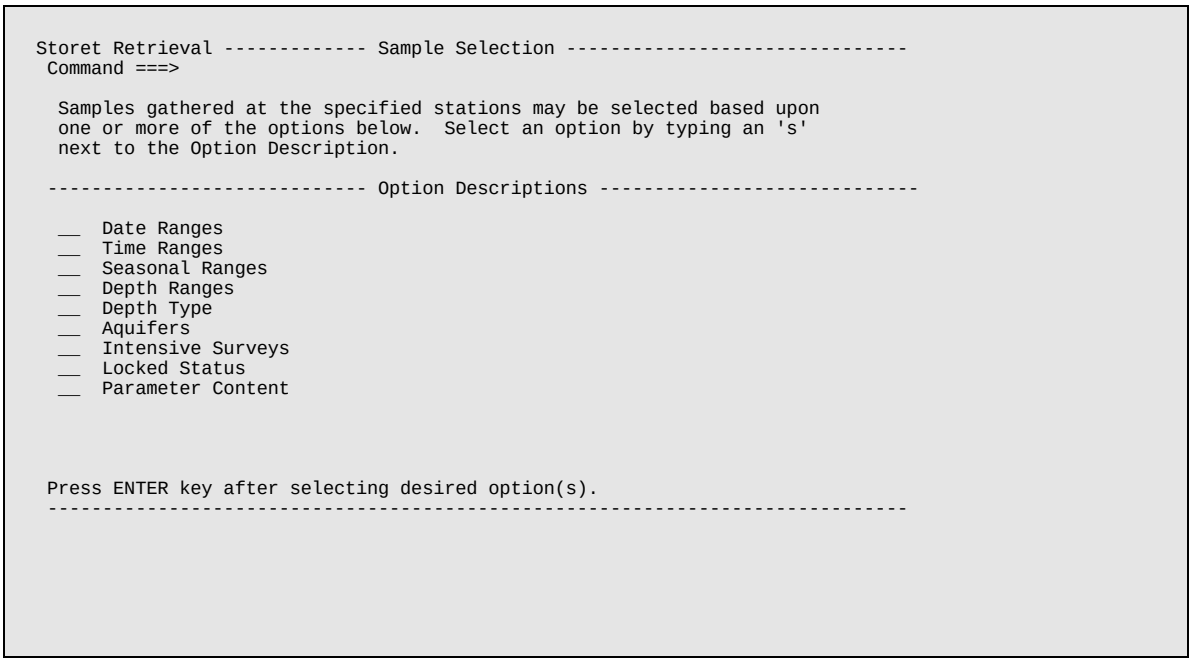
STEP 13. Select data for grab and composite samples.



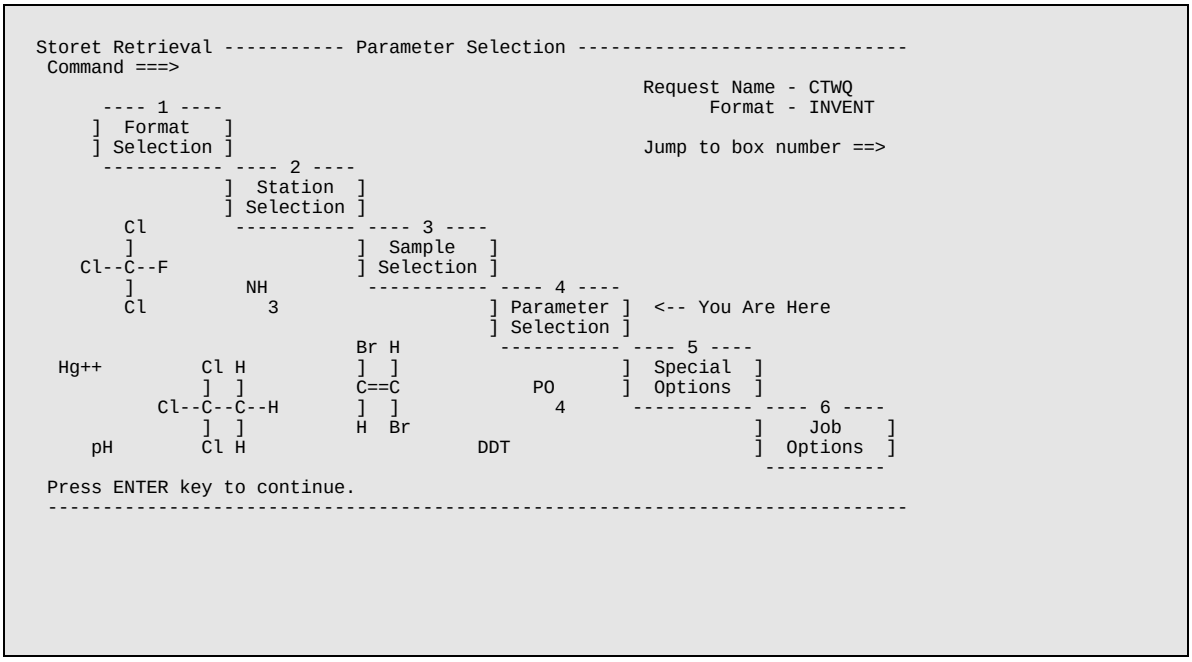
STEP 14. Select all composite sample types.



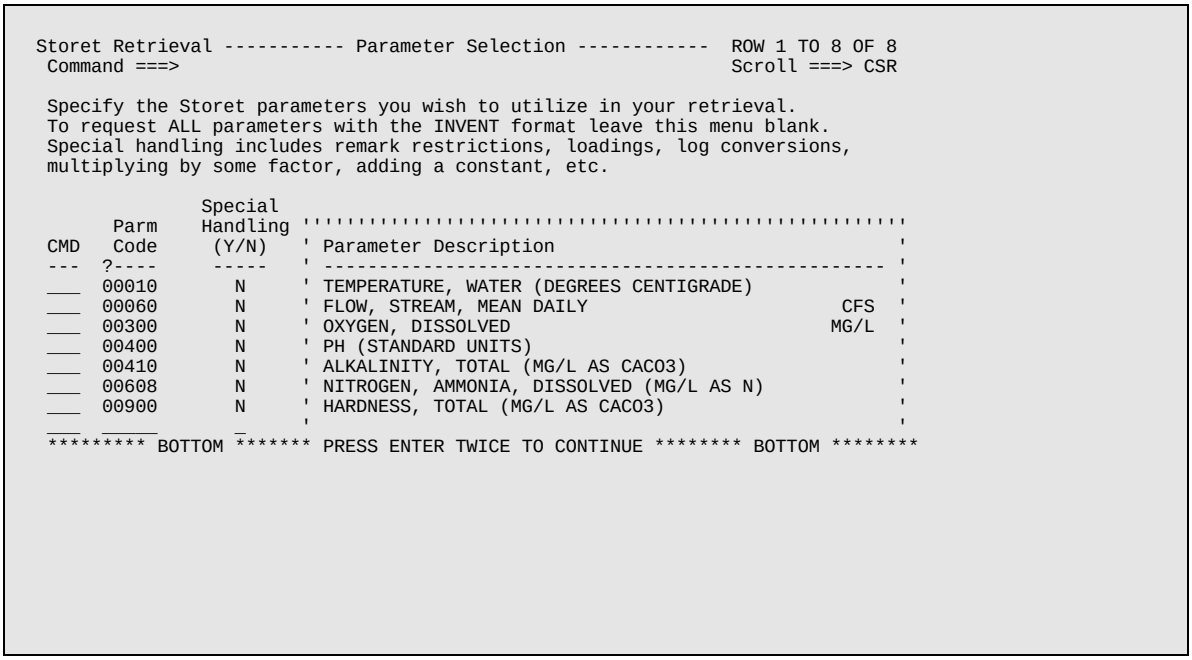
STEP 15. Do not further restrict sample selection.



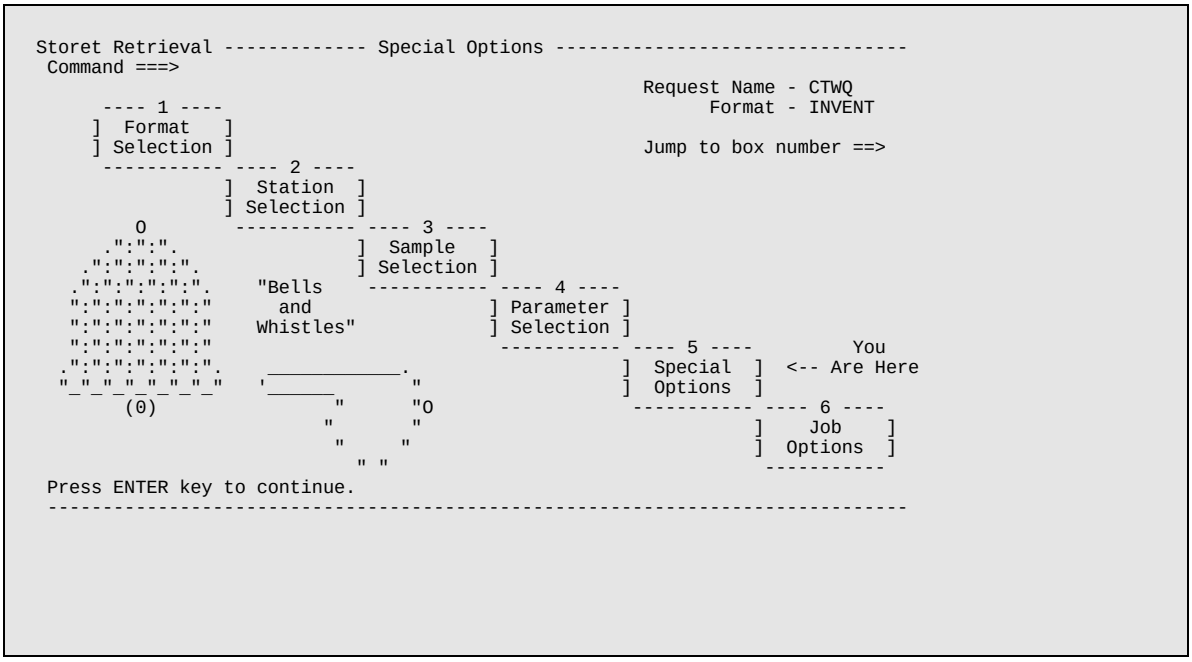
STEP 16. This screen is for information only.



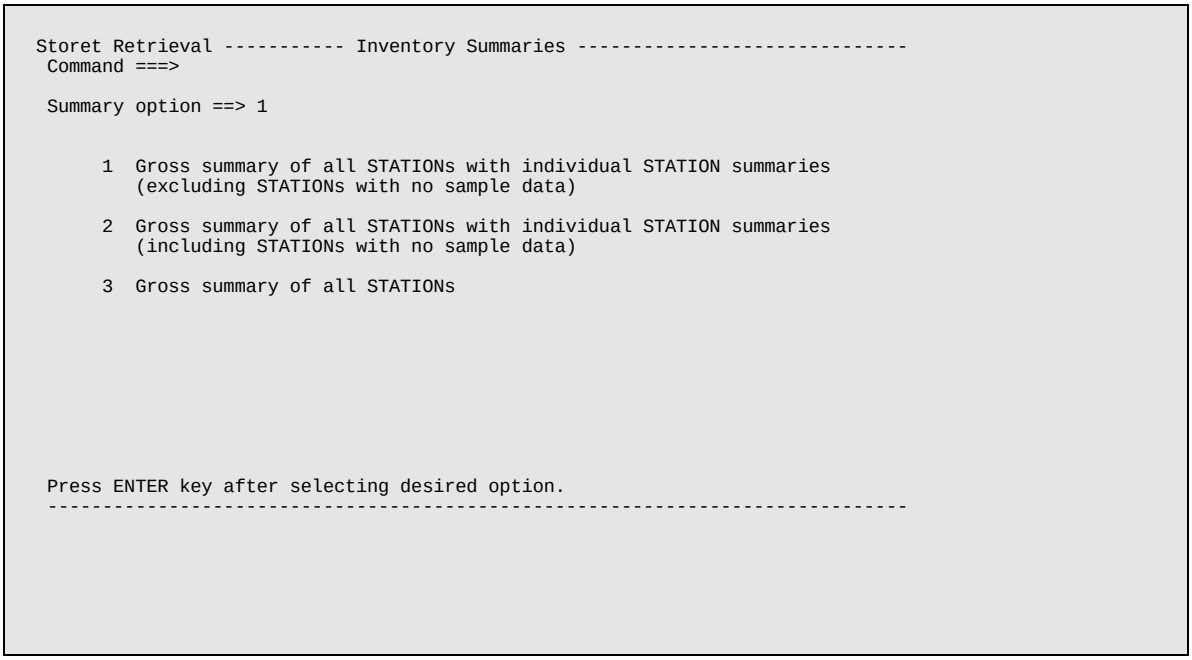
STEP 17. Enter the STORET parameter codes of interest. A "?" in the parameter code field will provide help in identifying parameter codes of interest.



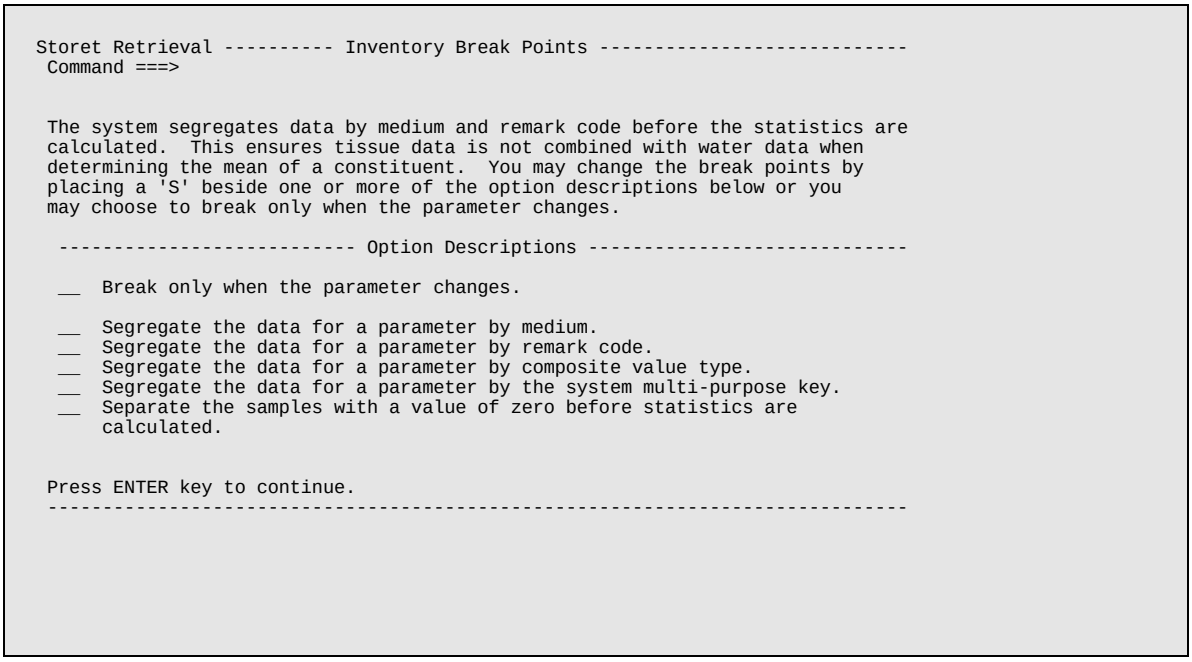
STEP 18. This screen is for information only.



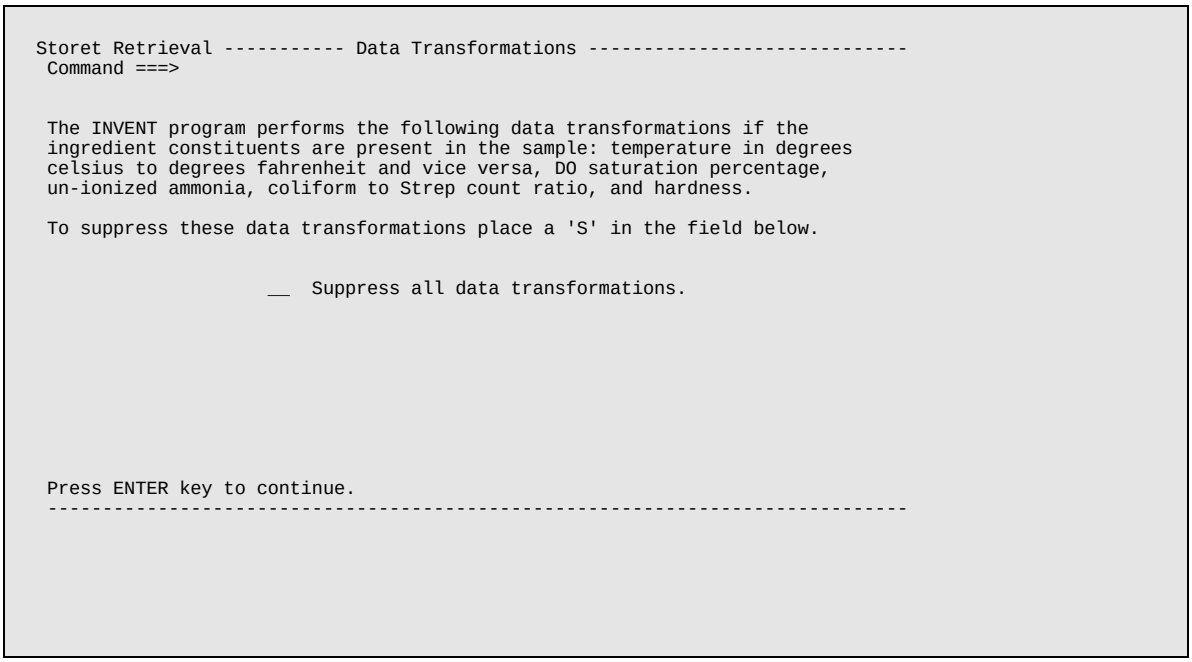
STEP 19. Select gross summary for all stations with individual station summaries. The purpose of this retrieval is to identify the individual stations which have data.



STEP 20. No specific break points are needed.



STEP 21. No selection is needed for this screen.



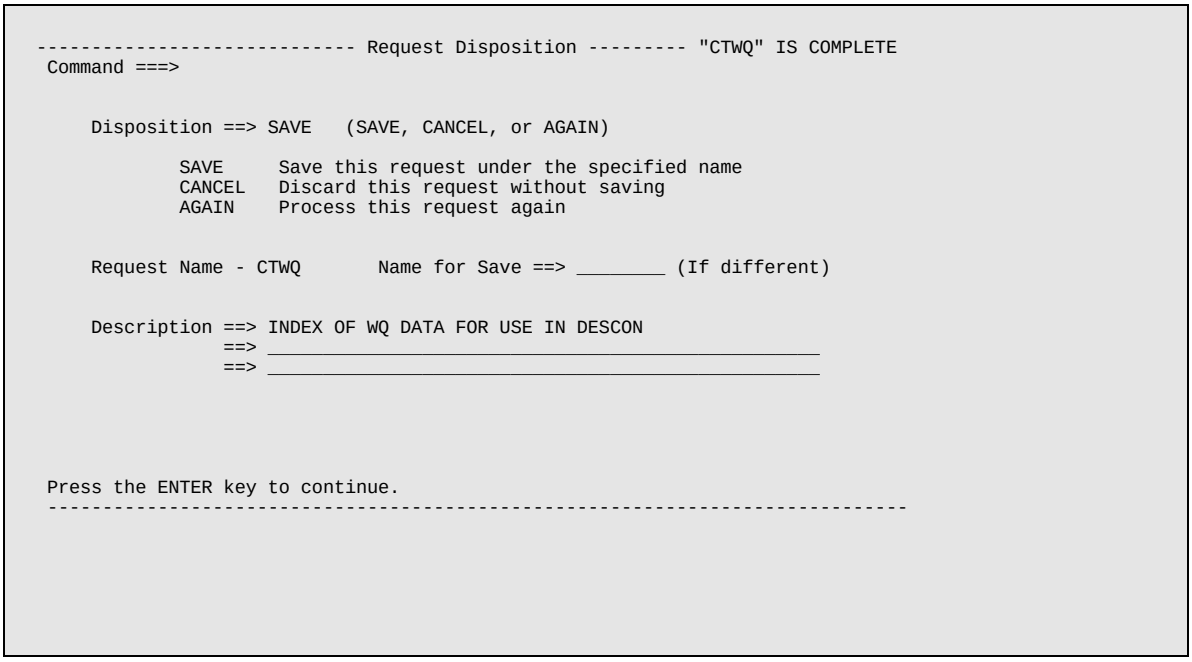
STEP 22. No input is needed for this screen.

```
Storet Retrieval -------------- Print Options ---------------------------------
 Command ===>


 Do you want the station header to print on the left side of the page
 or on the right side of the page? ==> R  (L or R)

 Enter up to 5 lines of text to be printed at the top of each page
 across from the station header.

 ==>
 ==>
 ==>
 ==>
 ==>







 Press ENTER key to continue.
 ------------------------------------------------------------------------------
```

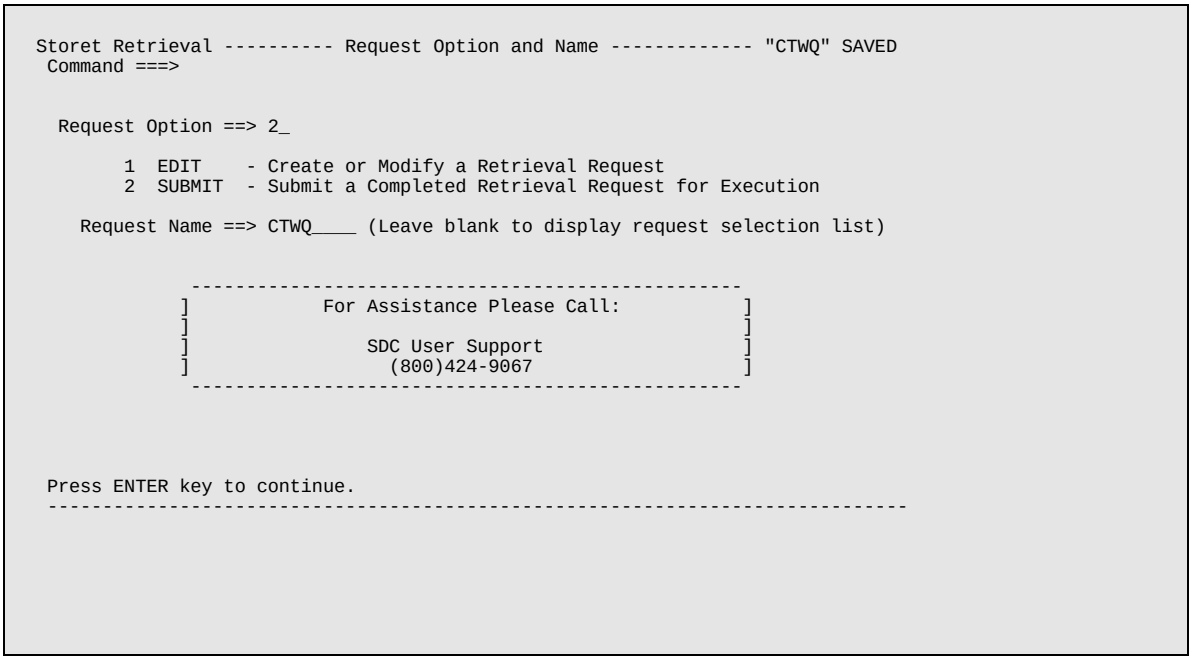
STEP 23. Identify your job submission parameters. Correct any erroneous or missing information.

```
Storet Retrieval --------------- Job Options ---------------------------------
 Command ===>

      The job submission parameters displayed below will be used when
      request CTWQ is submitted for execution.  If saved in your
      permanent profile, these parameter values will become the default
      (assumed) values for future requests.


      Modify any of the following job submission parameters you wish:

          PRIORITY ==> 2     (1 or 2)
          TIME     ==> 1     (Minutes)
                   ==> 00    (Seconds)
          BIN/ROOM ==> C811
          NOTIFY   ==> YES   (YES or NO)
          ROUTE    ==> HOLD
          JCL ECHO ==> MIN   (MAX, MIN, or NONE)

      Save these parameters in your permanent profile? ==> NO  (YES or  NO)


 Press ENTER key to continue.
 ------------------------------------------------------------------------------
```

STEP 24. Save the retrieval request and enter a description if desired.



STEP 25. Once the request has been saved, it must be submitted to retrieve the requested information.



STEP 26. Review the job submission parameters and correct any erroneous or missing information.

```
Storet Retrieval -------- Job Submission Parameters --------------------------
 Command ===>

         Status- COMPLETE     Format- INVENT      Path- GENERAL RETRIEVAL
     Description- INDEX OF WQ DATA FOR USE IN DESCON
                -
                -
      The job submission parameters displayed below will be used when
      request CTWQ is submitted for execution.  If saved in your
      permanent profile, these parameter values will become the default
      (assumed) values for future requests.

          PRIORITY ==> 2     (1 or 2)
          TIME     ==> 1     (Minutes)
                   ==> 00    (Seconds)
          BIN/ROOM ==> C811
          NOTIFY   ==> YES   (YES or NO)
          ROUTE    ==> HOLD
          JCL ECHO ==> MIN   (MAX, MIN, or NONE)

      Save job parameters in your permanent profile? ==> NO  (YES or NO)

 Press ENTER to submit this request or END to specify a different request.
 ------------------------------------------------------------------------------
```

STEP 27. This screen is for information only. No action should be taken.

```
Storet Retrieval ------------- Job Submission --------------------------------

                        ----------------------------
                       ]      Please Stand By       ]
                        ----------------------------

    Request Name - CTWQ       Format - INVENT          Path - GENERAL RETRIEVAL


          Status        Step
          ------------  -------------------------------------------------
          (Complete)    Format Selection

          (Complete)    Station Selection

          (Complete)    Sample Selection

          (Complete)    Parameter Selection

          (Complete)    Special Options

          (Processing)  Completing Job Submission

 ------------------------------------------------------------------------------
```

STEP 28. ***The job number is displayed. The user can use SDSF to view and retrieve the output. The output will contain summary information about all water quality monitoring stations in the specified geographic area.***

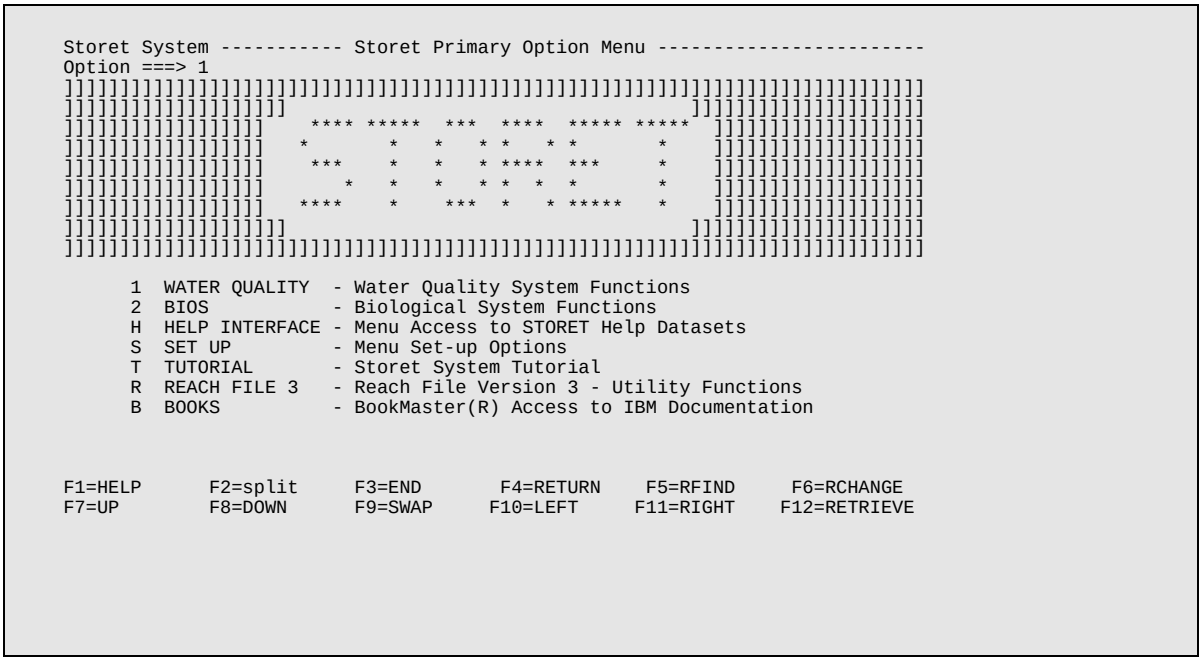
```
Storet Retrieval ------------- Job Information -------------------------------
 Command ===>

                           Your Job Name is HJI04
                          Your Job Number is 21104

      Request Name - VAWQ       Format - INVENT       Path - GENERAL RETRIEVAL

      Your request has been permanently saved in STORET.REQUESTS(CTWQ)

      SDSF should be used for the following job processing functions:

         -   Select jobs from the Output queue
         -   View jobs in the Input queue
         -   View jobs currently executing (active jobs)
         -   Route jobs to a remote destination
         -   Purge unwanted jobs

      SDSF is accessed from the ISPF primary options menu.  Enter RETURN
      on the Command line to return to the ISPF primary options menu.


 Press ENTER key to continue.
 ------------------------------------------------------------------------------
```

STEP 29. ***The "=X" command can be used to return to the READY prompt. The command "8.ST" can be used to access SDSF and review the job status.***

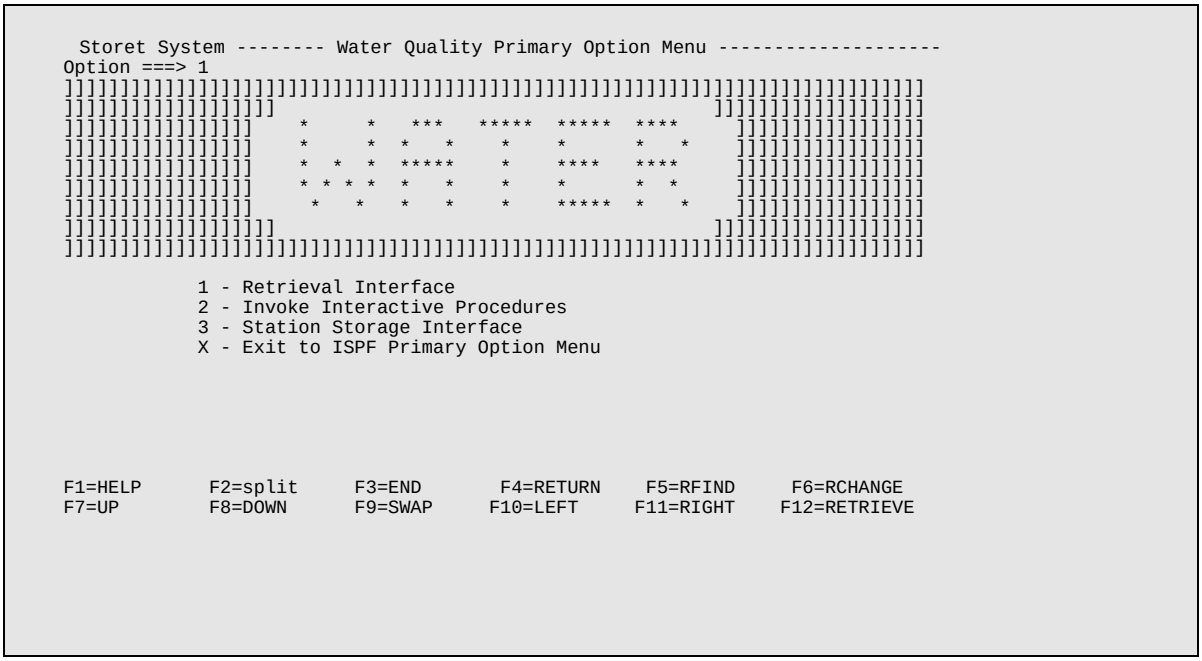
```
Storet Retrieval ---------- Request Option and Name --------------------------
 Command ===> =X


  Request Option ==> __

        1  EDIT    - Create or Modify a Retrieval Request
        2  SUBMIT  - Submit a Completed Retrieval Request for Execution

    Request Name ==> ________ (Leave blank to display request selection list)


             ------------------------------------------------
            ]            For Assistance Please Call:         ]
            ]                                                ]
            ]                SDC User Support                ]
            ]                  (800)424-9067                 ]
             ------------------------------------------------



 Press ENTER key to continue.
 ------------------------------------------------------------------------------
```

A2.3 Using the STORET interface to retrieve flow gage and water quality data for a specific station.

Step 1. Select Water Quality from the STORET Primary Option Menu.



Step 2. Select the water quality retrieval interface.



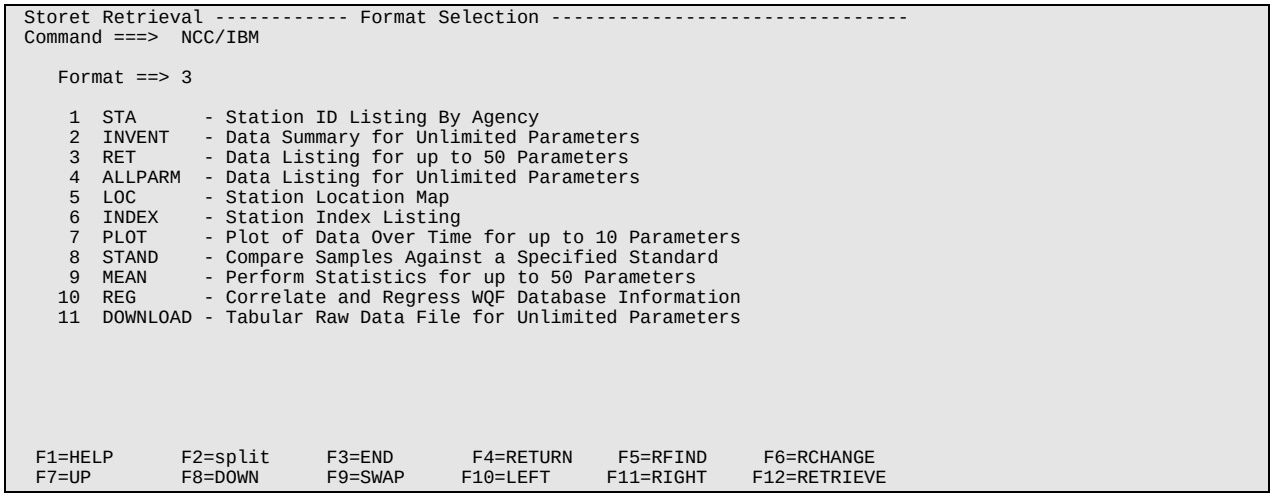
Step 3. Choose the edit option to build a new retrieval. Enter a name for the retrieval. If the name is not entered and earlier retrievals have been saved, a selection list of earlier retrievals will be displayed.

```
Storet Retrieval ---------- Request Option and Name --------------------------
Command ===>


 Request Option ==> 1_

       1  EDIT    - Create or Modify a Retrieval Request
       2  SUBMIT  - Submit a Completed Retrieval Request for Execution

   Request Name ==> QUINNIP__ (Leave blank to display request selection list)


             ------------------------------------------------
            ]            For Assistance Please Call:          ]
            ]                                                 ]
            ]               STORET User Support               ]
            ]                  (800)424-9067                  ]
             ------------------------------------------------




 F1=HELP      F2=split     F3=END       F4=RETURN    F5=RFIND     F6=RCHANGE
 F7=UP        F8=DOWN      F9=SWAP     F10=LEFT     F11=RIGHT    F12=RETRIEVE
```

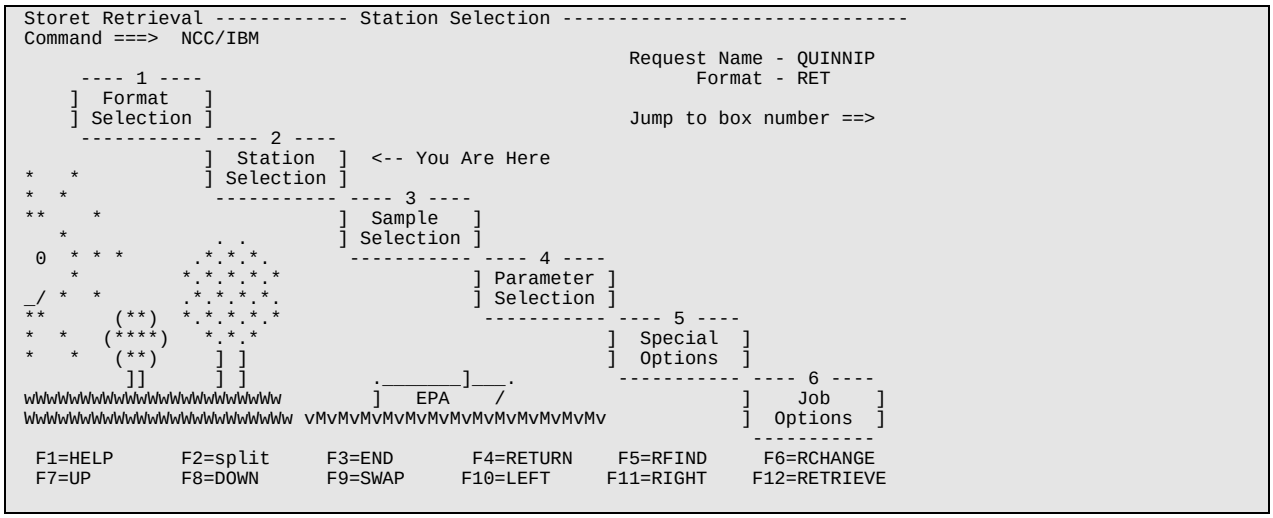
Step 4. Select a general water quality retrieval by selecting option 1.

```
 Storet Retrieval --------------- Request Path ---------------- "QUINNIP" IS NEW
Command ===>  NCC/IBM


   Request Path Option ==> 1


    1 GENERAL       - General water quality retrieval.

    2 GROUND WATER  - Retrieval of ground water data that was stored in
                      accordance with the data standards and procedures
                      established in the EPA Office of Ground Water
                      Protection's Data Management Manual.







   Note: Once a request's path has been specified it may NOT be changed.


 F1=HELP      F2=split     F3=END       F4=RETURN    F5=RFIND     F6=RCHANGE
 F7=UP        F8=DOWN      F9=SWAP     F10=LEFT     F11=RIGHT    F12=RETRIEVE
```

Step 5. Select option 3, RET.



Step 6. This screen is for information only. When editing a saved retrieval, it can be used to jump to a specific part of the retrieval.



Step 7. This selection limits the scope of the stations to be retrieved. Since the user has identified a specific station in a previous retrieval, station selection by agency code and station ID is used.

```
 Storet Retrieval ------------ Station Selection ------------------------------
 Command ===>  NCC/IBM

 Station Selection Option ==> 1

   1   By Agency Codes and Station IDs.
   2   Within States and Counties.
   3   Within Aquifers.
   4   By Latitude/Longitude Methods
   5   Within USGS Hydrologic Units.
   6   Within EPA Drainage Basins.
   7   By Station Type/Parameter Attributes.
   8   By EPA Reaches.
   9   Within EPA Ecoregions.









  F1=HELP      F2=split     F3=END       F4=RETURN    F5=RFIND     F6=RCHANGE
  F7=UP        F8=DOWN      F9=SWAP     F10=LEFT     F11=RIGHT    F12=RETRIEVE
```

Step 8. Enter the agency code, “s” for selection mode, and the starting station ID. Press ENTER, then press ENTER again to continue.

```
 Storet Retrieval ------------ Station Selection -------------  ROW 1 TO 6 OF 7
 Command ===>                                                 Scroll ===> CSR

 You may select all stations, ranges of primary and/or secondary stations, or
 individual stations for each specified agency code.

                 Selection Mode                                      Range
                    A=all                                         P=primary
        Agency      R=range       (starting)        (ending)      S=secondary
 CMD     Code       S=single     Station ID        Station ID     B=both
 ---    ------    --------------   ----------        ---------*     -----------
 ___    112WRD__         S        01196500_______   _______________       _

 ___    _________        _        _______________   _______________       _

 ___    _________        _        _______________   _______________       _

 ___    _________        _        _______________   _______________       _

 ___    _________        _        _______________   _______________       _

 ___    _________        _        _______________   _______________       _
  F1=HELP      F2=split     F3=END       F4=RETURN    F5=RFIND     F6=RCHANGE
  F7=UP        F8=DOWN      F9=SWAP     F10=LEFT     F11=RIGHT    F12=RETRIEVE
```

Step 9. Press ENTER to move to the next screen.

```
 Storet Retrieval ------------ Station Restriction -----------------------------
Command ===>

 You have selected stations by Agency-Station.  You may further limit the
 stations already selected by specifying one or more of the options below.
 Select an option by typing an 's' next to the Option Description.

---------------------------- Option Descriptions ------------------------------


 __  Restrict to Specific States or Counties
 __  Restrict to Specific Station Type/Parameter Attributes
 __  Restrict to Specific Archive Data Classes
 __  Restrict to Specific USGS Hydrologic Units
 __  Include Retired Data.      Use Retired Data Only? ==> N   (Y/N)









 F1=HELP      F2=split     F3=END       F4=RETURN    F5=RFIND     F6=RCHANGE
 F7=UP        F8=DOWN      F9=SWAP     F10=LEFT     F11=RIGHT    F12=RETRIEVE
```

Step 10. This screen is for information only. Press ENTER to proceed.

```
 Storet Retrieval ------------- Sample Selection --------------------------------
Command ===>
                                                    Request Name - QUINNIP
     ---- 1 ----                                          Format - RET
    ]  Format   ]
    ] Selection ]                                   Jump to box number ==>
     ----------- ---- 2 ----
          _      ]  Station  ]
        ]_]      ] Selection ]
     ___] ]       ----------- ---- 3 ----
    ]   ] ]                  ]  Sample   ]  <-- You Are Here
   "] O ] ]                  ] Selection ]
  " " ___] ]                  ----------- ---- 4 ----
 " "    ' '                              ] Parameter ]
 " "     =                               ] Selection ]
  " "                 ________             ----------- ---- 5 ----
   "." ==*===     (         )                         ]  Special  ]
    ]   /          ]* .* *]                          ]  Options  ]
 .--'  '------.    ] .* *.]                           ----------- ---- 6 ----
 ]             ]   ].* *. ]                                      ]    Job    ]
 '-------------'    '------'                                      ]  Options  ]
                                                                   -----------
 F1=HELP      F2=split     F3=END       F4=RETURN    F5=RFIND     F6=RCHANGE
 F7=UP        F8=DOWN      F9=SWAP     F10=LEFT     F11=RIGHT    F12=RETRIEVE
```

Step 11. Select data for grab and composite samples.

```
 Storet Retrieval ----- Grab/Composite Sample Selection ------------------------
Command ===>

Specify whether you want to retrieve Grab and/or Composite samples.

Grab/Composite Option ==> 3

     1  Grab (regular) samples only

     2  Composite samples only

     3  Grab and Composite samples









 F1=HELP      F2=split     F3=END       F4=RETURN    F5=RFIND     F6=RCHANGE
 F7=UP        F8=DOWN      F9=SWAP     F10=LEFT     F11=RIGHT    F12=RETRIEVE
```

Step 12. Select Mean Value sample type.

```
 Storet Retrieval --------- Composite Sample Values ----------------------------
Command ===>

 Select all or specific composite sample value types.

  _   All composite sample value types

-------------------- Specific Composite Sample Value Types --------------------
 S_   Mean Value
 __   Minimum Value
 __   Maximum Value
 __   Number of Samples Comprising the Composite
 __   Standard Deviation
 __   Coefficient of Error
 __   Coefficient of Variance
 __   Kurtosis
 __   Replicate Sample
 __   Sum of Squares
 __   Variance
 __   Skewness
 __   Precision
 __   Number of Samples in Composite Exceeds Established Limit
 F1=HELP      F2=split     F3=END       F4=RETURN    F5=RFIND     F6=RCHANGE
 F7=UP        F8=DOWN      F9=SWAP     F10=LEFT     F11=RIGHT    F12=RETRIEVE
```

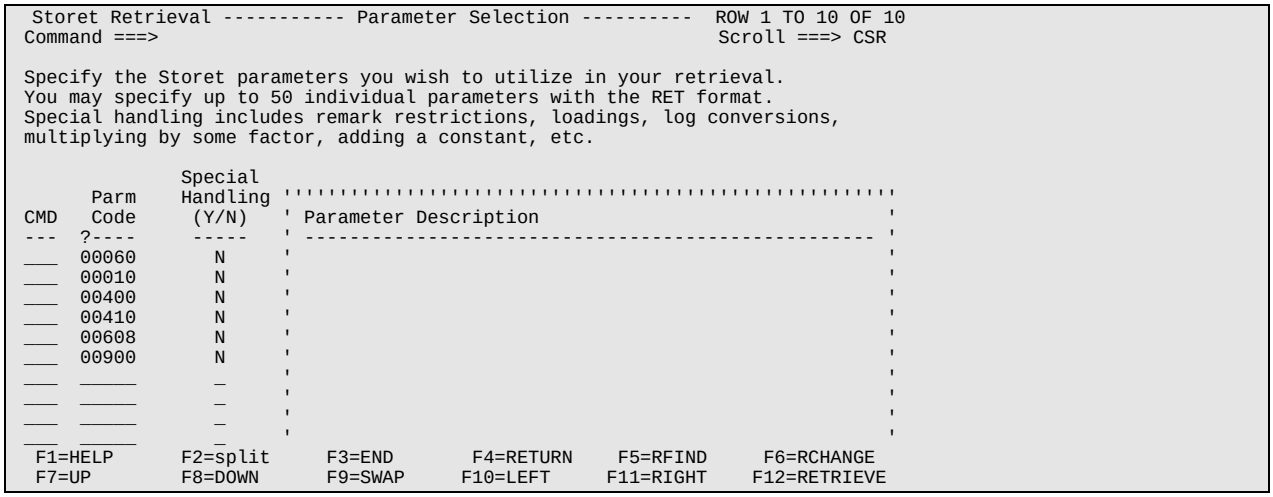
Step 13. Do not further restrict sample selection; press ENTER to continue.

```
 Storet Retrieval ------------ Sample Selection ------------------------------
Command ===>

 Samples gathered at the specified stations may be selected based upon
 one or more of the options below.  Select an option by typing an 's'
 next to the Option Description.

---------------------------- Option Descriptions ----------------------------

 __  Date Ranges
 __  Time Ranges
 __  Seasonal Ranges
 __  Depth Ranges
 __  Depth Type
 __  Aquifers
 __  Intensive Surveys
 __  Locked Status
 __  Parameter Content




 F1=HELP      F2=split     F3=END       F4=RETURN    F5=RFIND     F6=RCHANGE
 F7=UP        F8=DOWN      F9=SWAP     F10=LEFT     F11=RIGHT    F12=RETRIEVE
```

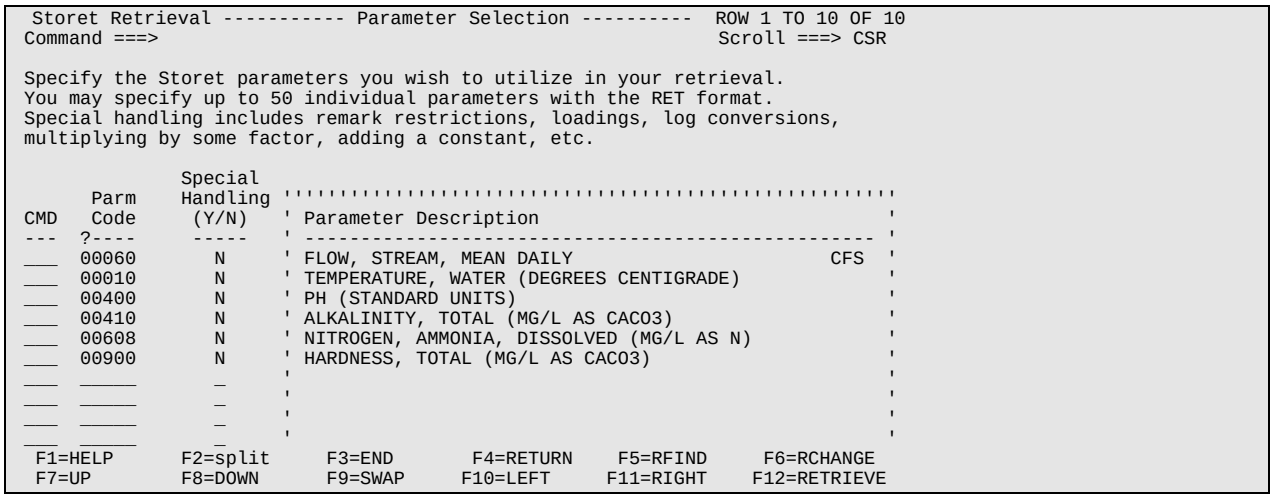
Step 14. This screen is for information only.

```
 Storet Retrieval ----------- Parameter Selection -----------------------------
Command ===>
                                                    Request Name - QUINNIP
    ---- 1 ----                                           Format - RET
   ]  Format   ]
   ] Selection ]                                    Jump to box number ==>
    ----------- ---- 2 ----
               ]  Station  ]
               ] Selection ]
      Cl        ----------- ---- 3 ----
      ]                    ]  Sample   ]
  Cl--C--F                 ] Selection ]
      ]          NH         ----------- ---- 4 ----
      Cl           3                   ] Parameter ]  <-- You Are Here
                                       ] Selection ]
                           Br H         ----------- ---- 5 ----
 Hg++         Cl H         ]  ]                    ]  Special  ]
              ]  ]         C==C            PO      ]  Options  ]
         Cl--C--C--H       ]  ]              4      ----------- ---- 6 ----
              ]  ]         H  Br                               ]    Job    ]
   pH         Cl H                    DDT                     ]  Options  ]
                                                                -----------
 F1=HELP      F2=split     F3=END       F4=RETURN    F5=RFIND     F6=RCHANGE
 F7=UP        F8=DOWN      F9=SWAP     F10=LEFT     F11=RIGHT    F12=RETRIEVE
```

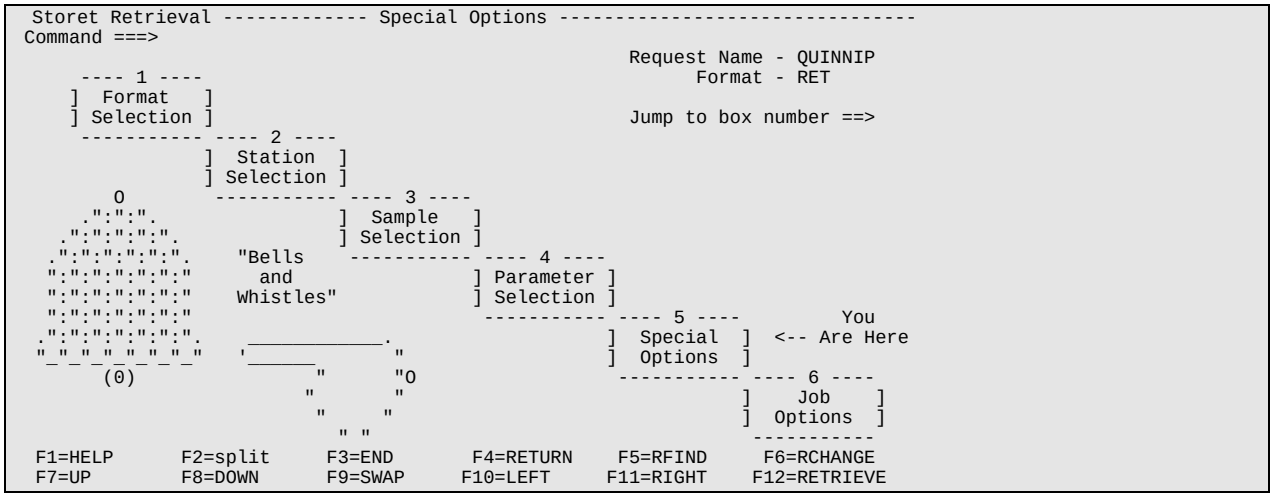
Step 15. Enter the STORET parameter codes of interest. A "?" in the parameter code field will provide help in identifying paramter codes of interest. Press ENTER.



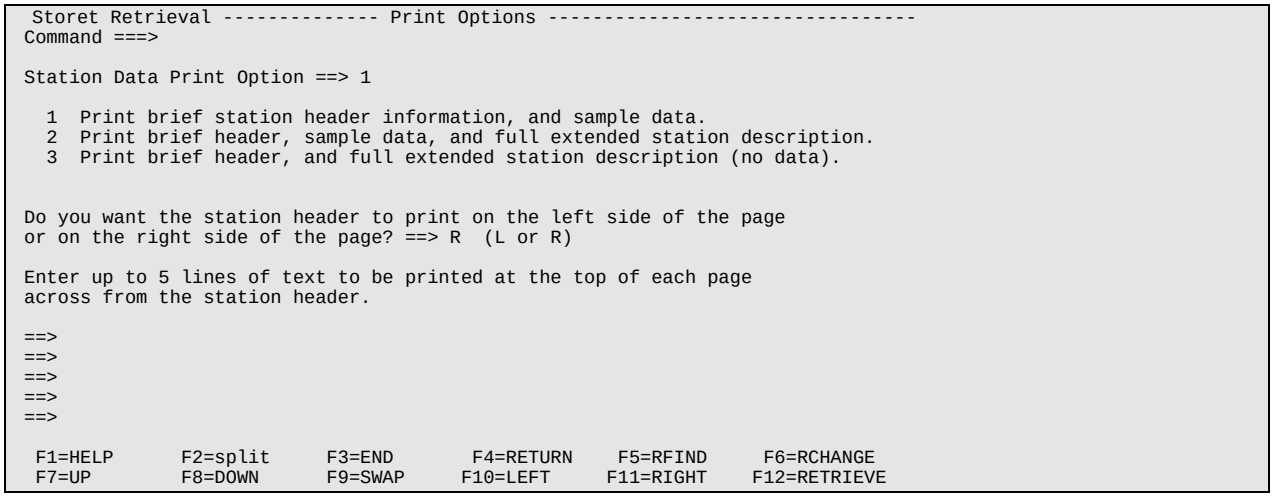
Step 16. Press ENTER again.



Step 17. This screen is for information only.



Step 18. Select option 1.



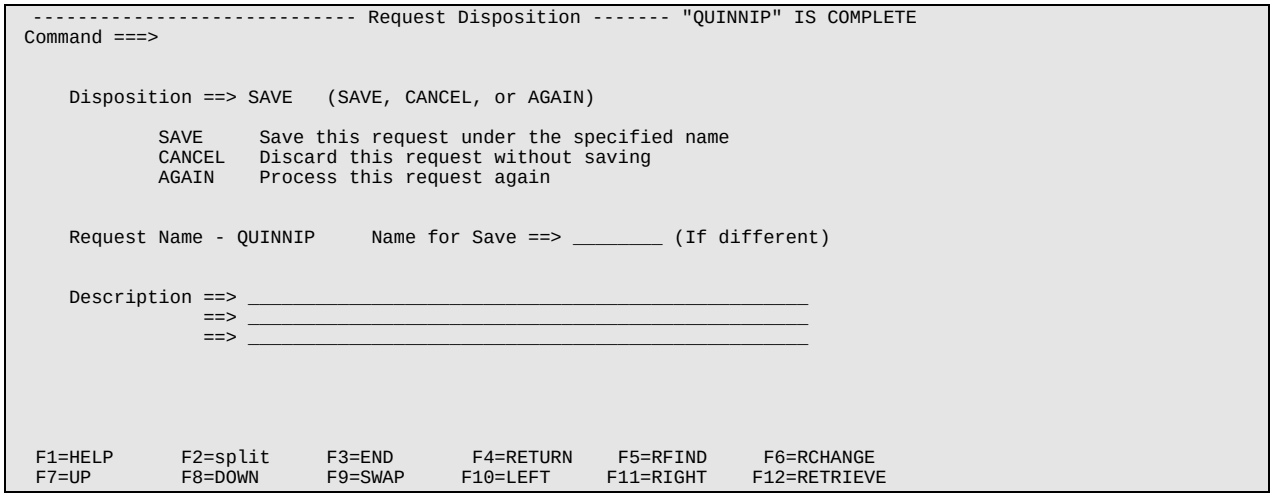
Step 19. No input is needed for this screen.

```
 Storet Retrieval -------------- Print Options ---------------------------------
Command ===>


Do you want to generate a listing of all stations encountered in the
retrieval containing locked data? ==> N  (Y or N)

An unlocking key is required to retrieve locked data.  The unlocking
key is specified in the Station Selection section of the interface
under Option 1 - By Agency Codes and Station IDs.









 F1=HELP      F2=split     F3=END       F4=RETURN    F5=RFIND     F6=RCHANGE
 F7=UP        F8=DOWN      F9=SWAP     F10=LEFT     F11=RIGHT    F12=RETRIEVE
```

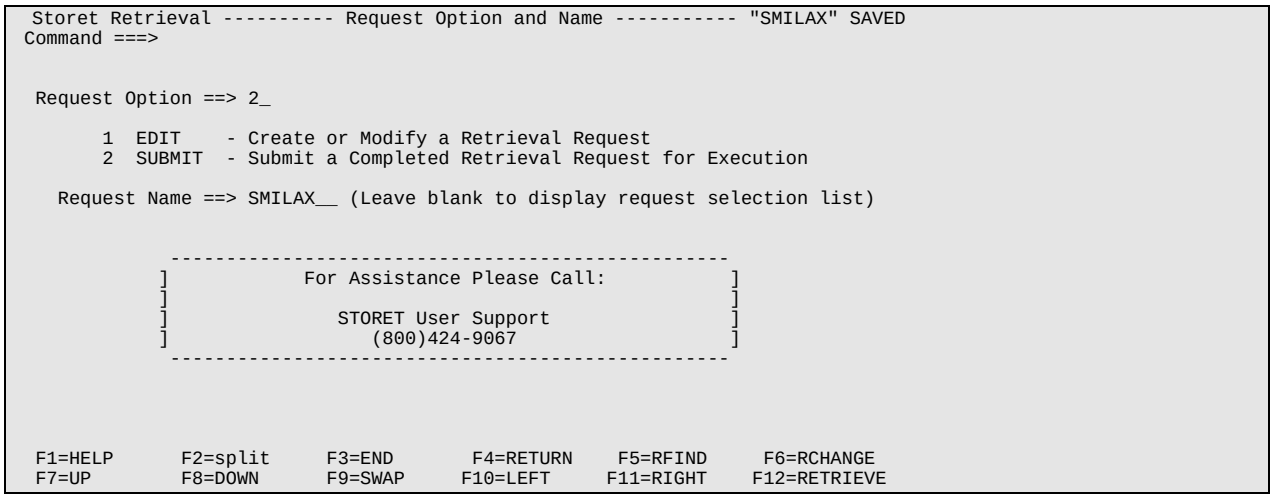
Step 20. Identify your job submission parameters. Correct any erroneous or missing information.

```
 Storet Retrieval --------------- Job Options ---------------------------------
Command ===>

     The job submission parameters displayed below will be used when
     request QUINNIP is submitted for execution.  If saved in your
     permanent profile, these parameter values will become the default
     (assumed) values for future requests.


     Modify any of the following job submission parameters you wish:

         PRIORITY ==> 2     (1 or 2)
         TIME     ==> 00    (Minutes)
                  ==> 30    (Seconds)
         BIN/ROOM ==> MHJI
         NOTIFY   ==> YES   (YES or NO)
         ROUTE    ==> HOLD
         JCL ECHO ==> MIN   (MAX, MIN, or NONE)

     Save these parameters in your permanent profile? ==> NO  (YES or  NO)


 F1=HELP      F2=split     F3=END       F4=RETURN    F5=RFIND     F6=RCHANGE
 F7=UP        F8=DOWN      F9=SWAP     F10=LEFT     F11=RIGHT    F12=RETRIEVE
```

Step 21. Save the retrieval request and enter a description if desired.



Step 22. Once the request has been saved, it must be submitted to retrieve the requested information.



Step 23. Review the job submission parameters and correct any erroneous or missing information.

```
 Storet Retrieval -------- Job Submission Parameters ---------------------------
 Command ===>

         Status- COMPLETE     Format- RET         Path- GENERAL RETRIEVAL
     Description-
                -
                -
      The job submission parameters displayed below will be used when
      request QUINNIP is submitted for execution.  If saved in your
      permanent profile, these parameter values will become the default
      (assumed) values for future requests.

          PRIORITY ==> 2     (1 or 2)
          TIME     ==> 00    (Minutes)
                   ==> 30    (Seconds)
          BIN/ROOM ==> MHJI
          NOTIFY   ==> YES   (YES or NO)
          ROUTE    ==> HOLD
          JCL ECHO ==> MIN   (MAX, MIN, or NONE)

      Save job parameters in your permanent profile? ==> NO  (YES or NO)

  F1=HELP      F2=split     F3=END       F4=RETURN    F5=RFIND     F6=RCHANGE
  F7=UP        F8=DOWN      F9=SWAP     F10=LEFT     F11=RIGHT    F12=RETRIEVE
```

Step 24. The job number is displayed. The user can use SDSF to view and retrieve the output.

```
  Storet Retrieval ------------- Job Information --------------------------------
 Command ===>

                           Your Job Name is HJI77
                         Your Job Number is 12777

      Request Name - QUINNIP     Format - RET          Path - GENERAL RETRIEVAL

      Your request has been permanently saved in STORET.REQUESTS(QUINNIP)

      SDSF should be used for the following job processing functions:

         -   Select jobs from the Output queue
         -   View jobs in the Input queue
         -   View jobs currently executing (active jobs)
         -   Route jobs to a remote destination
         -   Purge unwanted jobs

      SDSF is accessed from the ISPF primary options menu.  Enter RETURN
      on the Command line to return to the ISPF primary options menu.


  F1=HELP      F2=split     F3=END       F4=RETURN    F5=RFIND     F6=RCHANGE
  F7=UP        F8=DOWN      F9=SWAP     F10=LEFT     F11=RIGHT    F12=RETRIEVE
```

Step 25. Select SDSF from the STORET ISPF/PDF Primary Option Menu.

```
 -------------------- STORET ISPF/PDF PRIMARY OPTION MENU ----------------------
 OPTION ===> 8
                                                            Userid  - HJI
   0  ISPF PARMS   - Specify terminal and user parameters     Prefix  - HJIPHDC
   1  BROWSE       - Display source data or output listings   Model   - 3278
   2  EDIT         - Create or change source data             PF Keys - 12
   3  UTILITIES    - Perform utility functions                Time    - 10:18
   4  FOREGROUND   - Invoke language processors in TSO        Date    - 95/04/27
   5  BATCH        - Submit job for language processing       Julian  - 95.117
   6  COMMAND      - Enter TSO command or CLIST               Logon   - AASTORET
   7  DIALOG TEST  - Perform dialog testing                   Applid  - ISR
   8  SDSF         - LOCATE - FETCH - ROUTE - PURGE jobs in batch queues
   9  IBM PRODUCTS - Additional IBM program development products
  10  SCLM         - Software Configuration and Library Manager
   C  CHANGES      - Display summary of changes for this release
   T  TUTORIAL     - Display information about ISPF/PDF
   X  EXIT         - Terminate ISPF using log and list defaults
   F  FILE-AID     - Invoke FILE-AID dataset edit/browse utility
   E  EPA          - EPA/NCC Application Option Menu
   G  GROUP        - Group Application Option Menu
   U  USER         - User Defined Application Option Menu
   S  STORET       - Other Application - STORET
  F1=HELP      F2=split     F3=END       F4=RETURN    F5=RFIND     F6=RCHANGE
  F7=UP        F8=DOWN      F9=SWAP     F10=LEFT     F11=RIGHT    F12=RETRIEVE
```

Step 26. Select option “O”, Display jobs in the JES2 output queue.

```
 V1R4M0 ------------------  SDSF PRIMARY OPTION MENU  --------------------------
 COMMAND INPUT ===> O                                        SCROLL ===> PAGE
 PREFIX=HJI*  DEST=(ALL)  OWNER=*
  Type an option or command and press Enter.

     LOG       - Display the system log
     DA        - Display active users of the system
     I         - Display jobs in the JES2 input queue
     O         - Display jobs in the JES2 output queue
     H         - Display jobs in the JES2 held output queue
     ST        - Display status of jobs in the JES2 queues
     PR        - Display JES2 printers on this system
     INIT      - Display JES2 initiators on this system

     TUTOR     - Short course on SDSF (ISPF only)
     END       - Exit SDSF

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     US Government Users Restricted Rights - Use, duplication or
     disclosure restricted by GSA ADP Schedule Contract with IBM Corp.
  F1=HELP      F2=SPLIT     F3=END       F4=RETURN    F5=IFIND     F6=BOOK
  F7=UP        F8=DOWN      F9=SWAP     F10=LEFT     F11=RIGHT    F12=RETRIEVE
```
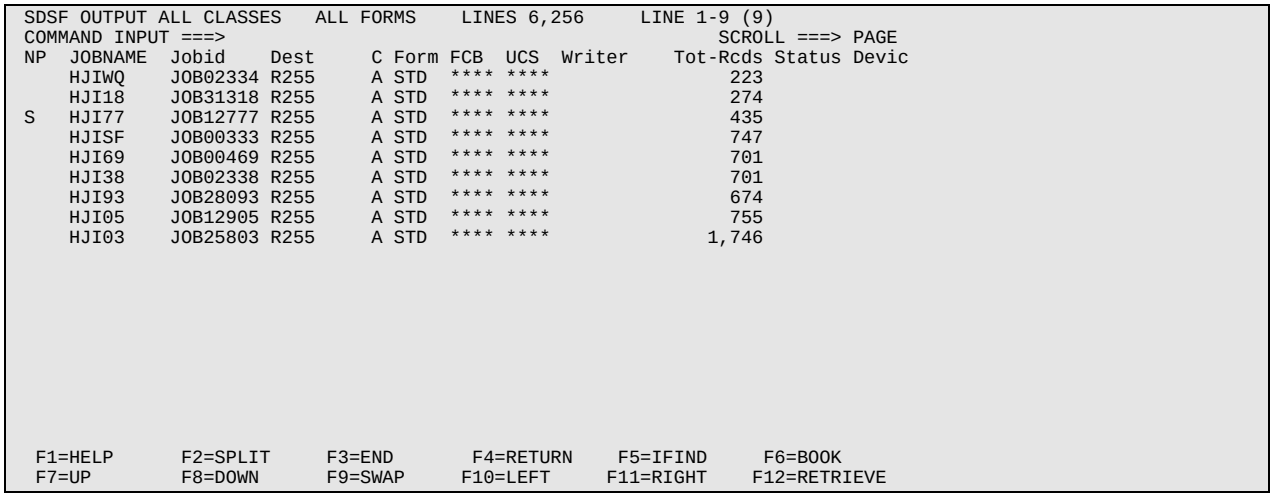
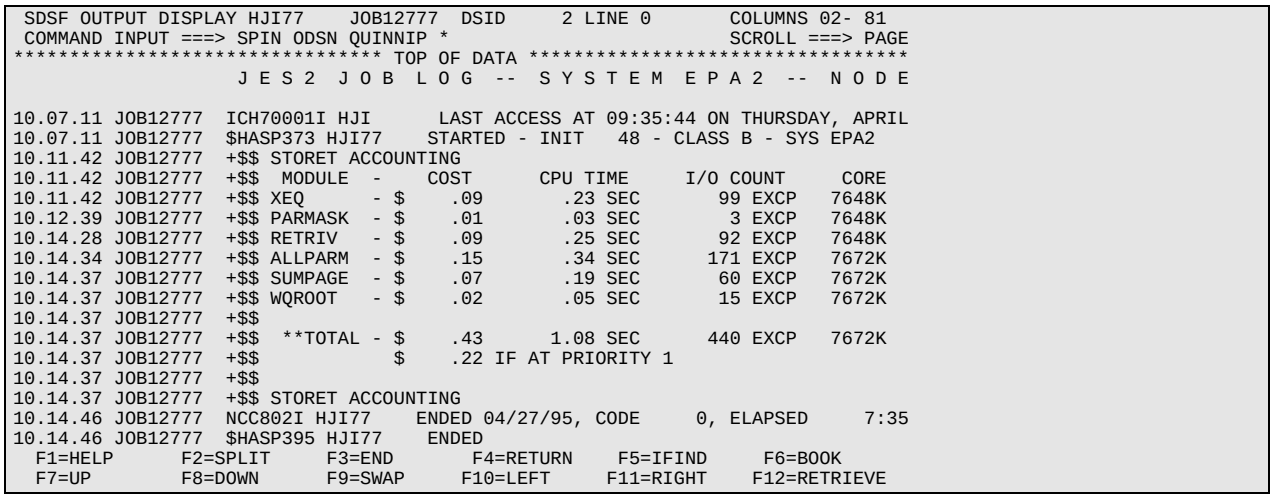

Step 27. Select the retrieval job by entering "S" in the NP column.



```
 SDSF OUTPUT ALL CLASSES   ALL FORMS    LINES 6,256     LINE 1-9 (9)
 COMMAND INPUT ===>                                     SCROLL ===> PAGE
 NP  JOBNAME  Jobid    Dest     C Form FCB  UCS  Writer    Tot-Rcds Status Devic
     HJIWQ    JOB02334 R255     A STD  **** ****               223
     HJI18    JOB31318 R255     A STD  **** ****               274
 S   HJI77    JOB12777 R255     A STD  **** ****               435
     HJISF    JOB00333 R255     A STD  **** ****               747
     HJI69    JOB00469 R255     A STD  **** ****               701
     HJI38    JOB02338 R255     A STD  **** ****               701
     HJI93    JOB28093 R255     A STD  **** ****               674
     HJI05    JOB12905 R255     A STD  **** ****               755
     HJI03    JOB25803 R255     A STD  **** ****             1,746
  F1=HELP      F2=SPLIT     F3=END       F4=RETURN    F5=IFIND     F6=BOOK
  F7=UP        F8=DOWN      F9=SWAP      F10=LEFT     F11=RIGHT    F12=RETRIEVE
```

Step 28. Enter "SPIN ODSN filename *" to print the file to your directory.



```
 SDSF OUTPUT DISPLAY HJI77    JOB12777  DSID     2 LINE 0       COLUMNS 02- 81
 COMMAND INPUT ===> SPIN ODSN QUINNIP *                        SCROLL ===> PAGE
******************************** TOP OF DATA ***********************************
                   J E S 2  J O B  L O G  --  S Y S T E M  E P A 2  --  N O D E

10.07.11 JOB12777  ICH70001I HJI      LAST ACCESS AT 09:35:44 ON THURSDAY, APRIL
10.07.11 JOB12777  $HASP373 HJI77    STARTED - INIT   48 - CLASS B - SYS EPA2
10.11.42 JOB12777  +$$ STORET ACCOUNTING
10.11.42 JOB12777  +$$  MODULE  -    COST      CPU TIME     I/O COUNT     CORE
10.11.42 JOB12777  +$$ XEQ      - $    .09       .23 SEC       99 EXCP   7648K
10.12.39 JOB12777  +$$ PARMASK  - $    .01       .03 SEC        3 EXCP   7648K
10.14.28 JOB12777  +$$ RETRIV   - $    .09       .25 SEC       92 EXCP   7648K
10.14.34 JOB12777  +$$ ALLPARM  - $    .15       .34 SEC      171 EXCP   7672K
10.14.37 JOB12777  +$$ SUMPAGE  - $    .07       .19 SEC       60 EXCP   7672K
10.14.37 JOB12777  +$$ WQROOT   - $    .02       .05 SEC       15 EXCP   7672K
10.14.37 JOB12777  +$$
10.14.37 JOB12777  +$$  **TOTAL - $    .43      1.08 SEC      440 EXCP   7672K
10.14.37 JOB12777  +$$            $    .22 IF AT PRIORITY 1
10.14.37 JOB12777  +$$
10.14.37 JOB12777  +$$ STORET ACCOUNTING
10.14.46 JOB12777  NCC802I HJI77    ENDED 04/27/95, CODE     0, ELAPSED     7:35
10.14.46 JOB12777  $HASP395 HJI77    ENDED
  F1=HELP      F2=SPLIT     F3=END       F4=RETURN    F5=IFIND     F6=BOOK
  F7=UP        F8=DOWN      F9=SWAP      F10=LEFT     F11=RIGHT    F12=RETRIEVE
```

Step 29. Use your normal download procedure to copy the file from your mainframe directory to your local computer. (Not shown, site-specific)

APPENDIX 3: DATA SYNTHESIS TECHNIQUES USED BY CONTINUOUS SIMULATION

The Continuous Simulation technique in DYNTOX provides three methods for synthesizing missing data:

- ❏ Linear Interpolation
- ❏ Simple Markov
- ❏ Multi-period Markov

Linear interpolation is the simplest method. It synthesizes missing data by linearly interpolating between the available observed data values that bound the missing value. This method should be used in cases where data are available over the majority of the period of record and only minor "gaps" need to be filled in. When synthesizing missing upstream flow data, a robust data record is required and linear interpolation is the only method which should be used to synthesize missing values. Also, linear interpolation will produce a constant value repeated over the entire simulation when one observed data point exists. Figure 3-1 shows an observed data set (denoted by x) and the values synthesized by linear interpolation.

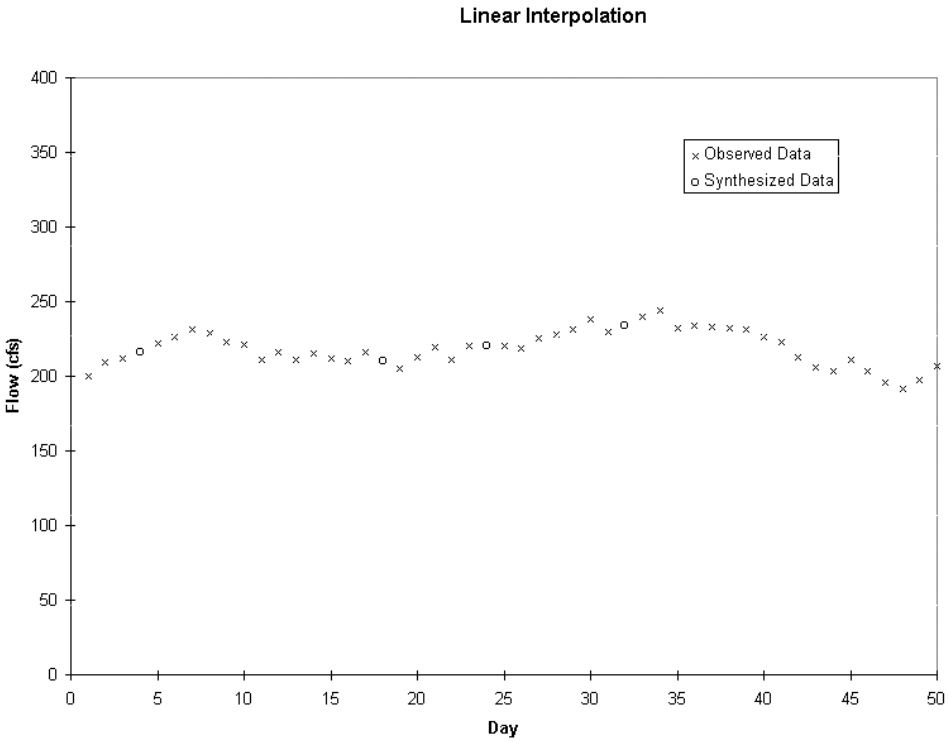


Figure 3-1. Linear Interpolation

The second method of data synthesis is a first-order, lag-one Markov process, referred to herein as simple Markov. With this technique, data for a given day are randomly determined from the overall data mean, overall data variance, the previous day's value, and an auto-correlation coefficient. The auto-correlation is a measure of how closely a given day's value is related to the previous day's value. The Markov process in DYNTOX assumes that daily fluctuations in model inputs are normally distributed. DYNTOX assumes an initial mean value and generates 50 data points in order to determine the first value used in the simulation. The only user input required by the simple Markov process is the auto-correlation coefficient. These coefficients can be determine using the SAS routine AUTOREG (SAS, 1982). Figure 3-2 shows observed data (x) and the values synthesized by simple Markov (O). Note that the observed data values are no longer used in the synthesized data set (e.g., days 406).

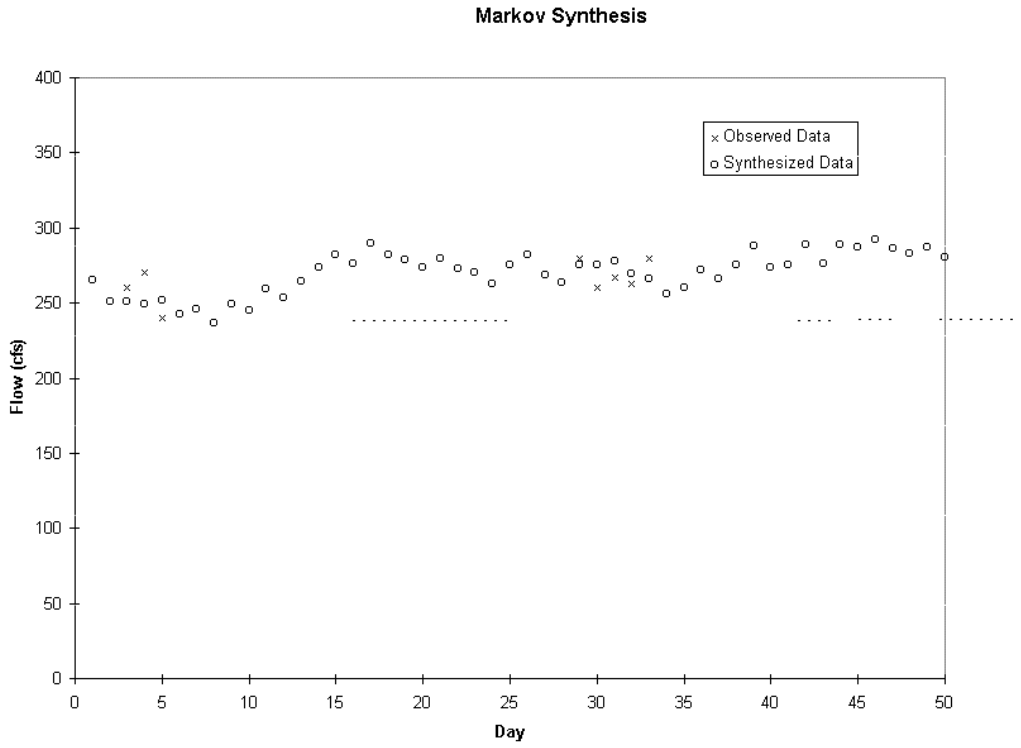


Figure 3-2. Markov Data Synthesis

Multi-period Markov synthesis is the third technique and involves a more complex level of synthesis. The simple Markov process assumes that the process for which data is synthesized is "stationary" over the period of simulation; that is, the mean and variance remain relatively constant over the entire period of the simulation. The multi-period Markov process is designed to handle cases of non-stationary processes, where the mean and/or variance are known to change over time. The primary example of a non-stationary process is effluent flow from batch treatment. In this situation flow may be zero for several days during treatment, then non-zero for the next few days during discharge. The multi-period Markov process allows the user to divide a

non-stationary process into as many repeating stationary periods as necessary. Each period requires data describing its mean value, standard deviation, and auto-correlation. These values must be calculated before performing a wasteload allocation. Using the batch treatment flow as an example, the user would specify two periods to describe the process. The first period would have a mean and standard deviation of zero and a length equal to the duration of the treatment period. The second period would have an appropriate mean and standard deviation and a length equal the duration of the discharge. DYNTOX then uses a Markov process to repeat the two periods until a data value for each day is generated.

APPENDIX 4: INPUT REQUIREMENTS FOR DYNTOX SIMULATION METHODS

Continuous Simulation Input Requirements

	Data Source
Model Parameters/Basin Constants:	
- Beginning and end date of simulation	USGS flow records
- Number of discharges above flow gage	User defined
- Averaging period (i.e., criteria duration)	User defined
- Water quality standard	User defined
Upstream River Inputs:	
- Time series flow data	STORET
- Data synthesis technique for flow	User defined
- Time series concentration data	STORET
- Data synthesis technique for concentration	User defined
- Time series data for environmental parameters affecting criteria (e.g., hardness)	User defined
- Data synthesis technique for environmental parameters	User defined
Discharge Inputs:	
- Time series flow data	Treatment records
- Data synthesis technique for flow	User defined
- Time series concentration data	Treatment records
- Data synthesis technique for concentration	User defined
- Partial mix factor	User defined
- Time series data for environmental parameters affecting criteria (e.g., hardness)	User defined
- Data synthesis technique for environmental parameters	User defined
Reach Inputs:	
- Time of travel information	Dye studies, current meters
- First order decay rate (s)	Instream data
- Drainage area ratio (s)	USGS topographic maps

Input Requirements for the Monte Carlo Technique

	Data Source
Model Parameters/Basin Constants:	
- Averaging period (i.e., criteria duration)	User defined
- Number of discharges above flow gage	User defined
- Number of Iterations	User defined
- Water quality criterion	User defined
Upstream River Inputs:	
- Statistical distribution for flow	User defined
- Statistical distribution for concentration	User defined
- Statistical distribution for criteria-related environmental conditions (e.g., hardness)	User defined
Discharge Inputs:	
- Statistical distribution for flow	User defined
- Statistical distribution for concentration	User defined
- Statistical distribution for criteria-related environmental conditions.	User defined
- Partial mix factor	User defined
Reach Inputs:	
- Time of travel information	Dye studies, current meters
- First order decay rate (s)	Instream data
- Drainage area ratio (s)	USGS topographic maps

Input Requirements for the Log Normal Technique

	Data Source
Model Parameters/Basin Constants:	
- Model averaging period	User defined
- Minimum river concentration of interest	User defined
- Maximum river concentration of interest	User defined
Upstream River Inputs:	
- Mean and standard deviation for flow	STORET
- Cross-correlation between river flow and river concentration	SAS
- Mean and standard deviation for concentration	STORET
- Cross-correlation between river flow and effluent flow	Statistical
Discharge Inputs:	
- Mean and standard deviation for flow	STORET
- Mean and standard deviation for concentration	STORET
- Cross-correlation between effluent flow and effluent concentration	SAS
- Partial mix factor	User defined
Reach Inputs:	
- Drainage area ratio	USGS topographic maps

APPENDIX 5: DYNTOX EXECUTABLE MODEL DISKETTE
EPA [823-C-95-002] (Attached to Back Cover)

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